unionGas
A Spectra Energy Company

September 23, 2011

Ms. Kirsten Walli
Board Secretary
Ontario Energy Board
2300 Yonge Street, 27th Floor
Toronto, ON M4P 1E4

Dear Ms. Walli:

RE: EB-2011-0327 – Union Gas Limited – 2012-2014 Demand Side Management Plan

On June 30, 2011, the Ontario Energy Board (the "Board") issued the Final Demand Side Management ("DSM") Guidelines for Natural Gas Utilities (the "Guidelines"). The Guidelines provide a framework for the 2012-2014 DSM Plans of Union Gas Limited ("Union") and Enbridge Gas Distribution.

Within the Guidelines, the Board directed the Utilities to file their respective DSM Plans by September 15, 2011. On September 14, 2011 Union submitted a letter to the Board indicating that it would not be in a position to file its 2012-2014 DSM Plan by September 15, 2011. In that letter, Union indicated that it would file its 2012-2014 on or before September 23, 2011.

Attached is Union's proposed 2012-2014 DSM Plan. Union's proposed 2012-2014 DSM Plan strikes the appropriate balance between the guiding objectives of the Board, stakeholder views and market conditions within Union's franchise area.

Union requires adequate lead time to implement its proposed 2012 DSM programs. To ensure program continuity, Union has requested certain interim approvals in the event that Union's 2012-2014 DSM Plan is not approved by November 15, 2011.

If you have any questions, please contact me at 519-436-4521.

Yours truly,

[Original signed by]

Marian Redford
Manager, Regulatory Initiatives

cc: Crawford Smith (Torys)
EB-2008-0346 Intervenors

ONTARIO ENERGY BOARD

IN THE MATTER OF the *Ontario Energy Board Act, 1998*, S.O. 1998, c.15 (Schedule. B);

AND IN THE MATTER OF an Application by Union Gas Limited pursuant to Section 36(1) of the *Ontario Energy Board Act, 1998*, for an Order or Orders approving the 2012 to 2014 Demand Side Management Plan.

APPLICATION

1. Union Gas Limited ("Union") is a regulated public entity incorporated under the laws of the province of Ontario, with its head office in the Municipality of Chatham-Kent.

2. Union conducts an integrated natural gas utility business that combines the operations of selling, distributing, transmitting and storage of gas and a non-utility storage business.

3. On June 30, 2011, the Ontario Energy Board (the "OEB" or the "Board") issued the Demand Side Management ("DSM") Guidelines for Natural Gas Utilities. The Board noted the natural gas utilities were expected to develop their DSM plans in accordance with the DSM Guidelines, and to submit those plans to the Board for approval.

4. Accordingly, Union hereby applies to the Board pursuant to Section 36 of the Ontario Energy Board Act for an Order or Orders effective January 1, 2012 approving Union's DSM Plan for the years 2012, 2013 and 2014.

5. Union further applies to the Board for the following:

   (a) Approval of DSM budgets and associated calculation methodology for the years 2012, 2013 and 2014;

   (b) Approval of the Program scorecard targets and associated target adjustment methodology for the years 2012, 2013 and 2014;

   (c) Approval of the DSM Incentive amounts and associated calculation methodology for the years 2012, 2013 and 2014;

   (d) Approval of the Resource Acquisition Programs, exclusive of the Large Industrial Rate T1/Rate 100 Program, budget and incentive mechanism related thereto;

   (e) Approval of the Large Industrial Rate T1/Rate 100 Program, budget and incentive mechanism related thereto;

   (f) Approval of the Market Transformation Programs, budget and incentive mechanism related thereto;

   (g) Approval of the Low-income Program, budget and incentive mechanism related thereto;

   (h) Approval of the Stakeholder Terms of Reference;

   (i) Approval of the Evaluation Plans;

   (j) Approval to continue the Board approved Lost Revenue Adjustment Mechanism and DSM variance account;

6. Union also applies to the Board for an interim order if a Board decision cannot be released by November 15, 2011 for the 2012 to 2014 DSM Plan. Union requires a decision on the Plan from the Board prior to 2012 to prevent market disruption and establish the required contracting commitments to ensure program continuity in the market. Union recognizes, however, that there is limited time between now and the end of the year to complete the regulatory process and for the Board to issue a final Decision.

Specifically, Union is requesting an interim order to approve;

a) Approval of DSM budgets for the year 2012;

b) Approval of the Resource Acquisition Programs; exclusive of the Large Industrial Rate T1/Rate 100 Program;

c) Approval of the Low-income Program;

7. Union also applies to the OEB for such interim order or orders approving the above as may from time to time appear appropriate or necessary.

8. Union further applies to the Board for all necessary orders and directions concerning procedures for the determination of this application.

9. This application is supported by written evidence that will be filed with the Board and may be amended from time to time as circumstances may require.

10. The persons affected by this application are the customers resident or located in the municipalities, police villages and Indian reserves served by Union, together with those to whom Union sells gas, or on whose behalf Union transmits or stores gas. It is impractical to set out in this application the names and addresses of such persons because they are too numerous.

11. The address of service for Union is:

Union Gas Limited
P.O. Box 2001
50 Keil Drive North
Chatham, Ontario
N7M 5M1

Attention:	Marian Redford Manager, Regulatory Initiatives
Telephone:	(519) 436-4521
Fax:	(519) 436-4641

- and -

Torys LLP
Toronto Dominion Centre, Suite 3000
79 Wellington St. W.
Toronto, ON M5K 1N2
Attention: Crawford G. Smith (csmith@torys.com)

Telephone: (416) 865-8209
Fax: (416) 865-7380

DATED: September 23, 2011

UNION GAS LIMITED

By its Solicitors

Torys LLP
Toronto Dominion Centre, Suite 3000
79 Wellington St. W.
Toronto, ON M5K 1N2
Attention: Crawford G. Smith
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UNION GAS LIMITED

PROPOSED 2012 – 2014 DSM PLAN

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1 INTRODUCTION

Union Gas Limited ("Union") has prepared its Demand Side Management ("DSM") Plan (the "Plan") for the three year period 2012 – 2014 in compliance with the Guidelines for Natural Gas Utilities (the "Guidelines") dated June 30, 2011 (EB-2008-0346). The Guidelines were developed to provide guidance to the utilities when preparing their Plans.

Union is seeking approval of its Plan effective January 1, 2012. The Plan strikes the appropriate balance between the guiding objectives of the Board, stakeholder views, and market conditions within Union's franchise area. Union requires the Board's Decision on the Plan by November 15, 2012 to prevent market disruption, establish the required contracting commitments and to ensure program continuity in the market. Union recognizes that there is limited time between now and November 15, 2012 to complete the regulatory process and for the Board to issue its final Decision. Accordingly, in the event that a Board Decision cannot be released by November 15, 2011, Union has requested interim approval of the following:

a) Approval of DSM budgets for the year 2012;
b) Approval of the Resource Acquisition Programs; exclusive of the Large Industrial Rate T1/Rate 100 Program;
c) Approval of the Low-income Program;

Since 1997, Union's DSM Programs have produced substantial energy savings and bill reductions for customers. Energy conservation, and specifically natural gas DSM, continues to be an important public policy goal for the provincial government. The Green Energy and Green

Economy Act ("GEA"), and other related legislation, are aimed to increase conservation programs while creating green jobs and economic growth for Ontario. The legislation is part of Ontario's plan to become the leading green economy in North America. One of the largest underpinnings of that ambitious goal is to create the potential for savings and better managed household and business energy expenditures through a series of conservation programs and utility driven initiatives. Ontario's Environmental Commissioner supports this direction, and in relation to the natural gas utilities' DSM programs, stating that "conservation provides system benefits that help all gas consumers and environmental benefits for all Ontarians from reduced emissions. Limiting conservation funding means these benefits are lost."[1]

Since 1997 Union has delivered over 4.3 billion m^3 of natural gas savings. These natural gas savings correspond to a reduction of approximately 8.2 million tonnes of carbon dioxide equivalent emissions. It is clear that Union's DSM results play an important role in achieving the provinces' environmental objectives. Union has a proven track record of delivering DSM Program results and has served as a consistent source of energy information and assistance. Due to their unique position, natural gas utilities are able to provide stable programs for Ontario's energy consumers despite political changes, economic challenges and the natural gas pricing environment faced by customers.

The economic impact in both the province and the Union franchise area over the period following the 2008 recession has been significant. Although Canada skirted much of the

[1] Environmental Commissioner of Ontario. *Managing a Complex Energy System - Annual Energy Conservation Progress Report – 2010 (Volume One).* June 2011. p 4.

economic impact of the global financial recession and sovereign debt malaise, economic activity in Canada and Ontario is lower today when compared to the pre-2008 time period. Total housing starts have since recovered somewhat but are below past peak levels and labour force indicators are weaker: the unemployment rate is higher and the labour force participation rates are lower. The Canadian dollar has appreciated above parity with the U.S. dollar and many industrial establishments in our franchise have closed. Although monetary policy has lowered interest rates to levels not seen in 60 years, total household debt is high. Currently, in mid 2011, global economic activity in North America is slowing and fears of a double dip recession are rising. All of these issues support the need for continued efforts by Union Gas to help customers reduce their energy bills to save money and become more competitive in a global marketplace.

Union's DSM Programs have been impacted by this new and uncertain economic environment. Program take-up is negatively affected by weaker economic activity. In the short term, the expected impact of these factors is a delay in capital and operating investment in gas sector energy efficiency and, hence, lower program participation rates. Customer payback and return on investment calculations for natural gas efficiency expenditures are also negatively impacted by the current low price of natural gas. Together with rising electricity prices and the competition for customer attention from electric Conservation and Demand Management ("CDM") programming, these factors present challenges to natural gas DSM Programs over the term of the Plan. Within this context, the Guidelines have provided Union with a stable three year DSM framework to meet this challenge and the flexibility to adjust its DSM Program portfolio.

The Board's expectation, as set out in the Guidelines, was for the utilities to develop DSM Plans that would result in the: 1) maximization of cost effective natural gas savings; 2) prevention of lost opportunities; and 3) pursuit of deep energy savings. Union's Plan includes Resource Acquisition, Market Transformation and Low-income Programs (the "Programs"). In consideration of these objectives Union has rebalanced its portfolio of Programs to be consistent with the Guidelines. Union's Plan includes the following enhancements:

- Greater emphasis on deeper measures. These deep measures drive higher gas savings per participant and avoid lost market opportunities for energy efficiency.
- Increased emphasis on Market Transformation Programs to drive fundamental market changes in Ontario.
- More targeted programming to the large industrial market to quantify energy savings opportunities and help optimize operational efficiency.
- A more holistic approach to the energy needs of low-income energy consumers. The Program will include providing high efficiency furnaces and water heaters and a multi-family offering to ensure all building stock is addressed when working with social housing providers.
- Increased budget for research and evaluation activities to ensure new measures are considered over the term of the Plan and all parties have confidence in the natural gas savings delivered within the DSM portfolio.

Consultation Efforts

As part of developing the Plan, Union consulted with a broad range of stakeholders, including intervenors, industry organizations, customers, home builders, the OPA and service providers. Union regularly engages industry stakeholders in each sector to ensure its Programs are tailored to the needs of the market and to refine its delivery strategy.

Intervenor Consultation on 2012 – 2014 DSM Plan

On August 11, 2011, Union held a full day consultation on its draft Plan with intervenors and interested parties. At the consultation, the programs, scorecards, and budget allocation of the Plan were reviewed and feedback was provided. Following the consultation, Union circulated meeting notes to all stakeholders, including those not able to attend. In addition, Union offered stakeholders the opportunity to provide written comments on Union's proposed Plan. The material provided in advance of the August 11, 2011 consultation, the meeting invitation, attendance list and meeting notes are provided in Appendix B.

Union held a subsequent consultation on August 18, 2011 to communicate Plan changes made as a result of the August 11, 2011 consultation session. Material provided in advance of the August 18, 2011 meeting, the meeting invitation and attendance list is provided in Appendix C. A summary of the changes Union made from the original Plan proposal to the final Plan is provided in Appendix D.

Between August 11, 2011 and September 20, 2011, Union consulted individually with the Low-Income Energy Network ("LIEN"), Vulnerable Energy Consumers Coalition ("VECC"), Building Owners and Managers Association ("BOMA"), Federation of Rental-housing Providers of Ontario (" FRPO"), Canadian Manufacturers & Exporters ("CME"), Industrial Gas Users Association ("IGUA") and Pollution Probe. Union also met with the Green Energy Coalition ("GEC") to discuss market transformation opportunities. Any changes that resulted from these individual meetings are included in Appendix D and reflected in Union's Plan.

Union notes that although it consulted with stakeholders when developing the Plan and incorporated, where appropriate, the feedback provided through consultation, it does not have consensus on the Plan. It is Union's view that the Plan is consistent with the Guidelines while balancing the goals of the Board and the interests of Union and its stakeholders.

Enbridge Gas Distribution Consultation

Union and Enbridge have consulted extensively throughout the process of developing the Plan. While there are regional differences between the franchise areas and some variation in the programs offered, Union intends to continue to work closely with Enbridge over the term of the Plan. This will result in efficiencies in program planning, evaluation and ensure a high degree of alignment across Ontario on DSM Program offerings.

Stakeholder Engagement Terms of Reference Consultation

As contemplated by the Guidelines, a separate consultation was held jointly with Enbridge to establish a Stakeholder Engagement Terms of Reference ("ToR"). At Enbridge's July 20, 2011 DSM Consultative meeting, intervenors were invited to nominate members to a Working Group to develop the ToR in consultation with both utilities. The utilities were informed on July 24, 2011 that the Working Group intervenor members would consist of CME, LIEN, IGUA, GEC and the School Energy Coalition ("SEC")

Half day sessions were held with the Working Group on August 19, 22, 24 and 26th. In addition, a final conference call was also conducted on August 31st. Union and Enbridge engaged a third party consultant, Mr. Mike Messenger[2] of Itron, to present an overview of stakeholder engagement models in other jurisdictions at the first Working Group session. Mr. Messenger attended subsequent sessions via conference call. Consensus was not reached on the final ToR with the Working Group. Appendix E provides Union's proposed ToR.

Rate T1/Rate 100 Customer Consultation

As indicated in the Guidelines:

"the Board is of the view that large industrial customers possess the expertise to undertake energy efficiency programs on their own. As a result, ratepayer funded DSM programs for large industrial customers are no longer mandatory."[3]

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[2] Mr. Messenger's curriculum vitae and presentation are included in Appendix F.
[3] Ontario Energy Board. *Demand Side Management Guidelines for Natural Gas Utilities.* (EB-2008-0346). June 30, 2011. p. 26

To assist Union in its determination as to whether or not to continue to provide DSM Programs to large industrial rate classes, Union surveyed all Rate T1 and Rate 100 customers. Specifically, Union asked customers if they supported the continuation of DSM Programs and for their input on our program proposals. Based on the feedback from customers, Union believes that DSM Programs for Rate T1 and Rate 100 customers should be continued. The survey results and Union's further justification for the continuation of Programming for Rate T1/Rate 100 customers is provided below.

Justification for Large Industrial Rate T1/Rate 100 Program

As indicated above, Union surveyed all Rate T1 and Rate 100 customers to determine if it should continue to offer DSM Programming to large industrial customers. Based on the survey results, Union determined that it should continue DSM Programming to these customers.

Resource Acquisition Programs that previously focused on process and capital equipment incentives were valued by customers, however capital incentives in and of themselves were not sufficient to build a sustainable culture of energy efficiency in an organization. Union's proposed Rate T1 and Rate 100 Program is the next step in the evolution of energy efficiency programming for large industrial customers. Building on a long established, successful Resource Acquisition Program, the new Program draws out those attributes that customers have stated provide them the most value at the least cost. Leveraging Union's in house expertise, our energy engineers will focus the customer on building a sustainable culture of energy efficiency within their organization through the training and development of staff and the development and support of in house energy teams. Union's Program will provide detailed energy assessments and studies that enable facilities to quantify the real savings that can be achieved. This will enable plant managers to provide the technical business case justification executives require to support investment in energy efficiency. In addition, the new Program focuses incentives on the implementation of operating and maintenance related energy improvements. Customers have consistently indicated that in times of economic uncertainty, it is the spending on items that do not directly impact production numbers that comes under fire, like energy improvements. As mentioned previously, the focus of these facilities is not on energy management, but on production numbers. The true value of Union's Program is in keeping energy management a focus for these organizations to drive a sustainable culture of energy efficiency in organizations across Ontario.

As of August, 2011, there are 56 Rate T1 customers and 15 Rate 100 customers. Each of these customers is strategically account managed from the plant level to the corporate decision makers. It has been Union's experience that, although these customers tend to be large sophisticated industrial customers in their specific industry, their expertise and focus is not on energy management. Largely, energy costs are improperly viewed as a sunk cost incurred as part of the manufacturing process rather than a prospective cost with significant savings opportunities. Plants are measured based on production output and associated cost controls with resources focused primarily on production target outcomes. Union adds value by providing experience, knowledge and support, which encourage the customer to maintain a continual focus on the saving opportunities that can be afforded through energy management best practises.

The purpose of the customer research undertaken was to gain an understanding of the customers' views of the current value of Union's efficiency Program; to determine what Enersmart DSM offerings customers would like Union to provide beyond 2011; and what average cost would customers be willing to pay for the Program as part of a rate payer funded initiative. Surveys were sent to all customers in these two rate categories and, where appropriate, to multiple contacts within a customer site. Customers were also given the opportunity to provide verbatim comments with respect to their perception of the value of the Program and to ask any potential Program questions. The DSM Program survey for Rate T1 and Rate 100 Customers Report is provided in Appendix G.

72% of the eligible customers responded to this survey. 69% of the respondents support Union's continued provision of DSM Programs. Those in support of the continuation of DSM programming can be further broken down between the industrial/institutional customers and power customers. 73% of the Industrial/Institutional customers support continuing Programs while only 54% of the power generators are supportive. Power generators represent 18% of the customers in these rate classes. The remainder are industrial clients, greenhouse growers, and hospitals. The survey can also be further delineated by rate class with 72% of Rate T1 customers and 58% of Rate 100 customers showing support for continuing DSM programming.

To ensure the development and promotion of a Program that is of value to this customer group, Rate T1 and Rate 100 customers were asked for their input on Union's Large Industrial Rate T1/Rate 100 Program proposals. The input received from customers is consistent with Union's proposed Program, focusing on operating and maintenance optimization incentives and process improvement studies. Respondents have indicated that they want Union to provide targeted energy management programs with experienced technical resources and support for energy efficiency initiatives. Project Managers understand the customers' production processes and equipment and, as a result, Union is able to provide not only technical expertise but business case support for energy efficiency projects that would otherwise not be considered.

With respect to the appropriate cost for the Program, the survey provided a dollar value range for respondents to select from. The dollar value was presented as the gross cost of the Large Industrial Rate T1/Rate 100 Program prior to the receipt of any individual customer incentives relative to the delivered cost of gas at their facility. A dollar value range for Rate T1 customers went from $0.00 to $0.025/GJ, with $0.025/GJ representing the average rate impact over the term of the previous DSM Plan. Rate 100 customers had a range of $0.00 to $0.05/GJ, with the $0.05/GJ representing the average rate impact to a Rate 100 customer over the term of the previous DSM Plan. For Rate 100, 50% of the respondents selected the current level of rate payer funding of $0.05/GJ, and a further 8% selected $0.015/GJ. For Rate T1, 31% of Rate T1 respondents chose the current level of funding at $0.025/GJ, and the average response for this rate class was $0.02/GJ. These rate payer funding points are in line with Union's recommended budget and Program proposal for the energy efficiency services for Rate 100 and Rate T1 submitted as part of this application. The proposed 2012 Program budget includes a rate payer funded level of $0.018/GJ for the Rate T1 rate class and $0.019/GJ for the Rate 100 rate class. Schedule 1 shows a comparison of the 2012 Program cost to the Program costs incurred in 2010.

The proposed 2012 DSM related costs used in the analysis include the proposed 2012 DSM budget and the proposed DSM incentive at a 100% utility achievement level. The 2010 DSM related costs include the actual DSM Program spend, the market transformation incentive amount per the EB-2011-0038 filing, plus the actual 2010 SSM deferral amount per the EB-2011-0038 filing.

The survey results indicate that, with the exception of the power market, the Rate T1 and Rate 100 customers, made up of industrial and commercial customers, such as greenhouses and hospitals, support the Large Industrial Rate T1/Rate 100 Program with some level of funding. It is therefore Union's view, based on the customer response, that the Rate T1 and Rate 100 rate classes should continue to be afforded the opportunity to participate in rate funded DSM Programming.

In addition to the survey results supporting the continuation of DSM programming in Rate T1 and Rate 100, Union notes that competitors of the industrial and commercial Rate T1 and Rate 100 customers are found in other contract rate classes that are eligible for DSM programming. Steel, automotive, hospitals, greenhouses and chemical companies form part of the Rate M4, Rate M5 and Rate 20 rate classes. Customers in the Rate M4, Rate M5 and Rate 20 rate classes will continue to have access to Union's incentives and resources to improve their competitiveness through energy efficiency initiatives. It would be inappropriate and unfair to deny those Rate T1 and Rate 100 customers, competing in the same industrial and commercial environment, access to similar initiatives simply because of their rate class designation. This is true especially when Rate T1 and Rate 100 customers have expressed their support for the continuation of these Programs.

2 UNION'S PROPOSED 2012 – 2014 DSM FRAMEWORK

Per the Guidelines, the company's Plan includes Union's Proposed Framework, Characteristics of Distribution System (Appendix A), Proposed Programs (Appendix A), Stakeholder Engagement Terms of Reference (Appendix E), Input Assumptions (Appendix H), Avoided Costs (Appendix I), Evaluation Studies (Appendix J) and ICF Marbek Natural Gas Energy Efficiency Potential Study (Appendix K).

2.1 Budget

Union's 2012 DSM budget will be $30.091 million, adjusted annually for inflation. For 2012, the budget including inflation is $30.954 million. The calculation of the proposed 2012 budget is provided in Table 1 below. Union's proposed 2012 budget is consistent with the Guidelines which allow for the utilities 2011 budget to be increased by 10% to support of Low-income Programs. The Guidelines also allow the utilities to increase their 2011 budget by inflation each year.

To calculate inflation Union has used the four quarter rolling average at Q1, 2011 of the Gross Domestic Product Implicit Price Index ("GDP-IPI") value rather than the Q3, 2011 GDP-IPI indicated in the Guidelines because the third quarter GDP-IPI will not be available until November, 2011. Any variance between the proposed 2012 DSM budget and the actual 2012 DSM costs will be trued up in the DSM Variance Account. For 2013 and 2014, Union proposes to use the four quarter rolling average at Q2 of each year of the GDP-IPI inflation factor, released at the end of August, to align with the timing of Union's annual rate setting process.

Table 1
2012 DSM Budget Calculation
($ 000's)

Line	Calculation of Overall Budget	
1	2011 Budget	27,355
2	10% Increase for Low-income (line 1* 10%)	2,736
3	Total 2012 Budget	30,091
	Calculation of Low-income Budget	
4	Minimum 2012 Low-income Plan Budget	4,103 (1)
5	10% Increase for Low-income	2,736
6	Total 2012 Low-income Budget Before Portfolio Costs	6,839
7	Portfolio Level Costs Allocated to Low-income	1,004
8	Total 2012 Low-income Budget (line 6 + line 7)	7,843
	Calculation of Inflation	
9	Inflation (line 3 * 2.87%)	864
10	Total 2012 Budget With Inflation (line 3 + line 9)	30,954

(1) As indicated at page 26 of the Guidelines

With the exception of the Low-income budget, Union's 2012 DSM budget is allocated to rate classes based on the forecasted budget by rate class. Budgeted program costs were calculated at the customer class level (e.g. Residential, C/I General Service etc). The portfolio-level costs that could not be assigned to a customer class were allocated based on the percentage allocation of the program costs. For example, as 25% of the 2012 program budget was assigned to C/I General Service, 25% of the portfolio costs were allocated to this customer class. As customer incentives received are tracked at a rate class level, the forecasted customer class budgets were allocated to individual rate classes based on the 2010 customer incentives paid by rate class (e.g. within the C/I General Service customer class the 2010 customer incentive allocation of 42% Rate M1, 38% Rate M2, 7% Rate 01 and 12% Rate 10 was used to allocate the 2012 C/I General Service budget). This methodology will be used to forecast the DSM budget, by rate class, for each year of the Plan.

The Guidelines state that Low-income Programs should be funded by all rate classes. Union proposes to allocate the 2012 Low-income DSM budget of $8.068 million ($7.843 million plus $0.225 million of inflation) to rate classes in proportion to the most recent Board-approved allocation of rate base. Accordingly, for 2012, Union proposes to use the 2007 Board-approved allocation of rate base (EB-2005-0520, Exhibit G3, Tab 2, Schedule 2, Rate Base, updated for EB-2005-0520 Board Decision). For 2013 and 2014, Union will update the Low-income DSM budget allocation to rate classes based on the approved rate base allocation in Union's 2013Cost of Service Proceeding. In Union's view, allocating Low-income DSM costs to infranchise distribution rate classes using rate base is a reasonable approach and is consistent with the intent of the Guidelines.

Table 2 provides the allocation of the 2012 DSM budget by rate class.

Table 2
2012 DSM Program Costs by Rate Class

Line No.	Particulars	Pre-Inflation Budget: Main Portfolio	Pre-Inflation Budget: Low-income [1]	Pre-Inflation Budget: Total	Inflation [2]: Main Portfolio	Inflation [2]: Low-income	Inflation [2]: Total	Total: Main Portfolio	Total: Low-income	Total: Total
		(a)	(b)	(c) = (a+b)	(d)	(e)	(f) = (d+e)	(g)	(h)	(i) = (g+h)
	North									
1	R01	2,366	1,705	4,071	68	49	117	2,434	1,754	4,188
2	R10	928	315	1,243	27	9	36	955	324	1,279
3	R20	777	163	941	22	5	27	800	168	968
4	R100	1,200	216	1,416	34	6	41	1,234	222	1,456
	South									
5	M1	8,707	3,986	12,693	250	114	364	8,957	4,100	13,058
6	M2	2,881	606	3,487	83	17	100	2,963	623	3,587
7	M4	1,157	162	1,318	33	5	38	1,190	166	1,356
8	M5A	1,291	99	1,390	37	3	40	1,328	102	1,430
9	M7	532	100	632	15	3	18	547	103	650
10	T1	2,409	491	2,900	69	14	83	2,478	505	2,984
11	Total	22,247	7,843	30,091	638	225	864	22,886	8,068	30,954

(1) Includes portfolio level costs attributable to low-income
(2) 2.87% (Four quarter rolling average of GDP-IPI at Q1, 2011)

Table 3 provides the annual DSM budget by Program for each year of the Plan prior to the addition of inflation. The 2012 - 2014 DSM budget shown in Table 3 was established based on historical results, stakeholder input and Union's assessment of the market opportunities in each sector. Union may adjust the planned sector level spending during the market planning process that will be undertaken annually in Q4 prior to the Program year. Per the Guidelines, Union shall inform the Board and the Consultative in the event cumulative fund transfers among Board-approved programs exceed 30% of the approved annual DSM budget for any one program.

Table 3
2012 – 2014 DSM Plan Budget

	Year		
	2012 ($000)	2013 ($000)	2014 ($000)
Program Budget			
Resource Acquisition			
Residential Program	4,103	4,282	4,054
Commercial/Industrial Program	9,181	9,181	9,106
Large Industrial T1/R100 Program	3,147	3,147	3,147
Low-Income			
Low-Income Program	6,839	6,839	6,839
Market Transformation			
High Efficency Water Heating Program	1,552	1,238	1,506
High Efficiency Residential New Build Program	726	860	820
Integrated Energy Management Systems Program	690	690	765
Programs Sub-total	26,237	26,237	26,237
Portfolio Budget			
Research	1,066	1,066	1,066
Evaluation	969	969	969
Administration	1,819	1,819	1,819
Total DSM Budget	**$30,091**	**$30,091**	**$30,091**

Union will track the variance between the DSM budget included in rates, by rate class, and the actual DSM dollars spent by rate class. The variance, by rate class, will be disposed of annually through Union's deferral disposition application.

2.2 Targets

Union has used a balanced scorecard approach to establish targets for each of its Programs. It is Union's view that metrics should include both leading indicators, such as training initiatives or assessments completed, and lagging indicators such as cumulative m^3 or participation rates. It is important to measure both leading and lagging indicators to ensure that Union's Programs are performing well and delivering results to customers. Including leading indicators ensures that

Programs will deliver future energy savings. Scorecards have been established at the program type level to provide adequate flexibility so that Union can react to market developments. This also allows Union to react to changes in input assumptions by adjusting the design, delivery and set of DSM measures offered.

Union is proposing four scorecards. They are Resource Acquisition, Large Industrial Rate T1/Rate 100, Low-income, and Market Transformation. A separate balanced scorecard for Union's Large Industrial Rate T1 and Rate 100 Program provides additional transparency for the targets and rate impacts for customers in these rate classes. The scorecards are discussed in more detail below.

As indicated above, one of the Board's objectives when developing the Guidelines was to encourage the pursuit of deep energy savings. In defining deep measures, Union considers measures to be deep if they result in relatively long term savings as they would not reasonably be uninstalled prior to their end of useful life. Examples of deep measures include wall and attic insulation, condensing boilers and custom projects such as upgrades to industrial processes. Discretionary low-cost retrofit measures, such as showerheads and pre-rinse spray valves, are not considered deep for the purpose of the Plan or scorecard targets. These measures do not prevent lost opportunities and may be easily uninstalled prior to their end of useful life. Appendix H, Table 1 lists the deep measures/offerings which will be counted towards achievement of this metric on the applicable scorecards provided below.

Consistent with the Guidelines, Union has established annual targets for each of the three program years of the Plan. As the program results to calculate the DSM incentive are based on best available information, the cumulative natural gas savings metric included in Union's Resource Acquisition, Large Industrial Rate T1/Rate 100, and Low-income scorecards will be impacted by changes in input assumptions resulting from the evaluation and audit process of the same program year. To confirm the cumulative natural gas targets for the subsequent program year, Union will calculate a Target Adjustment Factor ("TAF") for each scorecard based on the variance in cumulative natural gas savings due only to changes in input assumptions confirmed through the Audit. This factor will be applied to the 50%, 100% and 150% cumulative natural gas savings metric targets included in tables 4 - 6 below for the following year of the Plan. The formula for the TAF is provided below.

$$\text{TAF} = \frac{(\text{Cumulative } m^3 \text{ Savings Using Post-Audit Input Assumptions - Cumulative } m^3 \text{ Savings Using Planning Input Assumptions*})}{\text{Cumulative } m^3 \text{ Savings Using Planning Input Assumptions*}}$$

* Union's planning input assumptions are included in Appendix H

For example, should changes to input assumptions for the 2012 program year confirmed through the Audit result in a cumulative natural gas savings value for the Resource Acquisition scorecard that is 10% higher than using Union's planning input assumptions (included in Appendix H), the 2012 targets will remain unchanged. However, the 50%, 100% and 150% cumulative natural gas savings metric targets in the 2013 Resource Acquisition scorecard will be escalated by 10% to reflect the changes in input assumptions. This approach rewards Union's ability to react to new information within the program year while recognizing that some Program results are driven by a few key measures, and should the input assumptions for these measures be adjusted materially, the targets established at the start of this planning period would no longer be appropriate for the remaining year(s) of the Plan. This is a greater risk under cumulative natural gas savings targets than under TRC measurement as a change in measure life, for example, will have a higher impact compared to the discounting of future resource savings under TRC.

Should a change to the Market Transformation Programs be required within the term of the Plan Union will consult its stakeholders and may file revised scorecard targets with the Board for the following year(s) of the Plan.

Union has developed its 100% scorecard targets on a bottom-up basis using market fundamentals, historical data, relevant research, current input assumptions, projected budgets and feedback from intervenors and industry stakeholders. For the cumulative natural gas savings and deep measure metrics, Union has established the 50% and 150% target levels as a multiplier of the 100% target. The multiplier for the 50% target level is 0.5 (50% target = 100% target × 0.5). Therefore, Union will earn no utility incentive for achieving half of its weighted scorecard target but will begin to achieve its utility incentive only after this point. For example in the event 75% of the overall scorecard target was achieved, the utility would receive 20% of the maximum utility incentive for that scorecard. In establishing the multiplier for the 150% target level, Union considered that it would only be reimbursed up to a maximum of 15% above its DSM budget for a given year via the DSM Variance Account. Union therefore established the multiplier for the 150% target level as 1.25 (150% target = 100% target × 1.25). Within this structure Union must achieve a 25% increase above the target with funding of only 15% above the DSM budget. Therefore, Union is challenged to drive increased participation above the 100% scorecard target level. For the metrics that are unique to individual programs, such as the Market Transformation Programs, Union has established the 50% and 150% metric levels based on an assessment of the unique nature and objectives of the Program.

2.2.1 Resource Acquisition Scorecard Exclusive of Large Industrial Rate T1/Rate 100

The metrics in the Resource Acquisition scorecard include cumulative natural gas savings and number of deep measure participants. Union included these metrics as they reflect the three guiding principles of the Board; the cumulative natural gas savings metric rewards Union for maximizing gas savings for customers while the deep measure participants metric motivates Union to focus on preventing lost opportunities and pursuing energy savings which persist for the customer. The Guidelines had outlined these metrics should be included in the Resource Acquisition scorecard to drive the multiple objectives of the Programs.

Union had initially developed the Resource Acquisition scorecard[4] to included a metric for the $ spent/cumulative m^3 savings as suggested by the Guidelines. Based on feedback received at Union's August 11, 2011 consultation, this metric was removed from the final scorecard. At the August 18, 2011 consultation, Union had proposed a 50% weighting for each of the metrics in recognition of the equal importance of driving natural gas savings with delivering deep measures that prevent lost opportunities for energy savings in the market. Union maintains both metrics are

[4] Union's initial Resource Acquisition scorecard structure presented at the August 11, 2011 consultation meeting is included in Appendix B.

equally important to drive the multiple objectives outlined in the Guidelines. Union has, however, allocated a higher weighting to the cumulative natural gas savings metric. Union has placed a greater emphasis on the cumulative natural gas savings metric in direct response to feedback received from stakeholders.

Table 4
2012 – 2014 Resource Acquisition DSM Scorecards

2012 Resource Acquisition Scorecard				
Metric	**Metric Target Levels**			**Weight**
	50%	**100%**	**150%**	
Cumulative Natural Gas Savings (m3)	279,020,000	558,041,000	697,551,000	60%
Deep Measures	1,746	3,490	4,363	40%

2013 Resource Acquisition Scorecard				
Metric	**Metric Target Levels**			**Weight**
	50%	**100%**	**150%**	
Cumulative Natural Gas Savings (m3)	278,600,000	557,200,000	696,501,000	60%
Deep Measures	1,813	3,625	4,532	40%

2014 Resource Acquisition Scorecard				
Metric	**Metric Target Levels**			**Weight**
	50%	**100%**	**150%**	
Cumulative Natural Gas Savings (m3)	277,616,000	555,231,000	694,040,000	60%
Deep Measures	1,813	3,625	4,532	40%

Scorecard Metrics Description

a. Cumulative Natural Gas Saved (m^3)

- The total natural gas saved for all resource acquisition offerings (excluding Rate T1/Rate 100 rate classes) delivered by Union for the term of their measure life, net of adjustment factors such as free ridership, spillover and persistence.

b. Deep Measures

- The total number of deep measures delivered by Union as listed in Appendix H, Table 1and amended as appropriate in the event new measures are confirmed within the term of the Plan (excluding Rate T1/Rate 100 rate classes).
- Each prescriptive measure is considered one unit and each custom project is considered one unit towards the target.

2.2.2 Large Industrial Rate T1/Rate 100 Resource Acquisition Scorecard

Union has separated the Large Industrial Resource Acquisition Program into a separate scorecard to provide additional transparency for all stakeholders for the targets and budget associated with this Program. The metrics in the Large Industrial Rate T1/Rate 100 scorecard include cumulative natural gas savings and percentage of customers participating.

The cumulative natural gas savings metric is included as part of the three guiding principles set out by the Board. With only 71 customers in Rate T1 and Rate 100 funding the Program, the percentage of customers participating metric ensures that Union is motivated to drive as many customers in the rate class as possible to participate.

Union's original Large Industrial Rate T1/Rate 100 scorecard[5] had included a metric for the $ spent/cumulative m^3 savings as suggested by the Guidelines. It had also included an effectiveness measure whereby customers would be surveyed as to whether Union is providing effective energy conservation support with achievement based on a top 3 box score percentage[6]. Based on feedback received at Union's August 11, 2011 consultation, these metrics were removed from the final scorecard. At the August 18, 2011 consultation meeting with stakeholders, Union had proposed a 50% weighting for each metric in recognition of the equal importance of driving natural gas savings with ensuring broad participation to ensure rate class cross subsidization is minimized.

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[5] Union's initial Large Industrial Rate T1/Rate 100 scorecard structure presented at the August 11, 2011 consultation meeting is included in Appendix B[6] A "top 3 box" score refers to the percentage of respondents providing an 8, 9, or 10 on a 10 point scale.

[6] A "top 3 box" score refers to the percentage of respondents providing an 8, 9, or 10 on a 10 point scale.

Union responded to stakeholder feedback on the 50% weighting proposed by allocating a higher weighting to the cumulative natural gas savings metric in the scorecard below.

Table 5
2012 – 2014 Large Industrial Rate T1/Rate 100 DSM Scorecards

2012 Large Industrial T1/R100 Scorecard				
Metric	Metric Target Levels			Weight
	50%	100%	150%	
Cumulative Natural Gas Savings (m3)	100,000,000	200,000,000	250,000,000	60%
Percentage of Customers Participating	30%	40%	50%	40%

2013 Large Industrial T1/R100 Scorecard				
Metric	Metric Target Levels			Weight
	50%	100%	150%	
Cumulative Natural Gas Savings (m3)	100,000,000	200,000,000	250,000,000	60%
Percentage of Customers Participating	30%	40%	50%	40%

2014 Large Industrial T1/R100 Scorecard				
Metric	Metric Target Levels			Weight
	50%	100%	150%	
Cumulative Natural Gas Savings (m3)	100,000,000	200,000,000	250,000,000	60%
Percentage of Customers Participating	30%	40%	50%	40%

Scorecard Metrics Description

a. Cumulative Natural Gas Saved (m^3)

- The total natural gas saved for all projects delivered to Rate T1/Rate 100 rate class customers for the term of their measure life, net of adjustment factors such as free ridership, spillover and persistence.

b. Customers Participating (%)

- The total number of Rate T1, Rate 100, Rate 100/20 and Rate 100/25 customers that receive an incentive in a given year, divided by the total number of customers in those rate classes on December 31 each year.
- Every contract (or Service Agreement Number) will be considered (or defined) as one customer, except in cases where:
  - The customer is ineligible for DSM (i.e. Transmission customers).
  - The customer did not receive natural gas in that given year.

2.2.3 Low-income Scorecard

Consistent with the three guiding principles contained in the Guidelines, the metrics in the Low-income scorecard include cumulative natural gas savings as well as the number of residential deep measure participants and multifamily deep measures. The Guidelines indicate that these metrics should be included in the Low-income scorecard to drive the multiple objectives of the Program. Union's original Low-income scorecard[7] had included a metric for the $ spent/ cumulative m^3 savings as suggested by the Guidelines. Based on feedback received at Union's August 11, 2011 consultation this metric was removed from the final scorecard. Union has separated the residential deep measure participant metric from the multi-family deep measures metric based on feedback received at the second consultation meeting held August 18, 2011. Consistent with the Weatherization scorecard filed with full consensus from the Low-income subcommittee of stakeholder groups in Union's Incremental 2011 Low-income DSM Plan (EB-2010-0055), Union is proposing that half of the metric weighting be allocated to natural gas savings and half allocated to the number of deep measure participants. This weighting structure ensures equal emphasis on each of the dual objectives of ensuring depth of savings for low-income energy consumers with breadth of program reach within this customer group.

[7] Union's initial Low-income scorecard structure presented at the August 11, 2011 consultation meeting is included in Appendix B

Table 6
2012 – 2014 Low-income DSM Scorecards

2012 Low-Income Scorecard				
Metric	Metric Target Levels			Weight
	50%	100%	150%	
Cumulative Natural Gas Savings (m3)	18,204,000	36,409,000	45,511,000	50%
Residential Deep Measure Participants	275	550	688	25%
Multi-Family Deep Measures	95	190	238	25%

2013 Low-Income Scorecard				
Metric	Metric Target Levels			Weight
	50%	100%	150%	
Cumulative Natural Gas Savings (m3)	15,924,000	31,848,000	39,809,000	50%
Residential Deep Measure Participants	325	650	813	25%
Multi-Family Deep Measures	113	225	281	25%

2014 Low-Income Scorecard				
Metric	Metric Target Levels			Weight
	50%	100%	150%	
Cumulative Natural Gas Savings (m3)	15,570,000	31,141,000	38,926,000	50%
Residential Deep Measure Participants	375	750	938	25%
Multi-Family Deep Measures	85	170	213	25%

Scorecard Metrics Description

a. Cumulative Natural Gas Saved (m^3)

- The total natural gas saved for all Low-income offerings delivered by Union for the term of their measure life, net of adjustment factors such as free ridership, spillover and persistence.
- For the building envelope component of Union's home retrofit offering the natural gas savings will be calculated based on the results of the pre and post energy audits conducted by certified energy auditors on a custom basis using HOT2000. Should the methodology for calculating these results change over the term of the Plan Union's targets would be adjusted accordingly.

b. Residential Deep Measure Participants

- Each home is treated as one deep measure participant that receives at least one Low-income deep measure as listed in Appendix H, Table 1 or a substantial insulation measure (e.g. increase in insulation in more than half of the walls, basement walls or attic of the home) as well as associated cost-effective air sealing.

c. Multi-Family Deep Measures

- For Union's Social and Assisted Housing Multi-Family offering each prescriptive deep measure (as listed in Appendix H, Table 1 and amended as appropriate in the event new measures are confirmed within the term of the Plan) is considered one unit and each custom project is considered one unit towards the target.

2.2.4 Market Transformation Scorecard

Union's Market Transformation Scorecard includes three Programs: Residential High Efficiency Water Heating, Residential New Home Efficiency and Industrial Integrated Energy Management Systems ("IEMS"). As each Program must be assessed on its own merits based on the Program's specific objectives, the metrics in Union's Market Transformation scorecard are tailored to measuring Union's success in overcoming the key market barriers and, as a result, advancing adoption of the efficient technologies and industry practices. Union's Market Transformation Programs are designed to change the operation of the market (e.g. generate a change in builder practices or create new behavioural norms) and to ensure that the impacts of Union's market transformation efforts continue after Union's market intervention has concluded. Union's Market Transformation scorecard, therefore, includes leading indicators that drive education and awareness as well as lagging indicators that measure the ultimate outcomes and action taken in response to the Program intervention.

While Union had considered the potential for the Residential New Home Efficiency Program, Union's original Market Transformation scorecard[8] presented at the August 11, 2011 consultation had not included this Program. Based on feedback from those in attendance at the August 11, 2011 meeting, consultation with industry stakeholders and a desire to deliver this Program, Union has included it in the Plan and Market Transformation scorecard. In addition,

[8] Union's initial Market Transformation scorecard structure presented at the August 11, 2011 consultation meeting is included in Appendix B

the Residential High Efficiency Water Heating Program had initially been developed by Union to include both the new construction and retrofit market. Union has removed the retrofit offering to focus exclusively on the residential new construction market based on the input of the attendees at the August 11, 2011 consultation. Union has included context for the metrics and metric weights for each of the Market Transformation Programs below. The High Efficiency Water Heating, New Home Efficiency and IEMS Programs have cumulative metric weights of 40%, 30% and 30% respectively. While Union considers the objectives of each Program equally important, this weighting structure reflects the higher budget allocation to the High Efficiency Water Heating Program. The Market Transformation Program metrics are described in more detail below.

High Efficiency Water Heating Program

Union has included metrics for the percentage market uptake, participating builders and number of education sessions and consumer/industry shows for this Program. The market uptake metric ensures Union is driven to increase the penetration of high efficiency water heating technology in the residential new home construction market. This metric measures the increase in ultimate market adoption over the term of the Program. The participating builders metric ensures the Program drives broad adoption by residential homebuilders to facilitate widespread market acceptance. The final metric, which measures the number of education sessions Union leads and consumer/industry shows at which Union exhibits, ensures the utility invests in market education on the technology and its benefits. This is a key component of long-term transformation. Education and awareness on both the supply and demand side of the market is required to address the fundamental market barriers which currently limit adoption of the technology, and ensure continued uptake once Union exits the Program. While each metric is required to drive fundamental change in the market, Union has allocated the highest weight on the market uptake metric as it measures the ultimate outcome that results in natural gas savings.

New Home Efficiency Program

The metrics for this Program measure the number of new participating builders enrolled in the Program, prototype homes built, and the percentage of homes built to an efficiency standard at least 15% above 2012 Ontario Building Code ("OBC 2012") by participating builders. The builder metric is required to ensure a significant proportion of the production builders in Union's franchise area (defined as those that build a minimum of 50 housing starts per year) are enrolled in the Program. This will ensure the building practices promoted by the Program result in widespread change in builder practices. The metrics for prototype homes and residential homes built ensure the Program is measured on the ultimate change in building practices of builders in new home construction. Over the term of the Plan, the metric weighting shifts, from an emphasis on participating builders in 2012 to the percentage of homes built 15% above OBC 2012 by participating builders in 2014, to reflect the evolution of the Program.

Integrated Energy Management Systems Program

The IEMS Program is the next evolution of DSM Programs for the industrial market. It builds on the successful Resource Acquisition Program to date and will drive industrial customers to implement a sustainable culture of energy efficiency within their organizations. While this approach to conservation is still in its infancy, the Program will look to shift the culture of the business to quantify, implement, and validate energy efficiency improvements. The Program targets behaviour based, process based, and equipment based initiatives. The metrics in the IEMS section of the Market Transformation scorecard reflect the longer term horizon of the Program and the necessary phases to ensure transformation.

Union has identified the measurable outcomes of the Program as assessments completed, implementation/installation and persistence reports. The assessments completed metric motivates Union to convince customers to take a comprehensive and costly review of their entire facility and fully commit to the three year cultural change process. It is critical to demonstrate that Union has facilitated the customer through plan development, baseline establishment and identification of a strategy for data collection.

The implementation/installation metric measures the number of customers who complete an implementation agreement for metering and monitoring. The achievement of this metric will demonstrate that Union has overcome the challenges of changing corporate policies to install and commission expensive and complicated metering systems which will allow customers to generate energy savings.

The final stage of measuring actual performance through persistence reports over an 18 month period will demonstrate success and sustainability. This metric measures the ability of Union to illustrate it has influenced and proven the adoption of continuous improvement. This ensures long-lasting fundamental change has been achieved within the organization.

In the first year of the Program, the weighting is heavily focused on the assessments completed metric to reflect the first stage of the Program. In recognition of the evolution of the Program over the term of the Plan, the weightings shift to incrementally increase the weight of the implementation/installation and persistence reports metrics respectively in 2013 and 2014.

Table 7
2012 – 2014 Market Transformation DSM Scorecards

2012 Market Transformation Scorecard					
Program	**Metric**	**Metric Target Levels**			**Weight**
		50%	**100%**	**150%**	
High Efficiency Water Heating	Market Uptake	14%	15%	16%	20%
	Participating Builders	40	50	60	10%
	Education Sessions & Consumer/Industry Shows	8	15	22	10%
New Home Efficiency	New Participating Builders	6	8	10	25%
	Prototype Homes Built	20% of Participating Builders	30% of Participating Builders	40% of Participating Builders	5%
Integrated Energy Management Systems	Assessments Completed	4	7	10	25%
	Implementation/Installation	1	2	3	5%

2013 Market Transformation Scorecard					
Program	Metric	Metric Target Levels			Weight
		50%	100%	150%	
High Efficiency Water Heating	Market Uptake	2012 actual result + 0%	2012 actual result + 2%	2012 actual result + 4%	20%
	Participating Builders	2012 actual result + 5%	2012 actual result + 10%	2012 actual result + 15%	10%
	Education Sessions & Consumer/Industry Shows	15	22	29	10%
New Home Efficiency	New Participating Builders	2	4	6	10%
	Prototype Homes Built	50% of Participating Builders	60% of Participating Builders	70% of Participating Builders	10%
	Homes Built (>15% above OBC 2012) by Participating Builders	2%	4%	6%	10%
Integrated Energy Management Systems	Assessments Completed	4	8	12	17.5%
	Implementation/Installation	1	2	4	7.5%
	Persistence Reports	1	2	3	5%

2014 Market Transformation Scorecard					
Program	Metric	Metric Target Levels			Weight
		50%	100%	150%	
High Efficiency Water Heating	Market Uptake	2013 actual result + 0%	2013 actual result + 2%	2013 actual result + 4%	20%
	Participating Builders	2013 actual result + 5%	2013 actual result + 10%	2013 actual result + 15%	10%
	Education Sessions & Consumer/Industry Shows	15	22	29	10%
New Home Efficiency	New Participating Builders	1	2	3	5%
	Prototype Homes Built	70% of Participating Builders	80% of Participating Builders	90% of Participating Builders	10%
	Homes Built (>15% above OBC 2012) by Participating Builders	2013 actual result + 4%	2013 actual result + 6%	2013 actual result + 8%	15%
Integrated Energy Management Systems	Assessments Completed	5	10	15	15%
	Implementation/Installation	1	3	5	10%
	Persistence Reports	1	2	3	5%

Scorecard Metrics Description

a. High Efficiency Water Heating Market Uptake

- The percentage of new build homes that install a residential natural gas water heater with efficiency equal to or greater than 0.80 in Union's franchise area.
- A new build home is defined as a newly built home that has gas service activated between January 1- December 31.

b. High Efficiency Water Heating Participating Builders

- A residential home builder that participates in the Union Gas High Efficiency Water Heater program (they install at least 1 unit in 1 of their homes).

c. High Efficiency Water Heating Education Sessions & Consumer/Industry Shows

- Each builder/trade education session led by Union, or homeowner/consumer/industry show at which Union exhibits with a focus on high-efficiency water heating.
    - Builder/trades education sessions are Union Gas led events that serve to educate builders with a minimum of 10 participants (e.g. “train the trainer” event, builder session a local geographic area, etc.).
    - Homeowner/consumer shows can include home shows, energy clinics or events geared to residential homeowners preferably with a new build focus (for example exhibit a booth at the London Home Show).
    - Industry Shows are those that are geared towards builders/trades/sales agents to serve to educate, have breakout sessions, networking, key note speakers, etc. (Examples include: Exhibiting a booth at the following trade shows: Ontario Home Builder Association’s Builder’s forum, Construct Canada/ Home Builder & Renovator Forum, etc.).

d. New Home Efficiency Program New Participating Builders

- A residential home builder that builds a minimum of 50 housing starts per year and participates in the Union Gas New Home Efficiency Program by signing a Participation Contract. in the program year.
- New builders to the program are measured on an incremental basis each year (a builder enrolled in the program in a prior year will not be counted toward the annual achievement of this metric).

e. New Home Efficiency Program Prototype Homes Built

- Calculated as the percentage of participating builders in the program who build a prototype home in relation to the actual total number of participating builders in the program to-date.
- A prototype home is a single home built to a 15% higher energy efficiency standard than the Ontario Building Code (OBC 2012) by participating builders
- The home must have an activated gas service in order to be included in the metric

f. New Home Efficiency Program Homes Built (>15% above OBC 2012)

- Calculated as the percentage of homes built to a 15% higher energy efficiency standard than the Ontario Building Code (OBC 2012) in relation to the total number of homes built in a program year by actual participating builders
- The home must have an activated gas service in order to be included in the metric
    - In 2013 this is defined as 4% of the participating builder’s housing starts (for example 4 out of 100 homes will be built to the higher efficiency level)
    -

g. IEMS Assessments Completed

- In order to fully identify utility use areas for Water, Air, Gas, Electricity, Steam (W.A.G.E.S), the entire industrial facility must undergo an assessment study. The study will identify the utility using equipment/areas, and divide the facility into energy use centres where utility usage can be aggregated with production data for optimum tracking.
- The metric is considered complete per customer once the Facility Assessment report is submitted to Union Gas. Facilities served by each unique account number will be considered one customer.

h. IEMS Implementation/Installation

- In order to properly meter and monitor the facility W.A.G.E.S an implementation plan must be generated. Once this plan is submitted and approved by Union, Union and the customer will enter into an implementation agreement.
- The Implementation metric will be achieved upon the completion of the implementation agreement for each customer. Facilities served by each unique account number will be considered one customer.

i. IEMS Persistence Reports

- Once the metering and monitoring system has been installed and commissioned, the customer can enter the Persistence Phase. During this eighteen month time period, the customer must submit quarterly persistence reports demonstrating that the monitoring system is in place, in use and has been integrated into their management reporting system. This could be substantiated by monthly/quarterly Key Performance Indicator report, Management review minutes etc.
- The Persistence phase will start with the submittal of the first report and be considered complete for achievement of this metric at the sixth quarterly submission by each customer. Facilities served by each unique account number will be considered one customer.

2.3 DSM Incentive

Union proposes the maximum DSM incentive amount available for the 2012 program year be $10.450 million. This represents the DSM incentive of $9.5 million outlined in the Guidelines scaled up by 10% in recognition of the 10% increase identified above in Table 1, line 2. The 10% increase is to be used to support Low-income Programs. This is in compliance with the Guidelines which stated the following:

> *"The natural gas utilities' total DSM budgets may be increased by up to 10%, provided the funds are solely used to support low-income programs. This means the total DSM budget for Enbridge may be increased by $2.81 million and by $2.74 million for Union. This funding increase will be considered incremental to the natural gas utilities' total DSM budget and is not cumulative.*[9]*"*

The Guidelines also state:

[9] Ontario Energy Board. *Demand Side Management Guidelines for Natural Gas Utilities.* (EB-2008-0346). June 30, 2011. p. 26

"To the extent that the approved DSM budgets deviate in magnitude from the Board proposed budgets, the Annual Cap should be scaled accordingly. This will help ensure that the eligible incentive amount is consistent with the expected level of efforts require[d] to achieve or exceed the approved targets.[10]*"*

Union proposes to escalate the maximum incentive amount available in 2013 and 2014 using the four quarter rolling average of the GDP-IPI as issued by Statistics Canada in the second quarter and published at the end of August.

The DSM incentive will be allocated between the Resource Acquisition, Low-income and Market Transformation Program types based on their approved budget shares. The DSM incentive will be further allocated between the Resource Acquisition scorecard and Large Industrial Rate T1/Rate 100 scorecard based on their approved budget shares. No incentive will be provided for achieving a scorecard-weighted score of less than 50%. Union will earn 40% of the DSM incentive for achieving a scorecard weighted score of 100%, with the remaining 60% available for performance up to the 150% target level. Scorecard results will be linearly interpolated between the scorecard metric target levels. The incentive amount will be capped at the scorecard weighted score of 150%. Table 8 displays the maximum shareholder financial incentive allocated to each scorecard based on their budget shares prior to the addition of the GDP-IPI for 2013 and 2014.

[10] Ontario Energy Board. *Demand Side Management Guidelines for Natural Gas Utilities.* (EB-2008-0346). June 30, 2011. p. 31

Table 8
Maximum DSM Incentive Allocated to Each Scorecard Prior to Inflation

	Year								
	2012			2013			2014		
	Budget	Budget Share	Max Utility Incentive	Budget	Budget Share	Max Utility Incentive	Budget	Budget Share	Max Utility Incentive
	($000)	%	($000)	($000)	%	($000)	($000)	%	($000)
Scorecard									
Resource Acquisition	13,283	50.6%	5,291	13,463	51.3%	5,362	13,160	50.2%	5,242
Large Industrial T1/R100	3,147	12.0%	1,253	3,147	12.0%	1,253	3,147	12.0%	1,253
Low-Income	6,839	26.1%	2,724	6,839	26.1%	2,724	6,839	26.1%	2,724
Market Transformation	2,968	11.3%	1,182	2,788	10.6%	1,110	3,091	11.8%	1,231
Total	**26,237**	**100.0%**	**10,450**	**26,237**	**100.0%**	**10,450**	**26,237**	**100.0%**	**10,450**

The DSM Incentive achieved by Union will be recorded in the DSM Incentive Deferral Account ("DSMIDA"). Union will apply annually for disposition of the balance in the DSMIDA . Incentive amounts paid to Union will be allocated to rate classes in proportion of the amount actually spent on DSM activities in each rate class. The actual spending by rate class will be based on the methodology outlined in section 2.5.

2.4 Lost Revenue Adjustment Mechanism ("LRAM")

In accordance with the Guidelines, Union will be eligible to recover the lost distribution revenues associated with DSM activity. The lost revenue adjustment mechanism variance account ("LRAMVA") will true up the actual impact of DSM activities. Union will calculate the full year impact of DSM Programs on a monthly basis, based on the volumetric impact for the measures implemented in that month. The Board-approved volumetric rate (average yearly Quarterly Rate Adjustment Mechanism ("QRAM") will be applied to the appropriate rate class for the implemented month's savings and for each remaining month in the calendar year.

For example, the natural gas savings implemented in March 2012 will have 10 months of LRAM calculated based on the average rate for that rate class for the year whereas natural gas savings implemented in November will have 2 months of LRAM calculated based on the average rate for that rate class for the year. The LRAM amount will be based on the best available information for input assumptions resulting from the evaluation and audit process of the program year.

2.5 DSM Variance Account ("DSMVA")

Union will track the variance between actual DSM spending by rate class relative to the DSM budget included in rates by rate class in the DSMVA. Union is eligible to recover up to an additional 15% above its approved DSM budget. Any incremental funding can only be used on Program expenses (not additional utility overheads).

With the exception of the Low-income budget, the actual DSM spending will be calculated as follows. The DSM program costs will be calculated by rate class based on the total actual DSM spend by rate class. Customer incentives received are the only element tracked at a rate class level and they will be allocated based on the amount spent within each rate class. All other program costs not tracked at the rate class level, such as promotion and administrative costs, will be allocated by customer class (e.g. Residential, C/I General Service), and assigned by rate class based on the percentage allocation of the customer incentive costs. All portfolio-level costs that cannot be attributed to an individual program, such as the support staff engaged in DSM evaluation and program tracking, will be allocated to a rate class based on the percentage allocation of the program costs by rate class.

The variance between the Low-income DSM budget included in rates and the actual amount spent on Low-income DSM Programming will be recovered in proportion to the most recent Board-approved rate base attributable to each rate class.

For 2012, the variance will be recovered in proportion to the most recent Board-approved allocation of rate base. Accordingly, for 2012, Union proposes to use the 2007 Board-approved allocation of rate base (EB-2005-0520, Exhibit G3, Tab 2, Schedule 2, Rate Base, updated for EB-2005-0520 Board Decision). For 2013 and 2014, the variance will be recovered in proportion to the approved rate base allocation in Union's 2013 Cost of Service Proceeding. In Union's view, allocating Low-income DSM costs to infranchise distribution rate classes using rate base is a reasonable approach and is consistent with the intent of the Guidelines.

Union will be eligible to access the incremental 15% above its annual Board-approved DSM budget provided that it has achieved its overall scorecard target (i.e. 100%) on a pre-audited basis for one or more of its scorecards. The DSMVA will be used to produce results against any Program scorecard(s) which have achieved the overall scorecard target.

2.6 Rate Impacts

Section 18.1, subsection 4 of the Board's Guidelines requested the following information.

a) The total amount of DSM spending to be recovered in rates and the allocation of those costs to the customer class(es) that will benefit from the DSM program applied for;

b) A forecast of the number of customers in each class and a forecast of m^3 of natural gas to be used as a charge determinant for the rate rider of each rate class to benefit from the DSM program(s); and

c) A comparison of the proposed rates with and without the DSM rate rider for the rate year in question.

The total amount of DSM spending to be recovered in rates and the allocation of those costs is provided in Table 2 above. Union does not recover DSM-related costs using a rate rider. DSM costs are included in approved delivery rates and are not separately identified. Although Union does not have a DSM-related rate rider, Schedule 2 provides the average rate for 2012, by rate class, with and without DSM-related costs.

In addition to the information above, Union has provided Schedule 1 which compares the total DSM related costs actually incurred in 2010 to the total DSM related costs Union expects to incur in 2012. The 2012 DSM related costs include the proposed 2012 DSM budget and the proposed DSM incentive at the 100% utility achievement level. The 2010 DSM related costs include the actual DSM costs incurred in 2010, the 2010 Market Transformation incentive amount per the EB-2011-0038 filing, plus the actual 2010 SSM deferral amount per the EB-2011-0038 filing.

Union has also provided Schedule 3 which provides the impact of DSM costs included in 2012 rates relative to Board-approved 2011 rates, as filed in Union's 2012 Rates application (EB-2011-0025).

The bill impact for a typical residential customer consuming 2,600 m3 per year in the Southern Operations area will be $3-4 per year. The bill impact for a typical residential customer consuming 2,600 m3 per year in the Northern & Eastern Operations area will be $7-8 per year.

The bill impacts shown above reflect the unit rate changes between the actual incurred DSM related costs in 2010 relative to the proposed DSM related costs in 2012 as shown in Schedule 2, column (o).

2.7 DSM Program Screening

Union's proposed screening methodology is consistent with the program screening approach outlined in the Guidelines. A Program includes the combination of offerings available to a target market within a Program type. Union has only applied for DSM Programs that, at a Program level, have a TRC ratio greater than 1.0, except in the case of Low-income Programs which are screened at a TRC ratio value of 0.70. Where a Program is not amenable to the mechanistic TRC screening approach, as is the case for Union's Market Transformation Programs, they have been assessed on a case-by-case basis.

Where a change in Program input assumptions (including net equipment or Program costs, and adjustments to account for free ridership, spillover effects or persistence of savings) is confirmed which causes a Program to subsequently screen below the acceptable TRC ratio, the results of the Program will be included towards achievement of Union's annual DSM targets for that year. Union would seek to adjust its Program approach from the point new input assumptions are confirmed forward to ensure Programs are cost effective. Where an offering is causing the Program to screen below the acceptable TRC ratio, a withdrawal period would be required to prevent market disruption and manage contracting commitments.

2.8 Avoided Costs

Avoided costs represent benefits in the TRC calculation (i.e. the benefits of not having to supply natural gas, electricity and water) and are integral to the determination of TRC benefits for the purposes of Program screening.

Since 2007, Union and Enbridge have used the same methodology in calculating avoided costs; however, the costs are specific to each Utility's franchise area and gas supply management policies and practices. The commodity portion is updated annually.

In Union's proposed Plan, Union will continue the same approach for the calculation of avoided costs. Union will use the Board approved weighted average cost of capital ("WACC"). The Board-approved WACC is currently 7.9% as approved in EB-2005-0520.

Appendix I includes the 2011 avoided costs for natural gas, electricity and water that Union used for TRC screening in this Plan. The actual avoided costs used for TRC screening in each program year will be filed annually in the Annual Report for the program year.

2.9 Stakeholder Engagement Process

As indicated above, the Guidelines contemplated separate consultation to establish a Stakeholder Engagement ToR. Union and Enbridge jointly held consultations with a Working Group to establish a ToR that balances utility accountabilities with the value the utilities have for intervenor perspectives. Although consensus was not achieved, Union's proposed new process improves overall efficiency, is highly inclusive, and continues to emphasize Union's commitment to strive for consensus as the underlying cornerstone objective of stakeholder engagement. Union's proposed ToR is included in Appendix E.

Section 16 of the Board Guidelines notes that Union and Enbridge are ultimately responsible and accountable for their DSM activities and, accordingly, consultative activities will be undertaken at the discretion of the utilities. With these accountabilities in mind, the utilities drew from utility experience and sought input from stakeholders to inform the ToR during the Working Group sessions. The resulting ToR reflects a level of engagement beyond not only the requirements for stakeholder consultation as outlined in the Guidelines but also the Evaluation and Audit Committee process established in EB-2006-0021. In addition to two Consultative meetings contemplated in the Guidelines, each year the ToR includes a provision for stakeholder involvement in:

- Development and update of input assumptions**;**
- Evaluation research priorities and future studies;
- Design and implementation of individual evaluation studies**;**
- Review of evaluation study work products, draft and final reports;

- The audit of DSM annual results; and
- Development of new Program ideas.

The stakeholder engagement process envisioned in the ToR also includes two committees to be formed with tasks specific to either evaluation/input assumptions, or the audit. In addition to enabling a more focused approach to both the evaluation/input assumption review activities and the annual audit, the efficiency of separating stakeholder engagement into two processes allows activities in both areas to move forward in tandem without having one process impede the other. It also ensures that an appropriate level of industry expertise is available to draw from to inform committee participants and allows for sufficient time to be dedicated to each activity. (i.e. evaluation/input assumptions are discussed throughout the year and not only during the audit when time in limited.) In total, the ToR envisions 22 meetings with the two distinctive committees. The committees and their benefits are described further in section 2.10 below and outlined in the ToR in Appendix E.

2.10 Evaluation and Audit Process

During the Plan period, Union will file an Annual Report summarizing the savings achieved, budget spent, and supporting evaluation studies. The Annual Report will be subject to a third party audit, which will also be filed annually. In addition to the Annual Report, Union will file an annual Technical Reference Manual ("TRM"), which will contain input assumptions considered best available at the time of the Audit. The process that Union proposes to follow to fulfill its evaluation and audit requirements per the Guidelines is outlined below.

In an effort to streamline the process and ensure greater consistency between Union and Enbridge, stakeholder involvement in the evaluation and audit process has been refined and a separate process for evaluation and the audit has been proposed. Evaluation will be guided by a common Technical Evaluation Committee ("TEC") between Union and Enbridge, while the audit will be guided by separate Audit Committees ("AC").

The TEC will be charged with reviewing all input assumptions related to the delivery of DSM in each program year from 2012 to 2014. As outlined in the ToR, the TEC will have an advisory role in the following evaluation activities:

- Aligning input assumptions between Union and Enbridge;
- Setting the evaluation priorities for each program year;
- Design and implementation of evaluation studies;
- Development and updating of the TRM;
- Following the audit, review of the Annual Report to confirm scope and priority of any recommended evaluation projects.

In the proposed ToR, the utilities will provide the TRM to the Auditor on April 1st for the purpose of the audit. As soon as practical subsequent to the audit, the utilities will jointly file the TRM with any updates with the Board.

As envisioned through the new ToR, an AC will have an advisory role throughout the annual third party audit. Union will select and retain the auditor and determine the scope of the audit. The ACs advisory role in the audit includes the following activities:

- Selection of the independent auditor to audit the Annual Report and determine the scope of the audit;
- Ensure that all comments on the Annual Report from the Consultative are reviewed by the auditor; and,
- The full audit process.

In addition, the AC will be responsible for meeting the reporting guidelines of the Board (found at Section 2.1.12 of the Natural Gas Reporting & Record Keeping Requirements Rule for Gas Utilities). The AC will provide a final report within 10 weeks from the later of the receipt of the Draft Annual Report and supporting evaluation studies from the Utility, or the hiring of the auditor. Recommendations of the AC with respect to DSMVA, LRAMVA and DSMIDA clearances will be included in the AC's final report. The AC will not consider any further information subsequent to the Board's filing deadline each year.

The role of the auditor is also outlined in the ToR which notes that the auditor will:

- Provide an opinion on the DSMVA, DSM Incentive and LRAM amounts proposed and any amendment thereto;
- Confirm the Target Adjustment Factor based on audit results has been calculated and applied correctly;

- Verify the financial results in the Annual Report to the extent necessary to give that opinion;
- Review the reasonableness of any input assumptions material to the provision of that opinion; and,
- Recommend any forward looking evaluation work to be considered.

In fulfillment of the Board requirements outlined in EB-2008-0346, the independent third party auditor is expected to take such actions by way of investigation, verification or otherwise as are necessary for the auditor to form its opinion.

With respect to Union's custom offerings, Union will undertake third party verification studies of a sample of custom projects that will be reviewed by the auditor for reasonableness. Third party verification studies are not intended to be duplicated by the auditor as they will be based on a sampling methodology that has received TEC input and are carried out by third party engineering companies. As outlined in the Guidelines, projects selected for assessment will consist of a random selection of 10% of the large custom projects representing at least 10% of the total volume savings for all custom projects and consist of a minimum number of five projects.

As noted above, Union's Evaluation budget for 2012 will be $0.969 million not including salaries. Relative to previous years, the overall evaluation budget has been increased to improve confidence in the DSM results and to recognize the greater level of stakeholder engagement. In addition to funding external third party evaluation consultants, this budget will be dedicated to paying for the TEC, the AC, two consultative meetings, as well as the Auditor.

2.11 Electricity Conservation and Demand Management ("CDM") and Other Partnerships

Union's focus is on the delivery of natural gas demand side management. However, with the electric utilities actively engaged in CDM activity over the coming three years, Union believes there are opportunities to provide customers seamless energy conservation solutions as well as optimize expertise, time and financial resources from the utilities. Therefore, as appropriate Union will engage all relevant market players, primarily electric utilities, to pursue collaboration in DSM and CDM delivery.

Where Union partners with rate regulated electricity distributors, all natural gas savings will be attributed to Union and vice versa for electricity savings.

Where Union partners with "other" parties (e.g. governments, non-rate-regulated private sector, etc.) benefits will be determined upfront of the Program's launch within a partnership agreement. Where the benefit share for Union is greater than 20% of the share that would have been allocated using a "percentage of dollars spent" approach, Union will file the explanation for the difference with the Board. Union will file expected Program spending for each of the partners prior to Program launch, and actual Program spending after completion of the Program.

2.12 Research

Union has long recognized that Research and Development activities are the source of new Programs and offerings. Over the term of the Plan, Union will continue to investigate emerging technologies and new opportunities that provide an enhanced understanding of the market Union serves. Through these investigations, the utility is able to offer customers a full suite of cost-effective Programs in ever changing markets.

Given the Board's desire for greater coordination between the natural gas utilities in Ontario, Union will continue to conduct these activities in coordination and collaboration with Enbridge. Union will enhance this collaborative process through regular and frequent research meetings with Enbridge, at which utility research ideas are vetted before projects are initiated. In addition, after projects are completed, experiences are shared to inform future potential Program design. This makes the undertaking of joint research projects with Enbridge more systematic and ensures that the process leverages both utilities' extensive technical and market resources. Union will follow this process over the term of the Plan resulting in more cost effective projects, minimal duplication of research efforts and greater value to customers.

Research ideas are generated for the Residential, Low-income, Commercial and Industrial sectors from internal employees, Enbridge, research exchanges with other utilities outside of Ontario, industry associations and experts, customers, conferences, and trade shows etc. Research projects thoroughly investigate critical input assumptions relating to natural gas, electrical and water savings, costs and equipment life, among a variety of typical usage data for various market segments. Market information, such as market barriers, market shares, and how supply chains operate, is also examined to assist Union in designing Programs that are well informed with a strategic approach to the market. Information garnered through research informs Union's Program design process to overcome identified market barriers and target the appropriate customers in a manner that is most cost effective. Existing Programs are impacted by changes in market conditions. Market saturation, competitive alternatives, technology advances, the economy and other external forces drive the importance of research in order to adapt to shifting market conditions and continue to improve upon the diverse portfolio of Programs for customers.

Research additionally enables the utility to convert common custom DSM projects into prescriptive offerings. In such cases, research can determine common average input assumptions based on typical equipment use and characteristics, as well as market data. This provides information for a mass marketing campaign or broad based customer outreach, which in turn drives further participation. Increased participation is achieved through a more straightforward application process which typically results in a more streamlined process for customers and a more efficient evaluation process. A corollary benefit of research moving custom options towards more prescriptive Program offerings is that it allows Union's custom project resources to focus on projects which are truly unique in nature.

Through its research efforts, Union will continue to work with Enbridge to investigate leading edge Program options for all customer segments. While the technologies under investigation will change over the duration of the Plan to include new compelling energy efficient options and solutions for customers, Union currently has various technologies and ideas under consideration for further research. They include zone heating and energy efficiency benchmarking in the residential and low income markets, boiler controls in commercial and industry specific improvements such as high efficiency greenhouse glazing in the industrial market.

UNION GAS LIMITED
Rate Class impacts of DSM
2010 Actual versus 2012 Budget

Line No.	Particulars		2010 Actual DSM Spend	2010 Current Low Income DSM	2010 Market Trans. in Deferrals (1)	2010 SSM in Deferrals (2)	2010 Total 2010	2012 Budget DSM	2012 Budget Low-Income (3)	2012 Subtotal (4)	2012 Budget DSM Incentive	2012 Total 2012	Unit Rates 2010 DSM	Unit Rates 2012 DSM	Unit DSM Rate Change
			(a)	(b)	(c)	(d)	(e) = (a+b+c+d)	(f)	(g)	(h) = (f+g)	(i)	(j) = (h+i)	(k) = (e)	(l) = (j)	(m) = (l-k)
	Delivery North														
1	**R01**	Revenue ($000's)	1,340	295	88	194	1,917	2,434	1,754	4,188	360	4,547	1,917	4,547	2,630
2		Volumes (10^3m^3) (6)	873,086	873,086	873,086	873,086	873,086	863,695	863,695	863,695	863,695	863,695	873,086	863,695	
3		Average rate (cents / m^3)	0.1535	0.0338	0.0100	0.0222	0.2196	0.2818	0.2031	0.4849	0.0416	0.5265	0.2196	0.5265	0.3069
4		Average rate ($ / GJ) (5)	0.041	0.009	0.003	0.006	0.058	0.075	0.054	0.128	0.011	0.139	0.058	0.139	0.081
5		Average rate change													139.8%
6	**R10**	Revenue ($000's)	419	-	-	88	507	955	324	1,279	157	1,436	507	1,436	929
7		Volumes (10^3m^3) (6)	400,382	400,382	400,382	400,382	400,382	451,957	451,957	451,957	451,957	451,957	400,382	451,957	
8		Average rate (cents / m^3)	0.1048	-	-	0.0219	0.1267	0.2112	0.0717	0.2830	0.0348	0.3177	0.1267	0.3177	0.1911
9		Average rate ($ / GJ) (5)	0.028	-	-	0.006	0.034	0.056	0.019	0.075	0.009	0.084	0.034	0.084	0.051
10		Average rate change													150.8%
11	**R20**	Revenue ($000's)	521	-	-	368	889	800	168	968	108	1,076	889	1,076	186
12		Volumes (10^3m^3) (6)	530,768	530,768	530,768	530,768	530,768	519,357	519,357	519,357	519,357	519,357	530,768	519,357	
13		Average rate (cents / m^3)	0.0982	-	-	0.0693	0.1675	0.1540	0.0323	0.1863	0.0208	0.2071	0.1675	0.2071	0.0396
14		Average rate ($ / GJ) (5)	0.026	-	-	0.018	0.044	0.041	0.009	0.049	0.006	0.055	0.044	0.055	0.010
15		Average rate change													23.6%
16	**R100**	Revenue ($000's)	2,700	-	-	1,296	3,997	1,234	222	1,456	167	1,623	3,997	1,623	(2,374)
17		Volumes (10^3m^3) (6)	2,271,427	2,271,427	2,271,427	2,271,427	2,271,427	2,219,052	2,219,052	2,219,052	2,219,052	2,219,052	2,271,427	2,219,052	
18		Average rate (cents / m^3)	0.1189	-	-	0.0571	0.1760	0.0556	0.0100	0.0656	0.0075	0.0731	0.1760	0.0731	(0.1028)
19		Average rate ($ / GJ) (5)	0.031	-	-	0.015	0.047	0.015	0.003	0.017	0.002	0.019	0.047	0.019	(0.027)
20		Average rate change													-58.4%
	Delivery South														
21	**M1**	Revenue ($000's)	8,902	1,415	412	943	11,672	8,957	4,100	13,058	2,124	15,182	11,672	15,182	3,510
22		Volumes (10^3m^3) (6)	2,765,410	2,765,410	2,765,410	2,765,410	2,765,410	2,650,399	2,650,399	2,650,399	2,650,399	2,650,399	2,765,410	2,650,399	
23		Average rate (cents / m^3)	0.3219	0.0512	0.0149	0.0341	0.4221	0.3380	0.1547	0.4927	0.0802	0.5728	0.4221	0.5728	0.1507
24		Average rate ($ / GJ) (5)	0.085	0.014	0.004	0.009	0.112	0.090	0.041	0.131	0.021	0.152	0.112	0.152	0.040
25		Average rate change													35.7%
26	**M2**	Revenue ($000's)	1,403	-	-	483	1,886	2,963	623	3,587	516	4,102	1,886	4,102	2,217
27		Volumes (10^3m^3) (6)	1,073,198	1,073,198	1,073,198	1,073,198	1,073,198	1,017,919	1,017,919	1,017,919	1,017,919	1,017,919	1,073,198	1,017,919	
28		Average rate (cents / m^3)	0.1307	-	-	0.0450	0.1757	0.2911	0.0612	0.3524	0.0507	0.4030	0.1757	0.4030	0.2273
29		Average rate ($ / GJ) (5)	0.035	-	-	0.012	0.047	0.077	0.016	0.093	0.013	0.107	0.047	0.107	0.060
30		Average rate change													129.4%
31	**M4**	Revenue ($000's)	563	-	-	475	1,038	1,190	166	1,356	161	1,517	1,038	1,517	479
32		Volumes (10^3m^3) (6)	473,628	473,628	473,628	473,628	473,628	462,743	462,743	462,743	462,743	462,743	473,628	462,743	
33		Average rate (cents / m^3)	0.1188	-	-	0.1004	0.2191	0.2571	0.0359	0.2930	0.0347	0.3278	0.2191	0.3278	0.1086
34		Average rate ($ / GJ) (5)	0.031	-	-	0.027	0.058	0.068	0.010	0.078	0.009	0.087	0.058	0.087	0.029
35		Average rate change													49.6%
36	**M5A**	Revenue ($000's)	632	-	-	354	986	1,328	102	1,430	179	1,609	986	1,609	623
37		Volumes (10^3m^3) (6)	383,809	383,809	383,809	383,809	383,809	369,224	369,224	369,224	369,224	369,224	383,809	369,224	
38		Average rate (cents / m^3)	0.1646	-	-	0.0923	0.2570	0.3596	0.0276	0.3872	0.0486	0.4358	0.2570	0.4358	0.1788
39		Average rate ($ / GJ) (5)	0.044	-	-	0.024	0.068	0.095	0.007	0.103	0.013	0.115	0.068	0.115	0.047
40		Average rate change													69.6%
41	**M7**	Revenue ($000's)	885	-	-	527	1,412	547	103	650	74	724	1,412	724	(688)
42		Volumes (10^3m^3) (6)	281,914	281,914	281,914	281,914	281,914	269,201	269,201	269,201	269,201	269,201	281,914	269,201	
43		Average rate (cents / m^3)	0.3139	-	-	0.1868	0.5007	0.2032	0.0383	0.2414	0.0274	0.2689	0.5007	0.2689	(0.2319)
44		Average rate ($ / GJ) (5)	0.083	-	-	0.049	0.133	0.054	0.010	0.064	0.007	0.071	0.133	0.071	(0.061)
45		Average rate change													-46.3%
46	**T1**	Revenue ($000's)	2,531	-	-	1,257	3,788	2,478	505	2,984	335	3,318	3,788	3,318	(470)
47		Volumes (10^3m^3) (6)	4,853,733	4,853,733	4,853,733	4,853,733	4,853,733	4,794,769	4,794,769	4,794,769	4,794,769	4,794,769	4,853,733	4,794,769	
48		Average rate (cents / m^3)	0.0521	-	-	0.0259	0.0781	0.0517	0.0105	0.0622	0.0070	0.0692	0.0781	0.0692	(0.0088)
49		Average rate ($ / GJ) (5)	0.014	-	-	0.007	0.021	0.014	0.003	0.016	0.002	0.018	0.021	0.018	(0.002)
50		Average rate change													-11.3%
51		TOTAL REVENUE	19,897	1,710	500	5,985	28,093	22,886	8,068	30,954	4,180	35,134	28,093	35,134	7,041

Notes:
(1) EB-2011-0038, Exhibit A, Tab 3, Schedule 1, Page 1 of 2, line 21 (Market Transformation Incentive).
(2) EB-2011-0038, Exhibit A, Tab 3, Schedule 1, Page 1 of 2, line 11.
(3) Allocated to rate classes in proportion to 2007 Board-Approved Rate Base.
(4) EB-2011-0025, Rate Order, Working Papers, Schedule 16, column (e).
(5) Conversion to GJ's based on Heat Value of 37.75 GJ / 10^3m^3.
(6) 2010 Volumes per Board-approved EB-2009-0275 filing. 2012 Volumes per proposed EB-2011-0025 filing.

UNION GAS LIMITED
DSM in Proposed 2012 Distribution Rates

Line No.	Particulars		Proposed Rates with DSM (1)	DSM-related Component (2)	Proposed Rates without DSM	DSM in Proposed Rates
			(a)	(b)	(c) = (a-b)	(d) = (b/a)
1	R01	Distribution Revenue ($000's)	134,415	4,188	130,227	
2		Volumes (10^3m^3)	863,695	863,695	863,695	
3		Average rate (cents / m^3)	15.5628	0.4849	15.0779	3.1%
4	R10	Distribution Revenue ($000's)	21,321	1,279	20,042	
5		Volumes (10^3m^3)	451,957	451,957	451,957	
6		Average rate (cents / m^3)	4.7174	0.2830	4.4344	6.0%
7	R20	Distribution Revenue ($000's)	7,245	968	6,278	
8		Volumes (10^3m^3)	519,357	519,357	519,357	
9		Average rate (cents / m^3)	1.3951	0.1863	1.2088	13.4%
10	R100	Distribution Revenue ($000's)	15,095	1,456	13,639	
11		Volumes (10^3m^3)	2,219,052	2,219,052	2,219,052	
12		Average rate (cents / m^3)	0.6802	0.0656	0.6146	9.6%
13	M1	Distribution Revenue ($000's)	334,817	13,058	321,760	
14		Volumes (10^3m^3)	2,650,399	2,650,399	2,650,399	
15		Average rate (cents / m^3)	12.6327	0.4927	12.1400	3.9%
16	M2	Distribution Revenue ($000's)	41,356	3,587	37,769	
17		Volumes (10^3m^3)	1,017,919	1,017,919	1,017,919	
18		Average rate (cents / m^3)	4.0628	0.3524	3.7104	8.7%
19	M4	Distribution Revenue ($000's)	12,251	1,356	10,895	
20		Volumes (10^3m^3)	462,743	462,743	462,743	
21		Average rate (cents / m^3)	2.6476	0.2930	2.3545	11.1%
22	M5A	Distribution Revenue ($000's)	8,646	1,430	7,217	
23		Volumes (10^3m^3)	369,224	369,224	369,224	
24		Average rate (cents / m^3)	2.3418	0.3872	1.9546	16.5%
25	M7	Distribution Revenue ($000's)	5,967	650	5,317	
26		Volumes (10^3m^3)	269,201	269,201	269,201	
27		Average rate (cents / m^3)	2.2167	0.2414	1.9752	10.9%
28	T1	Distribution Revenue ($000's)	56,242	2,984	53,258	
29		Volumes (10^3m^3)	4,794,769	4,794,769	4,794,769	
30		Average rate (cents / m^3)	1.1730	0.0622	1.1108	5.3%
31	Total DSM in 2012 Proposed Rates ($000's)			30,954		

Notes:
(1) EB-2011-0025, Rate Order, Working Papers, Schedule 5, column (g).
(2) EB-2011-0327, Exhibit A, Schedule 1, column (h).
Excludes DSM Incentive amounts as these are managed through annual deferral dispositions.

UNION GAS LIMITED
Calculation of 2012 DSM Budget
Allocation by Rate Class

Line No.	Particulars ($000's)	2011 Approved DSM Budget (1)	2012 DSM Program Budget (2)	2012 Low Income Program Budget (3)	2012 Inflation Factor (4)	2012 Total 2012 DSM Budget	DSM Budget Variance
		(a)	(b)	(c)	(d)	(e) = (b+c+d)	(f) = (e-a)
	Northern & Eastern Operations Area						
1	R01	2,380	2,366	1,705	117	4,188	1,808
2	R10	2,053	928	315	36	1,279	(774)
3	R20	1,477	777	163	27	968	(510)
4	R100	2,375	1,200	216	41	1,456	(919)
5	Total North (lines 1-4)	8,285	5,271	2,400	220	7,891	(395)
	Southern Operations Area						
6	M1	7,930	8,707	3,986	364	13,058	5,127
7	M2	3,286	2,881	606	100	3,587	301
8	M4	2,693	1,157	162	38	1,356	(1,337)
9	M5	-	1,291	99	40	1,430	1,430
10	M7	1,023	532	100	18	650	(373)
11	T1	1,671	2,409	491	83	2,984	1,312
12	Total South (line 6-11)	16,604	16,976	5,444	643	23,064	6,459
13	Total Union (line 5 + line 12)	24,890	22,247	7,843	864	30,954	6,064

Notes:
(1) EB-2010-0148, Rate Order, Working Papers, Schedule 4, column (p).
(2) Per EB-2011-0327 filing.
(3) Allocated to rate classes based on 2007 Board-approved rate base.
(4) Inflation factor of 2.87% obtained from Statistics Canada, National Income and Expenditure Accounts, Table 30 - Cansim Table No 3800003 First Quarter 2011.

Annual % Change in GDP IPI	
April - June 2010	3.04%
July - September 2010	2.60%
October - December 2010	2.81%
January - March 2011	3.04%
Average % Change	2.87%

PROPOSED DSM PROGRAMS

PROGRAMS OF

UNION LIMITED

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1/ DISTRIBUTION SYSTEM CHARACTERISTICS

On page 45, under section 18.1 of the Guidelines, the Board requested the following characteristics of Union's distribution system:

a) Total natural gas purchases;

b) Sales by rate class; and

c) Number of customers by rate class.

The information requested by the Board is below.

a) Total Natural Gas Purchases

Below is the total gas purchased for system sales customers and the quantity of gas supplied for the account of direct purchase customers in 2010 as reported to the Board through the Q4 2010 Reporting and Record Keeping Requirements. Union does not purchase gas for direct purchase customers.

Gas Purchased for System Sales Customers:	3,151 10^6m^3
Gas Supplied for the Account of Direct Purchase Customers:	9,461 10^6m^3

b) and c) Sales and Number of Customers by Rate Class

Sales and number of customers by rate class as of Q4, 2010 are included below respectively. This information has also been provided in Union’s 2010 Deferral Disposition Proceeding (EB-2011-0038).

UNION GAS LIMITED
Total Gas Sales Revenue by Service Type and Rate Class
All Customer Rate Classes
Year Ended December 31

Line No.	Particulars ($000s)	2009 Actual System Sales (a)	ABC-T (b)	ABC Unbundled (c)	Bundled-T (d)	T-Service (e)	Total (f)	2010 Actual System Sales (g)	ABC-T (h)	ABC Unbundled (i)	Bundled-T (j)	T-Service (k)	Total (l)
	General Service												
1	Rate M1 Firm	842,724	72,384	37,524	1,259	-	953,891	742,945	62,690	29,384	893	-	835,912
2	Rate M2 Firm	128,671	17,618	4,270	12,626	-	163,185	112,890	16,660	3,179	11,081	-	143,810
3	Rate 01 Firm	277,483	70,432	-	976	-	348,891	246,293	58,770	-	1,109	-	306,172
4	Rate 10 Firm	52,938	12,608	-	10,040	-	75,586	40,094	11,090	-	10,141	-	61,325
5	Rate 16 Interruptible	-	-	-	-	-	-	-	-	-	-	-	-
6	Total General Service	1,301,816	173,042	41,794	24,901	-	1,541,553	1,142,221	149,211	32,563	23,223	-	1,347,218
	Wholesale - Utility												
7	Rate M9 Firm	-	-	-	970	-	970	-	-	-	876	-	876
8	Rate M10 Firm	16	5	-	-	-	21	9	3	-	-	-	12
9	Rate 77 Firm	-	-	-	-	-	-	-	-	-	-	-	-
10	Total Wholesale - Utility	16	5	-	970	-	991	9	3	-	876	-	888
	Contract												
11	Rate M4	7,037	132	-	13,098	-	20,267	3,887	115	-	11,540	-	15,542
12	Rate M6	-	-	-	-	-	-	-	-	-	-	-	-
13	Rate M7	-	-	-	9,020	-	9,020	-	-	-	6,381	-	6,381
14	Rate 20 Storage	-	-	-	-	1,199	1,199	-	-	-	-	1,376	1,376
15	Rate 20 Transportation	4,699	-	-	7,431	7,514	19,644	3,861	-	-	8,532	7,407	19,801
16	Rate 100 Storage	-	-	-	-	816	816	-	-	-	-	839	839
17	Rate 100 Transportation	-	-	-	-	13,293	13,293	-	-	-	-	12,639	12,639
18	Rate T-1 Storage	-	-	-	-	9,746	9,746	-	-	-	-	9,982	9,982
19	Rate T-1 Transportation	-	-	-	-	45,824	45,824	-	-	-	-	49,548	49,548
20	Rate T-3 Storage	-	-	-	-	1,447	1,447	-	-	-	-	1,392	1,392
21	Rate T-3 Transportation	-	-	-	-	3,803	3,803	-	-	-	-	3,614	3,614
22	Rate M5	477	-	-	8,938	-	9,415	4,765	36	-	8,759	-	13,560
23	Rate 25	19,558	-	-	-	2,797	22,355	11,070	-	-	-	3,536	14,606
24	Rate 30	-	-	-	-	130	130	-	-	-	-	66	66
25	Total Contract	31,771	132	-	38,487	86,569	156,959	23,583	151	-	35,212	90,400	149,345
26	Total Revenue	$ 1,333,603	$ 173,179	$ 41,794	$ 64,358	$ 86,569	$ 1,699,503	$ 1,165,813	$ 149,365	$ 32,563	$ 59,311	$ 90,400	$ 1,497,451

Note:

1 Originally Filed in EB-2011-0038 as Exhibit A, Tab 2, Appendix A, Schedule 8

UNION GAS LIMITED
Total Customers by Service Type and Rate Class
All Customer Rate Classes
Year Ended December 31 (1)

		2007 Board-Approved						2009 Actual						2010 Actual					
Line No.	Particulars	System Sales	ABC-T	ABC-Unbundled	Bundled T	T-Service	Total	Sales	ABC-T	ABC-Unbundled	Bundled T	T-Service	Total	System Sales	ABC-T	ABC-Unbundled	Bundled T	T-Service	Total
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
	General Service																		
1	Rate M1 Firm	-	-	-	-	-	-	723,093	184,653	102,461	940	-	1,011,147	783,779	161,276	79,713	930	-	1,025,698
2	Rate M2 Firm	663,740	297,276	34,458	1,690	-	997,164	2,789	2,636	355	786	-	6,566	3,055	2,517	262	773	-	6,607
3	Rate 01 Firm	172,580	125,484	-	166	-	298,230	203,416	100,853	-	314	-	304,583	223,892	84,611		343	-	308,846
4	Rate 10 Firm	1,329	1,344	-	300	-	2,973	1,074	893	-	280	-	2,247	1,110	758		286	-	2,154
5	Rate 16 Interruptible	-	-	-		-	-	-	-	-	-	-	-					-	-
6	Total General Service	837,649	424,104	34,458	2,156	-	1,298,367	930,372	289,035	102,816	2,320	-	1,324,543	1,011,836	249,162	79,975	2,332	-	1,343,305
	Wholesale - Utility																		
7	Rate M9 Firm	-	-	-	2	-	2	-	-	-	2	-	2	-	-	-	2	-	2
8	Rate M10 Firm	4	-	-	-	-	4	1	1	-	-	-	2	1	1	-	-	-	2
9	Rate 77 Firm	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
10	Total Wholesale - Utility	4	-	-	2	1	7	1	1	-	2	-	4	1	1	-	2	-	4
	Contract																		
11	Rate M4	13	-	-	181	-	194	12	3	-	130	-	145	9	2	-	119	-	130
12	Rate M6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	Rate M7	-	-	-	8	-	8	-	-	-	6	-	6	-	-	-	6	-	6
14	Rate 20 Storage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	Rate 20 Transportation	10	-	-	20	35	65	3	-	-	19	30	52	3	-	-	17	31	51
16	Rate 100 Storage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	Rate 100 Transportation	-	-	-	-	19	19	-	-	-	-	16	16	-	-	-	-	16	16
18	Rate T-1 Storage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	Rate T-1 Transportation	-	-	-	-	68	68	-	-	-	-	53	53	-	-	-	-	53	53
20	Rate T-3 Storage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	Rate T-3 Transportation	-	-	-	-	1	1	-	-	-	-	1	1	-	-	-	-	1	1
22	Rate M5	-	-	-	133	-	133	3	-	-	121	-	124	4	1	-	125	-	130
23	Rate 25	56	-	-	-	67	123	46	-	-	-	52	98	46	-	-	-	53	99
24	Rate 30	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-
25	Total Contract	79	-	-	342	190	611	64	3	-	276	153	496	62	3	-	267	154	486
26	Total Customers	837,732	424,104	34,458	2,500	191	1,298,985	930,437	289,039	102,816	2,598	153	1,325,043	1,011,899	249,166	79,975	2,601	154	1,343,795

Note:
1 Customer count for storage is included in the transportation customer count.
2 Originally Filed in EB-2011-0038 as Tab 2, Appendix A, Schedule 10

2/ PROGRAMS

This section provides an outline of the Programs Union plans to deliver over the 2012 – 2014 DSM Plan period. Union will remain focused on continual improvements with respect to its Programs and approach to market as new information becomes available. For example, changing market conditions, new information, or process improvements may warrant Union to alter its DSM Program mix to effectively utilize the DSM budget and achieve targets.

Resource Acquisition

1.0 *Residential Program*

1.0.1 Customer Class(es) Targeted

- The Energy Savings Kit ("ESK") offering is targeted to Union residential customers in detached, semi-detached, townhouses and individually metered row townhouses.
- The Attic and Basement Wall Insulation offering will target single-family residential homes built prior to 1980.

1.0.2 Rate Classes Targeted

- Rate M1, Rate 01

1.0.3 Residential Program Goals

Program goals for the Residential Program consist of the following:

- Create/increase customer awareness of both energy conservation and energy efficiency, with a primary focus on available energy efficiency offerings
- Influence customers to install energy efficient measures; thereby, improving efficiency in space and water heating
- Minimize the barriers that residential customers face in participating in energy efficiency offerings
- Empower customers to reduce their energy bills and environmental footprint

1.0.4 Residential Program Strategy

Program strategies to achieve Union's goals for the Residential Program include:

- Targeting the reduction of natural gas consumption for both space and water heating, by delivering a combination of customer communication, education and financial incentives
- Consistent with the direction provided from the Board, over the course of the Plan Union will decrease emphasis on basic measure offerings and increase focus on deep measure offerings

- As the focus on deep measure offerings grows, expand the geographical areas targeted; thereby, increasing the energy savings delivered through deep measure participants
- Reduce, but not eliminate, basic measure offerings to ensure that the residential market as a whole continues to have access to energy efficiency measures

1.0.5 Residential Program Offerings

The offerings delivered in the Residential Program are outlined below.

Energy Savings Kit ("ESK")

- ESKs have been distributed to Union's customers since 2000.

Description

- ESKs are pre-packaged measures designed to reduce a customer's energy usage and water consumption.
- In 2011 the Energy Saving Kit contained:
  - Energy efficient Showerhead [1.25 Gallons Per Minute (GPM) (4.73 LPM)]
  - Energy efficient kitchen aerator [1.50 GPM (5.68 LPM)]
  - Energy efficient bathroom aerator [1.00 GPM (3.79 LPM)]
  - Pipe wrap (two 1 meter lengths)
  - Teflon tape (1 roll for ease of showerhead installation)
  - $25 Programmable Thermostat coupon
- The new Energy Saving Kit, effective 2012, will continue to contain the above items and has been enhanced with the inclusion of a draft proofing kit, which will contain the following:
  - 1 Foam Can
    - Used for sealing air leakage through holes, gaps, and cracks
  - 1 Caulking Tube
    - Used for air sealing around fixed window sill frames, or along baseboards
  - 3 Rolls of Foam Tape [10 Ft roll (3 metres)]

        - Used to fill gaps around doors and windows
    - 4 Energy Saver Gaskets with 2 child safety inserts
        - Fits into electrical outlets and used to stop air leaks into the wall cavities

- The addition of the draft proofing kit enhances energy savings for customers and supports continued access to efficiency measures for the Residential market as a whole.

Target Market

- The ESK offering is targeted to Union residential customers in detached, semi-detached, townhouses and individually metered row townhouses who have a natural gas water heater or furnace.
- The primary target is customers who have not received a kit before. Customers who have previously received Union's former energy efficient kit will be eligible to receive a new kit and savings will be measured based on the replaced kit.
- This offering is not available to Union customers living in high-rise buildings and multi-family buildings with more than five units. These buildings are targeted by Union's commercial offerings.

Market Incentive

- All water savings measures are provided in the ESK at no cost to the customer
- All draft-proofing measures are provided in the ESK at no cost to the customer
- A $25 coupon for a programmable thermostat (PSTAT) is provided in the ESK

Market Delivery

- The ESK is delivered through a combination of customer communication, education and incentives, and is largely consistent with 2011.
    - Customer communication (e.g. Bill inserts and Direct Mail)
    - Education (e.g. Wise Energy Guide, InTouch, EnerSmart)

- Financial incentives (Rebate on PSTAT purchase)

- Union's communication and education tools deliver the message that a key way to reduce energy bills is through conservation. These vehicles provide specific and relevant advice on actions residential customers can take to achieve energy savings, such as the installation of an ESK.
- Union employs the following three approaches to deliver ESKs to the residential market
  - Pull Approach:
    - The Pull delivery method is a mass market approach. Customers initiate the request for an ESK after receiving marketing material created and distributed by Union.
    - Examples of marketing material customers receive and act upon are bill inserts, direct mail campaigns and advertisements for events that Union holds at major retail stores, local events and home shows. Customers further spread these messages through referrals to friends and neighbours. In the case of Direct Mail, Union targets only those customers who have not received an ESK in the past.
    - The customer then initiates a request for an ESK by going to the Union website, attending an event, visiting a pick-up location, or going to a local consumer show, etc.
  - Push Approach:
    - The Push delivery method is a mass market approach. Service providers and Heating, Ventilation and Air Conditioning Contractors ("HVACs") promote and distribute the ESK during their regular service calls, as well as at tradeshows and local events that they attend.
    - The service providers/HVACS receive an incentive for each ESK they distribute
    - This approach also encourages HVAC's to educate themselves on the value of energy efficiency and deliver this value to their customers. This is a form of capacity building by educating channels on the value of energy efficiency.
  - Install Approach:
    - In the install delivery method, service providers/HVACS promote the ESK during their regular service calls.
    - The service provider/HVAC then installs certain components of the kit (showerhead and pipe-wrap).

        - Service providers/HVACs receive an incentive for each ESK installed.

Barriers Addressed

- Some Union customers are not aware that the ESK is available. This is especially true in smaller cities/towns where retail and local events do not happen as frequently
    - To address this challenge Union actively solicits customers and selects retail and local event locations that are not only in urban centres, but also in areas close to the city's outer-edges. This makes it easier for those customers living in outlying areas to receive an ESK.
- Customers located in remote areas are less likely to have internet access and limited or no access to HVAC pick-up locations, making it more difficult for them to obtain an ESK.
    - To address this barrier Union ensures that all direct mail, bill insert and other marketing campaigns/materials include the option of mailing in an order form. /this approach allows customers without internet access or HVAC pick-up locations nearby to easily obtain an ESK
    - Union is developing a plan to provide customers with a phone number where they can request an ESK to accommodate those customers in remote areas with no access to the internet.
- Customers are not aware of energy and water savings options and/or draft proofing opportunities within their homes and how to properly address them. Therefore, they may not believe they require an ESK.
    - To address this Union clearly promotes energy and water savings options. Also Union will educate customers on how to identify draft proofing opportunities within the home to ensure that customers can easily identify that they need and would benefit from obtaining an ESK with draft proofing kit.
- With very low natural gas prices, and increasing electricity prices, customers are less focused on natural gas efficiency
    - To address this Union will educate customers on the importance of water and natural gas savings. With the addition of the draft proofing kit, Union will educate customers on electric and gas savings associated with sealing air leakage to prevent the loss of warm air in the winter and cool air in the summer.

Attic & Basement Wall Insulation

Description

- 2012 is the first year Union will offer a residential home insulation, deep measure offering
  - This offering provides prescriptive incentives for residential homeowners who install one or both of the following measures: Attic insulation – improving insulation from R-10 or below to R-40 or above
  - Basement wall insulation – improving insulation from R-1 or below to R-12 or above
- The offering encourages and incents homeowners to weatherize their homes, leading to deep energy savings and increased comfort due to:
  - Reduced cold air drafts, summer overheating and moisture/condensation problems
  - Reduced noise from outside the house
  - Improved indoor air quality and humidity levels
- To prevent lost opportunities, promotional material will educate customers on the benefits of undertaking additional air sealing measures, such as sealing exposed ducts, header areas, and service penetrations (including plumbing, wiring etc.).
- The Federal Government's *EcoEnergy Retrofit - Homes* program offers grants for attic and basement insulation. Union will build upon the momentum established by this initiative (and complementary support provided by the Ontario Government) by launching the attic and basement wall insulation offering when the 2011-2012 extension of the program is finished (anticipated end date is March 2012).

Target Market

- The offering will target single-family residential homes built prior to 1980 and heated by natural gas.
- To participate, existing insulation must be at R-1 or below for basement walls and at R-10 or below for attics.
- To improve cost effectiveness, the offering will primarily target unfinished attics and basements where insulation can be added without removing walls or other structures.

- For attics, insulation must be installed only where cavities separate conditioned space from unconditioned areas of the residence.

Market Incentive

- Customer incentives for this offering will be valued at 50% of the estimated incremental cost of each measure to a maximum value as outlined in Table 1 below.

Table 1 – Insulation Incentive Levels

Measure	Incentive Calculation	Maximum Incentive
Attic Insulation	50% of incremental cost	$300
Basement Insulation	50% of incremental cost	$825

- The incentive will be provided after the work is complete and receipts have been submitted to Union.
- The incremental cost includes the cost of the insulation and the cost of installation.

Market Delivery

- Union will drive participation in this offering via two main methods, including:
    - End-use customer communications. Customers will be targeted using a mix of promotions/initiatives that educate them on the benefits of improving insulation and air sealing to maximize energy efficiency and comfort.
        - Opportunities to target individual communities or neighbourhoods will be explored. Targeted areas that are suitable for these insulation offerings will be determined by analyzing billing data and other home characteristics obtained through a third party.
    - Working with mid-stream trade allies, including:
        - Contractors – Union will educate contractors on the benefits of improving insulation and air sealing, and will provide them with the material required to ‘sell’ these benefits, and Union’s our incentive offering, to customers when they are already at the home quoting on or completing other renovations/upgrades.

        - Insulation Installers – Union will provide these installers with marketing material they can provide to their customers above and beyond their own material. It will include the incentive value that Union is offering and will clearly explain the benefits of installing attic and basement wall insulation.

Barriers Addressed

Primary barriers preventing higher uptake in the market include the following:

- High product and installation costs
    - Union will address this barrier through the provision of financial incentives to eligible homeowners.
- Lack of customer awareness regarding what insulation they currently have in place
    - Union will address this barrier by educating customers on how to identify signs of insulation problems (e.g., wall is cold to touch in winter, uneven heating levels, mould growing in basement, ineffectiveness of air conditioning system in the summer).
- Lack of consumer awareness regarding the benefits of high efficiency insulation and how to differentiate between products
    - Union will address this barrier by educating customers on how to evaluate the thermal resistance of insulation, calculate payback on weatherization upgrades, and ultimately make informed purchase decisions.
    - Union will also encourage customers to have a professional energy audit or evaluation to understand insulation and air sealing opportunities in the home (including opportunities not incented by Union) and the benefits they could experience by upgrading.
- Lack of contractor expertise in selling the long-term benefits of high efficiency
    - Union will address this barrier by providing promotional materials to contractors to assist them in selling the benefits of improved insulation and Union's incentive offering.
- In addition to the barriers listed above, lost opportunities arise when homeowners complete extensive renovations/upgrades, but fail to add insulation. Due to the high cost of large renovation projects, such as finishing a basement or attic, insulation is not always viewed as a top priority or worthy investment. Unfortunately, once the space is finished and comfort and heating problems emerge, insulation is much more expensive and therefore often not installed.

- Union will address this barrier through the provision of financial incentives to eligible homeowners, and also through education (delivered both directly and using mid-stream channels).

1.0.6 Program Duration

- All offerings to residential customers are expected to be delivered throughout the 2012-2014 DSM Plan, although the insulation offering will be deferred until such time as federal program incentives come to an end.
- The measures within the offerings may vary should new measures be introduced or market conditions change over the course of the Plan.

1.0.7 Residential Program Budget

- Union has not included inflation in Table 2 below. Union proposes to use the Q2 GDP-IPI inflation factor, released at the end of August, to align with Union's annual rate setting process.

Table 2 - Residential Program Budget

Residential Program Budget ($000)			
Program Costs	**2012**	**2013**	**2014**
Promotion Costs	$2,049	$2,208	$2,092
Incentive Costs	$1,668	$1,688	$1,576
EM&V & Monitoring Costs	$20	$20	$20
Administrative Costs	$366	$366	$366
Total	**$4,103**	**$4,282**	**$4,054**

1.0.8 Residential Cost Effectiveness

Table 3 – Residential Program Cost Effectiveness

Measure	Participants	Total TRC Benefits	Total TRC Costs	Total Net TRC Before Program Costs	TRC Ratio
NHC - Faucet Aerator - Bath - 1.0gpm	280	$ 10,658	$ 111	$ 10,547	96.3
NHC - Faucet Aerator - Kitchen - 1.5gpm	280	$ 19,541	$ 242	$ 19,299	80.7
NHC - Showerhead - 1.25gpm	280	$ 59,398	$ 955	$ 58,443	62.2
Install - Faucet Aerator - Bath - 1.0gpm [1]	1,705	$ 27,328	$ 674	$ 26,654	40.5
Install - Faucet Aerator - Bath - 1.0gpm replacing existing 1.5gpm [1]	255	$ 1,807	$ 101	$ 1,706	17.9
Install - Faucet Aerator - Kitchen - 1.5gpm [1]	1,960	$ 85,837	$ 1,694	$ 84,143	50.7
Install - Pipe Insulation - 2m [1]	1,960	$ 57,369	$ 1,844	$ 55,525	31.1
Install - Showerhead - 1.25gpm [1]	1,705	$ 289,489	$ 5,816	$ 283,672	49.8
Install - Showerhead - 1.25gpm replacing existing 2.0 gpm [1]	255	$ 37,523	$ 869	$ 36,654	43.2
Pull - Faucet Aerator - Bath - 1.0gpm [1]	29,232	$ 564,105	$ 11,555	$ 552,549	48.8
Pull - Faucet Aerator - Bath - 1.0gpm replacing existing 1.5gpm [1]	4,368	$ 37,294	$ 1,727	$ 35,568	21.6
Pull - Faucet Aerator - Kitchen - 1.5gpm [1]	33,600	$ 1,662,189	$ 29,040	$ 1,633,148	57.2
Pull - Pipe Insulation - 2m [1]	33,600	$ 538,951	$ 31,611	$ 507,340	17.0
Pull - Showerhead - 1.25gpm [1]	29,232	$ 3,623,332	$ 99,710	$ 3,523,621	36.3
Pull - Showerhead - 1.25gpm replacing existing 2.0 gpm [1]	4,368	$ 469,656	$ 14,899	$ 454,757	31.5
Push - Faucet Aerator - Bath - 1.0gpm [1]	17,539	$ 252,977	$ 6,933	$ 246,044	36.5
Push - Faucet Aerator - Bath - 1.0gpm replacing existing 1.5gpm [1]	2,621	$ 16,725	$ 1,036	$ 15,689	16.1
Push - Faucet Aerator - Kitchen - 1.5gpm [1]	20,160	$ 794,601	$ 17,424	$ 777,177	45.6
Push - Pipe Insulation - 2m [1]	20,160	$ 310,214	$ 18,967	$ 291,247	16.4
Push - Showerhead - 1.25gpm [1]	17,539	$ 1,525,632	$ 59,826	$ 1,465,806	25.5
Push - Showerhead - 1.25gpm replacing existing 2.0 gpm [1]	2,621	$ 197,752	$ 8,940	$ 188,813	22.1
Thermostat - Programmable	6,000	$ 674,882	$ 85,500	$ 589,382	7.9
Attic Insulation	88	$ 27,163	$ 34,197	-$ 7,034	0.8
Basement Wall Insulation	87	$ 66,479	$ 96,412	-$ 29,932	0.7
Draft Proofing Kit [2]	56,000	$ 822,729	$ 504,000	$ 318,729	1.6
Total		**$ 12,173,630**	**$ 1,034,083**	**$ 11,139,546**	
		Promotion Costs	$ 2,048,417		
		Administration	$ 365,851		
		EM&V Costs	$ 20,000		
		Program Total		**$ 8,705,278**	
		Program TRC Ratio			**3.5**

1. TRC benefits adjusted based on 2010 verification study results. The adjustments reflect installation rates, persistance rates, percentage of showering under showerhead (for showerhead measures), and percentage of homes without gas water heaters.

2. Draft proofing kit includes: 1 Foam Can, 1 Caulking Tube, 3 Rolls of Foam Tape, 4 Energy Saver Gaskets with 2 Child Safety Inserts

1.0.9 Residential Program Targets

Table 4 – Residential Program Targets

2012 Residential Program Targets			
Metric	**Metric Target Levels**		
	50%	**100%**	**150%**
Cumulative Natural Gas Savings (m3)	12,409,000	24,819,000	31,023,000
Deep Measures	88	175	219

2013 Residential Program Targets			
Metric	Metric Target Levels		
	50%	100%	150%
Cumulative Natural Gas Savings (m3)	11,989,000	23,978,000	29,973,000
Deep Measures	155	310	388

2014 Residential Program Targets			
Metric	Metric Target Levels		
	50%	100%	150%
Cumulative Natural Gas Savings (m3)	11,005,000	22,009,000	27,512,000
Deep Measures	155	310	388

1.0.10 Rationale for Targets

Consideration of Board's Guiding Objectives

- Maximization of cost effective natural gas savings
    - As ESK measures are cost effective on a $/cumulative m^3 basis, Union has maintained delivery of ESKs, and added draft proofing measures, to ensure significant m^3 savings are achieved within the DSM budget allocated to the residential Program.
- Prevention of lost opportunities, pursuit of deep energy savings
    - Union has introduced a deep measure home insulation offering that will drive significant savings for each participant.
    - Union has reduced the level of ESK distribution in 2012, 2013 and 2014 relative to previous years, as the measures in the ESK are low cost discretional retrofits and do not constitute deep measures or lost opportunities.

Context for ESK Targets

Cost Effectiveness

- Union has been offering the ESK in the market since 2000 and has seen great success over the years. With increasing penetration in major cities it is getting harder and more expensive to reach new customers. Though Union is focusing on using the most cost effective delivery methods, the cost of reaching new customers is rising.

- Over the past five years, the ESK has continued to become less cost effective due to the rising costs of reaching new customers who have not received an ESK as well as changes in input assumptions.

- Moving forward, however, Union is using historical performance data to refine its delivery channel mix to target a greater proportion of ESKs through the more cost-effective channels.

- An example of a cost-effective channel that will be used more moving forward is the 'Pull channel', specifically where customers receive a bill insert or direct mail and request an ESK on the Union website.

Targets

- Given Union's shift of focus to the delivery of deeper measures, Union will be decreasing its focus on basic measure delivery over the course of the Plan and ultimately the targets tied to the offering. This is reflected in the decreased budget allocated to basic measure delivery as shown in Table 3.

Table 5: Energy Savings Kit Delivery and Budget Over the Term of the Plan

Energy Savings Kit Participants and Budget			
	2012	**2013**	**2014**
Draft Proofing[1]			
Units	56,000	54,000	50,000
Cumulative m^3 (000)	2,974	2,867	2,655
Programmable Thermostats			
Units	6,000	5,500	5,000
Cumulative m^3 (000)	2,719	2,492	2,266
Water Saving Measures[2]			
Units	56,000	54,000	50,000
Cumulative m^3 (000)	18,622	17,723	16,192
Total ESKs (Units)	**56,000**	**54,000**	**50,000**
Total Cumulative m^3 (000)	24,315	23,082	21,113
ESK Budget ($000)[3]	**$3,219**	**$3,222**	**$2,994**
$ Spent/Cumulative m^3	$0.132	$0.140	$0.142

[1] Caulking, Foam Can, Foam Tape, Foam Cover for Electric Outlets, Energy Saver Gasket with Child Safety Insert
[2] Showerhead, Kitchen Aerator, Bathroom Aerator, Pipe Wrap (x2)
[3] Promotion and incentive costs have been included as they are specific to the Energy Savings Kit Offering.

- The effect of decreasing the basic measures over the course of the Plan is that the overall residential cumulative m^3 savings will decrease.
- Basic measures are still cost effective on a $/cumulative m^3 basis when compared to deep measures. To ensure significant m^3 savings are achieved within the DSM budget allocated to the Residential Program, Union has maintained delivery of basic measures (ESK and PSTAT), and added draft proofing measures.

Context for Attic & Wall Insulation Targets

- Over the 2007-2010 period, Union estimates that approximately 4,000 Union customers installed attic insulation as part of the federal *EcoEnergy Retrofit – Homes* program, while 2,200 installed basement wall insulation. Assuming that installations were evenly dispersed through the three year period, approximately 1,300 and 700 homeowners respectively installed attic and basement wall insulation each year of the program.
- Union believes these estimated annual participation levels *in EcoEnergy Retrofit—Homes* represent the maximum activity for attic and basement wall insulation in a given year. These estimates are also consistent with the 2017 static forecast for the home weatherization measure included in the 2007 Efficiency Potential Study completed by ICF Marbek.
- Using this maximum potential, Union adjusted annual targets downward to reflect the following:
    - As a result of *EcoEnergy Retrofit—Homes*, the "low-hanging fruit" for these measures is now gone. Remaining customers that qualify for the offering are likely not aware of the insulation deficiency and will require aggressive marketing and education to convert.
    - Compared to *EcoEnergy Retrofit – Homes*, the Union offering has more complicated qualification requirements, less scale (regional vs. national), a reduced budget, and also lacks the support of major federal and provincial agencies and government organizations.
    - The 2012 target takes into account a delay in launching the offering, as the *EcoEnergy Retrofit – Homes* program is not expected to conclude until March, 2012.
- Measure adoption has already reached a mature state, following support from *EcoEnergy Retrofit – Homes*. Therefore, adoption is expected to be flat once initial momentum has been built.

Table 6: Attic & Basement Wall Insulation Delivery and Budget

Attic & Basement Wall Insulation Participants and Budget			
	2012	**2013**	**2014**
Attic Insulation			
Units/Projects	88	155	155
Cumulative m^3 (000)	124	218	218
Basement Wall Insulation			
Units/Projects	87	155	155
Cumulative m^3 (000)	380	678	678
Total Insulation Units/Projects	**175**	**310**	**310**
Total Cumulative m^3 (000)	**504**	**896**	**896**
Insulation Budget ($000)	**$498**	**$674**	**$674**
$ Spent/Cumulative m^3	**$0.988**	**$0.752**	**$0.752**

1.0.11 Challenges Union Will Face in Achieving Residential Targets

Challenges in Achieving ESK Targets Include:

- Market acceptance – Customers who were most receptive to the ESK have already implemented it. Therefore, it will be more challenging for Union to drive the remaining market to adopt and install the measures in the kit.
- Cost to reach new customers is rising as a more targeted approach is required
- Changes in input assumptions as a result of the annual evaluation process would affect the m^3's earned per unit
- Offer is limited to customers with natural gas heaters; therefore, 10% of Union customers do not qualify
- Market opportunity – it is becoming increasingly challenging for channel partners to find and target customers who have not received an ESK as the offer has been delivered since 2000
- Targeting new locations with lower ESK saturation will require Union to establish new channel relationships over the term of the Plan

[5] Promotion and incentive costs have been included as they are specific to the attic and basement wall insulation offering

- Reduction in number of kits distributed through retail events due to higher level of penetration in major cities
- Ontario Power Authority ("OPA") launched a "Save on Energy" peasure that partners with retailers in May and October to promote discounts on electric products such as CFLs and Power Bars. Although these products don't compete directly with Union' offerings, there could be a conflict for retail channels that offer the OPA program
- With more focus on deep measures, there will be a shift in internal resources to accommodate this offering and fewer resources to accommodate ESK's
- Electricity CDM measures will also be targeted at Union customers, which will dilute the focus on Union's offerings

Challenges in Achieving Attic & Basement Wall Insulation Targets

- Changes in input assumptions that impact m^3 earned per unit
- Market acceptance – In order to make attic and basement wall insulation a prescriptive offering, qualification criteria will be stringent and will be challenging to explain to customers
- Union does not anticipate launching the offering until the The *EcoEnergy Retrofit-Homes* offering concludes. The program is expected to run until March, 2012.
- Additional market intelligence must be gathered and the development of new channels and relationships will take time.
- Given success of *EcoEnergy Retrofit-Homes*, Union anticipates facing challenges in identifying and targeting remaining qualifying homes for insulation measures. It is estimated that approximately one third of single-family homes within the Union franchise area will not qualify for the offering based on vintage alone (built in 1980 or after), while a further proportion will have already installed insulation or will not meet other eligibility requirements. Limits in market opportunity and the advanced stage of market adoption for these measures suggest a mass-market approach will not be sufficient to achieve the 100% target. A targeted approach will be required.
- Experience with Low Income Weatherization has revealed that insulation opportunities can vary dramatically across regions, suggesting a need for local cooperation, experimentation and analysis in order to effectively target homes on an individual or neighbourhood basis. The heterogeneous nature of the Ontario housing stock will also require that Union continually tailor its approach to market.

- A homeowner is more likely to undertake basement insulation as part of a broader basement renovation (for example: finishing the basement for extra living space). Major expenditures such as this will be impacted by the economic downturn.

1.1 *Commercial/Industrial Program*

1.1.1 Customer Class(es) Targeted

- Commercial / Industrial General Service and Commercial / Industrial Contract customers
- Targets market segments that include but are not limited to:
  - Manufacturing, Industrial Processing and Refining, Municipalities, Universities, Schools, Hospitals, Warehouse and Greenhouse
  - Commercial customers with multiple facilities in Union's franchise area that are managed by a single corporate entity (i.e. National Accounts)

1.1.2 Rate Classes Targeted

- Rate classes eligible: Rate M1, Rate M2, Rate 01, Rate 10, Rate M4, Rate M5, Rate M7, Rate 20

1.1.3 Program Goals

Program goals for the Commercial / Industrial Program consist of the following:

- Increase customer's awareness and knowledge of energy efficient practices, and provide education on how to operate in an energy-efficient manner
- Generate long term energy savings in commercial, institutional and industrial facilities
- Increase participation from customers who have not yet embraced a culture of conservation in their facility

1.1.4 Program Strategy

Program strategies to achieve Union's goals for the Commercial / Industrial Program include:

- Deliver a comprehensive suite of cost effective DSM initiatives across all sectors and customer types
- Provide customers with incentives, education and training to help them reduce their energy usage

- Expand the knowledge base and awareness of service providers including: HVAC contractors, architects, designers and engineers (key influencers) on energy efficiency technologies by motivating them to take action and market high efficiency technology
- Build strategic relationships with key organizations and service providers to maximize alliance opportunities to expand the reach of the Program.

1.1.5 **Program Offerings**

Union encourages the adoption of energy efficient technology and equipment targeting facilities in the commercial, institutional and industrial markets, using a segment focus. Union influences end-use customers, and the many stakeholders and trade allies in this market, to use best practices when operating or replacing equipment and when implementing energy efficiency projects. Offerings will continue to target end use customers and will be marketed both directly through an account management approach and indirectly through trade allies.

The offerings delivered in the Commercial / Industrial Program are outlined below.

Prescriptive Offering

The prescriptive offering will provide customers with a list of recommended technologies that have pre-determined incentive and savings amounts, defined by facility type and equipment size. The application process for the prescriptive offering promotes ease of participation as no additional analysis or savings calculations are required. This allows customers with multiple facilities the option of rolling out technologies to an entire portfolio in an efficient way. Program initiatives target space heating, water heating, ventilation, building controls, heat recovery and efficient equipment (for cooking, cleaning and laundry) applications.

Description

- The prescriptive offering consists of several energy efficient measures that target significant m^3 savings:
  - Condensing Boilers
  - Infrared Heating
  - Energy Recovery Ventilators
  - Heat Recovery Ventilators
  - Condensing Rooftop Units
  - Drain Water Heat Recovery Systems
  - Laundry Washing Equipment with Ozone
  - Condensing Unit Heaters
  - Condensing Gas Water Heaters
  - Demand Control Kitchen Ventilation
  - CEE Tier 2 Front-Loading Clothes Washers
  - Energy Star Dishwashers
  - Hot Water Conservation (Showerheads and Faucet Aerators)
  - Energy Star Convection Ovens
  - Energy Star Steam Cookers
  - Energy Star Fryers
  - High-Efficiency Under-Fired Broilers
  - Hydronic Boilers
  - Air Curtains (Pedestrian Doors & Shipping Docks)
  - Destratification Fans

- Union will explore additional measures to include in the prescriptive offering over the course of the Plan, including but not limited to:
  - Linkageless Controls
  - Non-Condensing Boilers
  - Boiler Economizers (Non Condensing & Condensing)
  - Greenhouse Energy Curtains
  - Demand Control Ventilation
  - High Performance Greenhouse Glazing
  - Boiler Tune-Up
  - Boiler Outdoor Reset Controls
  - Destratification Fans < 20 ft Diameter and/or < 25 ft Ceiling Height
  - Thermodynamic Process Controls
  - Commercial Weatherization and Insulation (Roof and Wall)

- Where appropriate, several of these commercial measures will also be delivered to the social housing sector as part of the Low-income Program. Further details on the Low-income Program can be found in Section 1.3.

Market Incentive

- Incentive levels for energy efficiency measures in the prescriptive offering are established based on the following criteria:
  - the m^3 savings generated
  - the incremental cost of the energy-efficient technology as compared to base case assumptions
  - the effectiveness of the incentive to increase uptake in the marketplace
- Incentives will be applied in a manner that will extend the reach of the Program to customers who have not participated in previous years because of hurdle rates, long project payback periods or lack of awareness and focus on energy efficiency initiatives
- Incentives are primarily directed towards the customer

Market Delivery

- For the past several years Union has focused on a segmented market approach consistent with marketing best practices. Through this framework, Union will continue to deliver Programs using a segmented market approach.
- Within each segment, Union identifies and targets the key players, segment leaders and service providers.
- Key economic drivers and decision making criteria common to the segment are identified to help establish complete energy solutions.
- Where applicable, measures will be targeted using a national account strategy to reach decision makers who are part of a centralized management decision making process for implementing energy improvements.
- Offers will be targeted directly to the customer, supported through Union's Account Management team.
- Indirect delivery channels consist of service providers including: HVAC contractors, design build contractors, engineers, building owners and managers

Barriers Addressed

Primary barriers preventing higher uptake in the market include the following:

- Lengthy payback periods
    - To address this barrier, Union offers incentives that reduce project payback time
- Economic conditions in the marketplace
    - To address this barrier, Union will benchmark past operating expenses and increase the customer's operating efficiency standard. Through this approach, Union demonstrates that saving energy reduces operating expenses year after year and will enable the customer to operate in a more sustainable manner.
- Customer awareness of Union's Program and of energy efficient options
    - In addressing this barrier, Union will focus on awareness and education through communication strategies including tradeshows, workshops, seminars, case studies, newsletters, website resources and other marketing collateral to improve penetration and Program take-up in commercial and industrial markets.

<u>Custom Offering</u>

Union focuses on advancing customer energy efficiency and productivity through providing a mix of custom incentive offerings to customers in the commercial, institutional and industrial markets. These offerings are applicable to both contract and non-contract customers and are described below.

Description

Union provides a mix of energy efficiency initiatives that can be customized to meet the distinct needs of different customers. These initiatives include the following elements:

- Communication and Education
    - Union offers a wide variety of materials aimed at building awareness for energy efficiency in the customer's facility. The focus is on educating the customer and their employees on how to identifying energy conservation opportunities and supplying them with the resources to research and evaluate possible solutions.

- Industrial Process Studies
    - Assist industrial customers in determining the optimal equipment operating efficiency, or process method that realizes the highest level of production for the lowest energy consumption.
    - These studies identify and quantify energy and cost saving opportunities, establish implementation costs and calculate payback periods for projects that include:
        - Steam generation systems
        - Steam trap surveys
        - Process Furnaces
        - Thermal fluid heaters
        - Vaporizers
        - Process Heaters
        - Other combustion equipment
- Energy Efficiency Feasibility Studies
    - Supports engineering feasibility studies, engineering simulations, energy audits, onsite energy managers, and metering and targeting assessments. All of these tools supply Union's customer contacts with the detailed engineering and ROI information needed to support customer senior management's decision to invest in energy efficiency measures.
- Equipment Incentives
    - Incentives are targeted at energy saving opportunities that improve the utilization of natural gas. Incentives are available for installations identified with or without an audit. Equipment incentives are designed to promote the installation of:
        - New and retrofit high-efficiency equipment
        - Higher efficiency process improvements
        - Equipment Improvements
        - Heat recovery devices
        - Energy management and controls

- Demonstration of New Technology
    - Encourages the adoption of new market-ready, repeatable, gas-fired technologies, limited to commercially available energy efficient products that do not have penetration in Ontario.
- Building Optimization
    - Research has shown that increases in energy efficiency can be realized by taking a whole building, whole systems approach to optimizing the performance of existing building systems.
    - This approach provides building operator training, best practices information, supports facility assessments, and supplies energy performance benchmarking to help commercial customers realize real energy reductions compared to predictive consumption modeling.
    - Union will proactively target larger commercial buildings in the institutional and office segments. By working directly with building operational staff, Union will assist in identifying and changing ineffective or problematic behavioural and operational practices within the structure to improve the overall building energy performance. By emphasising adjustments to existing equipment, Union will help customers realize the most effective operating circumstances. Union will influence behaviour changes through the following approach:
        - Union will assist customers by providing education on how to identify energy saving opportunities, through a number of optimization strategies
        - Customers will then implement the optimization strategies provided by Union
        - Union will incent the customer based on measured savings, via a CUSUM analysis[6] after year 1.

[6] A Cumulative Summary (CuSum) analysis isolates the affects of known variables (such as weather) to create a predictive model of anticipated natural gas consumption. The methodology then compares the actual natural gas consumption to the expected consumption based on this predicted baseline. By adding the series of differentials values over a set length of time: (i.e. monthly results for a year) the resulting cumulative total represents the total (in this example) annual avoided natural gas consumption.

Market Incentive

- Incentive levels for custom measures are established based on the m3 savings generated by the project
- Incentives will be directed to the customer

Market Delivery

- The custom offering is communicated and delivered directly to the customer by their Union Account Manager. The account management team has over a decade of experience in assisting customers to identify and address energy conservation opportunities, establishing a solid foundation of energy expertise and advice for customers to leverage.
- Delivery will be supported through collaboration with key organizations and service providers. This is required to:
  - Expand the reach of Union's Program offerings by targeting key market segments
  - Build strategic relationships with key organizations and service providers that influence the customer's energy decisions
- The engineering expertise of Union's Project Managers is utilized to provide technical support for new technologies, operating efficiency opportunities, and energy efficiency initiatives. Customers recognize the value of Union's technical project management expertise, which allows Union experts the opportunity to learn the details of specific processes and identify opportunities to influence where energy efficiency investments are made.

Barriers Addressed

Primary barriers preventing higher uptake in the market include the following:

- Lengthy project cycles and payback periods
  - To address this barrier, Union will offer incentives that reduce project payback time.
- Access to capital
  - Union will provide engineering calculations, business cases, best practise information and ROI data to assist the customer in positioning their internal business case to gain the support of customers' senior management for capital projects.

- Economic conditions in the marketplace
    - To address this barrier, Union educates customers on how saving energy reduces operating expense year after year to help customers operate in a more sustainable manner. To do this, Union will benchmark past operating expenses and identify opportunities to increase the customer's operating efficiency standard.
- Customer's awareness of Union's Programs and of energy efficient options
    - Union will focus on awareness and education through communication strategies including tradeshows, workshops, seminars, case studies, technical newsletters, website resources and other marketing collateral to improve penetration and Program take-up in commercial and industrial markets.

1.1.6 Program Duration

- All Program offerings in the Commercial / Industrial Program will be delivered throughout the three year DSM Plan.
- The specific measures within the offerings may vary should new measures be introduced or customer needs change over the course of the Plan.

1.1.7 Program Budget

- Union has not included inflation in the table below. Union proposes to use the Q2 GDP-IPI inflation factor, released at the end of August, to align with Union's annual rate setting process.

Table 7 – Commercial / Industrial Program Budget

2012 Commercial / Industrial Program Budget ($000)		
Program Cost	**Commercial / Industrial General Service**	**Commercial / Industrial Contract**
Promotion Costs	$ 924	$ 50
Incentive Costs	$ 3,714	$ 1,850
EM&V & Monitoring Costs	$ 20	$ 40
Administrative Costs	$ 1,937	$ 646
Total	**$ 6,595**	**$ 2,586**

2013 Commercial / Industrial Program Budget ($000)		
Program Cost	**Commercial / Industrial General Service**	**Commercial / Industrial Contract**
Promotion Costs	$ 924	$ 50
Incentive Costs	$ 3,714	$ 1,850
EM&V & Monitoring Costs	$ 20	$ 40
Administrative Costs	$ 1,937	$ 646
Total	**$ 6,595**	**$ 2,586**

2014 Commercial / Industrial Program Budget ($000)		
Program Cost	**Commercial / Industrial General Service**	**Commercial / Industrial Contract**
Promotion Costs	$ 849	$ 50
Incentive Costs	$ 3,714	$ 1,850
EM&V & Monitoring Costs	$ 20	$ 40
Administrative Costs	$ 1,937	$ 646
Total	**$ 6,520**	**$ 2,586**

1.1.8 Cost Effectiveness

Table 8 – Commercial/Industrial Program Cost Effectiveness

	Measure	Participants	Total TRC Benefits	Total TRC Costs	Total Net TRC Before Program Costs	TRC Ratio
Retrofit	Air Curtains - Double Door	5	$ 24,748	$ 11,875	$ 12,873	2.1
Retrofit	Air Curtains - Single Door	5	$ 9,620	$ 7,838	$ 1,783	1.2
Retrofit	Building Optimization [55]	30	N/A	N/A	N/A	
New Build/Retrofit	CEE Tier 2 Front-Loading Clothes Washer (Multi Family)	1,000	$ 1,300,674	$ 540,000	$ 760,674	2.4
New Build/Retrofit	Commercial Custom [56]	100	$ 15,375,615	$ 3,564,214	$ 11,811,400	4.3
New Build	Condensing Boiler - Space Heating 300 to 999 MBtu/h [1]	35	$ 684,688	$ 213,088	$ 471,600	3.2
Retrofit	Condensing Boiler - Space Heating 300 to 999 MBtu/h [2]	120	$ 2,413,101	$ 751,003	$ 1,662,098	3.2
New Build	Condensing Boiler - Space Heating over 1,000 Mbtu/h [3]	35	$ 2,042,778	$ 635,752	$ 1,407,027	3.2
Retrofit	Condensing Boiler - Space Heating over 1,000 Mbtu/h [4]	55	$ 2,964,985	$ 922,760	$ 2,042,225	3.2
New Build	Condensing Boiler - Space Heating up to 299 MBtu/h [5]	65	$ 489,562	$ 149,065	$ 340,497	3.3
Retrofit	Condensing Boiler - Space Heating up to 299 MBtu/h [6]	140	$ 987,308	$ 396,872	$ 590,436	2.5
New Build/Retrofit	Condensing Gas Water Heater (1,000gal/day) - Purchase	15	$ 55,773	$ 31,778	$ 23,996	1.8
New Build/Retrofit	Condensing Gas Water Heater (100gal/day)	15	$ 11,939	$ 31,778	-$ 19,839	0.4
New Build/Retrofit	Condensing Gas Water Heater (500gal/day)	15	$ 31,393	$ 31,778	-$ 385	1.0
New Build	Condensing Rooftop Units (MUA) All other Commercial Efficiency + 2 speed > 6000 cfm [7]	1	$ 31,001	$ 9,120	$ 21,881	3.4
New Build	Condensing Rooftop Units (MUA) All other Commercial Efficiency + 2 speed 1700 - 5999 cfm [8]	1	$ 13,199	$ 4,357	$ 8,841	3.0
New Build	Condensing Rooftop Units (MUA) All other Commercial Efficiency + VFDs > 6000 cfm [9]	1	$ 51,235	$ 9,206	$ 42,030	5.6
New Build	Condensing Rooftop Units (MUA) All other Commercial Efficiency + VFDs 1700 - 5999 cfm [10]	1	$ 22,040	$ 4,431	$ 17,609	5.0
New Build	Condensing Rooftop Units (MUA) Multifamily & Healthcare Efficiency + 2 speed > 6000 cfm [11]	1	$ 48,756	$ 9,136	$ 39,621	5.3
New Build	Condensing Rooftop Units (MUA) Multifamily & Healthcare Efficiency + 2 speed 1700 - 5999 cfm [12]	1	$ 21,186	$ 4,437	$ 16,749	4.8
New Build	Condensing Rooftop Units (MUA) Multifamily & Healthcare Efficiency + VFDs 1700 - 5999 cfm [13]	1	$ 34,079	$ 4,477	$ 29,602	7.6
New Build	Condensing Rooftop Units (MUA) Multifamily & Healthcare Efficiency + VFDs> 6000 cfm[14]	1	$ 78,381	$ 9,222	$ 69,159	8.5
New Build	Condensing Rooftop Units (MUA) Multifamily & Healthcare Improved efficiency > 6000 cfm [15]	1	$ 19,443	$ 6,275	$ 13,168	3.1
New Build	Condensing Rooftop Units (MUA) Multifamily & Healthcare Improved efficiency 1700 - 2999 cfm [16]	1	$ 5,061	$ 2,245	$ 2,816	2.3
New Build	Condensing Rooftop Units (MUA) Multifamily & Healthcare Improved efficiency 3000 - 5999 cfm [17]	1	$ 10,388	$ 3,738	$ 6,650	2.8
New Build/Retrofit	Condensing Unit Heater [18]	5	$ 16,362	$ 11,804	$ 4,559	1.4
New Build/Retrofit	DCKV Dinner House (10000 - 15000 cfm)	1	$ 92,507	$ 19,000	$ 73,507	4.9
New Build/Retrofit	DCKV Fast Casual (< 5000 cfm)	2	$ 48,762	$ 19,000	$ 29,762	2.6
New Build/Retrofit	DCKV Full Menu (5000 - 9999 cfm)	12	$ 685,068	$ 171,000	$ 514,068	4.0
New Build	Destratification Fan [19]	10	$ 164,776	$ 63,189	$ 101,587	2.6
Retrofit	Destratification Fan [20]	20	$ 673,580	$ 126,378	$ 547,202	5.3
New Build	DWHR - Ent - Arena [21]	1	$ 16,485	$ 8,846	$ 7,638	1.9
Retrofit	DWHR - Ent - Arena [22]	1	$ 16,485	$ 13,783	$ 2,702	1.2
New Build	DWHR - Hospital - Dishwashing [23]	1	$ 6,234	$ 1,682	$ 4,552	3.7
Retrofit	DWHR - Hospital - Dishwashing [24]	1	$ 16,105	$ 2,575	$ 13,530	6.3
New Build	DWHR - Hospital - Laundry [25]	1	$ 153,255	$ 35,388	$ 117,868	4.3
New Build	DWHR - Laundromat	1	$ 173,408	$ 35,350	$ 138,057	4.9
Retrofit	DWHR - Laundromat	1	$ 173,408	$ 38,770	$ 134,637	4.5
New Build	DWHR - Nursing Home - Dishwashing [26]	1	$ 4,477	$ 1,681	$ 2,796	2.7
New Build	DWHR - University/College Cafeterias - Dishwashing [27]	1	$ 8,324	$ 1,681	$ 6,643	5.0
Retrofit	DWHR - University/College Cafeterias - Dishwashing [28]	1	$ 20,991	$ 3,086	$ 17,904	6.8
New Build/Retrofit	Energy Star Convection Ovens - Full Size	10	$ 16,184	$ 7,000	$ 9,184	2.3
New Build/Retrofit	Energy Star Dishwasher - Rack Conveyor - Multi Tank - High Temperature - Purchase	5	$ 148,860	$ 1,051	$ 147,809	141.6
New Build/Retrofit	Energy Star Dishwasher - Rack Conveyor - Multi Tank - High Temperature - Rental	5	$ 77,489	$ 4,463	$ 73,026	17.4
New Build/Retrofit	Energy Star Dishwasher - Rack Conveyor - Single Tank - High Temperature - Purchase	30	$ 540,266	$ 52,013	$ 488,253	10.4
New Build/Retrofit	Energy Star Dishwasher - Rack Conveyor - Single Tank - High Temperature - Rental	5	$ 46,872	$ 4,463	$ 42,410	10.5
New Build/Retrofit	Energy Star Dishwasher - Stationary Rack - High Temperature - Purchase	5	$ 26,297	-$ 1,400	$ 27,697	NA [58]
New Build/Retrofit	Energy Star Dishwasher - Stationary Rack - High Temperature - Rental	5	$ 12,491	$ 3,987	$ 8,504	3.1
New Build/Retrofit	Energy Star Dishwasher - Stationary Rack - Low Temperature - Purchase	30	$ 128,324	-$ 8,400	$ 136,724	NA [58]
New Build/Retrofit	Energy Star Dishwasher - Stationary Rack - Low Temperature -Rental	5	$ 10,159	$ 3,806	$ 6,353	2.7
New Build/Retrofit	Energy Star Dishwasher - Undercounter - Low Temperature - Purchase	50	$ 51,629	-$ 390	$ 52,019	NA [58]
New Build/Retrofit	Energy Star Fryer	200	$ 415,830	$ 164,480	$ 251,350	2.5
New Build	Energy Star Steam Cookers	10	$ 59,729	$ 16,000	$ 43,729	3.7

New Build	ERV 1 - up to 1000CFM - Multi Family, Health Care, Nursing [29]	20	$ 200,196	$ 41,146	$ 159,050	4.9
Retrofit	ERV 1 - up to 1000CFM - Multi Family, Health Care, Nursing [30]	20	$ 164,322	$ 31,841	$ 132,481	5.2
New Build	ERV 2 - over 1000CFM - Multi Family, Health Care, Nursing [31]	10	$ 351,887	$ 72,323	$ 279,564	4.9
Retrofit	ERV 2 - over 1000CFM - Multi Family, Health Care, Nursing [32]	15	$ 647,544	$ 125,477	$ 522,066	5.2
New Build	ERV 3 - up to 2000CFM - Hotel, Restaurant, Retail [33]	15	$ 112,846	$ 41,690	$ 71,157	2.7
Retrofit	ERV 3 - up to 2000CFM - Hotel, Restaurant, Retail [34]	15	$ 113,160	$ 39,469	$ 73,690	2.9
New Build	ERV 4 - over 2000CFM - Hotel, Restaurant, Retail [35]	15	$ 419,494	$ 154,977	$ 264,517	2.7
Retrofit	ERV 4 - over 2000CFM - Hotel, Restaurant, Retail [36]	10	$ 218,697	$ 76,280	$ 142,417	2.9
New Build	ERV 5 - up to 2000CFM - Office, Warehouse, School [37]	20	$ 130,556	$ 75,525	$ 55,031	1.7
Retrofit	ERV 5 - up to 2000CFM - Office, Warehouse, School [38]	20	$ 94,970	$ 51,901	$ 43,069	1.8
New Build	ERV 6 - over 2000CFM - Office, Warehouse, School [39]	20	$ 360,126	$ 208,328	$ 151,798	1.7
Retrofit	ERV 6 - over 2000CFM - Office, Warehouse, School [40]	20	$ 433,722	$ 237,028	$ 196,694	1.8
New Build	High Efficiency Under-Fired Broilers	4	$ 12,812	$ 4,064	$ 8,748	3.2
New Build	HRV >2,000cfm-Hotel, Restaurant, Retail, Rec [41]	10	$ 121,319	$ 68,624	$ 52,694	1.8
Retrofit	HRV >2,000cfm-Hotel, Restaurant, Retail, Rec [42]	10	$ 133,043	$ 68,624	$ 64,418	1.9
Retrofit	HRV ≥2,000cfm-School,Office, Warehouse, Man [43]	10	$ 85,127	$ 68,624	$ 16,503	1.2
New Build	HRV 500 to 2,000cfm-Hotel, Restaurant, Retail, Rec [44]	20	$ 121,258	$ 68,590	$ 52,668	1.8
Retrofit	HRV 500 to 2,000cfm-Hotel, Restaurant, Retail, Rec [45]	10	$ 51,661	$ 26,647	$ 25,014	1.9
New Build	HRV Multi Family, Health Care, Nursing [46]	10	$ 78,720	$ 24,761	$ 53,959	3.2
Retrofit	HRV Multi Family, Health Care, Nursing [47]	10	$ 71,000	$ 20,337	$ 50,663	3.5
Retrofit	HWC - Faucet Aerator - Bath - 1.0gpm (Multi Family) [59]	2,300	$ 29,859	$ 1,221	$ 28,638	24.4
Retrofit	HWC - Faucet Aerator - Kitchen 1.5gpm (Multi Family) [59]	1,000	$ 40,676	$ 1,161	$ 39,515	35.0
Retrofit	HWC - Showerhead - 1.25gpm (Multi Family) [59]	4,300	$ 553,389	$ 14,667	$ 538,722	37.7
Retrofit	HWC - Showerhead - 1.25gpm replacing existing 2.0gpm (Multi Family) [59]	1,333	$ 137,620	$ 4,547	$ 133,073	30.3
New Build/Retrofit	Industrial Custom [57]	90	$ 59,544,225	$ 10,878,227	$ 48,665,998	5.5
New Build	Infrared Heating - 101 to 300 MBtu/hr [48]	225	$ 1,311,949	$ 288,011	$ 1,023,938	4.6
Retrofit	Infrared Heating - 101 to 300 MBtu/hr [49]	100	$ 583,817	$ 128,173	$ 455,644	4.6
New Build	Infrared Heating - 20 to 100 MBtu/hr [50]	150	$ 509,871	$ 107,701	$ 402,170	4.7
Retrofit	Infrared Heating - 20 to 100 MBtu/hr [51]	150	$ 460,286	$ 96,240	$ 364,046	4.8
New Build/Retrofit	Laundry Washing Equipment with Ozone - <= 120 lbs & >= 200,000 lbs/yr [52]	20	$ 482,157	$ 201,848	$ 280,309	2.4
New Build/Retrofit	Laundry Washing Equipment with Ozone - > 120 lbs & 1,000,000 lbs/yr [53]	1	$ 120,539	$ 27,848	$ 92,691	4.3
New Build/Retrofit	Laundry Washing Equipment with Ozone - > 120 lbs & 260,000 - 1,000,000 lbs/yr [54]	5	$ 379,698	$ 139,242	$ 240,456	2.7
New Build/Retrofit	New Measure 2012 [60]	220	N/A	N/A	N/A	N/A
Retrofit	Prescriptive Schools - Elementary (hydronic boilers with 83%+)	2	$ 58,622	$ 12,623	$ 45,999	4.6
Retrofit	Prescriptive Schools - Secondary (hydronic boilers with 83%+)	2	$ 237,407	$ 21,126	$ 216,281	11.2
	Total		**$ 98,903,882**	**$ 21,583,622**	**$ 77,320,260**	
			Promotion Costs	$ 974,220		
			Administration	$ 2,582,842		
			EM&V Costs	$ 60,000		
			Program Total Net		**$ 73,703,198**	
			Program TRC Ratio			**3.9**

1	Condensing Boiler - 300 to 999 Mbtu/h measure is quasi-prescriptive. Savings are based on an average capacity of 534,055 Btu/hr from 2010 year results
2	Condensing Boiler - 300 to 999 Mbtu/h measure is quasi-prescriptive. Savings are based on an average capacity of 548,979 Btu/hr from 2010 year results
3	Condensing Boiler - over 1000 Mbtu/h measure is quasi-prescriptive. Savings are based on an average capacity of 1,593,363 Btu/hr from 2010 year results
4	Condensing Boiler - over 1000 Mbtu/h measure is quasi-prescriptive. Savings are based on an average capacity of 1,471,707 Btu/hr from 2010 year results
5	Condensing Boiler - up to 299 Mbtu/h measure is quasi-prescriptive. Savings are based on an average capacity of 198,000
6	Condensing Boiler - up to 299 Mbtu/h measure is quasi-prescriptive. Savings are based on an average capacity of 185,394
7	Condensing Rooftop Units (MUA) All other Commercial Efficiency + 2 speed > 6000 cfm measure is quasi-prescriptive. Savings are based on an average capacity of 8,644 CFM from marketing forecast
8	Condensing Rooftop Units (MUA) All other Commercial Efficiency + 2 speed 1700 - 5999 cfm measure is quasi-prescriptive. Savings are based on an average capacity of 3,680 CFM from marketing forecast
9	Condensing Rooftop Units (MUA) All other Commercial Efficiency + VFDs > 6000 cfm measure is quasi-prescriptive. Savings are based on an average capacity of 8,647 CFM from marketing forecast
10	Condensing Rooftop Units (MUA) All other Commercial Efficiency + VFDs 1700 - 5999 cfm measure is quasi-prescriptive. Savings are based on an average capacity of 3,720 CFM from marketing forecast
11	Condensing Rooftop Units (MUA) Multifamily & Healthcare Efficiency + 2 speed > 6000 cfm measure is quasi-prescriptive. Savings are based on an average capacity of 8,660 CFM from marketing forecast
12	Condensing Rooftop Units (MUA) Multifamily & Healthcare Efficiency + 2 speed 1700 - 5999 cfm measure is quasi-prescriptive. Savings are based on an average capacity of 3,763 CFM from marketing forecast
13	Condensing Rooftop Units (MUA) Multifamily & Healthcare Efficiency + VFDs 1700 - 5999 cfm measure is quasi-prescriptive. Savings are based on an average capacity of 3,767 CFM from marketing forecast
14	Condensing Rooftop Units (MUA) Multifamily & Healthcare Efficiency + VFDs> 6000 cfm measure is quasi-prescriptive. Savings are based on an average capacity of 8,664 CFM from marketing forecast
15	Condensing Rooftop Units (MUA) Multifamily & Healthcare Improved efficiency > 6000 cfm measure is quasi-prescriptive. Savings are based on an average capacity of 8,690 CFM from marketing forecast
16	Condensing Rooftop Units (MUA) Multifamily & Healthcare Improved efficiency 1700 - 2999 cfm measure is quasi-prescriptive. Savings are based on an average capacity of 2,262 CFM from marketing forecast
17	Condensing Rooftop Units (MUA) Multifamily & Healthcare Improved efficiency 3000 - 5999 cfm measure is quasi-prescriptive. Savings are based on an average capacity of 4,643 CFM from marketing forecast
18	Condensing Unit Heater measuer is quasi-prescriptive. Savings are based on an average capacity of 183,000 Btu/hr from Page 29 of NGTC report "DSM Opportunities Associated with Unit Heaters" April 22, 2009
19	Destratification Fan measure is quasi-prescriptive. Savings are based on an average capacity of 13,089 sqrft from 2010 year results
20	Destratification Fan measure is quasi-prescriptive. Savings are based on an average capacity of 26,753 sqr.ft from 2010 year results
21	DWHR - Ent - Arena measure is quasi-prescriptive. Savings are based on an average capacity of 12 showerheads from marketing forecast
22	DWHR - Ent - Arena measure is quasi-prescriptive. Savings are based on an average capacity of 12 showerheads from marketing forecast
23	DWHR - Hospital - Dishwashing measure is quasi-prescriptive. Savings are based on an average capacity of 149 beds from marketing forecast
24	DWHR - Hospital - Dishwashing measure is quasi-prescriptive. Savings are based on an average capacity of 149 beds from marketing forecast
25	DWHR - Hospital - Laundry measure is quasi-prescriptive. Savings are based on an average capacity of 149 beds from marketing forecast
26	DWHR - Nursing Home - Dishwashing measure is quasi-prescriptive. Savings are based on an average capacity of 107 beds from marketing forecast
27	DWHR - University/College Cafeterias - Dishwashing measure is quasi-prescriptive. Savings are based on an average capacity of 519 meals served per day from marketing forecast
28	DWHR - University/College Cafeterias - Dishwashing measure is quasi-prescriptive. Savings are based on an average capacity of 519 meals served per day from marketing forecast
29	ERV 1 - up to 1000CFM - Multi Family, Health Care, Nursing is quasi-prescriptive. Savings are based on an average capacity of 681 CFM from 2010 year results
30	ERV 1 - up to 1000CFM - Multi Family, Health Care, Nursingis quasi-prescriptive. Savings are based on an average capacity of 527 CFM Btu/hr from 2010 year results
31	ERV 2 - over 1000CFM - Multi Family, Health Care, Nursing is quasi-prescriptive. Savings are based on an average capacity of 2,394 CFM from 2010 year results
32	ERV 2 - over 1000CFM - Multi Family, Health Care, Nursing is quasi-prescriptive. Savings are based on an average capacity of 2,769 CFM from 2010 year results
33	ERV 3 - up to 2000CFM - Hotel, Restaurant, Retail is quasi-prescriptive. Savings are based on an average capacity of 920 CFM from 2010 year results
34	ERV 3 - up to 2000CFM - Hotel, Restaurant, Retail is quasi-prescriptive. Savings are based on an average capacity of 871 CFM from 2010 year results
35	ERV 4 - over 2000CFM - Hotel, Restaurant, Retail is quasi-prescriptive. Savings are based on an average capacity of 3,420 CFM from 2010 year results
36	ERV 4 - over 2000CFM - Hotel, Restaurant, Retail is quasi-prescriptive. Savings are based on an average capacity of 2,525 CFM from 2010 year results
37	ERV 5 - up to 2000CFM - Office, Warehouse, School is quasi-prescriptive. Savings are based on an average capacity of 1,250 CFM from 2010 year results
38	ERV 5 - up to 2000CFM - Office, Warehouse, School is quasi-prescriptive. Savings are based on an average capacity of 859 CFM from 2010 year results
39	ERV 6 - over 2000CFM - Office, Warehouse, School is quasi-prescriptive. Savings are based on an average capacity of 3,448 from 2010 year results
40	ERV 6 - over 2000CFM - Office, Warehouse, School is quasi-prescriptive. Savings are based on an average capacity of 3,923 CFM from 2010 year results
41	HRV >2,000cfm-Hotel, Restaurant, Retail, Rec is quasi-prescriptive. Savings are based on an average capacity of 2,001 CFM from 2010 year results
42	HRV >2,000cfm-Hotel, Restaurant, Retail, Rec is quasi-prescriptive. Savings are based on an average capacity of 2,001 CFM from 2010 year results
43	HRV ≥2,000cfm-School,Office, Warehouse, Man is quasi-prescriptive. Savings are based on an average capacity of 2,001 CFM from 2010 year results
44	HRV 500 to 2,000cfm-Hotel, Restaurant, Retail, Rec is quasi-prescriptive. Savings are based on an average capacity of 1,000 CFM from 2010 year results
45	HRV 500 to 2,000cfm-Hotel, Restaurant, Retail, Rec is quasi-prescriptive. Savings are based on an average capacity of 777 CFM from 2010 year results
46	HRV Multi Family, Health Care, Nursing is quasi-prescriptive. Savings are based on an average capacity of 722 CFM from 2010 year results
47	HRV Multi Family, Health Care, Nursing is quasi-prescriptive. Savings are based on an average capacity of 593 CFM from 2010 year results
48	Infrared Heating - 101 to 300 MBtu/hr is quasi-prescriptive. Savings are based on an average capacity of 156,600 Btu/hr from 2010 year results
49	Infrared Heating - 101 to 300 MBtu/hr is quasi-prescriptive. Savings are based on an average capacity of 156,806 Btu/hr from 2010 year results
50	Infrared Heating - 20 to 100 MBtu/hr is quasi-prescriptive. Savings are based on an average capacity of 87,840 Btu/hr from 2010 year results
51	Infrared Heating - 20 to 100 MBtu/hr is quasi-prescriptive. Savings are based on an average capacity of 78,493 Btu/hr from 2010 year results
52	Laundry Washing Equipment with Ozone - <= 120 lbs & >= 200,000 lbs/yr is quasi-prescriptive. Savings are based on an average capacity of 200,000 lbs based on bottom of bucket (NGTC)
53	Laundry Washing Equipment with Ozone - > 120 lbs & 1,000,000 lbs/yr is quasi-prescriptive. Savings are based on an average capacity of 1,000,000 lbs based on bottom of bucket (NGTC)
54	Laundry Washing Equipment with Ozone - > 120 lbs & 260,000 - 1,000,000 lbs/yr is quasi-prescriptive. Savings are based on an average capacity of 630,000 lbs based on midpoint of bucket (NGTC)
55	Building Optimization. TRC generated by a market scoping and potential study conducted by Portland Energy Conservations Inc (PECI) and through consultation with Enbridge Gas Distribution. PECI reviewed Union customer and project data for the past three years for each targeted market segment and built on their own best practices and the Canmet Energy Recommissioning Guide for Building Owners and
56	Commercial Custom. TRC Benefits and TRC Costs based on 3 year historical average of commercial custom results
57	Industrial Custom. TRC Benefits and TRC Costs based on 3 year historical average of indsutrial custom results
58	TRC ratio not applicable since incremental cost is negative
59	TRC benefits adjusted based on 2010 verification study results. The adjustments reflect installation rates, persistance rates, percentage of showering under showerhead (for showerhead measures), and
60	Input assumptions for New measures in 2012 are being developed and the screening will be provided in the annual report

1.1.9 Commercial/Industrial Program Targets

- Targets will remain consistent each year of the Plan

Table 9 – Commercial/Industrial Program Targets

2012 - 2014 Commercial/Industrial Program Targets			
Metric	Metric Target Levels		
	50%	100%	150%
Cumulative Natural Gas Savings (m3)	266,611,000	533,222,000	666,528,000
Deep Measures	1,658	3,315	4,144

1.1.10 Rationale for Targets

Targets for the C/I Program were established using the Board's stated objectives, budget required to deliver results and the associated rate impacts. Union has provided the following information to provide context for its C/I Program targets.

History

- Union has been delivering DSM to commercial and industrial customers since 1997 and will continue delivering Union's established and successful Programs. The C/I Program is expected to generate 533,222,000 m^3 of cumulative natural gas savings annually for the duration of the 2012-2014 framework.

Consideration of Board's Guiding Objectives

Maximization of Cost Effective Natural Gas Savings

- Union will maximize the cost effectiveness of the C/I Program by focusing on those offerings that deliver the highest m^3 savings for every dollar spent. This will be done through the following:
  - By continuing to deliver a custom offering to industrial customers. History has shown this market is the most cost effective for DSM Programs as Program spend is relatively small in relation to the cumulative m3 savings
  - Continuing to leverage existing infrastructure, delivery channels and market knowledge in Program design, avoiding duplication of existing services and resources

- Focusing on existing measures that have been successful in generating deep energy savings and have remaining market potential

Prevention of Lost Opportunities

- Union has prevented lost opportunities though the following:
    - Providing continual customer engagement, education and training on matters relating to energy efficiency ensures the implementation of energy efficiency initiatives when opportunities arise and accelerates Program take up
    - Partnering with trade allies and stakeholders to teach, share and promote best practises
    - Working with customer Energy Teams to maximize their effectiveness on all matters relating to energy efficiency
    - Educating the marketplace on energy efficiency best practises through various methods of communication. These include Union account management expertise and media such as the Union website, customer testimonials, case studies, editorials, and Program materials
    - Identifying a variety of new deep measures that will be incorporated into the prescriptive offering

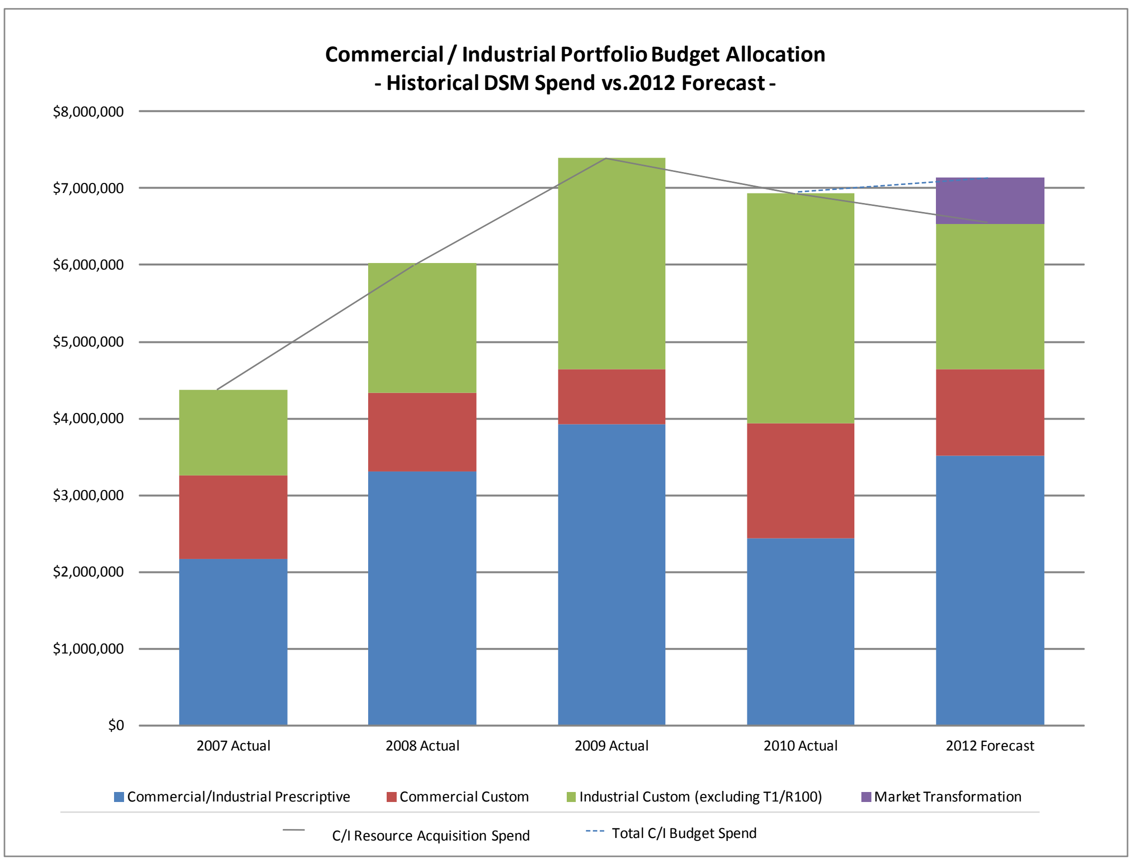
Pursuit of Deep Energy Savings

- Union will emphasize deep energy savings through the following:
    - Measures that do not meet the definition of deep measures will be phased out or eliminated in the 2012 framework; these measures include Low Flow Spray Valves, Programmable Thermostats, Low Flow Showerheads and Aerators.
    - Union will introduce new prescriptive measures that will drive deep energy savings over the course of the next three years.
    - The top six deep measures that Union will focus on include, Condensing Boilers, Energy Recovery Ventilators, Infrared Heaters, Destratification Fans, Condensing Make Up Air Units, and Drain Water Heat Recovery Systems; each has a measure life greater than (or equal to) 14 years.

Context for Targets

As displayed in Figure 1 below, the forecasted 2012 budget for the C/I Program portfolio remains consistent with the total C/I budget spend in 2009 and 2010. The overall C/I Resource Acquisition budget has decreased when compared to 2009 and 2010; this is a result of budget reallocation to the C/I Market Transformation Program. In addition, other factors that have affected the Resource Acquisition budget include the increased focus on deep measures, the introduction of the Building Optimization initiative and the increased focus on obtaining deeper market penetration.

Figure 1: Historical C/I DSM Spending vs. 2012 Forecast



*Excludes administrative and evaluation costs.

The 2012 forecasted cumulative natural gas savings for the C/I Program portfolio are lower than the cumulative natural gas results that were generated in 2009 and 2010. This is primarily due to the re-allocation of budget to Market Transformation resulting in a reduction in the Resource Acquisition budget and subsequently, a reduction in cumulative natural gas savings. Since customers in the Distribution Contract customer class provide the highest level of m^3 savings for every dollar of budget spend, even minor reductions in budget can have significant impacts on the total cumulative natural gas targets in the C/I Program portfolio.

Table 5 below demonstrates the reduction in the Resource Acquisition budget, and the resulting decrease in cumulative natural gas savings, for the Distribution Contract customer class (Non-Rate T1 and Rate 100) in 2012 when compared to prior years.

Table 10 - Cumulative Natural Gas Savings and Resource Acquisition Budget by Customer Class

Resource Acquisition Budget by Customer Class (Program and Incentive Costs Only)

Customer Class	2007 Actual ($000)	2008 Actual ($000)	2009 Actual ($000)	2010 Actual ($000)	2012 Forecast ($000)
Residential	2,160	3,044	2,838	2,888	3,717
C/I General Service	3,256	4,332	4,638	3,932	4,638
Distribution Contract (Non-Rate T1/R100)	1,111	1,693	2,762	3,001	⇔ 1,900
Total	6,527	9,069	10,238	9,821	10,255

Cumulative Natural Gas Savings by Customer Class

Customer Class	2007 Actual (000 m3)	2008 Actual (000 m3)	2009 Actual (000 m3)	2010 Actual (000 m3)	2012 Forecast (000 m3)
Residential	85,942	77,083	52,184	31,014	24,819
C/I General Service	221,923	220,812	369,679	201,875	211,691
Distribution Contract (Non-Rate T1/R100)	193,381	222,089	302,740	577,125	⇔ 321,531
Total	501,246	519,984	724,603	810,014	558,041

⇔ Represents significant change

Budgets

- The budget allocation for 2012 was derived by:
    - Analysing a breakdown of historical budget spend
    - Adhering to the Board's direction as set forth in the Guidelines
    - Analysing potential market opportunities for deeper savings
    - Considering rate impacts to customers

Table 11 – Commercial/Industrial Budget (Program and Incentive Costs Only)

Budget (Program and Incentive Costs Only)					
Offering	2007 Actual ($000)	2008 Actual ($000)	2009 Actual ($000)	2010 Actual ($000)	2012 Forecast ($000)
Commercial/Industrial Prescriptive	2,173	3,304	3,924	2,440	3,515
Commercial Custom	1,082	1,028	714	1,492	1,123
Industrial Custom *	1,111	1,693	2,762	3,001	1,900
C/I Program Total	**4,366**	**6,025**	**7,400**	**6,933**	**6,538**

* Non T1/R100

Assumes 44% of all DC budget was spent on non T1/R100 customers. This is consistent with breakdown in budget spend for 2008.

- Additional factors that have impacted the 2012 budget (shown above) include:
    - The commercial/industrial prescriptive budget has increased by approximately $1,000,000 from 2010 to 2012; this is due to:
        - An increased focus on deeper measures, which are inherently more costly to deliver
        - The introduction of additional deep measures (as identified in 4.2.5 – Program Offerings)
        - Higher costs in targeting customers who have not participated in previous years and are more challenging to reach and influence
    - The commercial custom budget has decreased by approximately $370,000 from 2010 to 2012; this is due to:
        - A number of technologies that are currently included through the custom offering, will be included in the prescriptive offering in 2012 and beyond (as identified in 4.2.5 – Program Offerings)

- Commercial custom offering now includes building optimization, which affects the offering mix and budget spend
- The industrial custom budget in the Commercial/Industrial Resource Acquisition Program has decreased by approximately $1,100,000 from 2010 to 2012; this is due to:
  - Approximately $600,000 allocated to Market Transformation for Integrated Energy Management Systems which will be targeted to industrial customers (4.7.8 – IEMS Program Budget excluding Administrative costs)
  - Budget from institutional contract customer have been removed from the industrial custom total and applied to commercial custom

Cumulative m^3 Targets

- Cumulative m^3 targets for 2012 were established using a bottom up analysis:
  - Units for all measures were forecasted using market fundamentals, historical data, current input assumptions and projected budgets

Table 12 – Historical Cumulative m^3 Savings

Historical Cumulative m3 Savings					
Offering	2007 Actual (000)	2008 Actual (000)	2009 Actual (000)	2010 Actual (000)	2012 Forecast (000)
Commercial/Industrial Prescriptive	147,517	143,164	252,597	169,032	129,013
Commercial Custom	74,405	77,648	117,081	32,843	82,678
Industrial Custom *	193,381	222,089	302,740	577,125	321,531
C/I Program Total	**415,304**	**442,901**	**672,419**	**779,000**	**533,222**

* Non T1/R100

Assumes 33% of all DC custom m3's were driven from non T1/R100 customers. This is consistent with other years where T1/R100's were tracked separately.

- Additional factors that have impacted the 2012 cumulative m^3 forecast include:
  - The commercial/industrial prescriptive target has decreased by approximately 40,000,000 cumulative m^3s; this is due to:
    - Commercial/Industrial prescriptive is impacted by changes in input assumptions, which were more favourable in past years
    - Commercial/Industrial prescriptive is impacted by phasing out shallow measures

- The commercial custom target has increased by approximately 50,000,000 cumulative m^3s; this is due to:
    - Savings from institutional contract customers are now being accounted for under commercial custom savings (as opposed to industrial custom in 2010)
    - The introduction of the building optimization offering
- The industrial custom target has decreased by approximately 256,000,000 cumulative m^3 s; this is due to:
    - Refocusing from custom to Market Transformation to drive sustainable behaviours in the market
    - Natural gas savings from institutional contract customer have been removed from the industrial custom total and applied to commercial custom

Deep Measures

- The number of deep measures were established using a bottom up analysis:
    - Units for all measures were forecasted using market fundamentals, historical data, and budget availability

Table 13 – Commercial/Industrial Deep Measures

Deep Measures					
Offering	2007 Actual	2008 Actual	2009 Actual	2010 Actual	2012 Forecast
Commercial/Industrial Prescriptive	2,275	2,457	3,748	2,090	3,095
Commercial Custom	515	341	198	263	130
Industrial Custom *	117	123	221	274	90
C/I Program Total	**2,907**	**2,921**	**4,167**	**2,627**	**3,315**

* Non T1/R100
Assumes 66% of all DC custom projects were from non T1/R100 customers. This is consistent with other years where T1/R100's were tracked separately.

- Additional factors that have impacted the 2012 deep measure forecast include:
    - The number of deep measures in commercial/industrial prescriptive have increased by 1005 units; this is due to :
        - A change in measure mix (as identified in Section 1.1.5 – Program Offerings)

        - There will be increased emphasis on deep measures than in 2010 as Union phases out shallow measures

    - Commercial prescriptive is also impacted by measures that have been phased out over the past several years (i.e. Rooftop Units were a significant contributor in 2009)

    - The number of deep custom projects in commercial has decreased by 133 units; this is due to:

        - The makeup of commercial custom has changed to include Building Optimization

        - A decrease in the commercial custom budget

    - The number of deep custom measures in industrial has decreased by 184 units; this is due to:

        - Units from institutional contract customers are now forecasted under commercial custom (as opposed to industrial custom in 2010)

        - A decrease in industrial custom resource acquisition as Union reallocates resources to Market Transformation

1.1.11 Challenges Union will Face in Achieving Commercial / Industrial Program Targets

- Challenges exist through limited support and participation from service providers in extending Union Program information and establishing awareness with customers

- A diminished number of large industrial projects which historically provide significant contribution to the overall savings achieved

- Union expects slower take-up in the first year with the introduction of new prescriptive measures and building optimization, as new offers need to build momentum in the market.

- Input assumption risk for several deep measures in the prescriptive offering due to the risk of changes to input assumptions based on selected measure evaluation, on an annual basis

- The potential for reduced customer interest in natural gas conservation as a result of:

    - Rising electricity prices

    - Projected stable natural gas prices

    - Incentives dollars being offered through CDM programming

- The effects of an unstable economic environment could have on:
    - Equipment improvements and the deployment of capital
    - New construction and real estate investments
    - Commodity prices and affiliated ROI calculations for energy efficiency improvements
    - Manufacturing and industrial production

1.2 *Large Industrial Rate T1 and Rate 100 Program*

The Large Industrial Rate T1 and Rate 100 Program is designed to focus this customer group on energy management toward increased activity in process improvements, through assessment and feasibility studies, measured performance benchmarks and operational and maintenance improvements. This Program seeks to maximize customer participation, relies heavily on Union personnel expertise, and leverages Union's direct one-on-one customer interaction.

1.2.1 Customer Class(es) Targeted

- Large Commercial / Industrial firm service contract customers
- This group of customers is comprised of large volume manufacturing operations, power plants, institutional clients, greenhouse operations and industrial process customers

1.2.2 Rate classes Targeted

- Rate T1 - Storage and Transportation Rates for Contract Carriage Customers (Union South)
- Rate 100 - Large Volume High Load Factor Firm Service (Union North)

1.2.3 Program Goals

Program goals for the Large Industrial Rate T1 and Rate 100 Program consist of the following:

- To provide Rate T1 and Rate 100 customers with the tools and support to assess their energy usage as compared to industry best practices
- To demonstrate the long term value of process and equipment improvements through sustainable reductions in energy consumption
- To encourage the adoption of behavioural and process changes that supports a continual focus on energy management
- To provide valued tools and services that leverage Union's expertise in the area of energy efficiency in a cost effective manner

1.2.4 Program Strategy

Program strategies to achieve Union's goals for the Large Industrial Rate T1 and Rate 100 Program consist of the following:

- Utilize a series of foundational steps that build on each other. Union's Program strategy begins with creating awareness of energy efficiency, followed by engineering assessment and analysis of potential projects and cumulates with the installation of high efficiency equipment and the establishment of better operating practices.
- Engage the customer across a broad section of touch points to increase the awareness of the positive benefits achieved through active energy management. This includes plant sites, corporate offices and senior management levels.
- Provide financial incentives that are beneficial and add value to the customer, by encouraging customers to continual focus on energy management in their regular maintenance plans. These plans are developed and budgeted at the local level, where continual pressure on expenditures often results in cuts to maintenance budgets that would improve the energy efficiency of a facility. Incentives targeted to this equipment have the greatest impact on the local facility.

1.2.5 Program Offerings

The offerings delivered in the Large Industrial Rate T1and Rate 100 Program are outlined below.

Customer Engagement

- Provides a targeted and connected set of offerings that will afford Union's Rate T1 and Rate 100 customers with improved cost effectiveness
- Provides education, training and technical expertise to Rate T1 and Rate 100 customers

Site Energy Assessments

- Evaluation of a facility's energy use to identify the most cost-effective, energy saving opportunities in their processes

Process Improvement Studies

- Gather and analyze data on process related equipment, to quantify opportunities for energy and cost savings

O&M Optimization Incentives

- Identify new areas for operational efficiencies and drive the implementation of O&M related energy improvements

Description

1. Customer Engagement

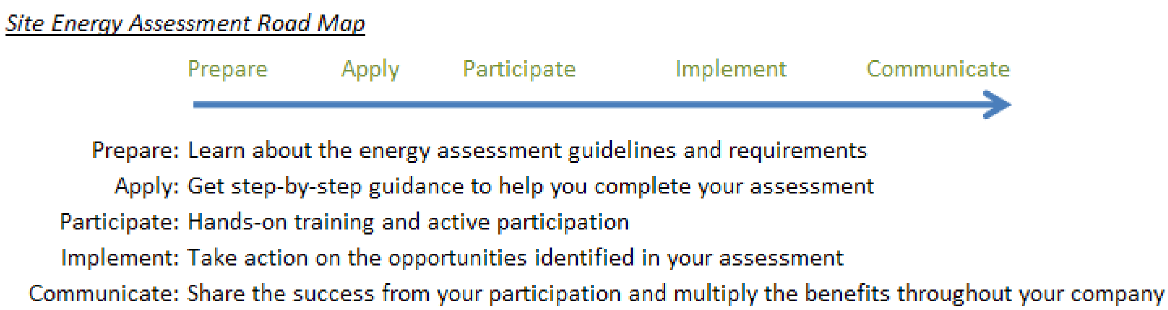
The Customer Engagement offering consists of the following elements:

- Capacity and Knowledge Building
    - Provides education, technical expertise and training opportunities through on-site or off-site sessions conducted by third-party subject-matter experts or Union staff, to increase overall energy management knowledge and capacity for our customers
    - Provides offsite technical training activities - localized sessions, webinars, focused editorials, and modeling
- Energy Team Support
    - Assists in the formation and implementation of a customer Energy Team and the provision of resources to increase customer's effectiveness at identifying, evaluating and implementing energy-saving projects
    - Assistance provided in the form of ongoing participation in customer-centered Energy Teams, involving technical expertise, experience and supportive information
    - Improvement to existing energy teams by providing technical expertise, sharing best practices, creating forums and working to improve overall effectiveness.=
- Corporate Recognition
    - Valuable recognition for top performers of energy efficiency and environmental stewardship projects.

2. Site Energy Assessments

- Assessments are conducted by Union experts, who play a pivotal role in the identification of cost-effective energy saving opportunities for customer consideration. Union experts will utilize industry-recognized software tools available from the U.S. Department of Energy:

  - Steam System Tool Suite: Steam System Assessment Tool, 3EPlus
  - Combined Heat & Power Application Tool
  - Process Heating Assessment and Survey Tool
  - Mechanical Insulation Assessment and Design Tools
- Installation of temporary wireless metering devices will be made available for the duration of the assessment at no charge to the customer.
- Assessments identify low and no cost savings opportunities for energy savings
- Assessments also identify target areas that require additional and more in-depth analysis, via a Process Improvement Study.



3. Process Improvement Studies

Union supports third party studies, where Union pays a percentage of the cost, for the purpose of:

- Quantifying specific in-depth opportunities for reduced natural gas consumption or increased production
- Conducting a focused effort to gather & analyze data on process related equipment
- Supplying the customer with metering for baseline, at no cost
- Demonstrating results of energy saving expectations ($/m^3), implementation costs and ROI calculations
- Implementing projects that include, but are not limited to:
  - Steam plant/system surveys, insulation survey, combustion optimization, and process changes

4. O&M Optimization Incentives

- Financial incentives are directed towards performance improvement actions that are typically contained within an operation and maintenance (O&M) budget. Focus is on the implementation of high energy saving activities, where emphasis includes:
    - Raising customer awareness of the energy and productivity saving opportunities of performance improvements from their existing systems
    - Common performance improvement opportunities that can save natural gas
- Financial incentives influencing performance improvement target:
    - Steam / Thermal Systems
    - HVAC Systems
    - Combustion Systems
    - Process Heating Systems
    - Other Natural Gas Consuming Equipment, Systems and Processes
- Incentives are available with or without an audit. Under both circumstances, Union's role is that of a knowledgeable third party with cross-sector expertise in performance improvement opportunities.

Market Incentive (O&M Optimization Incentives)

- Incentive levels are established to drive operational and maintenance improvement within the customer's facility
- Incentives will be directed to the customer

Market Delivery

- This energy efficiency Program is delivered directly to customers in these rate classes by dedicated Union Account Managers and Project Managers. Union experts are knowledgeable about individual customers' businesses and have background and training in energy efficiency and natural gas applications.
- Collaboration with key organizations, original equipment manufacturers, vendors and consultants is required to:
    - Expand the reach of Union's Program offerings.
    - Educate and influence energy saving best practices with customers.

  - Develop customers' capacity to make energy efficiency decisions.
  - Promote the investigation and implementation of energy efficiency projects.

Barriers Addressed

Primary barriers preventing higher uptake in the market include the following:

- In this customer group, the focus is on their core manufacturing competency. Energy use is not considered a core production management system metric as energy consumption is widely viewed as a "cost of doing business". Increasing the efficiency of energy use is a significant challenge in many industrial plants due to its broad scope and that it is not as vital as production or quality control issues.
  - Union's support for energy teams through training, energy assessments and recognition addresses this barrier.
- Some customers demonstrate a low priority on important maintenance for energy-using equipment and energy systems, allowing inefficient energy use to continue without management awareness.
  - To address this barrier, Union provides support through financial incentives for cost-effective performance improvement implementation action addresses this barrier.
  - In addition, Union's educational forums, which present customers with best practices and promote knowledge sharing.
- Difficulty for operations and maintenance personnel to obtain resources to devote to energy saving projects.
  - Undertaking Site Energy Assessments completed by Union personnel and co-funding Process Improvement Studies provides information required to strengthen customers' business cases for projects which save natural gas.

1.2.6 **Program Duration**

- All Program offerings in the Rate T1 and Rate 100 Program will be delivered over the course of the three year Plan
- The offerings may vary should new measures be introduced or market conditions change over the course of the Plan

1.2.7 Program Budget

- Union has not included inflation in the table below. Union proposes to use the Q2 GDP-IPI inflation factor, released at the end of August, to align with Union's annual rate setting process.

Table 14 – Rate T1 / Rate 100 Customer Program Budget

2012 T1/R100 Customer Program Budget ($000)			
Program Cost	**2012**	**2013**	**2014**
Promotion Costs	$ 360	$ 360	$ 360
Incentive Costs	$ 1,840	$ 1,840	$ 1,840
EM&V & Monitoring Costs	$ 40	$ 40	$ 40
Administrative Costs	$ 907	$ 907	$ 907
Total	**$3,147**	**$3,147**	**$3,147**

1.2.8 Cost Effectiveness

Table 15 – Large Industrial Rate T1/Rate 100 Program Cost Effectiveness

Measure	Participants	Total TRC Benefits	Total TRC Costs	Total Net TRC Before Program Costs	TRC Ratio
T1/R100 Offering (Custom) [1]	30	$ 41,085,780	$ 1,170,257	39,915,523.00	35.1
Total		**$ 41,085,780**	**$ 1,170,257**	**$ 39,915,523**	
		Promotion	$ 360,000		
		Administration	$ 906,511		
		EM&V Costs	$ 40,000		
		Program Total Net TRC		**$ 38,609,012**	
		Program TRC Ratio			**16.6**

1. T1/R100 Offering (Custom). TRC Benefits and TRC Costs based on 3 year historical average of T1/R100 custom results

1.2.9 Large Industrial Rate T1 and Rate 100 Program Targets

- Targets will remain consistent each year of the Plan

Table 16 – Large Industrial Rate T1 / Rate 100 Targets

2012 - 2014 Large Industrial T1/R100 Program Targets			
Metric	Metric Target Levels		
	50%	100%	150%
Cumulative Natural Gas Savings (m3)	100,000,000	200,000,000	250,000,000
Percentage of Customers Participating	30%	40%	50%

1.2.10 Rationale for Targets

A key consideration in developing targets for this market has been a detailed analysis of historical achievement levels for similar projects completed with customers in these rate classes. On that basis, targets have generally been developed based on average historical achievement levels.

Consideration of Board's Guiding Objectives

Maximization of Cost Effective Natural Gas Savings

- Union will maximize the cost effectiveness of the Program for large industrial customers by:
  - Continuing to drive O&M efficiency upgrades to Rate T1 and Rate 100 customers. History has shown this market is the most cost effective as Program spend is relatively small in relation to the cumulative m^3 savings achievable.
  - Continuing to leverage existing infrastructure, delivery channels and internal expertise to drive more energy savings for the given budget.
  - By directing attention to the assessment of heating systems, Union provides a pivotal solution in the form of knowledge and expertise needed by our customers to assist in the identification of cost-effective energy saving strategies.

Prevention of Lost Opportunities

- Lost opportunities are prevented through the following:

- Union has designed a targeted and complementary set of offerings for Rate T1 and Rate 100 customers that take customers from the initial identification stage, to actual idea implementation. This ensures opportunities are not just identified, but are implemented using best practises and best available information.
- Provide support, information, experience and expertise required to create and implement energy teams. Union's focus on establishing energy teams in large industrial facilities helps identify opportunities that otherwise would have been lost where customers may not have recognized the potential for efficiency gain.
- For companies who already have an existing energy team Union will provide technical expertise, share best practices, create forums and work to improve the teams overall effectiveness.
- Educating Rate T1 and Rate 100 customers on energy efficiency best practises, through various methods of communication, including direct-to-customer through Union account and project management expertise, and forms of media including: website, case studies, editorials, technical resources, etc.
- Partnering with trade allies and stakeholders to teach, share and promote best practices to maximize their effectiveness on all matters relating to energy efficiency

Pursuit of Deep Energy Savings

- In pursuit of long term deep energy savings, the Rate T1 and Rate 100 Program's four offerings – Customer Engagement, Site Energy Assessments, Process Improvement Studies and Operation & Maintenance Optimization Incentives – have been established. This is a comprehensive approach shift where Union's staff, through influence and demonstration of expertise, enable energy conservation to become an imbedded component of the customer's organizational culture.
- Financial incentives are directed towards O&M performance improvement actions. Focus is on the implementation of significant energy and productivity saving opportunities, where deep savings can be realized with our large industrial customers.

Context for Targets

Budgets

- The budget allocation for 2012 was derived by:
  - Analysing a breakdown of historical budget spend

- Adhering to the board's direction as set forth in the guidelines
- Considering rate impacts to Rate T1 and Rate 100 customers
- Analysing market opportunities for deeper savings

Table 17 – Rate T1/Rate 100 Budget Breakdown

Budget Breakdown		
Offering	**Program Cost ($000)**	**Incentive Cost ($000)**
Engagement	110	0
Process Improvement Studies	30	786
Site Energy Assessments	150	0
O&M Performance Incentives	70	1,054
Total	**360**	**1,840**

Budget Breakdown	
Resource Acquisition Scorecard Total ($000)	**2,200**

- Additional factors that have impacted the 2012 budget forecast include:
  - The reallocation of approximately $1,100,000 from equipment incentives, to Engagement, Process Improvements Studies and Site Energy Assessments
  - The forecasted incentive budget for Rate T1 and Rate 100 customers has been reduced from the average incentive spend of $1,870,000 (2008 – 2010) to reduce the rate impact on this customer segment

Cumulative m^3 Targets

- Cumulative m^3 targets for 2012 were established using a bottom up analysis:
  - Units for all measures were forecasted using market fundamentals, historical data, current input assumptions and projected budgets

Table 18 – Rate T1 / Rate 100 Information

T1/R100 Information					
Project Type	2008-2011* Total Number of Projects	2008-2011* Average Number of Projects Per Year	Average Cummulative m3 Savings Per Project (000)	2012 Forecasted Number of Projects	2012 Forecasted Cumulative m3 Savings (000)
Combustion Optimization	10	2.9	565	3	1,694
Condensate Return	3	0.9	499	1	499
Economizer Repair	3	0.9	466	1	466
Insulation	13	3.7	1,747	4	6,986
Steam Leak Repairs	18	5.1	8,290	5	41,448
Steam Reduction	2	0.6	60,368	1	60,368
Steam trap Repairs	51	14.6	4,622	15	69,328
Stretch	-	-	-	-	19,210
Total	**100**	**28.6**	**-**	**30**	**200,000**

* 2011 Projects are YTD and were only counted up until June 2011

- Additional factors that have impacted the 2012 cumulative m^3 forecast include:
    - The Rate T1 and Rate 100 target has been impacted by a change in offering mix; specifically incentives will no longer be provided for capital projects
    - 28 O&M projects have occurred on average every year for the last 3.5 years (out of 71 facilities
    - Based on historical averages, Union forecasts 181,000,000 cumulative m^3s for 2012; Union has added an additional 19,000,000 cumulative m3 stretch target

Participation Rates

- The participation rate is the proposed metric for Rate T1 and Rate 100 customers in lieu of a metric that tracks the number of deep measures installed
    - This ensures Union reaches a high proportion of customers within the Rate T1 and Rate 100 rate class and reduces cross subsidization between customers in a rate class, as all will be actively encouraged to participate
    - The participation rates were established using a bottom up analysis
    - Rates were forecasted using market fundamentals, historical data and current offerings

Table 19 – Rate T1/Rate 100 Participation Rate

Participation Rate				
Deep Measure Participants	**2008**	**2009**	**2010**	**2012**
Total Number of Participants (studies & incentives)	25	27	37	28
Total Number of T1/R100 Customers*	71	71	71	71
Participation Rate	**35%**	**38%**	**52%**	**40%**

* Every contract (or specific Service Agreement Number) counts as one customer
* Excludes those who are DSM ineligible because they are transmission customers
* Excludes those customers who do not have gas
* Includes R100 /20 and R100 /25

- Additional factors that have impacted the 2012 participation rate include:
    - An average of 42% of customers have been participants for qualifying projects in the most recent 3 years
    - 28 O&M projects have occurred on average every year for the last 3.5 years (out of 71 facilities)
    - Incentives will no longer be provided for capital projects.
    - A reduction in the breadth of incentives being offered for Rate T1 and Rate 100 customers

1.2.11 Challenges Union will face in Achieving Rate T1 and Rate 100 Targets

- The targets will be challenging as they require an optimal economic environment, broader customer participation, and highly cost effective projects.
- Broad customer participation can only be accomplished through optimal implementation of energy assessments, training sessions and energy team participation.
- Require customers advocate on behalf of Union's energy expertise both within their organization and potentially to other organizations.
    - Customers have to convince their senior management of the value energy efficiency upgrades provide
- Union has a diverse set of customers in the Rate T1 and Rate 100 rate classes including hospitals, greenhouse growers, power marketers, and manufacturing facilities. Since Union will be offering a new Program, Union will have to gain awareness, educate and create traction in each of these markets in the first year.

- Union will need to provide appropriate resources across all markets despite geographic challenges.
- Union will be able to obtain customers attention and influence behaviour, but are still exposed to risks around capital spending cycles (projects and budgets are cyclical and are difficult to predict one year to the next).
- Customers have very specialized processes and Union will have to find the precise industry experts to provide the information required.

Low-income

1.3 *Low-income Program*

1.3.1 Customer Class(es) Targeted

- Residential, C/I General Service

1.3.2 Rate Classes Targeted

- Rate M1, Rate M2, Rate 01, Rate 10

1.3.3 Goals

Program goals for the Low-income Program consist of the following:

- To reduce the energy burden of Union's low income customer base
- To provide offerings to Union's low income customer base that adhere to the Guiding Principles outlined in section 4.2 of the Guidelines
- To continue to develop the breadth and the depth of the low income offerings throughout the term of the multi-year Plan
- To minimize the barriers that low income customers face in participating in energy conservation programs

1.3.4 Program Strategy

Program strategies to achieve Union's goals for the Low-income Program include:

- Address all measures and natural gas savings opportunities in the dwellings that lead to an overall cost-effective Program
- Grow the offering's infrastructure across Union's franchise area
- Provide customers with the education required to continue conservation in their home after measure installation has been performed
- Address universality by expanding the Program to new low income markets (i.e. Social and Affordable Housing Multi-Family Offering)

- Foster relationships with key influencers in the low income community (i.e. social service agencies)

1.3.5 Program Offerings

The following offerings will be delivered to Union's low income customer base.

Helping Homes Conserve

Description

- Provides the free installation of up to two energy efficient showerheads, two metres of pipe wrap and a programmable thermostat. Kitchen and bathroom aerators are left behind for self installation.
- Education material, including an easy to read "how to use your programmable thermostat" guide and an energy saving guide with no-cost and low-cost tips, are left behind for the customer.

Target Market

- Customers who reside at or below 135% of the most recent Statistics Canada pre-tax Low-income Cut-Offs ("LICO") for communities of 500,000 or more, as updated from time to time.
- Any household that pays their own natural gas bills and resides within a community in which greater than or equal to 40% of households qualify for the LICO threshold listed above.
- Any social or assisted housing tenant residing in a Part 9[7] or Part 3[8] building.
- Further eligibility criteria is outlined on page 8 & 9 of EB -2008-0346.

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[7] A Part 9 building is one that is three or fewer storeys in building height, having a building area not exceeding 600 square metres.

[8] A Part 3 building is one that is three or more storeys in building height, or one having a building area exceeding 600 square metres.

Market Incentive

- The offering is delivered at no cost to the customer

Market Delivery

- The offering will primarily be delivered through a neighbourhood strategy where postal codes with high-propensities of low income customers (40% or greater) are targeted. Customers will receive pre-notification of a visit by a direct mail notification sent one week prior to the visit and a reminder flyer sent 72 -24 hours prior to a visit. A toll-free number is included on all material for customers to book an appointment or if they have any questions or concerns.
- A secondary delivery approach will involve working with community partners such as social service agencies to help refer their clientele into the Program. Union will pass these leads on to their contracted delivery agent who will then contact the customer to book an appointment for an install.
- To reach tenants residing within social or assisted housing, Union will work directly with social and assisted housing providers to deliver the offering to their tenant base.
- All measures will be installed by contracted delivery agents and all programmable thermostats will be installed by licensed gas fitters.

Barriers Addressed

- Cost of measures
    - Union has addressed this barrier as measures are offered at no-cost to the customers to provide access for customers who would otherwise not have the financial means to participate.
- Customer awareness
    - Union uses a targeted approach to addresses awareness and up-take by reaching a large breadth of low-income customers through a neighbourhood approach. This approach brings the offering right to the customers' door instead of putting the burden of pursuing the Program on the customers' shoulders.

- Installation requirements
    - Union provides free installation for the measures to address any issues that customers may face in installing measures, such as programmable thermostats (i.e. seniors).

Home Retrofit Offering

Description

- Provides a free home energy audit ("A Audit") to qualified homeowners and tenants to determine the building envelope upgrade needs of the home, and to undertake those upgrades that meet the qualifying criteria.
- Potential upgrades include; attic insulation, wall insulation, basement insulation and draft-proofing measures. In addition, an assessment will be performed on the home's furnace and water heater to establish whether the customer qualifies for an upgrade.
- If health and safety issues are discovered during the "A audit" stage that would prevent a measure from being installed (i.e. venting issues) then Union will assess whether the issues fall within their Health & Safety protocols and, if qualified, will address the issues within the home to allow for measure installations. Union will work with industry experts to define appropriate Health & Safety protocols.
- Once all of the eligible upgrades have been performed in the home, a follow-up home energy audit ("B Audit") will be performed to evaluate the energy savings realized in the home by the installation of the measures.
- During all stages of the offering, customers will receive one-on-one education from the auditors and contractors, and education materials tailored for this customer base will be left behind for the customers.

Target Market

- Customers who reside at or below 135% of the most recent Statistics Canada pre-tax Low-income Cut-Offs ("LICO") for communities of 500,000 or more, as updated from time to time.
- Private homeowners, or tenants who pay their utility bill, who were a recipient of one of the following social benefits within the last twelve months:

I. The National Child Benefit Supplement;
II. Allowance for the Survivor;
III. Guaranteed Income Supplement;
IV. Allowance for Seniors;
V. Ontario Works;
VI. Ontario Disability Support Programs; or
VII. LEAP Emergency Financial Assistant Grant.

- Any social or assisted housing tenant residing in a Part 9 building[9]
- Further eligibility criteria is outlined on page 8 & 9 of EB -2008-0346.

Market Incentive

- The offering is delivered at no cost to the customer
- Health and Safety incentive caps will be set once Union has properly assesses what issues may need to be addressed in the home and what their average costs may be (i.e. average costs of installing new vents)

Market Delivery

- This offering will be delivered using a multi-channel approaching including, but not limited to the following:
    - Social Service Agencies
        - Union will foster relationships with social service agencies within the community to inform them about the Program and how it can benefit their clients.
        - Union will seek to establish more formalized relationships with strategic agencies wherein the agency would actively recruit customers into the Program by educating the customer on the Program and asking them some

[9] A Part 9 building is one that is three or fewer storeys in building height, having a building area not exceeding 600 square metres.

pre-qualifying questions (i.e. age of the home). Union will provide education for the front-line staff of strategic social service agencies and will provide a financial incentive to the agency for each qualified customer lead.

- Social and Assisted Housing Providers
  - Union will work directly with social and assisted housing providers to bring the home retrofit offer to their tenant base.
  - The housing providers will qualify tenants that meet the income eligibility criteria by referring to the data they have on tenants that receive rent subsidies. Providers also can help pre-qualify which homes would be eligible for measures based on building stock information such as, age of the home, structure of the home, maintenance history, etc.
  - Union will reach out to providers through municipalities, Organizations and Associations (i.e. Ontario Not-For- Profit Association) and direct marketing activities
- Direct Marketing
  - Union will reach out to pre-identified low income customers using direct marketing mediums (i.e. direct mail) to drive awareness and take-up.
  - Customers will be pre-identified by data analysis that will look at demographics such as the postal code income level and penetration, the age of the home, the square footage of the home and historical m^3 consumption.
- Education Workshops, Community Groups & Events
  - Union will host education workshops at social service agency partners' locations to teach customers about low cost and no cost conservation tips they can perform in their home. During these workshops Union will make the audience aware of the home retrofit offering and will sign-up interested participants.
  - A number of community groups and events are hosted for low income residents (i.e. church groups) in order to assist them with many of their day-to-day struggles. Union will seek to support these groups and events and to provide them with the necessary support to educate their attendees with information on the offering.
- Through Helping Homes Conserve Offering
  - While performing basic measure installations through Union's Helping Homes Conserve offering, technicians will assess whether the home would

be a prime candidate for the Home Retrofit offering. Technicians will perform this assessment by asking the customer some basic questions about their home (i.e. age of the home) and by assessing the structure of the home (i.e. double brick home).

        - Union will provide training to technicians who perform basic measure installations to teach them how to properly asses the home.

- All audits (“A and B”) will be performed by Certified Energy Auditors.

Barriers Addressed

- Cost of the measures
    - Union has addressed this barrier as measures are provided at no-cost to the customer. This approach provides access for customers who would otherwise not have the financial means to participate.
- Access to the offering
    - Union works directly with housing providers to counter any barrier tenants may face if the burden is put on them to get their housing provider on board.
- Awareness of the offering
    - Union will reach out to trusted partners in the community to address awareness by leveraging the channels low income customers go to for information and guidance.
- Managing the installation process
    - Provide a direct install offering for the measures in the home to remove any onus on the customer to source out qualified contractors. This will also provide them with the comfort that the installations in their home are being performed by quality controlled professionals.

<u>Social and Assisted Housing Multi-Family Offering</u>

Description

- Support Social and Assisted Housing Providers to address energy efficient upgrades in their buildings

- Eligible Upgrades may include:
  - Prescriptive measure upgrades, such as Condensing Boilers and Condensing Gas Water Heaters
  - Custom measure upgrades including building envelope upgrades and Building Optimization

- Provides social and affordable housing providers with "enhanced" incentives for any Commercial prescriptive or custom offering for multi-family buildings
- Comprehensive education will be offered to all influencers on the energy usage in the building including, housing providers, builder operators and tenants
- Offering addresses both technology requirements as well as operational and building operator changes, through identifying best practices and optimizing maintenance procedures that will result in reduced natural gas usage

Target Market

- Social Housing Providers that operate part 3 buildings with tenants who reside at or below 135% of the most recent Statistics Canada pre-tax Low-income Cut-Offs ("LICO") for communities of 500,000 or more, as updated from time to time.
- Further eligibility criteria is outlined on page 8 & 9 of EB -2008-0346.

Market Incentive

- The enhanced incentives include the following:
  - 50% of the eligible costs* of the project up to a maximum of 55% of the estimated eligible costs
  - 50% of the incentive can be provided in advance of the project if required by the social or assisted housing provider
  - Free site assessment and eligible low-cost/no-cost upgrades for Building Optimization
  - Comprehensive education and training for social housing providers, building operators and tenants

**Eligible Costs include; the cost of the measure, the cost of the installation of the measure and the cost of any assessment required determining the upgrade needs of the given measure.*

Market Delivery

- Union will work directly with Social and Assisted Housing Providers to assess the needs of their buildings. Union will reach out to providers through multiple channels including:
    - Municipalities
    - Organizations and Associations (i.e. Ontario Not-For- Profit Association)
    - Direct Marketing mediums

Barriers Addressed

- Access to capital to fund measures
    - To address this barrier Union offers enhanced incentives to reduce the financial burden that housing providers face trying to purchase measures by allowing providers to realize their return on investment earlier by reducing the payback on the measures.
- Lack of decision making abilities around conservation upgrades by the low income tenants who reside in the building as property managers must agree to any Program uptake.
    - To address this barrier, Union works directly with social and affordable housing providers who manage Part 3 buildings, to remove the barrier of access to conservation for low income tenants residing in these buildings.

1.3.6 Program Duration

- All offerings in the low income Program will be delivered throughout the 2012 -2014 DSM Plan
- The measures within the offerings may vary should new measures be introduced or market conditions change over the course of the Plan

1.3.7 Program Budget

- Union has not included inflation in the table below. Union proposes to use the Q2 GDP-IPI inflation factor, released at the end of August, to align with Union's annual rate setting process.

Table 20 – Low Income Program Budget

2012 Low Income Program Budget ($000)		
Program Cost	**Residential**	**C/I General Service**
Promotion Costs	$1,116	$200
Market Incentive Costs	$3,293	$1,218
EM&V & Monitoring Costs	$10	$30
Administrative Costs	$602	$370
Total	**$5,021**	**$1,818**

2013 Low-income Program Budget ($000)		
Program Cost	**Residential**	**C/I General Service**
Promotion Costs	$1,014	$155
Market Incentive Costs	$3,288	$1,370
EM&V & Monitoring Costs	$10	$30
Administrative Costs	$602	$370
Total	**$4,914**	**$1,925**

2014 Low-income Program Budget ($000)		
Program Cost	**Residential**	**C/I General Service**
Promotion Costs	$1,078	$155
Market Incentives	$3,656	$938
EM&V & Monitoring Costs	$10	$30
Administrative Costs	$602	$370
Total	**$5,346**	**$1,493**

1.3.8 Cost Effectiveness

Table 21 – Low Income Cost Effectiveness

Measure	Participants	Total TRC Benefits	Total TRC Costs	Total Net TRC Before Program Costs	TRC Ratio
Attic Insulation (Weatherization) [3]	550	$ 349,994	$ 412,676	-$ 62,682	0.8
Basement Insulation (Weatherization) [3]	550	$ 1,302,870	$ 959,783	$ 343,087	1.4
Building Optimization [5]	70	N/A	N/A	N/A	N/A
CEE Tier 2 Front-loading Clothes Washer (Multi Family)	88	$ 114,459	$ 47,520	$ 66,939	2.4
Condensing Boiler - up to 299 Mbtu/h [1]	5	$ 35,261	$ 14,174	$ 21,087	2.5
Condensing Gas Water Heater (1000gal/day) - Purchase	15	$ 55,773	$ 31,778	$ 23,996	1.8
Early Furnace Replacement - 60% AFUE	28	$ 16,540	$ 14,504	$ 2,036	1.1
Early Furnace Replacement - 70% AFUE	82	$ 28,902	$ 42,476	-$ 13,574	0.7
Early Hot Water Heater Replacement (0.575 to 0.62 EF)	28	$ 1,660	$ 4,704	-$ 3,044	0.4
HHC - Faucet Aerator - Bath - 1.0gpm [4]	10,000	$ 587,411	$ 5,841	$ 581,570	100.6
HHC - Faucet Aerator - Kitchen - 1.5gpm [4]	10,000	$ 1,398,217	$ 12,771	$ 1,385,446	109.5
HHC - Pipe Insulation - 2m [4]	10,000	$ 350,291	$ 9,702	$ 340,589	36.1
HHC - Showerhead - 1.25gpm exist 2.0-2.5 [4]	3,000	$ 743,888	$ 11,256	$ 732,632	66.1
HHC - Showerhead - 1.25gpm exist 2.6+ [4]	7,000	$ 2,926,815	$ 26,265	$ 2,900,550	111.4
HHC - Thermostat - Programmable	6,000	$ 1,172,163	$ 160,083	$ 1,012,080	7.3
HWC - Faucet Aerator - Bath - 1.0gpm (Multi Family) [4]	5,000	$ 64,911	$ 2,655	$ 62,256	24.4
HWC - Faucet Aerator - Kitchen - 1.5gpm (Multi Family) [4]	5,000	$ 203,380	$ 5,805	$ 197,575	35.0
HWC - Showerhead - 1.25gpm (Multi Family) [4]	5,000	$ 643,475	$ 17,055	$ 626,420	37.7
HWC - Showerhead - 1.25gpm replacing existing 2.0gpm (Multi Family) [4]	5,000	$ 516,203	$ 17,055	$ 499,148	30.3
Sealing Measures (Weatherization) [3]	550	$ 375,901	$ 148,126	$ 227,775	2.5
Social and Assisted Housing Multi-Family Offering (Custom) [2]	12	$ 232,473	$ 332,500	-$ 100,027	0.7
Wall Insulation (Weatherization) [3]	550	$ 562,081	$ 437,481	$ 124,600	1.3
Total		**$ 11,682,669**	**$ 2,714,210**	**$ 8,968,459**	
		Promotion Costs	$ 1,315,648		
		Administration	$ 971,549		
		EM&V Costs	$ 40,000		
		Program Total Net TRC		**$ 6,641,262**	
		Program TRC Ratio			**2.3**

1. Condensing Boiler measure is quasi-prescriptive. Savings are based on an average capacity of 185,394 Btu/hr from 2010 year results
2. Social and Assisted Housing Multi-Family Offering (Custom). Input assumptions based on driving a TRC ratio of 0.7 by funding 50% of the full cost, up to the budgeted
3. Weatherization (Attic Insulation, Basement Insulation, Sealing Measures, Wall Insulation). 1220 m3 saved per home is the expected average derived from 150 work plans created for Union Gas by EnviroCentre in 2010 & 2011 (the m3 saved by each measure were totaled to comprise of the 1220 m3 average). 180 kWh saved per home derived from the 150 work plans. Average retrofit cost of $3483.10 based on the sum of average cost/m3 saved in each measure in 150 work plans. 20 year measure life for
4. TRC benefits adjusted based on 2010 verification study results. The adjustments reflect installation rates, persistance rates, percentage of showering under showerhead (for showerhead measures), and percentage of homes without gas water heaters.
5. Building Optimization savings and total resource costs will not be realized until 2013, from all participants in the 2012 year.

1.3.9 Low-income Program Targets

Table 22 – Low-Income Program Targets

2012 Low-Income Program Targets			
Metric	**Metric Target Levels**		
	50%	**100%**	**150%**
Cumulative Natural Gas Savings (m3)	18,204,000	36,409,000	45,511,000
Residential Deep Measure Participants	275	550	688
Multi-Family Deep Measures	95	190	238

2013 Low-Income Program Targets			
Metric	**Metric Target Levels**		
	50%	**100%**	**150%**
Cumulative Natural Gas Savings (m3)	15,924,000	31,848,000	39,809,000
Residential Deep Measure Participants	325	650	813
Multi-Family Deep Measures	113	225	281

2014 Low-Income Program Targets			
Metric	**Metric Target Levels**		
	50%	**100%**	**150%**
Cumulative Natural Gas Savings (m3)	15,570,000	31,141,000	38,926,000
Residential Deep Measure Participants	375	750	938
Multi-Family Deep Measures	85	170	213

1.3.10 Rationale for Targets

Union established its Low-income targets on a bottom-up basis based on market conditions, the DSM budget, and the Board's Guidelines for Natural Gas Distributors. Union has provided the following information to provide context for its Low-income Program targets.

History

- Union delivered Helping Homes Conserve since 2007
- Union has delivered the Home Weatherization since 2009

- Union will be offering a Social Housing Multi-Family offering for the first time in 2012
  - Union's historic Low-income participation and budget in relation to the targets for 2012 are included for reference in Table below

Table 23 - Low-Income Historic Results and 2012 Target

Low Income Participants and Budget						
	2007 Actual	**2008 Actual**	**2009 Actual**	**2010 Actual**	**2011 Forecast**	**2012 Target**
HHC Participants[10]	6,363	7,694	18,478	14,508	15,000	10,000
Weatherization Participants	-	-	75	134	400	550
Multi-Family Units	-	-	-	-	-	190
Low Income Budget ($000) Promotion/Incentive Costs[11]		$1,445	$2,170	$1,575	$4,368	$5,827

Consideration of Board's Guiding Objectives

- Union has addressed lost opportunities in the home by expanding the deep measure offering to address furnaces and water heaters in need of retirement
- Union has increased the focus on deep measures by expanding deep measure offerings to Part 3 buildings and by increasing targets around deep measures while decreasing targets around basic measures
- Union has considered the CDM program offerings in the market when developing their DSM Program offerings in order to create a platform for collaboration
- Union has included an education and training strategy in all offerings put forward

Context for Helping Homes Conserve Targets

- Union has been delivering Helping Homes Conserve in the market since 2007 and has seen great success over the years. Given the saturation in the market and Union's shift of focus to the delivery of deeper measures, Union will be decreasing its focus on basic measure delivery over the course of the Plan and ultimately the targets tied to the offering.
- The effect of decreasing basic measure delivery over the course of the Plan is that the overall cumulative m^3 target will decrease with it. The reason for this is that while basic

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[10] Participants are based on homes that received a kitchen aerator.
[11] Only promotion and incentive costs have been included as this is how program costs have historically been reported.

measures do not provide deep savings, they are inexpensive and therefore can drive a lot of m^3 savings from a volumetric standpoint.

Context for Home Retrofit Targets

- In 2011, Union is targeting to weatherize 400 single family homes (100% target) while developing its internal and external infrastructure to continue to expand over the next three years. Increasing the number of homes to 550 single family homes (100% target) in 2012, and increasing the 100% target by 100 homes year over year in subsequent years will be a significant increase for Union considering the unique challenges faced in delivering this offering in the market.
- Although growth is an important element of a low income Program, it is critical to grow the Program at a manageable level given the intricacies involved with this programming and the sensitivities of working in a customers' home. Quality assurance is integral to provide the customer with a positive experience and to ensure that the proper protocols are met when installing measures in the home.
- Union feels that it's in the customers' best interests to focus not only on depth in the Program but also breadth. Although the overall m^3 energy savings from smaller footprint may be relatively less than a larger footprint home, the impact those savings have on the customer are just as significant (typically an average of 25% - 30% savings in a home, regardless of size of the footprint). Incenting Union to simply drive m^3 savings would shift focus away from customers who are residing in smaller footprint homes due to the smaller extraction of m^3's available.
- In order to develop the cumulative m^3 target for the custom weatherization component of the home retrofit offering, Union started by assessing the current average annual savings of 1,220 m^3's. Consensus had been reached with a sub-committee of interveners representing the broader consultative that this annual average m^3 was a stretch for Union as part of the Low Income Incremental Plan filing. Union then calculated the typical proportion of m^3's that are derived from the suite of measures in the home (assumed 50% basement insulation, 15% attic insulation, 20% wall insulation and 15% draft-proofing) and multiplied them out by their given measure life.

Context for Social and Assisted Housing Multi-Family Offering

- 2012 will be the first year Union will be delivering an offering specifically designed for Social Housing Multi-Family providers. Union believes it will take time to assess and grow traction in this market. Based on current market knowledge, the maximum number of buildings that would qualify for this offering in Union's franchise area is 225 buildings, which is a relatively small target market and will make the targets Union put forward quite challenging. Union will invest time in 2012 to further assess this market and to gain further insights on the needs of the market, including timelines for including projects in their capital budgets.

- Social Housing Providers have limited access to funds to perform upgrades to their buildings. Often conservation upgrades are not considered due to conflicting priorities of other upgrades that are needed on the buildings (i.e. in-suite repairs). Union will continue to be challenged to ensure that conservation upgrades are prioritized with the limited capital funds social and assisted housing providers have available to them.

1.3.11 Challenges Union will Face in Achieving Low-income Targets

Helping Homes Conserve

- The aggressive basic measure targets that the LDC's are working towards as part of the CDM Home Assistance Program may shift the focus of Union's existing delivery infrastructure given Union's decrease in targets from previous years.
- As Union continues to drive this Program in the market, the saturation levels continue to increase. There are only a limited number of low income customers who qualify for this offering in Union's franchise area and not all of these customers are receptive to participating. Union is reaching maturity in this offering and believes the remaining potential will be the most challenging in the market to achieve (no more "low hanging fruit).
- Union will need to expand into harder to reach communities in order to achieve this level of traction given Union's current saturation rate in the market. Delivering the offering in more remote areas has proven to be challenging given the staffing requirements to deliver the offering locally. Often it is quite costly and resource intensive for delivery agents to enter these areas and the requests to do so are often met with resistance.

Home Retrofit Offering

- Union will be competing with all of the LDC's to secure delivery agents to perform weatherization installations. This may prove to be challenging given the relatively small number of delivery agents in the Ontario market. While Union has been working with LDC's to seek program collaboration, Union questions whether the market can bear such a significant ramp-up in the demands of the market in such a short time frame.
- The Federal Governments *EcoEnergy Retrofit - Homes* Program will require a significant amount of Certified Energy Auditors to perform both their basic audit and blower door test audit in 2012. There will also be competing demand in the market from the Home Energy Savings Program in Ontario. Availability of resources in the market may cause delays for Union to get the required number of audits performed to reach the targets.

- The targets represent a continual stretch for Union over the course of the three years. This will require Union to focus not only on the targets at hand but to continue to grow infrastructure and efficiencies to drive continual growth over the years.
- Union believes that collaborating with LDC's in the communities where the home retrofit offering is being delivered is an important element of the Program; however, these efforts will take time and resources and may slow down Union's ability to enter into a new market given the considerations required for a partnership agreement.
- It is often a lengthy process to bring a customer through all stages of the Program given the need to not only to qualify their home but to income qualify them as well. Throughout these qualification stages there can be many hurdles such as customers ability to accurately answer pre-qualifying questions (i.e. historical upgrades in home) which can lead to a long process prior to installations even commencing. Once customers are qualified for the Program, additional challenges may be faced such as missed appointments or health and safety concerns that can prolong the process even further.
- The targets set represent a significant stretch for Union given the history with this Program to date. There are many barriers faced with this Program including; identifying the customer, building trust with the customer, educating customers on the Program, qualifying the customers, screening the homes, prepping the home for installations, performing installations and measuring the results. Although Union can continue to get more effective at addressing these barriers, the barriers will none the less continue to exist. Therefore, the targets put forward will be challenging to achieve.

Social Housing Multi-Family Offering

- It will take time to grow traction in this market due to Union's limited experience with the market to date.
- Union anticipates that even when traction is achieved in this market that the opportunity in the market will be limited due to the small market share that Multi-Family buildings have in Union's franchise area.
- Even with enhanced incentives, Social Housing Providers have limited access to capital and often face conflicting priorities when making decisions on how to invest that capital into their buildings.
- Social Housing Providers are often resource constrained and may have challenges with having the proper support in place to participate in offering such as Building Optimization.
- Given the capital and resource challenges that this segment of the market faces when it comes to operating and maintaining their buildings, the ability to achieve aggressive targets in this market will be a significant challenge for Union.

Market Transformation

Union is recommending three Market Transformation Programs – a residential High Efficiency Water Heater Program, a residential New Home Efficiency Program, and an industrial Integrated Energy Management System Program. Each is outlined below. In the prior DSM framework Union had one Market Transformation Program related to drain water heat recovery equipment in residential new home construction. This Program is being discontinued due to findings that have significantly reduced expected savings from the equipment. Union's drain water heat recovery cumulative m^3 savings per unit were 7,930 m^3 as approved in the Generic Proceeding Phase 2 (EB-2006-0021). Using best available data, Union has assessed the cumulative m^3 savings have fallen to 1,609 - 916 m^3 depending on whether it is used in conjunction with typical showerheads in use today or the energy efficient showerheads delivered by Union. The change in savings was driven by new calculation methods and values developed by Natural Resources Canada ("NRCAN"), as well as shower use data collected in showerhead studies and applied in Union's energy efficient showerhead input assumptions.

In exiting this Program, Union must honour commitments already made by builders. Therefore, funding for a Program exit has been included within the High Efficiency Water Heating Program budget as outlined below.

1.4 *High Efficiency Water Heating Program [Energy Factor (EF) of 0.80 or higher]*

NRCAN's Office of Energy Efficiency has proposed amending the Energy Efficiency Regulations for water heaters to be sold or leased in Canada. Union's understanding is that these revised regulations, as currently drafted, propose to increase the minimum efficiency for gas fired water heaters from the existing minimum efficiency of EF 0.57 to EF 0.80 for a 151 litre storage tank water heater. Timing for these changes at this point is uncertain; available information suggests this change will take place between 2016 and 2020. In response to these expected changes in minimum efficiency regulations, Union has developed a new High Efficiency Water Heater Program to remove existing barriers and promote the creation of market conditions in the new home market that support these significantly increased standards.

1.4.1 **Customer Class(es) Targeted**

- Residential new building construction single family detached homes and individually metered town-homes

1.4.2 **Rate Classes Targeted**

- Rate M1, Rate 01

1.4.3 **Goals**

The goals of the High Efficiency Water Heating Program are:

- To remove market barriers currently preventing adoption of high efficiency water heaters (0.80 EF and above) and build a competitive market for these measures
  - ➢ Transformation: Increase the market share of high efficiency water heaters in the new build market
- To support the development of market conditions necessary to support future building code changes and/or federal regulations regarding water heater efficiency
  - ➢ Transformation: Increase experience with and acceptance of high efficiency water heaters by residential home builders
- To support the development of a market such that a sufficient volume of water heaters are produced and sold into the Ontario marketplace to reduce the overall cost of the product to home buyers
  - ➢ Transformation: Decrease incremental costs to home buyers of purchasing/renting a high efficiency water heater

1.4.4 **Strategy**

- Work cooperatively with residential home builders and their sales agents to:
  - Effectively promote the benefits of high efficiency water heaters to home buyers
  - Enhance home buyer knowledge to increase uptake and reduce call-backs to the home builders and potential dissatisfaction related to high efficiency water heaters
  - Facilitate training for installers of high efficiency water heaters with the goal of increasing quality of installations, and increasing comfort with these products
- Offset the incremental cost to home builders and home buyers using a financial incentive

1.4.5 **Program Offerings**

Description

- The High Efficiency Water Heater Program seeks to transform the new build market for high efficiency natural water heaters with an EF of 0.80 or higher.
- In Canada, commercially available models meeting this efficiency standard are currently limited to tankless and condensing tankless technologies in the residential market. The Program will support additional technologies as they become available in the market.
- Union will seek opportunities to support the commercialization of new 0.80 EF (or higher) technologies, including storage tank models. These efforts will include collaboration with third parties such as: manufacturers, rental providers, other utilities, energy efficiency agencies and associations.
- Union will facilitate training of builders, builder sales centres, installers and rental companies to ensure they understand the key benefits of high efficiency water heaters and can promote them to customers.

Target Market

- The High Efficiency Water Heating Program will target residential new build, single family detached homes and individually metered town-homes. New housing starts in the Union franchise area are currently forecasted to be approximately 15,500 to 18,000 annually over the term of the Plan.
- In the water heater market, customers have the choice of renting or purchasing their unit; therefore, this Program will seek to transform both the new build rental and purchase markets.

Market Incentive

- The High Efficiency Water Heating Program will offer an incentive of $250 for each new home with a water heater that has an EF of 0.80 or above. The incentive will be divided between the builder and home buyer as required to mitigate the incremental cost of installation and the high efficiency water heater.
- For purchased water heaters, this incentive will cover a portion of the incremental cost of purchasing a higher efficiency water heater.
- For rental water heaters, this incentive will cover roughly two years of incremental rental fees, depending on the model installed.
- For both rental and purchase incentives, proof of purchase/rental will be required.
- The incentive will be adjusted throughout the life of the Program based on market acceptance.

Market Delivery

- This energy efficiency Program will be targeted to multiple distribution channels in the market, including, but not limited to;
    - Residential home builders and their sales agents
    - Sub-contracted water heater installers
        - Union will work with installers (generally plumbers) sub-contacted by builders to increase builder comfort with the measures, as well as ensuring high quality installations.
    - Rental providers
        - Union will work with builder account managers employed by rental providers as a secondary method to reach builders and promote the measure.
    - Manufacturers
        - Union will work with manufacturers of high efficiency water heaters in developing promotional and educational materials aimed at both home builders and home buyers.

- A direct-to-consumer approach will also be employed through attendance at consumer and industry events targeted at prospective home buyers such as home shows.

Barriers

- The primary barrier faced by the High Efficiency Water Heater Program is reluctance amongst builders to install water heating technologies that have the potential to increase call-backs and customer dissatisfaction.
- This reluctance stems from performance differences between tankless and storage tank units. These differences, such as delays waiting for hot water, can create customer dissatisfaction.
  - Union will address this barrier by providing marketing support and training to builders and their sales agents on establishing customer expectations prior to move-in, which will lead to greater comfort with the measure.
  - Union will also address this barrier by developing information on the ideal design location for optimal performance of tankless units.
- Higher costs for high efficiency units
  - Union will address this barrier by providing an incentive for new homes with a high efficiency water heater installed.
- General lack of familiarity/interest from new home buyers who often focus any increased spend on aesthetic upgrades, such as granite counter tops or cathedral ceilings, as opposed to enhanced energy performance upgrades hidden in the basement.
  - Union will address this barrier by providing marketing support and training to builders and their sales agents to effectively promote the benefits of high efficiency water heaters.
    - The financial incentive will help build initial interest in this measure and provide an opportunity for builders to promote the value of high efficiency water heaters.
    - A direct-to-consumer approach through consumer/industry event attendance by Union will also address this barrier.
- Increased maintenance required for tankless units. If this maintenance is not undertaken, performance problems can emerge from issues such as scaling and liming.

- Union will address this barrier though education provided to home buyers through builders and rental providers.

- Past builder experience with an older generation of high efficiency models that had performance issues. Builders prefer to use proven, reliable options.
  - With the support of manufacturers, Union will address this barrier with education and training sessions.
- Installers require specialized training in order to install tankless units. If not installed correctly, quality issues could emerge.
  - Union will work with installers employed or sub-contracted by builders to build capacity and competency in installing high efficiency water heaters.
  - Union will explore opportunities with trade associations to enhance awareness of high efficient water heaters and the installation requirements to its members.

1.4.6 **Program Duration**

- Union anticipates that intervention in the market will be required for six years, with 25% market penetration achieved in the final year.
- The Program timeline is aggressive given the following market characteristics:
  - Minimum efficiency water heaters currently dominate the market. Moving the market from 0.57 EF to 0.80 EF represents a significant shift.
  - The introduction of a new 2012 Ontario Building Code establishes new requirements around energy efficiency; this change represents a significant challenge for builders in terms of understanding and awareness of the new Code requirements. Home and plumbing designs will potentially be affected and require modifications to meet the new building code. The various option packages which have been developed to make it easier for builders to comply with the code do not include 0.80 EF water heaters. Installing a high efficiency water heater therefore represents going above code during a period in which builders will be stretched to meet the new requirements.
  - Since this product is relatively new to the new build market and many builders are unfamiliar with both the benefits and adjustments required to install a high efficiency water heater in their home design, momentum at the early stages of this Program will be slow.
- After 6 years, and 25% market share, Union will have transformed this market, as it will be at a place where:

  - take up will continue absent a Program
  - market conditions will be such that a change in federal efficiency regulations or the Ontario Building Code regarding water heater efficiency can occur more easily

- Experience from other New Build programs, such as the *ENERGY STAR For New Homes* program, suggests that a measure has the necessary momentum to be included in the Building Code or regulated federally when the following conditions exist:
  - A significant pool of builders have experience with the measure
  - Costs associated with the measure can be accurately estimated
  - The long term quality/reliability of the measure has been proven in the field
- These conditions come into place as take-up increases and the market gains experience with the measure. In the case of *ENERGY STAR for New Homes*, this level of experience was achieved at a market penetration of approximately 25% and subsequently many program elements were adopted into the Ontario Building Code.

Program Evolution

- The primary market barrier preventing higher uptake of high efficiency water heaters is builder reluctance to install measures that have the potential to increase call-backs and customer dissatisfaction. The evolution of the strategy therefore is shaped around the elimination of this barrier in the following phases:

Table 24 – High Efficiency Water Heating Program Evolution

Phase	Description of Interventions and Market Effects	Estimated Market Share for High Efficiency Water Heaters
Phase 1 - Builder Awareness	• Union educates customers, builders and manufacturers on the measure, using incentives as a means to build interest • Early adopters participate in the Program	• < 16%
Phase 2 - Builder Acceptance	• Builders gain familiarity and comfort with the measure • Builders learn how to educate customers in order to mitigate call-backs • As “early adopters” develop comfort with the measure, interest is generated amongst additional, more risk-adverse builders	• 16-20%
Phase 3 - Withdrawal	• Union gradually reduce incentives and builder support while builders start to promote high efficiency water heaters without marketing assistance from Union • Builders begin to position high efficiency water heaters as a selling point for their homes, allowing interest to be maintained in the absence of a full incentive	• 21-25%
Phase 4 - Exit	• Union completely withdraws incentives and Program support. Market penetration is maintained through builder promotion of measures	• > 25%

1.4.1 High Efficiency Water Heater Program Budget

- Union has not included inflation in the table below. Union proposes to use the Q2 GDP-IPI inflation factor, released at the end of August, to align with Union's annual rate setting process.

Table 25 – High Efficiency Water Heating Program Budget

High Efficiency Water Heating Program Budget ($000)			
Program Costs	**2012**	**2013**	**2014**
DWHR Sunset costs	$550	$0	$0
Promotion Costs	$200	$222	$200
Incentive Costs	$583	$797	$1,087
Administrative Costs	$219	$219	$219
Total	**$1,552**	**$1,238**	**$1,506**

1.4.2 High Efficiency Water Heating Program Targets

Table 26 – High Efficiency Water Heating Program Targets

2012 High Efficiency Water Heating Program Targets			
Metric	**Metric Target Levels**		
	50%	**100%**	**150%**
Market Uptake	14%	15%	16%
Participating Builders	40	50	60
Education Sessions & Consumer/Industry Shows	8	15	22

2013 High Efficiency Water Heating Program Targets			
Metric	**Metric Target Levels**		
	50%	**100%**	**150%**
Market Uptake	2012 actual result + 0%	2012 actual result + 2%	2012 actual result + 4%
Participating Builders	2012 actual result + 5%	2012 actual result + 10%	2012 actual result + 15%
Education Sessions & Consumer/Industry Shows	15	22	29

2014 High Efficiency Water Heating Program Targets			
Metric	Metric Target Levels		
	50%	100%	150%
Market Uptake	2013 actual result + 0%	2013 actual result + 2%	2013 actual result + 4%
Participating Builders	2013 actual result + 5%	2013 actual result + 10%	2013 actual result + 15%
Education Sessions & Consumer/Industry Shows	15	22	29

1.4.3 Rationale for Targets

Consideration of Board's Guiding Objectives

Pursuit of deep energy savings

- After furnaces, water heaters represent the second largest natural gas consumption in a residential dwelling, accounting for an average of 20-25% of annual consumption. Once installed, high efficiency water heaters result in substantial, long lasting savings over the life of the measure.

Maximization of cost effective natural gas savings

- The Program becomes more cost effective over the term of the Plan, with the $/cumulative m^3 decreasing from $0.16/$m^3$ in 2012 to $0.13/$m^3$ in 2014.
- High efficiency water heaters save customers a significant amount of natural gas per year as compared with 0.57 storage water heaters

Prevention of lost opportunities

- High efficiency (EF=0.80) water heaters have a useful life of 15 years or more, depending on the model; therefore, ensuring the highest efficiency water heaters are installed in new construction prevents significant lost opportunities.

Context for Targets

- Targets for market uptake were developed as follows:
  - o The baseline market share was informed by internal research by Union, which estimated the market share of tankless water heaters to be approximately 14% in

2010. A target market share of 15% has been set for the 100% achievement level in 2012.

- For the 2013 and 2014 Program years, Union will be in Phase 1 of the Program Evolution strategy, with an expectation of linear growth in market uptake as interest and awareness in the technology grows. The target therefore reflects an increase in market share of 2% over the achievement in the previous year (i.e. the 100% target for 2013 = 2012 actual results + 2%).

- Targets for builder participation were developed as follows:
  - In Phase 1 of the Program Evolution strategy, Union expects participation to come predominantly from the builders that are market leaders in energy efficiency.
  - At the 50%, 100%, and 150% achievement levels, the builder participation target increases by 5%, 10% and 15% respectively in the 2013 and 2014 Plan years, with the expectation that participation will grow linearly in Phase 1 of the strategy.

- Targets for education sessions and customer/industry shows were developed as follows:
  - The 2012 target is based on facilitating builder education sessions across the Union franchise area to gauge initial measure interest as well as attending consumer/industry trade shows.
  - For the 2013 and 2014 Plan years, targets reflect an increase in events. Based on experience gained in 2012, Union will be in a better position to identify the builders that present the greatest opportunity for participation in the Program and will host sessions accordingly.
  - With a new building code being introduced, 2012 will be a challenging year for builders and Union will have to compete against other priorities for their time. The changes to the building code will require many builders to make significant changes to their building designs, and as a result it will be very challenging to convince builders to attend training sessions on measures not required under the code.

1.4.4 Challenges Union will Face in Achieving High Efficiency Water Heating Program Targets

- With a new building code being introduced, 2012 will be a challenging year for builders and Union will have to compete against other priorities to gain Program participants.
- The 2012 target will also be challenging as many of the homes built in the first half of the year will have been designed and /or under construction, and the water heater decision made, before the Program has been introduced.

- High efficiency water heating is more expensive and some builders will be reluctant to pass on additional costs to home buyers in a competitive marketplace.
- The builder sales teams are not experienced with selling the benefits of high efficient water heaters and education and training components are key to the success of this Program.
- Installers (generally plumbers) must receive specialized training to ensure high efficiency water heaters are installed correctly. Many installers are sub-contracted (not employed directly by the builder) and contracts will potentially be re-negotiated to take into account the change in installation requirements. Contracts are typically negotiated only once a year, potentially leading to a lag in participation. Installers may also attempt to negotiate higher prices.
- Currently, high efficiency water heaters are perceived as a niche technology to be used only in homes with high water use or space considerations. In order to increase market share, Union will have to address this perception.
- Builders are reluctant to have call backs and some have had previous poor experiences with high efficiency water heaters. They may be reluctant to venture into this field again.

1.5 *New Home Efficiency Program*

The New Home Efficiency Program is a new Program that has been proposed following input from the Consultative. Union has additionally consulted with a number of home builders and has received favourable comments on the value this Program would bring to the market. Given the significant change in the Ontario Building Code in 2012, the introduction of this new Program will be extremely important in continuing to encourage new home builders to build above code.

1.5.1 Customer Class(es) Targeted

- Residential new build market, both single family detached homes as well as individually metered town-homes

1.5.2 Rate Classes Targeted

- Rate M1, Rate 01

1.5.3 Goals

The goals of the New Home Efficiency Program are for residential new home production builders to:

- Review their key business functions and building practices with the purpose of identifying areas where efficiencies can be gained.
  - Transformation: Union will address the underlying drivers of business performance in order for builders to successfully adopt energy efficiency.
- Integrate the identified new best practices into their daily business functions and new housing starts.
  - Transformation: Builders incorporate more efficient processes in the way they are running their business and operating their design practices
- Incorporate high efficiency measures into their new home designs to improve overall house efficiency by at least 15% above Ontario Building Code (OBC) 2012.

  - Transformation: Each participating builder will increase the percentage of housing starts built to the higher efficiency standard during the Program and beyond, with the ultimate goal of complete transformation.

- Utilize the savings identified through the New Home Efficiency Program to reduce the incremental costs associated with the energy efficient upgrades.

  - Transformation: By ensuring these upgrades result in minimal incremental cost, this will result in more competitiveness for the builder, creating a desire within the organization to transform their business model to build to a higher efficiency.

- Educate builders on how to promote energy efficient homes to ensure there is customer demand for their product.

  - Transformation: By educating and providing tools to builder sales teams, this will ensure their ability to sell these homes will be more effective.

- By 2016, those builders that were introduced to the Program in year one (2012) will have the majority of their housing starts at 15% above OBC 2012 and those introduced in year two will have half of their housing starts at 15% above OBC 2012.

  - Transformation: Increase the market share of higher efficiency homes such that market conditions are acceptable for increased minimum efficiency standards in future building codes.

1.5.4 **Program Strategy**

Strategies to achieve Union's Program goals for the New Home Efficiency Program include:

Builder Strategy

- Educate and build awareness amongst residential builders about the benefits/savings of taking a 'whole home approach' to building more efficiently. Through a consultative approach, those cost savings identified through refined building practices will assist in reducing the incremental costs associated with building to a higher energy efficiency standard – 15% above current building practices – improving their competitiveness and profitability in the marketplace.

Sales Agent Strategy

- Educate and provide sales and marketing tools to builder sales teams to improve their relative effectiveness in selling higher efficiency homes to new home buyers.

Consumer Strategy

- Educate and build awareness amongst new home buyers about the benefits of higher efficiency homes – this will heighten their understanding of the energy savings they will experience and will increase both their desire and demand for these new homes, which will drive builder commitment to this Program

1.5.5 **Program Offerings**

The offering that will be delivered in the New Home Efficiency Program is outlined below.

Description

- This Program utilizes the Building Canada model which is based on the philosophy of Total Quality Management ("TQM") to help builders run their business functions more effectively and to build their new homes more efficiently.
- Over a three-year period, Union and a third-party consultant will review a builder's key business functions from start to finish, including analyzing and designing/re-designing management controls, operating procedures, purchasing, contracts, and construction practices in order to optimize operating efficiencies, improve customer satisfaction and increase product quality.
- In exchange, participating builders will re-invest the accrued savings to improve the energy efficiency of their homes.

Process Flow

- Phase 1: (one year in duration)
    - Expression of interest/agreement by builder to participate
    - Corporate commitment - alignment across the company including the builder's corporate head office. Experienced consultants will require a cross-functional team of senior managers, led by the CEO or his/her designated "champion" to address the company's management issues that stand in the way of broader implementation of energy efficiency across the builders' entire production.
    - Contract - Union and each builder will sign a contract for participation for three years.
    - Consultative process - extensive modelling using Natural Resources Canada approved modelling software, on-site analysis, benchmarking current construction,

work with trades, identify "best" practice, audits, set management goals and priorities.

- Builder will build a prototype home and evaluate lessons learned into future builds. This is constructed as a field laboratory to demonstrate, de-bug and ultimately resolve issues relating to construction.

- Phase 2 : (one year in duration)
  - Develop a process map and critical path to process alignment
  - Integrated design process (architectural design, scopes of work, establish best practices)
  - Introduce and coach builder on opportunities to integrate high efficiency homes into sales and marketing materials and sales agent training
  - Goal is to have 10% of housing starts as high efficiency homes (15% above OBC 2012)
- Phase 3 : (one year in duration)
  - Encourage builder team to embrace new philosophy into company culture
  - Implement increased focus on integrating high efficiency homes into sales and marketing materials and sales agent training
  - Develop maintenance plan to facilitate independence from Program
  - Goal is to have 25% of housing starts as high efficiency homes (15% above OBC 2012)

Target Market

There are two target audiences in the New Home Efficiency Program:

- Primary target market is production builders in the Union franchise area (builders with 50 or more housing starts per year on average will be the target).
- Secondary target market is home builders not eligible for this Program. Training and education will be provided through regional workshops.

Market Incentive

The builder incentive is outlined below for each phase of participation. The incentive will come in the form of consulting services, education and training:

- Phase 1 - $29,000 per builder

- Phase 2 – $25,000 per builder
- Phase 3 – $21,000 per builder

Market Delivery

- This energy efficiency Program will be delivered through Union Residential Account Managers and will require collaboration with third party consultants and channel partners who will be required to:
  - Deliver required consulting services
  - Leverage manufacturing and channel partner relationships to provide product knowledge and education

Barriers

- The primary barrier is builder's concerns over the incremental costs associated with energy efficiency upgrades
  - To address this, Union will utilize the "whole home approach" to production to address all of the builders concerns through the consultative process. Union will leverage the experience of industry experts to provide the solutions that builders will be comfortable with and profitable implementing.
- A secondary barrier is new technologies or processes that are more energy efficient, but builders are unfamiliar with and reluctant to use.
  - To address this, Union will include in the Program offering education, a "train the trades" component and sales team training.
- A third barrier is addressing the difficulties that builders have in selling energy efficiency upgrades to their home buyers
  - To address this, Union will assist the builder with sales training and marketing materials.

1.5.6 Program Duration

- Union will enrol builders over the duration of the three-year Plan and provide support and incentives. The Program will run for five years to recognize builders that enrol in years two and three require support through the "sunset period".

Program Evolution

- The New Home Efficiency Program is a three-year commitment for the builder with a specified metric at the end of each phase:
    - Phase 1 – one prototype home built and certified
    - Phase 2 – 10% of housing starts that year will be 15% above code
    - Phase 3 – 25% of housing starts that year will be 15% above code
- Following the three phases of the Program Union will withdraw financial support. Builders will continue to use what they have learned to build homes which are 15% above OBC 2012.

1.5.7 New Home Efficiency Program Budget

- Union has not included inflation in the table below. Union proposes to use the Q2 GDP-IPI inflation factor, released at the end of August, to align with Union's annual rate setting process.

Table 27 – New Home Efficiency Program Budget

New Home Efficiency Program Budget ($000)			
Program Cost	**2012**	**2013**	**2014**
Promotion Costs	$300	$350	$300
Incentive Costs	$232	$316	$326
Administrative Costs	$194	$194	$194
Total	**$726**	**$860**	**$820**

1.5.8 New Home Efficiency Program Targets

Table 28 – New Home Efficiency Program Targets

2012 New Home Efficiency Program Targets			
Metric	**Metric Target Levels**		
	50%	**100%**	**150%**
New Participating Builders	6	8	10
Prototype Homes Built	20% of Participating Builders	30% of Participating Builders	40% of Participating Builders

2013 New Home Efficiency Program Targets			
Metric	Metric Target Levels		
	50%	100%	150%
New Participating Builders	2	4	6
Prototype Homes Built	50% of Participating Builders	60% of Participating Builders	70% of Participating Builders
Homes Built (>15% above OBC 2012) by Participating Builders	2%	4%	6%

2014 New Home Efficiency Program Targets			
Metric	Metric Target Levels		
	50%	100%	150%
New Participating Builders	1	2	3
Prototype Homes Built	70% of Participating Builders	80% of Participating Builders	90% of Participating Builders
Homes Built (>15% above OBC 2012) by Participating Builders	2013 actual result + 4%	2013 actual result + 6%	2013 actual result + 8%

1.5.9 **Rationale for Targets**

Consideration of Board's Guiding Objectives

Maximization of Cost Effective Natural Gas Savings

- To maximize cost effectiveness this Program yields a better $/m^3 over time. In the first year the focus is a review of current building processes and identifying energy efficiency measures, resulting in the creation of a prototype home. As a result, in the first year costs will be relatively high per m^3 saved. However by year three, the builder will have incorporated these new building practices in more homes realizing greater cost effectiveness of the Program.

Deep Measures

- Union is taking a "whole home approach" that focuses on deep measures that will drive extensive savings. These measures will primarily have longer life cycles (e.g. thermal envelope improvements).

Prevention of Lost Opportunities

- By working with builders to construct to a higher efficiency (15% above OBC 2012) this is the essence of preventing lost opportunities since the energy conservation technologies are installed at the beginning of the lifespan of the home, when it is most cost effective.

Context for Targets

Targets for builder participation were developed as follows:

- There are approximately 40 production builders in Union's franchise area that build 50 or more houses each year. With the new building code coming into place next year, most builders will be focused on adjusting their building practices to meet code, not exceed it, making it challenging to gain the focus and time required to commit to this Program. Signing up 8 participating builders in the first year of this new Program is a very aggressive target.

Targets for Prototype Homes Built were developed as follows:

- The phases do not begin until the contract is signed by a participating builder, which is expected to result in a time lag between the signing of the contract and building of the prototype home in Phase 1, which may not coincide with the calendar year (i.e. a contract to participate could be signed in December 2012, resulting in the prototype home being built in 2013 or potentially early 2014.)

Targets for Homes Built were developed as follows:

- For homes built the momentum will grow as the Program rolls out and participating builders complete the phases. This is demonstrated by the increase in the percentage of homes built 15% above OBC 2012 over the course of the Plan. In the early stages of the Program, a lag is also expected due to the extended sales cycle of larger builders.

1.5.10 **Challenges Union will Face in Achieving New Home Efficiency Program Targets**

- Acceptance of Program by builders and signing a three-year contract and committing to the Program goals.

- Current energy efficiency requirements in the Ontario Building Code will come into effect on January 1, 2012 and many builders are not ready for the new code which is a significant change, let alone going to 15% above.
- Ability of builders to work to the aggressive timeline of completing a prototype house in the first year enrolled in the Program (phase 1).
- Ability of sales agents to effectively sell value of energy efficiency
- Ability of builders to transition from a prototype home to production of homes that meet the Program requirements

1.6 *Integrated Energy Management Systems Program*

Integrated Energy Management Systems ("IEMS") seeks to generate energy savings from opportunities that do not qualify for support through Union's current DSM offerings. Building on Union's "Continuous Energy Management" platform, IEMS will focus on the utilization of energy management techniques to maximize the energy performance of industrial manufacturing facilities.

The IEMS approach will encourage the adoption of a management technique that utilizes a company's energy data to analyze historic and present day energy performance, set energy baselines and reduction targets with the goal to improve energy efficiency and the existing operating procedures. It builds on the principle "you can't manage what you don't measure". IEMS essentially combines the principles of energy use and statistics.

The IEMS Market Transformation Program offers Union the opportunity to actively influence customers in adopting and nurturing a culture of conservation and continuous energy improvement.

By adopting IEMS, customers will be able to:

- Recognize energy efficiency opportunities that would otherwise go unnoticed.
- Establish and sustain Energy Team(s), and embrace continuous energy efficiency improvement.
- Proactively manage their natural gas consumption through real-time measurement and analytical tools.

- Systematically baseline, track, and report energy intensity and carbon footprint performance, establish goals and ensure environmental compliance.
- Quantify, implement, and validate behaviour based, process based, and equipment based energy efficiency improvements.

1.6.1 **Customer Class(es) Targeted**

- Commercial / Industrial General Service and Commercial / Industrial Contract customers

1.6.2 **Rate Classes Targeted**

- Rate classes target: Rate M2, Rate 10, Rate M4, Rate M5, Rate M7, Rate 20

1.6.3 **Program Goals**

The goals of the new IEMS Program are:

1. To integrate energy conservation into customers' existing management systems and to foster a culture of continuous energy improvement consistent with the principles of ISO 50001.
    - Transformation: Customer adoption of ISO 50001[12] principles or certification.
2. To assist customers in identifying, quantifying and prioritizing opportunities for implementation of energy savings.
    - Transformation: Target to generate adoption in 50% of the target group of customers after 10 years.
3. To develop synergies between assessment consulting firms and measurement systems integration companies for holistic delivery of energy management principles.
    - Transformation: One source for integrated data capture and analysis - third party delivery of whole service energy measurement and management systems (integrators and consultants, and consultants packaging energy management services).
4. To educate and promote energy management best practices to all levels of the customer organization.

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[12] ISO 50001: International Standards Organization's Management System Standard for energy efficiency, which is expected to stimulate significant long-term increases in energy efficiency for certified organizations.

- Transformation: Energy monitoring, targeting and continuous improvement activities integrated into plant management and reporting system – including but not limited to monthly/weekly reporting metrics and yearly goals.

1.6.4 Program Strategy

Program strategies to achieve the Program goals for the IEMS Program will include:

1. Enable customer access to ongoing energy management expertise through dedicated time with Union Project Managers or third party funded evaluations.
2. Provide incentive to customers to quantify, implement and validate behaviour and process based energy efficiency improvements.
3. Facilitate capacity building and cooperation between energy management consulting firms and metering and monitoring system suppliers.
4. Encourage baseline measurements of process related equipment to effectively track and report both energy intensity and carbon footprint performance.

1.6.5 Program Offerings

The offerings that will be delivered in the IEMS Program are outlined below.

Description

Union will provide education, coaching and incentives to industrial customers through the development, implementation and persistence phases of a process energy monitoring and tracking system. The following three elements will be key components required from customers who participate in this Program:

- Completion of an IEMS Plan
- Completion of measurement system implementation
- Regular reports showing system persistence

Development, Implementation & Persistence Phases

1. Development & Assessment
   - Customer Identification
     - Union Industrial manufacturing customers
     - Minimum annual natural gas usage of 1,000,000 m^3
     - Multi-utility consumption
     - Annual utility expenditures of over $1,500,000
     - Natural gas usage must be for both process and heating loads
     - Customer shows organizational characteristics with strong executive support for energy efficiency and registration in organizational management standard (ISO 9001[13], TS 16949[14], ISO 14001[15])
   - Define performance requirements which must be met by participating customers
   - Develop minimum standards
   - Develop criteria for selection of a qualified service provider
     - Develop metrics to understand and grade service provider capabilities
     - Identify essential data points required for process tracking minimum requirements

2. Baseline Data Collection, Plan Approval & Implementation
   - Standardize reporting structure and requirements
   - Develop 3rd party service assessment service providers and sensor/meter integrators
   - Utilize existing 3rd Party Certifications (i.e. CEM, CMVP)
   - Engage OPA and other utility energy management initiatives and incorporate synergistic opportunities involving EM&T data collection systems

[13] ISO 9001: International Standard Organization's Standardized Requirements for a Quality Management System
[14] TS 16949: International Standard Organization's Technical Specifications for Quality Management System
[15] ISO 14001: International Standard Organization's Standardized Requirements for an Environmental Management System

- Leverage existing Union systems (i.e. Unionline) to keep Program costs manageable
- Plan approval and implementation

3. Persistence
    - Participants are required to share energy experiences related to the Program undertaken through various means including and not limited to site visitations, advisory groups, testimonials and / or published papers

The market implementation approach will involve the following marketing support elements:

- Program communication
    - Program sales information for Account Managers
    - In-person presentations to targeted customers and service providers
    - RFP templates and minimum report standards
- Program provides education and communication through:
    - Program Launch Meeting
        - Union staff: Account Managers, Project Managers
        - Service Providers
        - Customers
    - Program Information Package
        - Presentation
        - Letter of Introduction
        - RFP Template
        - Minimum Report Standards
        - Program Terms and Conditions

- Training (Internal Union Staff and External)
    - Account Manager specific training
    - Project Manager specific training
    - Customer Specific training
    - Service provider roles and responsibilities

Market Incentive

- Incentive levels for Integrated Energy Management Systems will be up to 75% of the incurred customer study cost and up to 50% of the incurred implementation cost. Specific incentive details are as follows:
    - 75% of assessment report costs up to a cap of $20,000
    - 50% of project implementation expenditures up to a cap of $100,000
        - 20% upon approval of plan
        - 20% after 50% of costs incurred
        - 20% after 75% of costs incurred
        - 10% upon completion of implementation
        - 30% during plan persistence phase to ensure continued use of system
- Incentives will be directed towards end use customers and will be paid at the completion of defined milestones.

Market Delivery

- This offering will be delivered directly to industrial customers by dedicated Union Account Managers and Project Managers. Union personnel are knowledgeable about individual customers' businesses and have background and training in energy efficiency and natural gas applications.
- Collaboration with key organizations and third-party consultants will be required to:
    - Expand the reach of Union's Program offering
    - Educate and influence energy saving best practices with customers
    - Develop customers' capacity to make energy efficiency decisions

- Promote the investigation and implementation of energy monitoring and tracking

Barriers Addressed

Primary barriers preventing higher uptake in the market include the following:

- High cost of monitoring system equipment and long payback period
  - Union will address this barrier through identification of no cost / low cost energy savings opportunities and quantify business case requirements for capital investment decisions, based on actual process data.
- Energy costs are often a small fraction of total production costs and are generally accepted as O&M expenses with little connection to management metrics
  - To address this barrier, Union will provide incentive funding and coaching during the process of developing the system – a long term commitment between Union and the customer, not just a single transactional arrangement.
- Customer' awareness of Union's Program and of energy management best practices
  - Integrate energy performance into the corporate culture of the facility through the ability to track and validate production improvements and energy improvements.

1.6.6 Program Duration

- The Program should have a total length of approximately 10 years with customers passing through the planning, implementation and establishing persistence over a three year timeframe.

Program Evolution

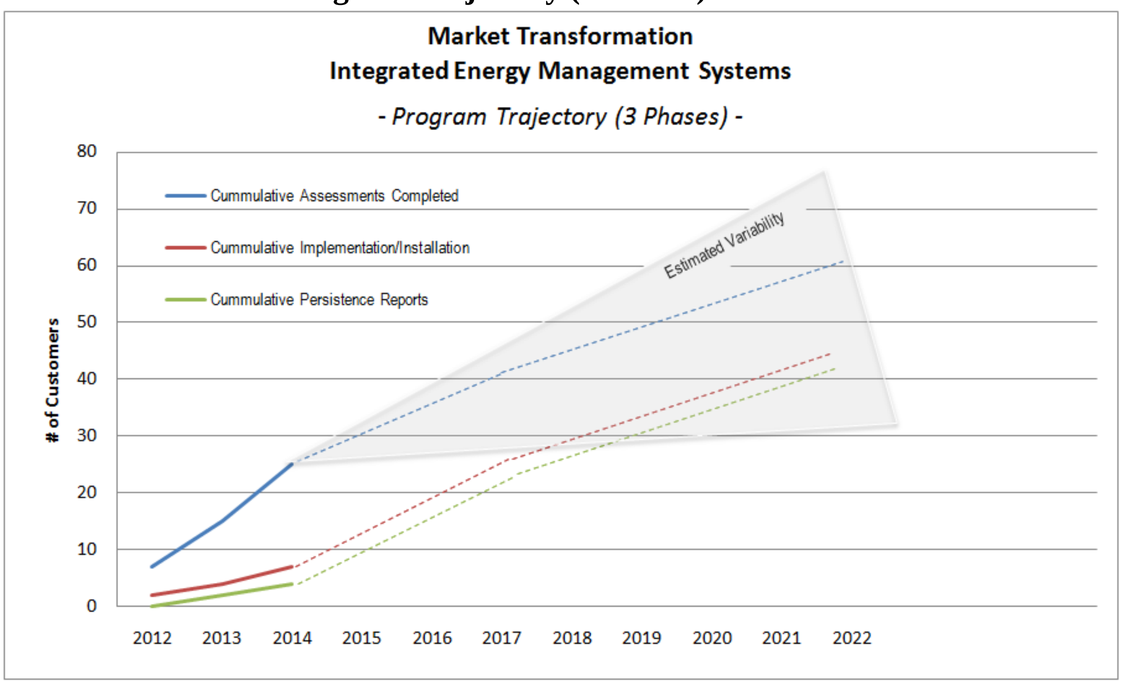
- As the IEMS Market Transformation Program is a 10 year Program, tied to the acceptance and adoption of ISO 50001 standards in the market, there is no planned exit of the Program during the 2012 – 2014 timeframe.
- Over the term of the Plan, Union will end its Program involvement with individual customers as they complete the persistence phase of the Program and no longer require Union's market intervention.
- Individual customer engagement is planned for the following timelines:
  - 6 months in the Development & Assessment phase
  - 12 months in Baseline Data Collection & Implementation Phase

- o 18 to 24 months in Persistence Phase

- Persistence → Transformation:
  - o During the persistence phase, the customer fully integrates monitoring of energy usage and tracking continuous energy improvement activities into their management system and the behaviour becomes innate in their ongoing plant operation.

- Union will support customers who have entered the Program through to the persistence phase and withdraw further financial incentives and Program support for IEMS from the market.

Figure 2 – Market Transformation Integrated Energy Management Systems Program Trajectory (3 Phases)



1.6.7 Program Budget

- Union has not included inflation in the table below. Union proposes to use the Q2 GDP-IPI inflation factor, released at the end of August, to align with Union's annual rate setting process.

Table 29 – IEMS Program Budget

2012 IEMS Program Budget ($000)			
Program Cost	**2012**	**2013**	**2014**
Delivery and Start Up Costs	$150	$50	$50
Promotion Costs	$150	$100	$75
Market Incentives	$300	$450	$550
Administrative Costs	$90	$90	$90
Total	**$690**	**$690**	**$765**

1.6.8 Integrated Energy Management Systems Program Targets

Table 30 – IEMS Program Targets

2012 Integrated Energy Management Systems Program Targets			
Metric	**Metric Target Levels**		
	50%	**100%**	**150%**
Assessments Completed	4	7	10
Implementation/Installation	1	2	3

2013 Integrated Energy Management Systems Program Targets			
Metric	**Metric Target Levels**		
	50%	**100%**	**150%**
Assessments Completed	4	8	12
Implementation/Installation	1	2	4
Persistence Reports	1	2	3

2014 Integrated Energy Management Systems Program Targets			
Metric	**Metric Target Levels**		
	50%	**100%**	**150%**
Assessments Completed	5	10	15
Implementation/Installation	1	3	5
Persistence Reports	1	2	3

1.6.9 Rationale for Targets

- 2012 will be the first year that Union will be offering IEMS and will be targeting energy management through the form of monitoring and targeting.
- Market transformation Programs are focused on facilitating fundamental changes that lend to greater market shares of energy-efficient products and services, and on influencing consumer behaviour and attitudes that strengthen a culture of conservation over the long term within workplaces. They are designed to make a permanent change in the marketplace over a long period of time. While these Programs promote the energy efficiency message through the culture of conservation, their savings may be indirect.
- Within the IEMS Program incentives are paid on demonstration of changes in customer behaviour and for persistence of these changes as they are integrated into the customer management culture. Over the term of its ten year duration, the Program will educate and, encourage customers to implement energy tracking methods, and reward customers who adopt energy tracking and improvement into their management system.

Consideration of Board's Guiding Objectives

Maximization of Cost Effective Natural Gas Savings

- Union will maximize cost effectiveness:
  - By aligning Union's Program and field expertise with consulting firms to provide comprehensive assessments.
  - By collaborating with measurement system integration companies in creating a holistic delivery for energy management principles.
  - By integrating data capture and analysis through third party delivery of whole service energy measurement and management systems (integrators and consultants, and consultants packaging energy management services).

Prevention of Lost Opportunities

- Union will prevent lost opportunities through:
  - Assisting customers in identifying, quantifying and prioritizing opportunities for implementation of energy savings. Once integrated into plant management and reporting systems, this changes cultural behaviour thus preventing lost energy saving opportunities.

  - Providing education and promotion reinforces energy management best practices to all levels of the customer organization, accelerating the identification and implementation of energy saving strategies.

Deep Measures

- Through integration of energy conservation into customers' existing management systems and through fostering a culture of continuous energy improvement consistent with the principles of ISO 50001, the IEMS Program demonstrates a pursuit of long term deep energy savings.

Context for Targets

Assessment Metric

- The number of assessments for 2012 -2014 was derived by:
  - Analyzing the level of incentive required to influence and conduct each assessment
  - Analyzing the potential number of assessments that can be conducted with the given budget and with the given number of resources
  - Considering rate impacts to distribution contract customers
  - Analyzing market opportunities for deeper savings

Table 31 – IEMS Assessment Metric

IEMS Assessment Metric			
Year of Assessment	**50%**	**100%**	**150%**
2012	4	7	10
2013	4	8	12
2014	5	10	15
Total	**13**	**25**	**37**

- Additional factors that have impacted the 2012 assessment forecast include:
  - Union will need to approach, educate and influence customers in the first year of the Program in order to move to implementation phase and gain traction

Implementation Metric

- The number of implementation/installations for 2012 -2014 was derived by:
    - Analyzing the level of incentive required to influence each installation
    - Analyzing the potential number of installations that can be conducted with the given budget
    - Considering rate impacts to distribution contract customers

Table 32 – IEMS Implementation/Installation Metric

IEMS Implementation/Installation Metric			
Year of Implementation/Installation	**50%**	**100%**	**150%**
2012	1	2	3
2013	1	2	4
2014	1	3	5
Total	**3**	**7**	**12**

- Additional factors that have impacted the 2012 implementation forecast include:
    - Typical ramp up time for implementation of a new Program
    - The time require to move from assessment phase to the implementation and installation phase

Persistence Metric

- The number of persistence reports for 2012 -2014 was derived by:
    - Analyzing the level of incentive required to influence each installation
    - Analyzing the lag time from installation to actual reporting

Table 33 – IEMS Persistence Report Metric

IEMS Persistence Report Metric			
Year of Persistence	**50%**	**100%**	**150%**
2012	0	0	0
2013	1	2	3
2014	1	2	3
Total	**2**	**4**	**6**

- Additional factors that have impacted the 2012 persistence forecast include:
  - The number of installations that can be conducted with the budget allocated to this Program will limit the number of persistence reports

1.6.10 **Challenges Union will Face in Achieving IEMS Targets**

- The cost of natural gas sub-meters will limit the participants to those customers who consume a large enough volume of gas and can justify the expenditure on an IEMS. Many customers at that level will find commitment to the persistence phase a challenge, where they will need to commit ongoing time to generating and analyzing reports.
- A challenge will be educating customers and overcoming their objections when they initially do not understand the potential benefits of having an IEMS in place as part of their daily operations.
- Union will require commitment from service providers and/or third party consultants to help drive the success of this Program.
- Union will need to train and certify a larger number of service providers and/or third-party consultants (or helping them train their staff) to partner with these customers.
- In the targeted customer group, there are a limited number of plants with sufficient complexity and energy intensity to see value in the expenditure on an IEMS.
- Union will need to carefully screen and pre-qualify for an IEMS to ensure that plants are in a position to move from assessment to implementation based on volume and opportunity.

DSM CONSULTATIVE MEETING

(August 11, 2011)

From:	Falvo, Victoria
To:	"Theresa@cela.ca"; "paul.clipsham@cme-mec.ca"; "vderose@blgcanada.com"; "jgirvan@ca.inter.net"; "Christine.Date@directenergy.com"; "Andrew.mandyam@enbridge.com"; "Judith.Ramsey@enbridge.com"; "normrubin.energyprobe@gmail.com"; "kai@web.net"; "dpoch1@xplornet.com"; "dpoch@eelaw.ca"; "cneme@energyfuturesgroup.com"; "mluymes@hrai.ca"; ahall@hrai.ca; "regulatory@HydroOne.com"; "ian.mondrow@gowlings.com"; "rob.rowe@rogers.com"; "jsimon@indeco.com"; "todorom@lao.on.ca"; "bhanjiz@lao.on.ca"; "rgriffin@cela.ca"; "raiken@xcelco.on.ca"; "jgibbons@pollutionprobe.org"; "Michael.Bell@oeb.gov.on.ca"; "Takis.Plagiannakos@oeb.gov.on.ca"; "marion.fraser@rogers.com"; "jay.shepherd@canadianenergylawyers.com"; "wmcnally@opsba.org"; "rhiggin@econalysis.ca"; robertpoirier@ropoirier.com; cturner@cgtaeng.com; dtripp@cietcanada.com; dana.silk@ottawa.ca; Russ.chapman@firebridgeinc.com; Hart.lenard@gmail.com; scott.rouse@energy-efficiency.com; hhunter@hfm.ca; julia.deans@civicaction.ca; tbrett@foglers.com; bmcintyre@trca.on.ca; ijarvis@enerlife.com; bdenney@trca.on.ca; vyoung@aegent.ca; lenore.dougan@ontarioenergyboard.ca; Boulton, Keith; Van Der Paelt, Sarah; Okrucky, Jeff; Lucas, Johanna; Wade, Cara-Lynne; McAlorum, Amanda; Marentette, Todd; Shaw, Ryan; Brooks, Tracey; Ginis, Haris; Moore, Alison; Redford, Marian; Organ, Ryan; Kulperger, Leslie; Wong, Alvin; Rumiel, Wally; Noorani, Imran; Andrew Mandyam; Rodney Idenouye; ekirkpatrick@torys.com
Subject:	Union DSM Consultative Meeting Tomorrow
Date:	August-10-11 4:00:09 PM
Attachments:	UGL Consultiave Meeting - Agenda .pdf ICFMarbek_EMVPlan_Low-incomeProgram_for Aug 11.pdf Historical LRAM m3 Savings 2008-2010.xlsx UGL Consultative Meeting Aug 11 .pdf

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Hello Everyone,

This is a kind reminder that Union's Multi-year Plan Consultative Meeting is tomorrow (Thursday, August 11th)

Time: 9:00 am – 4:30 pm (Continental breakfast will be served prior to the meeting at 8:30 am)

Venue: Ontario Room
InterContinental Toronto Centre
225 Front Street West
Toronto, ON

The following items are attached:

- Meeting agenda
- Presentation slide deck
- Low Income evaluation plan
- 2008-2010 Historical LRAM m3 Savings

For those who are unable to join us in person, you can find the dial-in and web conference details below this email.

We look forward to your participation.

Many thanks,
Victoria

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Conference Number

- 1-866-826-8611
- Code: 249972

Topic: Union Gas DSM Consultative Meeting
Meeting Number: 850 426 554
Meeting Password: consultative2011
1. Go to https://spectraenergy.webex.com/spectraenergy/j.php?ED=10442808&UID=0&PW=NNmVhNmM2NTdh&RT=NCMxMQ%3D%3D
2. If requested, enter your name and email address.
3. If a password is required, enter the meeting password: consultative2011
4. Click "Join".

UGL Stakeholders Invited

On Behalf of	Representative
AEE (the Association of Energy Engineers)	Doug Tripp
BCA (Building Commissions Association)	Herb Hunter
Canadian Environmental Law Association (on behalf of LIEN)	Theresa McClenaghan
CEEA (Canadian Energy Efficiency Alliance	Thomas Brett
CGTA	Charles G. Turner
CGTA	Lynda Turner
Civic Action	Julia Deans
CME	Paul Clipsham
CME	Vince DeRose
Consumers Council of Canada	Julie Girvan
Direct Energy	Christine Date
Enbridge	Andrew Mandyam
Enbridge	Judith Ramsay
Energy Probe	Norm Rubin
EnergyAtWork	Scott Rouse
EnergyAtWork	Julie Boudreau
EnviroCentre	Dr Dana Silk
Federation of Rental-housing Providers of Ontario (FRPO)	Dwayne Quinn
Firebridge	Russ Chapman
Green Energy Coalition	Kai Millyard
Green Energy Coalition	David Poch
Green Energy Coalition	Chris Neme
HRAI	Martin Luymes
HRAI	Andrew Hall
Hydro One Networks Inc.	Glen MacDonald
IGUA	Ian Mondrow
IGUA	Val Young
IGUA	Robert Rowe
IndEco on behalf of LIEN	Judy Simon
LIEN	Mary Todorow
LIEN	Zeenat Bhanji
LIEN	Renee Griffin
London Property Management Association	Randy Aiken
Ontario Energy Board	Micheal Bell
Ontario Energy Board	Lenore Dougan
Ontario Energy Board	Takis Plagiannakos
OSEA	Marion Fraser
Pollution Probe	Jack Gibbons
RO Poirier	Robert Poirier
SBC (Sustainable Buildings Canada)	Lenard Hart
Schools Energy Coalition	Jay Shepherd
TRCA (Toronto & Region Conservation Authority)	Bernie McIntyre
TRCA (Toronto & Region Conservation Authority)	Brian Denney
TRCA (Toronto & Region Conservation Authority)	Ian Jarvis
VECC	Roger Higgin

UGL DSM Plan Consultative - August 11

Stakeholders Present

Attended	Attendee		On behalf of
dialed in	Aiken	Randy	London Property Management Association
1	Bell	Micheal	Ontario Energy Board
1	Boudreau	Julie	EnergyAtWork
1	Dougan	Lenore	Ontario Energy Board
dialed in	Gibbons	Jack	Ontario Clean Air Alliance
1	Girvan	Julie	Consumers Council of Canada
1	Hall	Andrew	HRAI
dialed in	Hart	Lenard	SBC
1	Higgin	Roger	VECC
1	Jarvis	Ian	Enerlife
1	McIntyre	Bernie	TRCA (Toronto & Region Conservation Authority)
1	Millyard	Kai	Green Energy Coalition
dialed in	Morton	Corrie	Enbridge
dialed in	Neme	Chris	Green Energy Coalition
1	Rubin	Norm	Energy Probe
1	Shepherd	Jay	Schools Energy Coalition
1	Silk	Dana	EnviroCentre
1	Simon	Judy	IndEco on behalf of LIEN
1	Turner	Lynda	CGTA
1	Young	Val	IGUA

Agenda

Union Gas Multi-Year DSM Plan Consultative Meeting

Date: August 11th, 2011

Location: InterContinental Toronto Centre
Ontario Room
225 Front Street West, Toronto
Ontario Room

Time: 9:00 am – 4:30 pm

Continental breakfast will be served prior to the meeting

Start / Time Allotment		Item	Discussion Lead	Expected Outcome
8:30	:30	*Continental Breakfast*		
9:00	:15	Opening Remarks	Keith Boulton	Information
9:15	:90	DSM Plan Structure Overview	Victoria Falvo	Information
10:45	:15	*Break*		
11:00	:60	Residential Program	Cara-Lynne Wade	Information/ Discussion
12:00	:60	*Lunch*		
1:00	:90	Commercial/Industrial Program Large Industrial Program	Ryan Shaw	Information/ Discussion
2:30	:15	*Break*		
2:45	:60	Low-Income Program	Tracey Brooks	Information/ Discussion
3:45	:45	Closing Remarks	Keith Boulton	Information
4:30		*Adjourn*		

Union Gas Multi-year DSM Plan Consultative Meeting

August 11, 2011

Opening Remarks

Objectives of Today

- Union's Planning Process
- Seek input and feedback

Agenda

- Plan Elements – budgets and scorecards
- Programs and targets
- Evaluation plan approach

DSM Plan Structure Overview

Budgets, Incentive, Scorecards & Evaluation

Guiding Principles & Budgets

- Union to follow Board's three objectives:
    1. Maximization of cost effect natural gas savings
    2. Prevention of lost opportunities
    3. Pursuit of deep energy savings

- Increase focus on deep measures

Considerations

- Limit number of scorecards to keep it simple
- Budget has been split by program type:
    - Resource Acquisition
    - Market Transformation
    - Low Income
    - + T1/R100

Budgets by Program Type

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Program Type	% of 2010 Program Budget	% of 2012 Program Budget ($26.306M)	2012 100% Budget	2012 100% Utility Incentive
Resource Acquisition	66%	51%	$13.346 M	$2.120 M
Low Income	11%	26%	$6.839 M	$1.087 M
Market Transformation	9%	11%	$2.975 M	$0.473 M
T1 / R100	14%	12%	$3.147 M	$0.500 M
Portfolio Costs - Research & Evaluation - Salaries & Administration	N/A	N/A	$3.785 M	N/A
Total	**100%**	**100%**	**$30.140 M**	**$4.180 M**

- Low Income budget to be recovered from all rate classes by rate base
- Incentive will be recovered based on the spend in each rate class
- Scaling incentive due to LI increased budget - $950K (Cap $10.45M)

Budgets by Program

Program	Budget
Resource Acquisition	
Residential Program	$4.075 M
Commercial / Industrial Program	$9.271 M
T1 / R100 Program	$3.147 M
Low Income	
Low-Income Program	$6.839 M
Market Transformation	
Residential High Efficiency Water Heating	$2.350 M
C/I Integrated Energy Management Systems	$0.625 M
Total	**$26.306 M**

Evaluation Budget

	2010 Actual	2011 Projected	2012 Forecast
Amount ($000)	$749	$863	$1,393
As % of Total Budget	3.5%	3.5%	4.6%

Includes:

- Impact and process evaluation
- Verification
- Audit
- Technical expertise
- Stakeholder expenses
- Evaluation salaries

Projected Rate Impact

Class	2010 Rate Impact Budget & SSM	2012 100% Budget & SSM Forecast	2012 100% Low Income Budget Forecast	Total 2012 100% Rate Impact Forecast
South				
M1	**42%**	41%	51%	**43%**
M2	**7%**	13%	8%	**12%**
M4	**3%**	5%	2%	**4%**
M5	**4%**	5%	1%	**4%**
M7	**5%**	2%	1%	**2%**
T1	**14%**	10%	6%	**9%**
North				
Rate 01	**7%**	10%	22%	**13%**
Rate 10	**2%**	4%	4%	**4%**
Rate 20	**3%**	3%	2%	**3%**
Rate 100	**14%**	5%	3%	**5%**

Scorecards by Program Type + T1/R100

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- Four Separate Scorecards
- Projecting annual target for 3 years
  - 50%, 100%, 150%
  - Metrics
    - Cumulative m^3 savings
    - $ Spent / Cumulative m^3
    - Number of Deep Measure Participants
    - Others as specified
  - Free rider and Spillover included where available

Historical RA Results vs Budget

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Cumulative m3 Savings	2008	2009	2010	2012 – 100%
Residential	77,082,579	52,183,714	31,013,814	26,450,000
Commercial	276,433,832	369,678,520	201,875,066	208,000,000
Distribution Contract (Non-Rate T1/R100)	222,089,162	302,740,483	577,124,708	322,000,000
Total	**575,605,572**	**724,602,718**	**810,013,588**	**556,450,000**
$ Spent / cumulative m3	$0.0158	$0.0143	$0.0121	$0.0183

Program and Incentive Costs	2008	2009	2010	2012 – 100%
Residential	$ 3,043,684	$ 2,838,449	$ 2,888,286	$ 3,644,204
Commercial	$ 4,332,476	$ 4,637,816	$ 3,932,266	$ 4,774,000
Distribution Contract (Non-Rate T1/R100)	$ 1,692,706	$ 2,762,087	$ 3,000,629	$ 1,764,000
Total	**$ 9,068,866**	**$ 10,238,352**	**$ 9,821,181**	**$ 10,182,204**

*Does not include LI and T1/R100 results

Resource Acquisition Scorecard

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Draft 2012 Resource Acquisition Scorecard				
Metric	**50%**	**100%**	**150%**	**Weight**
Cumulative m3 Savings	278,225,000	556,450,000	695,562,500	40%
$ Spent / Cumulative m3	$0.040	$0.024	$0.022	30%
Deep Measure Participants	1,738	3,475	4,344	30%

Draft 2013 Resource Acquisition Scorecard				
Metric	**50%**	**100%**	**150%**	**Weight**
Cumulative m3 Savings	277,950,000	555,900,000	694,875,000	40%
$ Spent / Cumulative m3	$0.040	$0.024	$0.023	30%
Deep Measure Participants	1,805	3,610	4,513	30%

Draft 2014 Resource Acquisition Scorecard				
Metric	**50%**	**100%**	**150%**	**Weight**
Cumulative m3 Savings	276,950,000	553,900,000	692,375,000	40%
$ Spent / Cumulative m3	$0.040	$0.024	$0.023	30%
Deep Measure Participants	1,805	3,610	4,513	30%

Market Transformation Scorecard

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2012 Draft Market Transformation Scorecard					
Program	**Metric**	**50%**	**100%**	**150%**	**Weight**
HE Water Heating	Installed Units	5% Retro + 6% NB	6% Retro + 7% NB	7% Retro + 8% NB	30%
	Participating Builders	40	50	60	10%
	Education Sessions/Shows	8	15	22	10%
IEMS	Assessments Completed	4	7	10	35%
	Implementation/Installation	1	2	3	15%

T1/R100 Scorecard

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Draft T1/R100 Scorecard					
	Metric	50%	100%	150%	Weight
2012 2013 2014	Cumulative m3 Savings	100,000,000	200,000,000	250,000,000	40%
	$ / Cumulative m3	$0.026	$0.016	$0.015	20%
	% of Customers Participating (Incentives and Studies)	30%	40%	50%	20%
	Effectiveness Measure - DSM Value Assessment	55%	65%	75%	20%

Low-Income Scorecard

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2012 Draft Low-Income Scorecard				
Metric	50%	100%	150%	Weight
Cumulative m3 Savings	18,700,000	37,400,000	46,750,000	40%
$ Spent / Cumulative m3	$0.21	$0.18	$0.17	30%
Number of Deep Measure Participants	370	740	925	30%

2013 Draft Low-Income Scorecard				
Metric	50%	100%	150%	Weight
Cumulative m3 Savings	16,200,000	32,400,000	40,500,000	40%
$ Spent / Cumulative m3	$0.25	$0.21	$0.20	30%
Number of Deep Measure Participants	438	875	1,094	30%

2014 Draft Low-Income Scorecard				
Metric	50%	100%	150%	Weight
Cumulative m3 Savings	15,350,000	30,700,000	38,375,000	40%
$ Spent / Cumulative m3	$0.27	$0.22	$0.21	30%
Number of Deep Measure Participants	460	920	1,150	30%

Evaluation Plan Approach

- ICF Marbek is assisting with developing evaluation plans following the OPA's EM&V Protocols

- Evaluation Plans will be developed for:
  - **Low Income**
  - Residential
  - Residential Market Transformation
  - Commercial/Industrial
  - Commercial/Industrial Market Transformation
  - T1/R100 Rate Class

- Evaluation activities will be determined through the process established during the stakeholder engagement discussions

Questions/Comments

Program Overviews

Program Descriptions, Offerings and Targets

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Residential Program

Cara-Lynne Wade

Residential

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Resource Acquisition

Budget: $4.075 Million

- Energy Saving Kit (ESK) / Programmable Thermostats (Pstat)
- Draft Proofing Kit
- Basement and Attic Insulation

Market Transformation

Budget: $2.350 Million

- Launch High-Efficiency Water Heating (0.8EF)
- Not propose Drain Water Heat Recovery

Rate Classes Targeted

- M1 and R01

Energy Saving Kit Offering

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ESK Offering

- UG will continue to offer the ESK at no cost
  - 1.25gpm Showerhead
  - 1.5gpm Kitchen Aerator
  - 1.0gpm Bathroom Aerator
  - Pipe Wrap (x2)
  - Teflon Tape
  - Pstat Coupon ($15)

ESK Target Audience

- Single-family customers who have a natural gas water

Energy Saving Kit Offering

ESK Delivery Methods

- The ESK will continue to be delivered via ‘Push’, ‘Pull’, and ‘Install’ channels

Reduction in ESKs

- Due to an increased focus on deep measures, the number of ESKs projected in this plan has declined relative to previous years
- To drive maximum m3 savings and ensure continued access to efficiency measures across the Residential market, additional kit contents were evaluated

Draft Proofing Added to ESK

NEW - Draft Proofing Kit Added to Existing ESK

- Draft-Proofing Kit determined to have high m3 potential and to be cost-effective when included in existing ESK
- Draft Proofing Kit will include
  - Caulking, Foam Can, Foam Tape, Foam Cover for Electric Outlets, Energy Saver Gasket with Child Safety Insert
- Target Audience - Remains the same as the ESK's
- Delivery Method - Remains the same as the ESK's

ESK Participants & Budget

ESK Participants and Budget					
Metric	2008 Actual	2009 Actual	2010 Actual	2011 Target	2012 Target
Energy Saving Kit	96,500	83,000	75,000	75,000	54,000
ESK Budget	$2.9M	$2.5M	$2.9M	$2.9M	$1.9M
ESK Lifetime m3	71.3M	42.3M	31.0M	$23.4M	$22.8M
ESK $ Spent/m3	$0.041	$0.059	$0.093	$0.124	$0.083

- ESK cost effectiveness is forecasted to increase due to change in delivery channel approach/focus

Prescriptive Insulation Offering

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Insulation Offering

- Prescriptive incentives for installation of attic & basement wall Insulation
- Homeowners can take advantage of one or both incentives

Insulation Target Audience

- Residential, single-family homes - Built prior to 1980
- Must insulate total square footage of basement and/or attic
- Basement must have R-1 insulation or less
- Attic must have R-10 insulation or less

Insulation Delivery Methods

- Direct to end-customer, using targeted community approach
- Channel partners (e.g. Contractors)

Residential Program Draft Targets

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Offering	2012		2013		2014	
	Units	Cumulative m3	Units	Cumulative m3	Units	Cumulative m3
ESK	54,000	20,500,000	52,000	19,500,000	48,000	17,800,000
Pstat	5,000	2,300,000	5,000	2,300,000	5,000	2,300,000
Draft-Proofing	54,000	2,900,000	52,000	2,800,000	48,000	2,500,000
Insulation	175	750,000	310	1,300,000	310	1,300,000

Budget	2012	2013	2014
TOTAL	$4.075M	$4.171M	$4.018M

Proposal – Drain Water Heat Recovery

UG proposes that we do not move forward with DWHR

- Focus budget on deep measures that drive higher m3 savings

Market impact limited with exit/sunset funding

- Union Gas will honour builder commitments until June 2012

High-Efficiency WH (0.8EF) MT Offering

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High-Efficiency WH (0.8EF) Offering

- Incent retrofit & new-build customers to install a NG 0.8EF WH (tankless) instead of a NG tank
    - Incentive will drive greater take-up of NG 0.8EF WHs prior to code change
    - Prevents lost opportunity and increases overall efficiency of water heating market
- Education sessions for retrofit & new-build customers on benefits of a NG 0.8 EF water heater to increase installation rates
- Education and training for industry channels on benefits of a NG 0.8 EF water heater to increase installation rates

High-Efficiency WH (0.8EF) MT Offering

High-Efficiency WH (0.8EF) Target Audience

- M1 and R01 rate classes - Single-family customers
- Retrofit and New Build Customers

High-Efficiency Delivery Methods

- Direct to end-customer
- Builder
- Rental company
- Manufacturer

High-Efficiency WH (0.8EF) MT Metrics

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Budget	2012	2013	2014
TOTAL	$2.350 M	$2.255 M	$2.407 M

	Metric	50%	100%	150%	Weighting
2012	Installed Units	5% Retro + 6% NB	6% Retro + 7% NB	7% Retro + 8% NB	30%
	Participating Builders	40	50	60	10%
	Education Sessions & Consumer/Industry Shows	8	15	22	10%

	Metric	50%	100%	150%	Weighting
2013	Installed Units	2012 + 0% for Retro & NB	2012 + 1% for Retro & NB	2012 + 2% for Retro & NB	30%
	Participating Builders	63	66	69	10%
	Education Sessions & Consumer/Industry Shows	15	22	29	10%

	Metric	50%	100%	150%	Weighting
2014	Installed Units	2013 + 0% for Retro & NB	2013 + 1% for Retro & NB	2013 + 2% for Retro & NB	30%
	Participating Builders	72	76	79	10%
	Education Sessions & Consumer/Industry Shows	15	22	29	10%

Questions/Comments

Commercial Industrial Program
Large Industrial Program

Ryan Shaw

Commercial Industrial Programs

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Commercial Industrial Resource Acquisition Program

- Prescriptive Offering
- Custom Offering

T1/R100 Resource Acquisition Program

- Customer Engagement
- Site Energy Assessments
- Process Improvement Studies
- O & M Optimization Incentives

Commercial Industrial Market Transformation Program

- Integrated Energy Management Systems

C/I Resource Acquisition Program

Commercial Industrial Resource Acquisition Program

- Prescriptive Offering
- Custom Offering

Budget

- $9.271 million

Rate Classes Targeted

- M1, M2, 01, 10, M4, M5, M7, 20

Prescriptive Offering

- Similar design and purpose as previous years
  - Majority of current measures will be offered in 2012
- Emphasis on Deeper Measures
  - Phase out HWC (Showerheads and Aerators)
  - No longer offer Pre-Rinse Spray Valves
  - No longer offer Programmable Thermostats
- Number of new measures will likely be offered
  - Linkageless Control
  - Boiler Economizers
  - Demand Control Ventilation

Prescriptive – Market Details

- Target Audience
  - Commercial and Industrial Segments
  - MUSH, Multi-residential, Office, Retail, Warehouse, etc.

- Customer Focused Delivery
  - Highly Focused on End User Funding
  - Commercial Sales Personnel (Energy Advisors)
  - Design Engineers, ESCO's, Architects, Contractors, Distributors, etc.

Custom Offering Summary

- Consistent program design elements (compared to 2010 & 2011)
  - Equipment incentives
  - Feasibility studies and audits
  - Steam traps surveys
  - Educational component

- Enhanced program design elements
  - Incentives will be based on m3 savings (was 15% of project incremental costs)
  - The design assistance program (DAP) will no longer be offered
  - Commercial and Industrial incentive levels differ

Commercial Custom

- Commercial Custom Enhancements
  - Custom Equipment incentives calculated at $0.10/m3 to a maximum of $40,000
  - Building Optimization will be launched

- Commercial Custom Specifics
  - Feasibility Studies calculated at 30% up to $4,000 *
  - Steam Trap Surveys calculated at 50% up to $6,000
  - Demonstration of New Technologies calculated at 10% up to $50,000
  - Education incentives

* Multiple site feasibility studies will be capped at $10,000 per customer

Industrial Custom

- Industrial Custom Specifics
  - Custom Equipment incentives calculated at $0.05/m3 to a maximum of $40,000

- Industrial Custom Specifics
  - Process Improvement Studies paid at 66% up to $20,000
  - Feasibility Studies calculated at 50% up to $10,000
  - Steam Trap Surveys calculated at 50% up to $6,000
  - Demonstration of New Technologies calculated at 10% up to $50,000
  - Education incentives

Note: Total incentives capped at $250,000 per site

C/I Resource Acquisition Program

- Budget and Target Summary
  - Lack of consistent trend
  - C/I General Service affected by deeper measures
  - C/I General Service affected by enormous projects

Cumulative m3/Promotion and Incentive Costs					Promotion /Incentive Budget	Cumulative m3
Sector	2008 Actual	2009 Actual	2010 Actual	2012 Forecast		
C/I General Service Rate M1, M2, 01, 10	64	80	51	44	$4.774 M	208,000,000
C/I Contract Rate M4, M4, M7, 20	131	110	192	183	$1.764 M	322,000,000
Total					$6.538 M	530,000,000

T1/R100 Resource Acquisition Program

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T1/R100 Resource Acquisition Program

- Customer Engagement
- Site Energy Assessments
- Process Improvement Studies
- O&M Optimization Incentives

Budget

- $3.147million

Rate Classes Targeted

- T1, R100

T1/R100 Resource Acquisition Program

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- Objective
  - Provide a more targeted and connected set of offerings that will provide our T1/R100 customers with more value at a reduced rate impact

- Enhancements to Program Design
  - Focus on Capacity & Knowledge Building, Energy Teams, and Corporate Recognition
  - Value add through comprehensive site assessments
  - Increased focus on process improvement studies
  - Connected set of offerings around O&M optimization and performance

Customer Engagement

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- Customer Engagement

  Objective: Educate, train and provide technical expertise

  Result: Improved customer awareness, greater knowledge sharing, increased capacity for energy efficiency projects, targeted m3

- Can be broken down into 3 sub-categories
  - Capacity and Knowledge Building
  - Energy Team Support
  - Corporate Recognition

Customer Engagement

- Capacity and Knowledge Building
  - Technical training and expertise through onsite education forums
  - Technical sessions led by internal and external subject matter experts
  - Provide offsite technical training activities
    - e.g. Localized sessions, webinars, focused editorials, modeling, etc.

Customer Engagement

- Energy Teams
  - Support Energy Team Creation
    - Provide support, information, experience & expertise
  - Enhance Existing Energy Teams
    - Provide technical expertise, share best practices, create forums and work to improve the energy teams overall effectiveness

Customer Engagement

- Corporate Recognition

  - Provide valuable recognition to the top performers

  - Provide recognition in various forms
    - Plaques;
    - A full page print ad;
    - Financial reward;
    - Company news letters; etc.

Site Energy Assessments

- Objective
    - Quantify immediate opportunities for energy & low cost savings

- Summary of Offering
    - Focus on a particular energy system, either Steam or Process Heating (limited to gas)
    - Assessments at no cost to the customer (no incentive paid)
    - Are completed by internal UG personnel using DOE software and processes
    - UG provides free installation of temporary wireless metering devices

Site Energy Assessment Road Map

Prepare → Apply → Participate → Implement → Communicate

Process Improvement Studies

- Objective
  - Quantify deeper opportunities for energy / cost savings

- Summary of Offering
  - A focused effort to gather & analyze data on process related equipment
  - Studies to be completed by 3rd party providers (UG pays % of costs)
  - Customer will be supplied metering for baseline (at no cost)
  - Results are expected to have savings expectations ($/m3), costs and ROI calculations

Examples: Steam trap surveys, Insulation survey, Combustion optimization, etc.

O&M Performance Incentives

- Objective
  - Identify new areas for operational efficiencies

- Summary of Offering
  - Drive the implementation of new O&M improvements
  - Focus on O&M optimization and best practises
  - Areas that are eligible for incentives would include (but are not limited to):
    - Steam traps, Steam leaks, Condensate leaks, Steam line insulation, Heat exchangers, Combustion optimization, Economizer repairs, etc.

T1/R100 Resource Acquisition Program

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- T1/R100 Flow Diagram

T1/R100 Resource Acquisition Program

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- m3 Target Summary

T1/R100 Industrial Program	
Project Type	**Forecast Cumulative m3**
Combustion Optimization	1,694,282
Condensate Return	499,330
Economizer Repair	465,855
Insulation	6,986,397
Steam Leak Repairs	41,448,161
Steam Reduction	60,368,013
Steam Trap Repairs	69,328,387
Stretch	19,209,575
Total	**200,000,000**

T1/R100 Resource Acquisition Program

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- Budget: $3.147 Million
- Scorecard Summary
  - Customer rating for providing effective DSM programming
  - As budgets are held flat, targets remain constant over the term of the DSM Plan

Draft T1/R100 Scorecard					
	Metric	50%	100%	150%	Weighting
2012 2013 2014	Cumulative m3 Savings	100,000,000	200,000,000	250,000,000	40%
	$ / Cumulative m3	$0.026	$0.016	$0.015	20%
	% of Customers Participating (Incentives and Studies)	30%	40%	50%	20%
	Effectiveness Measure - DSM Value Assessment	55%	65%	75%	20%

C.I Market Transformation Program

Commercial Industrial Market Transformation Program

- Integrated Energy Management Systems

Budget

- $0.625 million

Rate Classes Targeted

- M1, M2, 01, 10, M4, M5, M7, 20

C.I Market Transformation Program

- IEMS Objective
  - Our goal is transform customer behaviour to drive increased operation performance

- Target Audience
  - Industrial customers
  - 1,000,000 m3 – 25,000,000 m3
  - Excludes T1/R100 customers

- Summary of Offering
  - Capacity Assessments
  - Implementation
  - Persistence
  - Peer Group Participation

C.I Market Transformation Program

- Summary of Incentives
  - 50% of project expenditures up to a cap of $100,000
  - 75% of assessment report costs up to a cap of $20,000

- Funding formula includes milestone payments:
  - 20% upon approval of EM&T Plan
  - 20% after 50% of costs incurred
  - 20% after 75% of costs incurred
  - 10% upon completion of implementation
  - 30% during EM&T Persistence phase to ensure continued use of system

IEMS Market Transformation Program - Metrics

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2012	Metric	50%	100%	150%	Weighting
	Assessments Completed	4	7	10	35%
	Implementation/Installation	1	2	3	15%

2013	Metric	50%	100%	150%	Weighting
	Assessments Completed	4	8	12	25%
	Implementation/Installation	1	2	4	15%
	Persistence Reports	1	2	3	10%

2014	Metric	50%	100%	150%	Weighting
	Assessments Completed	5	10	15	25%
	Implementation/Installation	1	3	5	15%
	Persistence Reports	1	2	3	10%

Questions/Comments

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Low-Income Program

Tracey Brooks

Low-Income

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Low-Income Program

- Home Weatherization Offering
- Helping Homes Conserve Program
- Social Housing Multi-Family Offering

Budget

- $6.839 Million

Rate Classes Targeted

- M1, M2, R01, R10

Home Weatherization Offering

- Union will continue to deliver building envelope upgrades at no cost to low-income energy consumers
  - Attic insulation, basement insulation, wall insulation and draft-proofing measures
- Union is expanding this offering to include additional deep measures
  - Furnace early replacement
  - Water heater early replacement
- Health & Safety Protocols
- Homeowner and Tenant Education

Target Audience

- Customers who have an income which is at 135% or below Statistics Canada's pre-tax, post-transfer Low-Income Cut-Off (LICO)* or are a recipient of a qualified benefit
- Private homeowners or tenants who pay their own utilities
- Social housing tenants regardless of utility bill payment
- Customers residing in residential dwellings

**Union uses the135% LICO level for communities of 500,000 or more across our franchise.*

Approach to Market

- Multi-channel approach will be used to recruit customers into the program:
  - Findings from the 2011 research and data analysis will help set approach
  - Social Service Agencies, Direct Marketing, Social Housing Providers, Education Workshops, etc.
- Income screening will be performed by external parties
- Delivery agents will perform home audits and measure installations

Helping Homes Conserve

- Provides low income customers with the free installation of basic measures
- Primarily delivered through a door-to-door approach – neighbourhoods with greater than 40% penetration of low income customers
- Lead generator for the Home Weatherization Program
- Program will decline throughout the term of the plan due to market saturation

Social Housing Multi-Family Offering

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Est. 1911

- Program will address non-Residential buildings housing low income tenants
- Offer “enhanced” incentives to social housing providers to allow access to existing Commercial Prescriptive and Custom programs:
  - 50% of actual eligible costs to a maximum of 55% of estimated costs
  - 50% of incentive can be accessed prior to the installation of the measure to assist with up-front capital costs
- Enhanced offerings for Hot Water Conservation and Building Optimization
- Education program for housing providers, building operators and tenants

Low Income Historical Results

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Low-Income Participant and Budget				
Metric	2008 Actual	2009 Actual	2010 Actual	2011 Target
Home Weatherization	0	75	134	400
Helping Homes Conserve	7,500	18,500	14,500	15,000
Low-Income Budget	$1.445 M	$2.170 M	$1.575 M	$4.368 M

Home Weatherization m3 Target

- Currently use an annual m3 target 1,220 m3/home
- For Multi-year Plan cumulative Home Weatherization m3 target based on estimated proportion of each insulation measure and calculated based on individual measure lives

Low-Income Scorecard

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Budget: $6.890 Million

2012 Draft Low-Income Scorecard				
Metric	**50%**	**100%**	**150%**	**Weight**
Cumulative m3 Savings	18,700,000	37,400,000	46,750,000	40%
$ Spent / Cumulative m3	$0.21	$0.18	$0.17	30%
Number of Deep Measure Participants	370	740	925	30%

2013 Draft Low-Income Scorecard				
Metric	**50%**	**100%**	**150%**	**Weight**
Cumulative m3 Savings	16,200,000	32,400,000	40,500,000	40%
$ Spent / Cumulative m3	$0.25	$0.21	$0.20	30%
Number of Deep Measure Participants	438	875	1,094	30%

2014 Draft Low-Income Scorecard				
Metric	**50%**	**100%**	**150%**	**Weight**
Cumulative m3 Savings	15,350,000	30,700,000	38,375,000	40%
$ Spent / Cumulative m3	$0.27	$0.22	$0.21	30%
Number of Deep Measure Participants	460	920	1,150	30%

Questions/Comments

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Reminder of next steps

Historical LRAM m3 Savings 2008

Sector/Program	DSM Savings		DSM Spending		
	Annual m3	Lifetime m3	Incentives	Program Costs	Total
Residential					
New Homes	0	0	$ -	$ -	$ -
Existing Homes	6,725,838	77,082,579	$ 1,616,180	$ 1,427,504	$ 3,043,684
Total	6,725,838	77,082,579	$ 1,616,180	$ 1,427,504	$ 3,043,684
Low Income	1,112,071	13,116,718	$ 951,211	$ 494,058	$ 1,445,269
Total	1,112,071	13,116,718	$ 951,211	$ 494,058	$ 1,445,269
Commercial					
New Buildings	4,925,591	117,996,849	$ 617,471	$ 115,465	$ 732,936
Existing Buildings	8,260,524	158,436,982	$ 3,034,591	$ 564,949	$ 3,599,540
Total	13,186,116	276,433,832	$ 3,652,062	$ 680,414	$ 4,332,476
Distribution Contracts					
Non-Rate R100/T1	12,899,473	222,089,162	$ 1,402,292	$ 290,414	$ 1,692,706
Rate R100/T1	27,928,678	470,901,915	$ 1,802,737	$ 373,346	$ 2,176,083
Total	40,828,151	692,991,077	$ 3,205,029	$ 663,760	$ 3,868,789
Grand Total	61,852,176	1,059,624,206	$ 9,424,482	$ 3,265,736	$ 12,690,218

Historical LRAM m3 Savings 2009

Sector/Program	DSM Savings		DSM Spending		
	Annual m3	Lifetime m3	Incentives	Program Costs	Total
Residential					
New Homes	0	0	$ -	$ -	$ -
Existing Homes	4,515,861	52,183,714	$ 1,580,325	$ 1,258,124	$ 2,838,449
Total	4,515,861	52,183,714	$ 1,580,325	$ 1,258,124	$ 2,838,449
Low Income	2,746,452	31,404,629	$ 2,017,218	$ 152,303	$ 2,169,521
Total	2,746,452	31,404,629	$ 2,017,218	$ 152,303	$ 2,169,521
Commercial					
New Buildings	3,682,427	76,319,847	$ 834,250	$ 130,783	$ 965,033
Existing Buildings	17,386,687	293,358,673	$ 3,175,040	$ 497,743	$ 3,672,783
Total	21,069,114	369,678,520	$ 4,009,290	$ 628,526	$ 4,637,816
Distribution Contracts					
Non-Rate R100/T1	20,833,348	302,740,483	$ 2,327,357	$ 434,730	$ 2,762,087
Rate R100/T1	43,439,524	684,777,223	$ 1,904,312	$ 355,709	$ 2,260,021
Total	64,272,872	987,517,706	$ 4,231,669	$ 790,439	$ 5,022,108
Grand Total	92,604,299	1,440,784,569	$ 11,838,502	$ 2,829,392	$ 14,667,894

Historical LRAM m3 Savings 2010

Sector/Program	DSM Savings		DSM Spending		
	Annual m3	Lifetime m3	Incentives	Program Costs	Total
Residential					
New Homes	3,543	35,429	$ 351.00	$ 200.00	$ 551.00
Existing Homes	2,963,736	30,978,385	$ 1,841,014	$ 1,046,721	$ 2,887,735
Total	2,967,279	31,013,814	$ 1,841,365	$ 1,046,921	$ 2,888,286
Low Income	1,981,427	22,742,259	$ 1,343,230	$ 231,834	$ 1,575,064
Total	1,981,427	22,742,259	$ 1,343,230	$ 231,834	$ 1,575,064
Commercial					
New Buildings	2,984,671	55,480,130	$ 800,845	$ 87,819	$ 888,664
Existing Buildings	8,012,579	146,394,936	$ 2,643,538	$ 400,064	$ 3,043,602
Total	10,997,250	201,875,066	$ 3,444,383	$ 487,883	$ 3,932,266
Distribution Contracts					
Non-Rate R100/T1	37,330,031	577,124,708	$ 2,782,862	$ 217,767	$ 3,000,629
Rate R100/T1	67,839,834	981,936,277	$ 1,905,506	$ 149,111	$ 2,054,617
Total	105,169,866	1,559,060,986	$ 4,688,368	$ 366,878	$ 5,055,246
Grand Total	121,115,822	1,814,692,125	$ 11,317,346	$ 2,133,516	$ 13,450,862

Draft Low Income Evaluation Plan 2012-2014
Summary Version

Program Overview

Market Opportunity

The following discussion presents the target market size, the barriers and hurdles that Union Gas Limited (UGL) intends to address through the Low-income Demand-side Management (DSM) program.

- **Market Size**

Approximately 20% of all Union Gas Residential customers are considered to be "Low Income", which represents around 240,000 customers. Customers are identified as low-income if they have a household income which is at 135% or below Statistic Canada's pre-tax, post transfer low-income cut-off (LICO).

As compared to the rest of Union Gas customers, the low-income customers:
- are older (68% are 55 years of age or older compared to 41%),
- spend less time in school (53% have high school as the highest level of education that they have completed compared to 24%), and
- have less access to the internet (59% have access compared to 87%).

Key market actors in the low-income market segment include: social service agencies, social housing providers, municipalities, property managers and other associations such as the Social Housing Services Corporation (SHSC) and the Ontario Non-Profit Housing Association (ONPHA).

- **Barriers and Hurdles Addressed**

The barriers and/or hurdles to be addressed by the program are summarized in the following table.

Segment	Market Obstacle		Description	Opportunity
Low-income household	☒ Market Hurdle	☐ Market Barrier	Low-income customers are difficult to reach	Multiple outreach channels involving strategic partners, direct mail, e-mail blast, website, etc.
Low-income household	☒ Market Hurdle	☐ Market Barrier	Low-income customers are difficult to identify	Extensive screening activities. Data mining and advance visualization and mapping technology to identify clusters of low-income customers.
Low-income household	☒ Market Hurdle	☐ Market Barrier	Financial hurdle: Low-income customers cannot afford energy efficient technologies	Providing equipment free of charge
Low-income household	☒ Market Hurdle	☐ Market Barrier	Cultural/Institutional hurdle (transaction cost): Low-income customers will not spend time investigating and installing energy conservation measures	Direct-install
Low-income household	☒ Market Hurdle	☐ Market Barrier	Informational hurdle: Low-income customers don't know the response to the following question: "How much money will they save?"	Information brochures, direct install, pre- and post-audit.
Low-income household	☐ Market Hurdle	☒ Market Barrier	Cultural/Institutional barrier (double-agent): Low-income	Providing equipment free of charge / Invest on their

			customers don't pay the energy bill directly.	behalf
Low-income household	☐ Market Hurdle	☒ Market Barrier	Informational barrier: Lack of education on energy conservation	Education activities including education guide, clinics, direct mail, email-blast, etc.
Property owners	☐ Market Hurdle	☒ Market Barrier	Cultural/Institutional barrier: Authority-Renters unable to authorize work on building structure	Seek partnership, and direct communication activities toward property owners.

Program Description

The UGL low-income program is a direct-install program that includes two major components: Helping Homes Conserve (HHC) which focuses on simple easy to install measures, and the Weatherization component which includes deeper measures providing greater energy savings..

The HHC offering provides low-income customers the free installation of up to two energy efficient showerheads, two metres of foam pipe insulation and a programmable thermostat. Additionally, bathroom and kitchen aerators are left behind for self-installation.

The home Weatherization offering provides low-income customers with a free home energy audit. Once the audit is completed, customers may be eligible for building envelope upgrades such as; attic insulation, basement insulation, wall insulation or various draft proofing measures (weather stripping, caulking etc.).

- **Goals and Objectives:**

The overall objectives for the low-income program are to:

(1) Reduce the overall energy related costs of low-income customers
(2) Provide awareness and education on conservation programs and benefits
(3) Provide access to conservation programs to low-income customers

The UGL Low-income program will lower the natural gas cost burden, and reduce the impact of future natural gas price increases on the most vulnerable Ontarians - i.e. low-income customers. In addition, the low-income program will maintain or increase the level of comfort of low-income customer dwellings.

- **Target Market:**

The UGL Low-income program targets UGL low-income customers, i.e. customer with household income equal of below 135% of Statistic Canada's LICO. Approximately 240,000 of UGL customers are eligible for the low income program.

- **Eligibility Criteria:**

The eligibility criteria to UGL Low-income program are:

(1) Eligible participants must be located in Union Gas' franchise area in targeted locales.
(2) Eligible participants must be identified as low-income if they have a household income which is at 135% or below Statistic Canada's LICO; based on a community size of greater than 500,000 residents.
(3) Eligible participants must have a natural gas furnace and/or gas-fired water heater.
(4) Eligible participants must be homeowners or tenants living in individually metered Part 9 buildings (3 stories or less) and Part 3 buildings ((4 stories or

more) which include the following: row/townhouse units, low rise quad/four-plex residences, low rise triplex or duplex residences, semi-detached and single detached residences, and high-rise multi-residential social housing regardless of who pays the bill (landlord vs. tenant).

In addition, participants will be eligible to the weatherization offering if the weatherization of their home has a benefit/cost ratio equal or above 0.7 based on the Total Resource Cost (TRC) Test. TRC Test is computed on the base of the pre-audit results.

To identify the low-income customers, UGL purchased third-party data consisting of postal codes that are analyzed and "ranked" based on average income, average household size, and percentage of income spent on food, renter-vs.-owner, and dwelling type. UGL removes any postal codes that fall "above average". Then, using UGL billing database and the low-income program tracking system, the lists are scrubbed from customers who don't live in the premise, non-customers, customers who have already participated in the low-income program or the mass market program, etc. Through this procedure, UGL identifies clusters of eligible participants, thus minimizing the risk of Do-Not-Qualify (DNQ) for the delivery agents. UGL prefers this method over systematically asking for proof-of-income because it yields satisfactory results for a much lower level of investment.

- **Key Program Elements:**

UGL seeks strategic partnerships with key market players such as social service agencies, social housing providers, municipalities, property managers and other associations such as the Social Housing Services Corporation (SHSC) and the Ontario Non-Profit Housing Association (ONPHA).

UGL implements a wide marketing campaign including customer-initiated direct mail, e-mail blasts targeting property managers in the affordable housing market, website and notification flyers.

UGL, in association with its strategic partners, presents energy conservation clinics in targeted cities, and in targeted neighborhoods.

UGL selects and contracts delivery agents to target potential participants as identified through the screening procedures presented above.

The delivery agents solicit the targeted customer with the HHC and the weatherization offering.

When an eligible customer agrees to receive the HHC kit, the delivery agent will install up to two low flow showerheads, two metres of foam pipe insulation and a programmable thermostat. Additionally, the delivery agent will leave behind bathroom and kitchen aerators for self-installation and the new thermostat instructions for the participant to program it later. The kit and and installation are delivered at no cost to participants.

When an eligible customer agrees to participate in the weatherization program, he/she will receive a free home energy audit. Once the audit is completed, the participant may be eligible for building envelope upgrades such as; attic insulation, basement insulation, wall insulation or various draft proofing measures (weather stripping, caulking etc.). Participants who receive building envelope upgrades will also be given a free post-energy audit to measure the effectiveness of the upgrades.

<table>
<tr><td></td><td>The equipment, materials and installation are delivered at no cost to participants.

• Program Timing:

The HHC offering has been in market since 2007. The weatherization offering has been in market since 2008. All the main program elements have all been rolled out at least once. The program will be offered in 2012 and in subsequent years subject to approval by the OEB.UGL seeks to have the relevance of the program assessed periodically by third-party evaluators.

• Estimated Participation:

In 2011, the participation in the HHC offering is foreseen to reach 20,000[1] participants, and the participation in the Weatherization program is foreseen to reach 400[2] participants.

• Budget:

In 2011, the budget for the program (including all program costs and incentive costs) is $6.568 Million.[3]

Program Theory / Program Logic Model
In summary, the program theory is as follows:
• In the short-term, the main program elements presented above will increase the level of awareness of UGL low-income customers, will convince qualified customers to participate, and will lead to the site visit and free installation of measures.
• In the medium-term, the program will yield to the implementation of Do-It-Yourself (DIY) measures, to the direct installation of the HHC kit, to the installation of left behind aerators, and to the direct weatherization of participating dwelling.
• In the long-term, the program will generate energy savings and non-energy benefit for the low-income customer, such as reduced energy bills, increased energy security and better comfort in the dwellings. Also, the program will yield acceptable customer satisfaction and will generate positive word-of-mouth that will in turn foster further program participation.</td></tr>
<tr><td>Evaluation Goals and Objectives</td><td>The rationale for evaluation can be categorized as follows:
• administrative (verified savings),
• experimental (measure effectiveness), and
• operational (cost-effectiveness).

The following discussion presents the goals and objectives of the planned evaluation. For the purpose of this plan, UGL will commit to ongoing administrative evaluation for the HHC program and determine any additional evaluation through discussions as established through the stakeholder engagement process.</td></tr>
</table>

[1] From: 2011 Marketing Plan - Low Income.docx
[2] “2011 Home Weatherization Scorecard” 2010 11 10 - FINAL_Union Incremental 2011 Low-Income DSM Plan.docx
[3] “2011 DSMVA” 2010 11 10 - FINAL_Union Incremental 2011 Low-Income DSM Plan.docx

<table>
<tr><td></td><td>
Overarching Concerns

Evaluation studies will be used to:

Validate or modify the current program theory/logic model
Reinforce accountability of delivery agent staff and program administrator staff
Provide feedback to the program manager such that improvements can be made that increase the program uptake
Provide feedback to the program manager such that improvements can be made to the various delivery mechanisms that result in greater participant satisfaction
Inform decisions regarding whether to increase and improve the education activities, decrease them or maintain the status quo based on the effectiveness to date
Demonstrate the effectiveness of measure and increase the precision of Project Input and Assumption (PIA) to improve savings projections and integrated resource planning
Improve the components of the HHC energy conservation kit
Inform long-term DSM program planning whether to continue the program, evolve the program or apply an exit strategy

Research Questions

Research questions include:

How can the program set of objectives and goals be improved? Are program goals set too high? Too low? (Process Evaluation)
What is the direct impact of individual program elements on energy consumption? (Impact evaluation)
What proportion of those effects can be attributed to the program? (Impact Evaluation – Causality and attribution)
How can the program better appeal to the targeted population? (Process Evaluation)
Are program designs and supporting organizational controls adequate? (Process Evaluation)
Are the tools used properly by program delivery agents? (Process Evaluation)
How might the program be improved? (Process Evaluation)
How effective has the program been in reducing lack-of-education barriers? (Market Effect Evaluation)

</td></tr>
<tr><td>Evaluation Elements</td><td>
While additional evaluation would be required to address the defined research questions, for the purpose of this plan UGL will commit to ongoing administrative evaluation for the HHC program. Any additional evaluation will be determined through discussions as established through the stakeholder engagement process.

Evaluation to be Conducted

☒ Impact Evaluation.
The program will be subject to verification impact evaluation in 2012, 2013, and 2014 during which:

the HHC savings claims will be validated through a verification telephone survey of a statistically representative sample
Uninstall and non-install rates will be measured

</td></tr>
</table>

Evaluation to be Considered

☐ **Process Evaluation.**
Depending on the evaluation priority discussions, the program may be subject to a comprehensive process evaluation:

- to validate and improve the program theory,
- to improve the marketing campaign, and the delivery mechanisms.

Process evaluations are performed through a set of surveys, consultations and field activities with the most important stakeholders: HHC participants, Weatherization participants, non-participants, strategic partners, and the delivery agents.

While any formal process evaluation study will be determined when setting evaluation priorities, Union will continue internal activities that would fall within the scope of process evaluation. These activities include:

- Ongoing communication with Union sales representatives and program delivery agents
- Formal statistically representative annual Market Research surveys with residential customer segments to gather insights and perspectives on Union's DSM programs and customer service in general

These two activities are further augmented by the verification studies and any information gathered through educational/awareness outreach sessions with program participants.

☐ **Market Effects Evaluation.**
Some market effect research questions may be considered for evaluation as determined through the priority discussions; the program intends to generate some awareness among low income customers through energy conservation clinics and other communication activity. Market effect evaluation should be considered as it will test the effectiveness of these activities at tackling informational barriers and whether these activities create a measurable impact.

Evaluation not to be considered

☐ **No Cost Effectiveness Evaluation.**

☐ **No Outcome Evaluation.**

The program administrator will be responsible collecting the data required to be used by external consultants in undertaking any evaluation work.

☐ Prescriptive Input Assumption Review	☒ Market Research/Participant Research
☐ Quasi-Prescriptive Input Assumption Review	☐ New Prescriptive Input Assumption
☐ Project-level M&V	☐ New Quasi-Prescriptive Input Assumption
☐ Energy Savings & Demand/Peak Reduction	☒ Net-to-Gross Ratio

Evaluation Approach	• **Verification Impact Evaluation** The evaluators will conduct a verification impact evaluation. The impact and attribution evaluation will be used to (1) estimate the net verified impact of individual program elements of HHC measures on energy consumption, (2) establish accountability of program administrator and delivery agent staffs regarding how the program actually yielded the savings that are reported to the OEB, (3) suggest improvements to the measures that are promoted through the program, and (4) calibrate future program savings projections for future DSM planning efforts. The program administrator will collect a certain amount of data used in evaluation through its routine tracking activities, and through careful indexing and storage of all program documentation. Sampling is going to be a key success factor of the M&V activities. Sampling should be designed to obtain key responses with statistically representative population. The analysis –based on the verification impact evaluation - should result in a verified savings for each of the HHC measures, and ultimately a realization ratio for each of the measures.
Special Provisions	No special provisions.
Data Collection Responsibilities	An independent EM&V contractor will be responsible for all external market data collection activities. **Tracking for Program Results** Union will be responsible for internal tracking of program data such as customer information, installation information, participant incentive, etc. All tracking data will be provided to the EM&V contractor during the verification of the HHC program. Using the tracking system, Union aggregates the annual program results into a tracking report, which is issued at the end of each year. This report will outline: • Number of HHC participants • Associated prescriptive m^3 savings of HHC participants (adjusted for installation and persistence verification) • Associated prescriptive equipment costs • Associated program and incentive costs • Number of LIWP participants • Associated custom m^3 savings delta between pre and post home audits to inform cumulative m^3 savings • Associated equipment and installation costs as established by delivery agent and are used to inform program cost per cumulative m^3 savings • Program-spend will be tracked separately to include: marketing and delivery expenses, salaries, verification and incentives.

Procurement Process

The independent EM&V contractors will be selected through a competitive tendering process. The bidder selection approach will be based on quality and cost.

Organization	Name	Title / Accountability
UGL	Program Manager	Program Tracking and Annual Tracking Reports – Collection of “Internal Data”.
UGL	Program Manager	Selection of the independent EM&V contractors
UGL	Program Manager	Coordination with the independent EM&V contractors
Independent EM&V Contractor selected to conduct the EM&V Studies	To Be Determined	Finalize the EM&V Plan Collect “External Data” Perform Analysis Deliver the EM&V Studies

Union Gas DSM Multi-year Plan Consultative Meeting

Meeting Minutes
August 11, 2011
Stakeholders present:

Jack Gibbons (Pollution Probe), Norm Rubin (Energy Probe), Julie Girvan (Consumers Council of Canada), Roger Higgin (VECC), Jay Shepherd (Schools Energy Coalition), Randy Aiken (London Property Management Association), Corrie Morton (Enbridge), Kai Millyard (Green Energy Coalition), Chris Neme (Green Energy Coalition), Andrew Hall (HRAI), Judy Simon (LIEN), Val Young (IGUA), Michael Bell (OEB), Lenore Dougan (OEB), Julie Boudreau (EnergyAtWork), Dana Silk (EnviroCentre), Ian Jarvis (Enerlife Consulting Inc.), Lenard Hart (Sustainable Buildings Canada – SBC), Bernie McIntyre (TRCA)

Overview

Questions, issues and comments:

Pollution Probe: Despite the Board's message that utilities are not obligated to deliver industrial programs, it does not mean industrial focus should be reduced. This seems irrational as industrial opportunities for savings are the greatest. It is not efficient to reduce spending on industrial - going from more effective to less effective programs is counterproductive
Suggestion: develop and bring forth to the Board, two budgets: i) maintain industrial focus at existing level of spending and ii) the new reduced scenario that UGL is proposing. Within this plan the benefits to GDP, decrease in GHG should be noted

GEC: Out of the 3,475 deep measure participants, 175 are residential. Could UG focus its programs to C/I participants only to achieve its targets without delivering resource acquisition programs within its residential segment?

SEC: The $/m3 metric incents UG to do more industrial than residential

Enerlife/GEC: What is the definition of deep measures?

Enerlife: Benchmarking? (e.g. Hospitals & schools typically have a consistent level of gas consumption data - this should be used for evaluation purpose)

SEC/GEC: Issues were raised with respect to the scorecard metric of *$ spent/cumulative m3*

- Would the utility be incented to deliver programs to CI and not residential?
- How should the change between the 100% to 150% be calculated for this metric?
- There is a built-in incentive for utility to used saved spending towards reducing greater m3

Energy Probe: The 50% scenario target is too low and easily achieved by UG. The 50% target should be closer to 3/4 of the 100% target, rather than 50%

VECC: What is the rationale for the 1% increase in evaluation budget for 2012? Is the shift due to the OPA's EM&V protocols

General clarification provided by UG:

- Slide 10: 2010 figures are actual
- Recovery of rate class is through volume
- Slide 8 represents the cost allocation and not the impact to the customer
- Slide 10 are direct program and incentive costs only, whereas slide 11 includes all salaries that can be directly associated with program
- Weighting of metrics was consistent with the Board's three guiding objectives and UG puts equal importance on each, but chose to have a slightly more emphasis on the cumulative m3.
- Consistent with the guidelines, the budgets within programs can be changed over the course of the year. Changes greater than 30% will have to be submitted to the Board for consideration. The Low Income budget has a budget floor.

- Research has a separate budget than the evaluation budget proposed
- The long term savings and free ridership have been included in the cumulative m3's savings and TRC calculations
- 50% target is reasonable because UG earns $0 incentive at this target level
- T1/R100 scorecard separated for clarity and transparency; OEB approval is needed so it would be difficult to pull out if embedded in Resource Acquisition scorecard

Information request:

SEC data request: scorecard metrics be broken down by sector and individual program for all measures
SEC data request: TRC calculations for previous years and proposed programs

Residential

Questions, issues and comments:

CCC: Education sessions & consumer industry trade shows metric needs to be further detailed
VECC: There is lost opportunity during home audits. Comprehensive draft proofing should be included in offering
Pollution Probe: It does not make sense to abandon the Drain Water Heat Recovery (DWHR) program if it is effective and if the market share is currently only at 18%
GEC: Market Transformation high efficiency water heating: what is the trajectory and exit?
  - Within 3 yrs, UG proposes to move the tankless market from 4% to 8% - this is not acceptable.

GEC: For the high efficiency water heating program it is difficult to combine the new and retrofit. Consider focusing only on retrofit.
SBC: There is no absolute certainty that tankless water heaters would become code in 2016. A good program should not be selected as a MT program because of an anticipation that it may become code in the future
GEC: MT should be replaced with a comprehensive multi-measure program (e.g incent Energuide scale to 83 to 85 as electric LDCs)
SEC/GEC/CCC: The message sent between UG and Enbridge is inconsistent for DWHR
GEC: It is questionable whether residential participants would install weather stripping and foam. A more comprehensive building retrofit would be more effective. An Energuide auditor conducting a proper blow door test could be incented to also complete insulation.
SEC: Metrics based on effort will be challenged by intervenors
GEC: 175 homes is low for residential weatherization

General clarification provided by UG:

- Within the scorecard, the 6% retrofit target already includes working with Reliance & Direct Energy
- DWHR, at time of inception in 2006 had a greater amount of m3's, however, given changes to the input assumptions, the m3's have reduced significantly - it is prudent for Union to use limited budget on a technology which results in higher m3 savings
- UG is working closely to align itself with Enbridge, however, the service territories are vastly different and has led to differences in approach to similar programs (e.g. DWHR)

Information request:

GEC: Savings calculation were based on 0.8EF or 0.72 tankless water heaters
SEC: What level would the insulation be taken to?
- Change market transformation metric to read replacement not retrofit

Commercial/Industrial

Questions, issues and comments:

Enerlife: What is the marketing strategy for targeting large multiple building owners?
GEC: How will the metric of effectiveness be measured on the T1/R100 scorecard?
SEC: The effectiveness metric on the T1/R100 scorecard is similar to an efforts metric
SEC: The scorecard target at the 50%, 100% and 150% do not line up
SEC: Minimum 50% should be higher
Enerlife: Management practices and management systems is more important and effective than retrofit technology incentives
GEC/IGUA/SEC: Market transformation: what is the transformed state and how would customer behavior change be measured?
SEC: UG should consider Integrated Energy Management Systems (IEMS) as resource acquisition rather than Market Transformation

General clarification provided by UG:

- UG is not exiting large building new construction, but will no longer fund the modeling/design
- UG has consulted with its customers within the T1/R100 rate class to seek their feedback on program design – focus group is planned to solicit further input on Union's 2012 – 2014 program
- The targets presented in the T1/R100 scorecard are for all three years of the framework
- Effectiveness metric would be measured by surveying T1/R100 customers to determine their satisfaction with the program (i.e. achieving 65% of customers who respond to surveys within the top 2 box rating)
- Customers are not currently doing IEMS as they are focused on production and will only adopt mandated changes

Information request:

GEC: Slide 39 - numbers presented (e.g. cumulated m3/promotion & incentive cost) should be portrayed consistently

Low Income

Questions, issues and comments:

SBC: Recognizing the timing, efforts required and difference between programs, there could potentially be opportunity to share the cost associated with outreach aspects between UG and electric programs for economies of scale.
VECC: Budget should be allocated across geographic distribution. A long term concern has been equity and coverage and tracking where the participants actually are located; representational mix of LI potential participants within UGL territory
LIEN: Scorecard metric should include a geographic distribution of LI (e.g. % saturation/success within these geographies)
GEC: Health & safety budget: If the amount per house is capped, it may not be enough for program to do what it needs per house. This may deem audits futile, when the measures cannot be installed. It is not needed for all houses, but some houses may require >$500
GEC: What are the plans for furnace and water heating offerings in the LI market?

General clarification provided by UG:

- UG would offer program to single, detached, 2-storey and 4-storey, previously untapped
- Social housing is addressed through comprehensive standpoint (i.e. with social housing provider)
- UG is currently focusing Weatherization offering on highly concentrated areas and full geographic coverage will take time (as was the case with Helping Homes Conserve). UG's intention is to move into other geographic areas (i.e. north)
- The 37.4M m3 target was built based on all program offerings
- The previous 0.7 TRC screen is still used as included in the Guidelines

Information request:

VECC: A comparison of the metrics within the scorecards to previous years

Discussion

Definition of Market Transformation:

EnviroCenter: Difficult for 2 utilities to transform the entire market. Drop the definition.

GEC: Keep the current OEB definition. Determining which program offerings should be placed in MT category is critical.
Characteristics that fall into the MT category should:
a) Prospect to transform market over a finite period of time (e.g. 10 year horizon)
  - It is problematic If there is no trajectory (i.e. performance goals) that can be observed over 3 year period

b) Transformation means there must be an exit strategy. Codes is obvious example, however, there are other indicators to indicate end state and indication that the market will not fall back to previous state (otherwise RA)
  - This delta must be significant enough
  - Exit, plan & trajectory
  - Initially it may not achieve linear results as it will require initial phase to gain momentum

Initial market share baseline study for year to year performance measurement
It is difficult to achieve MT within 1 jurisdiction, the likelihood of success are greater if partnership is formed with other jurisdictions (e.g. Enbridge and electrics) maybe not all things together but at least aligned with some aspects

Enerlife: MT is mostly achieved through owners and managers rather than suppliers. Consistency in management practices is key.

Definition of Deep Measure

GEC: Should be defined specific to each program on a case by case basis as it is difficult to have one definition be applied to all programs
High performance standard and deep savings are not the same thing
Comprehensive treatment of opportunities

Enerlife: Aimed to achieve high performance (i.e. a benchmark that can be used and levels to drive to)

SBC: Focus on performance and sustainability, rather than m3

DSM CONSULTATIVE MEETING

(August 18, 2011)

From: Falvo, Victoria
To: Falvo, Victoria; "Theresa@cela.ca"; "paul.clipsham@cme-mec.ca"; "vderose@blgcanada.com"; "jgirvan@ca.inter.net"; "Christine.Date@directenergy.com"; "Andrew.mandyam@enbridge.com"; "Judith.Ramsey@enbridge.com"; "normrubin.energyprobe@gmail.com"; "kai@web.net"; "dpoch1@xplornet.com"; "dpoch@eelaw.ca"; "cneme@energyfuturesgroup.com"; "mluymes@hrai.ca"; ahall@hrai.ca; "regulatory@HydroOne.com"; "ian.mondrow@gowlings.com"; "rob.rowe@rogers.com"; "jsimon@indeco.com"; "todorom@lao.on.ca"; "bhanjiz@lao.on.ca"; "rgriffin@cela.ca"; "raiken@xcelco.on.ca"; "jgibbons@pollutionprobe.org"; "Michael.Bell@oeb.gov.on.ca"; "Takis.Plagiannakos@oeb.gov.on.ca"; "marion.fraser@rogers.com"; "jay.shepherd@canadianenergylawyers.com"; "wmcnally@opsba.org"; "rhiggin@econalysis.ca"; robertpoirier@ropoirier.com; cturner@cgtaeng.com; dtripp@cietcanada.com; dana.silk@ottawa.ca; Russ.chapman@firebridgeinc.com; Hart.lenard@gmail.com; scott.rouse@energy-efficiency.com; hhunter@hfm.ca; julia.deans@civicaction.ca; tbrett@foglers.com; bmcintyre@trca.on.ca; ijarvis@enerlife.com; bdenney@trca.on.ca; vyoung@aegent.ca; lenore.dougan@ontarioenergyboard.ca; Boulton, Keith; Van Der Paelt, Sarah; Okrucky, Jeff; Lucas, Johanna; Wade, Cara-Lynne; McAlorum, Amanda; Marentette, Todd; Shaw, Ryan; Brooks, Tracey; Ginis, Haris; Moore, Alison; Redford, Marian; Organ, Ryan; Kulperger, Leslie; Wong, Alvin; Rumiel, Wally; Noorani, Imran; Andrew Mandyam; Rodney Idenouye; ekirkpatrick@torys.com
Subject: UG Multi-year Plan - Follow up to Information Requests
Date: August-17-11 10:20:32 PM
Attachments: 2011 UGL Incremental Low Income Plan scorecard.pdf
Cumulative Natural Gas Savings and Deep Measure Summary.xlsx
Revised Residential Market Transformation Scorecards-August 17 2011.docx

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Hello Everyone,

As a follow up to a couple of the information requests from last week, please find the following items attached:

- Union 2011 Incremental LI Plan Scorecard
- Summary of Union's historical cumulative NG savings and deep measures
- Revised Draft Residential MT Scorecards (based on program changes in the last week)

We are still working on the historical and 2012 TRC calculations which we will provide over the next few days.

The purpose of tomorrow's meeting is to review any adjustments made to our plan and programs based on the feedback we received last Thursday and over the course of this week. We will also provide a few clarifications due to questions/concerns we heard on our programs.

We look forward to speaking with you tomorrow afternoon at 2:30pm.
Thanks,
Victoria

Conference Number

- 1-866-826-8611
- Code: 249972

UGL Stakeholders Invited

On Behalf of	Representative
AEE (the Association of Energy Engineers)	Doug Tripp
BCA (Building Commissions Association)	Herb Hunter
Canadian Environmental Law Association (on behalf of LIEN)	Theresa McClenaghan
CEEA (Canadian Energy Efficiency Alliance	Thomas Brett
CGTA	Charles G. Turner
CGTA	Lynda Turner
Civic Action	Julia Deans
CME	Paul Clipsham
CME	Vince DeRose
Consumers Council of Canada	Julie Girvan
Direct Energy	Christine Date
Enbridge	Andrew Mandyam
Enbridge	Judith Ramsay
Energy Probe	Norm Rubin
EnergyAtWork	Scott Rouse
EnergyAtWork	Julie Boudreau
EnviroCentre	Dr Dana Silk
Federation of Rental-housing Providers of Ontario (FRPO)	Dwayne Quinn
Firebridge	Russ Chapman
Green Energy Coalition	Kai Millyard
Green Energy Coalition	David Poch
Green Energy Coalition	Chris Neme
HRAI	Martin Luymes
HRAI	Andrew Hall
Hydro One Networks Inc.	Glen MacDonald
IGUA	Ian Mondrow
IGUA	Val Young
IGUA	Robert Rowe
IndEco on behalf of LIEN	Judy Simon
LIEN	Mary Todorow
LIEN	Zeenat Bhanji
LIEN	Renee Griffin
London Property Management Association	Randy Aiken
Ontario Energy Board	Micheal Bell
Ontario Energy Board	Lenore Dougan
Ontario Energy Board	Takis Plagiannakos
OSEA	Marion Fraser
Pollution Probe	Jack Gibbons
RO Poirier	Robert Poirier
SBC (Sustainable Buildings Canada)	Lenard Hart
Schools Energy Coalition	Jay Shepherd
TRCA (Toronto & Region Conservation Authority)	Bernie McIntyre
TRCA (Toronto & Region Conservation Authority)	Brian Denney
TRCA (Toronto & Region Conservation Authority)	Ian Jarvis
VECC	Roger Higgin

Follow up Conference call - August 18

Stakeholders Present

Dialed in	Attendee		On behalf of
1	Aiken	Randy	London Property Management Association
1	Bell	Micheal	Ontario Energy Board
1	Boudreau	Julie	BOMA (Building Owners and Managers Association)
1	Gibbons	Jack	Ontario Clean Air Alliance
1	Girvan	Julie	Consumers Council of Canada
1	Millyard	Kai	Green Energy Coalition
1	Neme	Chris	Green Energy Coalition
1	Quinn	Dwayne	Federation of Rental-housing Providers of Ontario (FRPO)
1	Rubin	Norm	Energy Probe
1	Shepherd	Jay	Schools Energy Coalition
1	Silk	Dana	EnviroCentre
1	Simon	Judy	IndEco on behalf of LIEN
1	Young	Val	IGUA

Cumulative Natural Gas Savings and Deep Measure Participants Summary

Program	Metric	Actual Results				Plan 100% Target		
		2007	2008	2009	2010	2012	2013	2014
Low Income	Cumulative m3 Savings (000 m3)	7,292	13,117	31,405	22,742	37,400	32,400	30,700
	Deep Measure Participants	0	0	75	134	740	875	920
Residential Program	Cumulative m3 Savings (000 m3)	85,942	77,083	52,184	31,014	26,450	25,900	23,900
	Deep Measure Participants	15,210	8,407	14,246	0	175	310	310
Commercial/Industrial Program	Cumulative m3 Savings (000 m3)	221,923^	442,901	672,419	779,000	530,000	530,000	530,000
	Deep Measure Participants	2,790*	2,921	4,167	2,627	3,300	3,300	3,300
Large Industrial Rate 100/T1 Program	Cumulative m3 Savings (000 m3)	N/A^	470,902	684,777	981,936	200,000	200,000	200,000

^ Distrbution Contract custom projects have been excluded from the cumulative m3 summary for 2007 as the split between the Non-Rate 100/T1 and Rate 100/T1 rate classes is not available. The total cumulative m3 savings delivered to Distribution Contract customers in 2007 was 580,143,568 m3.

* Distrbution Contract custom projects have been excluded from the participant summary for 2007 as the split between the Non-Rate 100/T1 and Rate 100/T1 rate classes is not available. In total 176 Custom projects were delivered to Distribution Contract customers in 2007.

SCORECARD – High-Efficiency (0.8EF) Water Heating New Build Only

	Metric	50%	100%	150%	Weighting
2012	Installed Units	6%	7%	8%	30%
	Participating Builders	40	50	60	10%
	Education Sessions & Consumer/Industry Shows	8	15	22	10%

	Metric	50%	100%	150%	Weighting
2013	Installed Units	2012 + 0%	2012 + 2%	2012 + 4%	30%
	Participating Builders	63	66	69	10%
	Education Sessions & Consumer/Industry Shows	15	22	29	10%

	Metric	50%	100%	150%	Weighting
2014	Installed Units	2013 + 0%	2013 + 2%	2013 + 4%	30%
	Participating Builders	72	76	79	10%
	Education Sessions & Consumer/Industry Shows	15	22	29	10%

SCORECARD – New Home High-Efficiency Program

Scorecard				
	Metric	**50%**	**100%**	**150%**
2012	**Participating Builders**	**6**	**8**	**10**
	Number of Discovery Homes Yr 1 participants	**5**	**7**	**9**

	Metric	**50%**	**100%**	**150%**
2013	**Participating Builders**	**10**	**13**	**16**
	Energy Star Homes Enrolled	**155**	**205**	**250**

	Metric	**50%**	**100%**	**150%**
2014	**Participating Builders**	**10**	**13**	**16**
	Energy Star Homes Enrolled 2013	**750**	**925**	**1000**

Table 2: 2011 Home Weatherization Scorecard

Union Gas Low-Income Home Weatherization Scorecard					
Element	**Performance Metrics**	**Metric Value Levels**			**Weights**
		50%	**100%**	**150%**	
Ultimate Outcomes	Weatherization Participants	300	400	450	50%
	Total Natural Gas Savings (m^3)	366,000	488,000	549,000	50%

Scorecard Metrics Description:

a) Weatherization Participants: The number of homes of low-income energy consumers served through the program that receive at least one substantial insulation measure (e.g. increase in insulation in more than half of the walls, basement walls or attic of the home) as well as associated cost-effective air sealing.

b) Total Natural Gas Savings (m^3): The natural gas savings will be calculated based on the results of the pre and post energy audits conducted by certified energy auditors on a custom basis.

Due to the overall non-linear relationship of the scorecard incentive metrics, Union has provided an example of the calculation for the Home Weatherization scorecard in Table 3 below.

Table 3: Sample Score Calculation for Home Weatherization Scorecard

Sample Home Weatherization Scorecard Results			
Element	**Metric Performance**	**Weighted Score**	**Score**
Ultimate Outcomes	380 Weatherization Participants	90 % × 50	45.0%
	518,500 m^3 of Total Natural Gas Savings	125% × 50	62.5%
		Total	107.5%

The incentive for Union's performance, in this example, would be $430,000 (107.5% × $400,000).

Union views 2011 as a transition year towards a more integrated and robust low-income energy efficiency strategy that will ultimately result in more effective programming for low-income energy consumers.

3.2.2 Basic Audit

The addition of a basic home audit to the design of Union's Helping Homes Conserve program will allow Union to collect data to streamline the intake process for the Home Weatherization program. The audit will be performed by the basic measure installation contractor and will screen for information such as the age of the home, efficiency level of the equipment in the home and current insulation levels. A multi-fuel basic audit, which leverages the reach of Union's

SUMMARY OF CHANGES TO UNION DSM PLAN

BASED ON STAKEHOLDER FEEDBACK

APPENDIX D - Summary of Changes made to Union DSM Plan due to Stakeholder Feedback

During Union's stakeholder consultation process, feedback was received and suggestions were made on Union's initial Plan and subsequent proposals thereafter. The following summary lists the items Union changed in the Plan to address a number of stakeholder recommendations. While the summary does not reflect stakeholder consensus, it demonstrates the changes Union made to take stakeholder feedback into account.

Union Proposed	Stakeholder Comments & Feedback	Union Response: Changes Made to Plan
Cost Effectiveness Metric: Consistent with the DSM Guidelines, Union initially proposed 3 metrics for the Resource Acquisition and Low Income scorecards: cumulative m3 savings (40% weighting), # of deep measure participants (30%) and $ spend/m3 (30%). T1/R100 scorecard proposed also included the cost effectiveness metric.	Concerns were expressed that cost effectiveness as a metric within the scorecard (i.e. $ spend/m3) would overlap with the cumulative m3 metric. Stakeholders felt Union should report the cost effectiveness annually but that it was not an appropriate metric.	Although cost effectiveness is an important aspect of DSM programs, Union recognizes intervenors' concerns and believes that the utility should not have disincentive to drive further spending within a program if it is still cost effective. This metric has, therefore, been removed from the Resource Acquisition, Low Income and T1/R100 scorecards. Union will annually report on cost effectiveness as intervenors requested.
Weighting of Scorecard Metrics: Upon feedback received from Union's August 11 Consultative meeting, the $ spend/m3 was removed from the scorecard and the remaining metrics re-weighted equally (50%/50%)	The scorecard reflects an inadequate emphasis on cumulative m3 savings. Cumulative m3 savings metric should have a higher weighting.	Union considered each metric to be equally important, however, due to stakeholder's feedback that m3 savings should be a priority, UGL re-weighted the metric on the Resource Acquisition and T1/R100 scorecards with 60% allocated to cumulative m3 savings and 40% to # of deep measures/percentage of customers participating respectively.
EM&V Budget: Increase in Evaluation spend for 2012 by roughly 1% compared to 2010 Actual and 2011 Projected EM&V spend	The 1% increase equates to a large absolute dollar increase and requires a rationale to justify the increase (e.g. was this due to adopting OPA EM&V protocols?)	The increase was not a reflection of adopting the OPA EM&V protocols, but in response to Auditor and EAC recommendations from previous years' audits and UGL's efforts to stay current with industry best practices (e.g. current EM&V costs in other jurisdictions within North America, represent ~4-6% of total DSM expenditures)
Market Transformation: High Efficiency Water Heating Program for new build construction and retrofit markets	Overall concerns with the program. Targets were too low and combining new build and retrofit is difficult. This program should be replaced with a comprehensive multi-measure program such as incenting Energuide 83 to 85 (a new home efficiency program) similar to Enbridge's Market Transformation program.	Union removed the retrofit portion of the High Efficiency Water Heating Program to focus its efforts on transformation of the new build market. The targets for the new build market were increased substantially. Budget and resources available from removing the retrofit portion would now be used towards a New Home Efficiency program as stakeholders requested. Addition of the program also addressed stakeholders' request to be further aligned with Enbridge.

Market Transformation: New Home Efficiency program scorecard metrics included the number of participating builders and number of homes enrolled	Number of builders should increase year over year within the term of the Plan.	UGL has altered the metric to ensure the number of builders enrolled in the program is increased year over year.
Market Transformation: UG proposed 3 MT programs	GEC provided a new MT program idea for home labelling of energy efficiency.	UG will include this program idea in our research plan and dedicate time, resources and a research budget to the concept to get a better understanding of the market, opportunity, players, etc.
Low Income: To ensure depth of savings and breadth of program reach, the scorecard included metrics for cumulative m3 savings and # of deep measure participants	Overall concerns with the metrics. Specifically would like to see a two part scorecard breaking out the cumulative m3 for part 3 & part 9 buildings.	The Low-Income scorecard metrics have been broken out to include: cumulative m3 savings (50%), Residential deep measure participants (25%) and Multi-Family deep measures (25%).
T1/R100: Union proposed an effectiveness metric whereby customers would be surveyed as to whether UGL is providing effective energy conservation support with achievement based on a top 3 box score percentage.	Stakeholders did not support this metric as it was viewed as a reward for effort and could be influenced by the utility based on the timing and nature of the survey.	Union removed the effectiveness metric from the scorecard in response to stakeholder feedback.
Stakeholder Engagement Terms of Reference An initial Terms of Reference was provided to the working group at the beginning of the stakeholder engagement consultation process.	Feedback was received during the 5 working group meetings.	The Terms of Reference included in the Plan reflects the adjustments made by the utilities' in direct response to feedback received from the working group stakeholders

TERMS OF REFERENCE ON

STAKEHOLDER ENGAGEMENT

Terms of Reference

on

Stakeholder Engagement

for

Union Gas Limited DSM Activities

September 22, 2011

Table of Contents

1. Introduction and Background

i. Purpose of the Stakeholder Engagement Process

Stakeholder engagement in DSM addresses needs of the intervenors that represent ratepayer and environmental groups, the utilities**,** their customers, and the Ontario Energy Board (the Board). For ratepayer and environmental groups, stakeholder engagement provides insights into the activities of the natural gas utilities and an opportunity to provide input and influence the direction of those activities. This instills confidence in relation to accurate reporting and calculation of the DSM Variance Account (DSMVA), Lost Revenue Adjustment Mechanism (LRAM), and utility incentives and also provides confidence that program results are calculated using sound assumptions based on best available information. For the utilities and their customers, as well as stakeholders, the peripheral benefits of stakeholder engagement include the development and enhancement of utility DSM programs. For the Board and utilities, stakeholder engagement results in reduced regulatory burden and reassurance that the utilities continue to deliver successful and cost effective DSM programs.

ii. Definitions

For the purposes of these Terms of Reference the following definitions apply:

Intervenors:	organizations and their representatives who are granted intervenor status by the Board for a particular proceeding.
DSM Consultative:	the group of intervenors who have been granted status by the Board for a particular proceeding.
Stakeholders:	groups or individuals who have an interest in Ontario DSM matters, including intervenors. Other stakeholders who are not intervenors may be customers, trade allies, delivery agents, and others.

iii. Objective of the Terms of Reference

The purpose of the Stakeholder Terms of Reference is to clarify and define the roles and responsibilities of intervenors, other stakeholders, the utilities, and the Board with respect to participating in the stakeholder engagement processes proposed in this document. These include processes relating to program design, DSM measure input assumptions, evaluation research, and the audit of DSM program annual results. The Terms of Reference will lead to improved efficiency and effectiveness for intervenor and stakeholder engagement through the period of the 2012 – 2014 Multi-Year Plan.

iv Background to the Terms of Reference

As outlined in the Board's DSM Guidelines (June 30, 2011), Union Gas (Union) and Enbridge Gas Distribution (EGD) have jointly developed the Terms of Reference, however this document currently represents Union's proposal. The utilities consulted with intervenors to inform the Terms of Reference and Union is submitting the Terms of Reference to the Board as part of the 2012-2014 DSM Plan application.

In developing the Terms of Reference, the following consultation process was followed.

- At the July 20th meeting of the Enbridge DSM Consultative, intervenors were invited to nominate members to a Working Group to develop the Terms of Reference in consultation with the utilities. The Consultative nominated the following to the Working Group:
    - Vince DeRose, CME
    - Marion Fraser, LIEN
    - Ian Mondrow, IGUA
    - Chris Neme, GEC
    - Jay Shepherd, SEC
- The utilities were also represented and provided secretariat services to the Working Group.
- The utilities engaged a third party consultant, Mr. Mike Messenger of Itron[1], to present an overview of stakeholder / intervenor engagement models in other jurisdictions at the first Working Group meeting and to attend the remainder of the meetings via conference calls.
- The Working Group held 4 half-day sessions on August 19, 22, 24, and 26 as well as a two hour conference call on August 31.

As consensus was not reached on the Terms of Reference, this document represents Union's proposal.

The Terms of Reference go beyond the minimum requirements for consultation as presented in the Board Guidelines, Section 16.1.

> "All participants in the Board's consultation on the development of these Natural Gas DSM Guidelines (EB-2008-0346) should be invited to participate in the natural gas utilities' DSM stakeholder engagement process. As part of their stakeholder engagement process, each natural gas utility should hold a minimum of two meetings every year and invite all such participants (the "General DSM Meeting")."

In addition to two plenary Consultative meetings each year, the Terms of Reference include provision for intervenor involvement in:

- development and update of input assumptions**;**
- evaluation research priorities and individual studies**;**
- the audit of DSM annual results; and
- development of new program ideas.

---

[1] Mike Messenger is an internationally recognized expert in the field of energy efficiency, evaluation, and related policy framework development. He has also served as a leader of collaborative stakeholder groups charged with developing new program performance and shareholder incentive mechanisms in California.

The Terms of Reference also provide for involvement of other stakeholders in:

- development and update of input assumptions, and
- development of program ideas

2. Models for Intervenor and Stakeholder Engagement in the Utilities' DSM Activities

The model for intervenor / stakeholder engagement in the 2007 Multi-year Plan involved separate processes for the two natural gas utilities as follows:

- a minimum of two Consultative meetings each year; and
- creation of utility specific Evaluation Audit Committees to address matters relating to evaluation research and the audit of DSM annual results.

In addition, throughout the Plan period, the utilities consulted with their respective EACs prior to filing applications to update the measure assumptions used in their DSM programs.

The model proposed through this Terms of Reference document involves:

- a minimum of two plenary Consultative meetings each year for each utility;
- a common Technical Evaluation Committee and a common Technical Reference Manual (TRM) to document measure assumptions;
- a separate Audit Committee for each utility; and
- separate consultation initiatives relating to program ideas.

The proposed model offers several benefits.

- The division of functions will streamline both the process to update input assumptions and the audit process.
- The primary responsibility for critical review of evaluation research and input assumptions will rest with the Technical Evaluation Committee, thus streamlining the DSM audit process.
- The Technical Evaluation Committee will facilitate collaboration on evaluation research, and harmonization of DSM programs across the two utilities.
- The development of a common Technical Reference Manual represents best practice in DSM administration.
- The proposed model aligns with the Board Guidelines regarding
    - a minimum of two Consultative meetings each year for each utility; and
    - a common annual submission by the utilities to the Board to update the input assumptions.
- In addition, the proposed models align with the two Board processes of
    - Disposition of DSM Deferral Accounts; and
    - Annual filing of Updated Input Assumptions.

3. Principles for Intervenor and Stakeholder Engagement for the Natural Gas Utilities

The following principles will guide intervenor and stakeholder engagement activities of the natural gas utilities.

Roles and Accountability The utilities are ultimately responsible and accountable for their DSM activities including the design, development, implementation, and evaluation of DSM programs. Given this, the utilities will strive to reach consensus in matters before the Technical Evaluation Committee and the Audit Committees proposed in this document.

- The Ontario Energy Board is responsible for approving DSM programs and related matters.
- Stakeholders and intervenors advise and make recommendations to the utilities and the Board on DSM matters.

General

- Intervenor and stakeholder engagement activities are undertaken at the discretion of the natural gas utilities.
- Intervenor and stakeholder engagement processes should be designed to.
  - Instill confidence in relation to accurate reporting and calculation of the DSM Variance Account (DSMVA), Lost Revenue Adjustment Mechanism (LRAM), and utility incentives
  - Provide confidence that program results are calculated using sound assumptions based on best available information
  - Contribute to the development and enhancement of utility DSM programs
  - Reduce regulatory burden
- Intervenor and stakeholder engagement processes should not impede the utilities' ability to design, develop, implement and evaluate DSM programs in a timely manner.

Consensus

- Achievement of consensus is a goal but not a requirement of committee processes outlined in this Terms of Reference.
- Consensus is reached when all parties can sign on to a recommendation or position as in a settlement agreement to a Board proceeding.
- Where consensus is not reached, parties may file their separate positions with the Board.

Utilities' Commitment

The utilities have a responsibility to:

- convene meetings and otherwise manage the consultation process; and
- provide meeting notes in a timely manner.

Intervenor Commitment

- Intervenors who agree to participate on committees proposed in this document will make every effort to attend meetings and respond to information requests.
- Members of committees pledge to strive to make every meeting scheduled and to send substitutes in their place when they cannot attend.

All parties Commitment

- All parties will make every effort to ensure a constructive review of available evidence on the impact and effectiveness of the utilities' DSM programs
- In the interests of maintaining a positive working environment, each participant will maintain a professional level of courtesy towards other participants.

Committee Meetings

- If scheduling does not permit full attendance at committee meetings, utilities will convene meetings based on quorum where quorum is defined as the Committee utility representative(s) and two thirds of the intervenor representatives.

Confidentiality

- Non- disclosure agreements must be signed by participants when dealing with draft reports and study working documents. (refer to Appendix A)

- If any confidential information could potentially give the recipient an unfair business advantage in competing for work from the utilities, the utilities will "flag" such concerns in advance of providing the information and the potential recipient will have to choose to either: (1) not review the confidential information and remove himself / herself from the engagement process; or (2) accept and review the confidential information but commit to not pursuing the work opportunity.

Conflict of Interest

- In the case of a conflict of interest arising, it is the participant's responsibility to declare the conflict to the Committee as early as possible.

4. Consultative Meetings

As outlined in the Guidelines, the utilities will hold a minimum of two plenary meetings of the DSM Consultative in each calendar year and all intervenor participants in the Board's consultation on the development of the Guidelines (EB-2008-0346) will be invited to the Consultative meetings.

The subject of the meetings may include:

- reviewing annual DSM results;
- selecting any subcommittee that may be part of the intervenor engagement process (the Technical Evaluation Committee and the two Audit Committees); and
- providing advice on the development and operation of the natural gas utilities' DSM Plan as well as on the design and development of new programs.

5. Technical Evaluation Committee Terms of Reference

There will be one Technical Evaluation Committee for both natural gas utilities.

i. Goal and Objective

<u>Goal</u>

The goal of the Technical Evaluation Committee (TEC) is to:

- Contribute to the development of well documented and substantive Prescriptive Input Assumptions for the utilities' DSM programs and the development of cost effective, sound evaluation research on DSM programs.

<u>Objective</u>

The objective of the Technical Evaluation Committee (TEC) is to:

- Develop consensus recommendations on information and assumptions to be included in the Technical Reference Manual (TRM) and on evaluation research (evaluation priorities, evaluation studies).

ii. Scope of Work

The Technical Evaluation Committee will make recommendations on:

- the DSM input assumptions to be used by the utilities as documented in the TRM;
- evaluation priorities and future evaluation studies to be undertaken; and
- the design and implementation of evaluation studies.

iii. Composition and Selection

The Technical Evaluation Committee shall consist of five individuals:

- three intervenor representatives nominated by the DSM intervenors in the most recent Board proceeding of the two utilities; and
- one representative from Union and one representative from EGD, self selected by each utility. (Other representatives from the utilities may attend Committee meetings from time to time but are not Committee members.)

Note: Two technical consultants appointed by the Committee will attend all meetings as a resource to the Committee but are not Committee members.
Note: Other stakeholder representatives will be engaged on an as needed basis.

iv. Term

The intervenor members on the Committee will serve for a one year term, but are eligible for reappointment by the Consultative annually.

v. Process

- It is anticipated that approximately twelve monthly meetings (1/2 to a full day each) will be held in the first year. Fewer meetings may be required in years two and three.
- Regarding evaluation studies: Final Reports will not be considered confidential. Committee members will have access to draft reports and, on request, to other study work products as outlined in the study workplan. Draft reports and study work products will initially be considered confidential unless otherwise determined by the Board in a proceeding and will be available on signing a confidentiality declaration substantially in accordance with the form used by the Board from time to time.
- The Committee will endeavour to reach consensus on its recommendations. Where consensus is not reached the Committee members will outline their respective positions in the appropriate Board processes (application to clear DSM Deferral Accounts or the annual submission to Update Input Assumptions).

- The utilities will lead the process, convene meetings, circulate draft agendas, develop draft meeting minutes, etc.

vi. Outputs / Deliverables

Technical Reference Manual

- The Technical Reference Manual will be common to both Union Gas and Enbridge Gas Distribution and will document efficiency measure savings assumptions (and/or formulae) and all other assumptions (other than avoided costs) necessary for cost-effectiveness screening program metrics.
- The Technical Consultants will maintain the Manual on an ongoing basis to document the changes or additions recommended by the Committee.

- The utilities will file an annual update to the TRM with the Board as soon as practical after the audit. The report will outline changes to input assumptions of existing measures and proposed assumptions for new measures as recommended through Committee processes during the year.
- NOTE: As required in the Board Guidelines (6.1.2),

  > "The application (for updates and additions to the set of approved input assumptions) should be made annually, whether or not the gas utilities are requesting any changes to their set of input assumptions. The natural gas utilities annual application will provide a Board forum for stakeholders that will allow them to, among other things, request updates and/or additions to the set of input assumptions that may not have been identified by the natural gas utilities."

vii. Timing and Interface with the Audit

The utilities will file the annual TRM Update submission as soon as practical after the completion of the audit for year A and no later than the commencement of the audit for year B. The TEC will provide the latest board approved TRM and any TRM recommendations from the TEC to the Auditor by April 1st to be used for the purpose of the audit. Unless the auditor brings forward new information with evidence, the updated TRM as approved by the Board, along with any TEC recommendations provided on April 1st, will be considered best available information at the time of the audit.

viii. Fee Guidelines

Intervenor participants will invoice the utilities for meeting attendance and preparation up to the appropriate rate established by the OEB. The invoice will document activities, including consultation with Consultative members. The invoices for the intervenor time will be equally shared between the two utilities. It is expected that the level of commitment for intervenor participation in this process will not exceed 120 hours per year for each intervenor member. In the event additional hours are required, the Committee can revisit the Committee's budget requirements. Other stakeholders who are invited to attend Committee meetings from time to time may also be reimbursed at the discretion of the utilities.

ix. Roles and Responsibilities

Intervenor participants

In addition to participating on the Committee, the intervenor participants will:

- report back to the larger DSM Consultative;
- liaise with intervenor representatives on the Audit Committee; and
- at their discretion, file comments with the Board – particularly in the event that the Committee fails to reach consensus on the annual TRM update

Utilities

In addition to participating on the Committee, the utilities will:

- convene meetings and provide secretariat services to the Committee;

- support all costs associated with the intervenor representatives appointed to the Committee as per Board Guidelines, the technical consultants retained, and any stakeholder representatives invited to attend Committee meetings;
- support all costs associated with the conduct of all evaluation research studies;
- develop evaluation research priorities in consultation with the Committee;
- design and implement evaluation research studies in consultation with the Committee; and
- submit to the Board the annual application for the TRM Update as soon as practical after the audit's completion. The TRM Update will identify all changes to existing assumptions, all new assumptions and make clear whether any of the changes and additions were not the product of a Committee consensus.

Technical Consultants

The technical consultants will:

- provide professional expertise in relation to evaluation and to the development of input assumptions, encompassing experience in residential, commercial and industrial applications such as energy efficiency in low rise buildings, commercial buildings, industrial processes, market transformation, and so on; and,
- be responsible for documenting input assumptions changes and new measure assumptions throughout the year (the Technical Resource Manual).

The Ontario Energy Board

The role of the Ontario Energy Board is to:

- review recommendations relating to the annual filing of the Update to Input Assumptions; and
- where a consensus on the Update to Input Assumptions is not achieved, resolve any such dispute by way of Board Decision at the Board's discretion.

6. Audit Committee Terms of Reference

Each utility will have an Audit Committee.

i. Goal and Objective

The goal of the Audit Committee is to:

- Contribute to an effective and thorough audit of the utility's DSM results.

The objective of the Audit Committee (AC) is to:

- Reach consensus on the selection of the auditor, conduct of the audit and on recommendations concerning the utility's claims regarding DSM annual results.

ii. Scope of Work

The Audit Committee provides a forum for intervenor engagement throughout the audit process, from selection of the auditor to submission of the Committee's Audit Report to the Board. The Audit Committee will participate in:

- selection of the auditor;
- determining the scope of the audit;
- oversight of the audit; and
- make recommendations regarding the utility's claims regarding DSM results and DSMVA, LRAM, utility incentives and any target adjustments through the Audit Committee Report submitted to the Board.

iii. Composition and Selection

Each utility will have an Audit Committee, which shall consist of four individuals:

- three intervenor representatives nominated by the DSM intervenors in the current proceeding (intervenor participants serving on the TEC may also serve on the AC) ; and
- one representative from the utility, self selected by each utility. Other representatives from the utility may attend Committee meetings from time to time but are not Committee members.

iv. Term

Intervenor members will be appointed for each year's audit process, eligible for reappointment for successive audits. In the event that a member must resign, the same process will be used to nominate and appoint a replacement.

v. Process

- Meetings will be held from December through June, including possible joint meetings of the two audit committees, when necessary. It is expected that 9-10 meetings will be sufficient.
- The Committee will endeavour to reach consensus on the selection of the auditor, the conduct of the audits, and on recommendations concerning the utility's claims regarding DSM annual results. Where consensus is not reached, the Committee will outline areas of discrepancies in the Audit Committee's Report to the Board.
- The utility will lead the audit process, convene meetings, circulate draft agendas, develop draft meeting minutes, etc.
- All verification reports made available to the auditor will be available for review by all Committee members (with all customer identification information replaced by generic identifiers) and on signing a confidentiality declaration substantially in accordance with the form used by the Board from time to time.

vi. Outputs / Deliverables

The utility will file with the Board the

- Final Auditor's Report by June 30th as required by the Board's Natural Gas Reporting and Record Keeping Requirements Rules for Gas Utilities.

The utility will also file the following reports by July 31st with the Board:

- the Audit Committee's Report and
- the updated Final Annual Report.

vii. Fee Guidelines

Intervenor members will invoice the utility for time spent on committee matters at the appropriate rate established by the Board. The invoice will document activities, including consultation with Consultative members. Intervenors will submit separate invoices to each utility with respect to the Audit Committee of that utility. It is expected that the level of commitment for participation in this process will not exceed 60 hours per year for each intervenor member. In the event additional hours are required, the Committee can revisit the Committee's budget requirements.

viii. Roles and Responsibilities

Intervenors

In addition to participation on the Audit Committee, the intervenor members of the Committee will:

- represent the larger Consultative and stakeholder group comments arising out of the Draft Annual Report and bring forth any issues/concerns expressed
- review and submit to the Auditor comments on the utility's draft Annual Report; and,
- at their discretion, file comments with the Board – particularly in the event that the Committee fails to reach consensus on the selection of the auditor, the conduct of the Audit, the Final Annual Report, and/or the Audit Committee Report filed by the utility.

The Utilities

In addition to participating on the Committee, the utilities will:

- convene meetings and provide secretariat services to the Committee;
- provide the Draft Annual Report to the DSM Consultative and to Committee members;
- respond to issues that arise out of the audit process;
- update the Annual Report after the audit has been completed;
- support all costs associated with the costs of the Auditor and the Audit through the DSM evaluation budget;
- support all costs associated with the costs of intervenor representatives appointed to the Committee;
- Select and contract with the auditor in consultation with the Committee;
- manage and coordinate the audit process in consultation with the Committee;

- file with the Board the Audit Report, the Final Annual Report and the Audit Committee Report, noting in the process if any elements of the Final Annual Report and the Audit Committee Report do not represent the consensus of the Committee.

<u>The Auditors</u>

The Auditors shall, at a minimum:

- provide an audit opinion on the DSMVA, LRAM and incentive amounts proposed by the natural gas utility and any amendment thereto;
- confirm any target adjustments have been correctly calculated and applied;
- identify any input assumptions that either warrant further research or that should be updated with new best available information;
- review the reasonableness of any verification work that has been undertaken to inform utility results; and
- recommend any forward-looking evaluation work to be considered.

<u>The Ontario Energy Board</u>

The role of the Ontario Energy Board is to:

- review recommendations relating to the Audit Committee Report and utility application for clearance of DSM Deferral accounts; and
- where a consensus on the Audit Committee Report is not achieved, the Board will determine resolve any disputes by way of Board Decision at its discretion.

7. Program Consultation

Each utility will undertake separate utility-led consultation initiatives as outlined in their 2012 Plan.

i Objective

The objective of stakeholder engagement in DSM programs is to enhance the development of effective and innovative DSM programs through an exchange of ideas between the utilities, intervenors, and other stakeholders.

ii Scope of Program Consultation

Program consultation will be undertaken at the discretion of the utilities. As required by the Guidelines, each utility will hold at least two plenary DSM Consultative meetings each year. One or both of these Consultative meetings may include discussion of program Plans.

iii Participation

Intervenors and other stakeholders will be invited to participate at the discretion of the utilities. The utilities are not restricted in any way from soliciting input from non-intervenor stakeholders who have an interest in their DSM Plans. It is at the discretion of the utilities to include intervenors in any processes to engage non-intervenor stakeholders.

Appendix A: Confidentiality Agreement

Union Gas Limited – ____________________

DECLARATION AND UNDERTAKING TO UNION GAS LIMITED

I, ______________________, am counsel of record or a consultant for
.

DECLARATION

I declare that:

1. I have read the *Rules of Practice and Procedure* of the Ontario Energy Board (the "Board").
2. I am not a director or employee of a party to any Board proceeding for which I act or of any other person known by me to be a party in any Board proceeding.
3. I understand that this Declaration and Undertaking applies to all information that has not already been made public, and in respect of which Union Gas Limited ("Union") makes a written claim of confidentiality, that I receive in this process and any subsequent Board proceeding dealing with the subject matter of this process ("Confidential Information").
4. I understand that this Declaration and Undertaking is being made to Union at this time. In the event that, in the course of a subsequent Board proceeding dealing with the subject matter of this consultation process, the Board determines that any Confidential Information held by me under this Declaration and Undertaking:

   a) shall be considered to be confidential under the Board's *Practice Direction on Confidential Filings*, and I file a Declaration and Undertaking pursuant to that Practice Direction, or

   b) shall not be considered by the Board to be confidential and is to be placed on the public record;

   this Declaration and Undertaking shall thereafter be null and void with respect to that Confidential Information.

UNDERTAKING

I undertake that:

1. I will use Confidential Information exclusively for duties performed in respect of this process and any subsequent Board proceeding dealing with the subject matter of this process.
2. I will not divulge Confidential Information except to a person granted access by Union to such Confidential Information.
3. I will not reproduce, in any manner, Confidential Information without the prior written approval of Union. For this purpose, reproducing Confidential Information includes scanning paper copies of Confidential Information, copying the Confidential Information onto a diskette

or other machine-readable media and saving the Confidential Information onto a computer system.

4. I will protect Confidential Information from unauthorized access.

5. I will, promptly following the end of this process or the end of any subsequent Board proceeding dealing with the subject matter of this process, whichever shall be later, or within 10 days after the end of my participation in this process or any subsequent Board proceeding dealing with the subject matter of this process:

(a) return to Union, all documents and materials in all media containing Confidential Information, including notes, charts, memoranda, transcripts and submissions based on such Confidential Information; or

(b) destroy such documents and materials and file with Union a certification of destruction in the form prescribed by the Board pertaining to the destroyed documents and materials.

For this purpose, the end of any subsequent Board proceeding is the date on which the period for filing a review or appeal of the Board's final order in that proceeding expires or, if a review or appeal is filed, upon issuance of a final decision on the review or appeal from which no further review or appeal can or has been taken.

6. I will inform Union immediately of any changes in the facts referred to in this Declaration and Undertaking.

Dated at Toronto, this ____ day of ____, 2011.
Signature:
Name:
Company/Firm:
Address:
Telephone:
E-mail:

Mike Messenger CV and Presentation

Michael T. Messenger

Senior Principal Energy Consultant

Education

- M.S., Energy and Resources Program, University of California, Berkeley, 1981
- B.S., Energy Resource Management, Princeton University, 1978

Employment History

- Senior Principal Energy Consultant, Itron, Inc., 2008 – Present
- Program Specialist III, Utility Program Design and Evaluation, California Energy Commission, 2007–2008
- Independent Evaluation Consultant, Ontario Power Authority, 2006–2007
- Chief of Program Evaluation, California Energy Commission, 2003–2006
- Program Manager, Demand Responsive Program, California Energy Commission, 2001–2002
- Board Member – California Board for Energy Efficiency and California Measurement and Advisory Committee, California Energy Commission, 1997–1999
- Treasurer, and Committee Chair Program Planning and Measurement and Evaluation, California Board for Energy Efficiency, 1997–1999
- Chief Analyst, Demand Side Planning Office, California Energy Commission, 1992–1996
- Senior Economist, Demand Side Planning, California Energy Commission, 1987–1991
- Program Leader – Appliance Efficiency Office, California Energy Commission, 1983–1986
- Special Advisor to Commissioner James Walker, California Energy Commission, 1981–1983
- Research Associate, International Institute for Applied Systems Analysis, Laxenburg, Austria, 1979–1981
- Staff Scientist, Regional Energy Studies Group, Lawrence Berkeley Laboratory, 1978–1980

Selected Expertise

Mr. Messenger has worked in energy efficiency and evaluation since 1978, and is a nationally recognized expert in the field. Mr. Messenger specializes in the design and evaluation of energy efficiency and demand response programs and the development of policy frameworks and funding to support them. His major areas of expertise include:

- Energy Efficiency Evaluation and Program Planning
- Demand Response Evaluation and Planning
- Energy Policy
- Cost Benefit Analysis
- Market Potential and Goal Assessment
- Net to Gross Analysis
- Evaluation Framework and Protocol Development
- Market Assessment and Characterization Studies

Selected Project Experience

- Project Manager, Database for Energy Efficiency Resources in California (2010-2011)
- Project Manager, Independent Verification of Energy and Peak Savings from the EmPower Maryland Energy Efficiency Programs (2010)
- Project Manager, Review of Evaluation, Measurement and Verification Approaches Used to Estimate the Load Impacts and Effectiveness of Energy Efficiency Programs (LBNL, 2010)
- Project Manager, Development of EM&V Plans to Verify Peak Savings for Baltimore Gas and Electric's 2009-2011 Energy Efficiency Programs (2009)
- Project Manager, Assessment of the Feasible and Achievable levels of Electricity Savings from Investor Owned Utilities in Texas: 2009-2018 (2008)
- Project Manager, Development and Execution of Plan to Improve the Quantification of Energy Savings in the California Energy Commission Forecast (2008-2009)
- Development of Proposed Energy Savings Goals for the Investor Owned Utilities in California: 2009-2020 (May 2008)
- Development of Ex Ante Net Savings Estimates for Selected Residential Programs for the 2009-2011 Planning Cycle (CFL and appliance programs)
- Development of Proposed Electricity Savings Goals for Municipal Utilities in California (2007)

- Development of Proposed Energy Savings Goals for Investor Owned Electric and Natural Gas Utilities in California (2003-2004)
- Served on Team to Develop Research Plan for Statewide Critical Peak Pricing Pilot (2003-2004)
- Served on Team to Develop Energy Efficiency Program Evaluation Protocols for California (2004-2005)
- Development of Evaluation Framework and Protocols for Ontario Power Authority (2006-2007)
- Design and Management of Statewide Demand Response Programs (2000-2001)
- Development of Energy Efficiency Standards for State of California for Refrigerator/Freezers and Central Air Conditioners (1985)
- Original Developer of Database for Energy Efficient Resources (DEER) in California (1987)

Selected Papers and Publications

Messenger M, Goldman C and Schiller S, *Review of Evaluation, Measurement and Verification Approaches Used to Estimate the Load Impacts and Effectiveness of Energy Efficiency Programs* (Prepared for the Lawrence Berkeley National Laboratory, LBNL publication # 3277E, April 2010)

Messenger, M. *Lessons Learned in Developing Energy Efficiency Potential Analyses to Serve as the Basis for Energy Savings Goals* **(**Presentation to the ACEEE Energy Efficiency as a Resource Conference, Chicago, ILL, September 29, 2009)

Messenger, M. and M. Rufo. *Assessment of the Feasible and Achievable levels of Electricity Savings from Investor Owned Utilities in Texas: 2009-2018*. Prepared for Theresa Gross, Texas Public Utility Commission, January 2009.

Messenger, M. and Gary Klein. *Statewide Energy Efficiency Potential Estimates and Recommended Savings Targets for California Utilities*, Publication CEC-200-2007-019-SD. Presented before the Integrated Energy Policy Committee of the California Energy Commission on September 17, 2007. Available online at: http://www.energy.ca.gov/2007_energypolicy/documents/index.html#091707 .

Messenger, M. *Starting Over: Developing an Evaluation Framework and Protocols in Ontario*, Presented at the International Energy Program Evaluation Conference, Chicago, IL: August 2007.

Messenger, M., contributing author. *Conservation and Demand Management Resource Plan Part of the Integrated System Power Plan for the Province of Ontario*, December 2006. Available online at: http://www.powerauthority.on.ca/ipsp/Storage/33/2856_CDM_REVISED_Discussion_paper.pdf .

Messenger, M. *How Demand Response Initiatives will Shape the Market for Advanced Networks and Energy Management Systems in the 21st Century*, St. Louis, MO: September 6, 2006.

Messenger, M. *Costs and Benefits of Requiring Programmable Communicating Thermostats in New Homes and Small Businesses*, Presented at the Automated Metering Association International, Nashville, TN: October 11, 2006.

Messenger, M. *How to Simultaneously Stimulate the Growth of Energy Efficiency and Demand Response Resources at the Same Time: The California Story*, Presentation to the Midwest Energy Efficiency Alliance Conference, Chicago, IL: October 3, 2005.

Messenger, M. *Will the Advanced Metering Initiative and the Introduction of Dynamic Pricing Rates Affect the Content and Management of Utility Rate Cases in California and Beyond?* Presented for Managing the Modern Utility Rate Case, Las Vegas, NV: February 17 & 18, 2005.

Messenger, M. *Dynamic Pricing in California*, *Chapter 7 of Integrated Energy Policy Report*, California Energy Commission, Publication CEC-400-04-012, October 10, 2003.

Messenger, M. *Proposed Electricity Savings Goals for California*, California Energy Commission, October, 2003.

Messenger, M. *An Action Plan to Increase Demand Response in the California Market*, California Energy Commission, Publication CEC-400-02-016f, July 2002.

Messenger, M. *Understanding Market Transformation: A Summary of Energy Efficiency Market Research Performed in California from 1997 to 2000*, Presented at the National Symposium on Market Transformation Programs, Washington, DC: March 21, 2000.

Messenger, M. *Show Me the Money: The Battle for Control of Energy Efficiency Programs in California*, Presentation at the National Energy Services Conference, Tucson, AZ: December 8, 1999.

Messenger, M. and Chuck Goldman. *Planning for Judgment Day: An Approach to Developing Proposed Funding levels for Energy Efficiency Programs*, ACEEE Market Transformation Workshop, Washington, DC: March 1999.

Dickerson, Chris Ann, Pierre Landry, Michael Messenger, and Mary O'Drain. *Changing the Evaluation Frame in California from Individual Customers to Market Players in Energy Service Markets*, Presented at the Conference for the Association of Energy Service Professionals, Orlando, FL: December 1998.

Schlegel, Jeff, Michael Messenger, and Joe Eto, Draft of Proposed Policy Rules for Energy Efficiency Programs in California, July 9, 1997.

Messenger, M. *Proposed Guidelines for the Development of Market Characterization Studies in California*, Prepared for CADMAC Measurement and Advisory Group, November 1997.

Messenger, M. *Searching for Common Ground Among the Patron Saints of DSM: The Tale of the California Energy Services Working Group*, Association of Energy Services Journal, December 9, 1996.

Messenger, M. *California Retrospective: Recent Trends in Utility Program Funding and Design in California,* The Electricity Journal, July 1996, pp. 50-55.

Messenger, M. *From Resource Value to Market Transformation: Evolution or Revolution?* ACEEE Conference Proceedings, Asilomar, CA: August 1996.

Messenger, M. *Summary of California's Proposed Measurement and Evaluation Protocols*, published by SRC Corporation in Energy Evaluation Exchange January 1993.

Messenger, M. *A Review of Measurement Approaches and Savings Results from Utility Compact Fluorescent Lighting Programs*, Presented at California Compact Conference, San Diego, CA: November 1992.

Messenger, M. *Proposed Measurement and Evaluation Protocols and Methods to Integrate Results with Earnings*, Prepared for the CPUC's Measurement and Evaluation Rulemaking 91-008-002: June 15, 1992.

Messenger, M. *Can Greed Accuracy and Fairness be Mixed for the Public Good: The Case of the California Shareholder Incentive Experiment for Utility DSM Programs*, ACEEE Summer Study on Energy Efficiency in Buildings, Volume 8: Integrated Resource Planning. Asilomar, CA: August 1992.

Messenger, M. *Pros and Cons of the Collaborative Process in California: Can Cooperative Planning Lead to Better Conservation Programs?* Xenergy Clients Conference, Boston, MA: June 1991.

Messenger, M. *The Future of Demand Side Bidding in California: Boom or Bust?* Presented at the Western Energy Forum, San Francisco, CA: April 15, 1990.

Messenger, M. *Validating the Simulation Models Used to Predict Energy Use in New Homes: Results of the Building Monitoring Project*, ACEEE Summer Study on Energy Efficiency in Buildings, Volume 10: Program Evaluation. Asilomar, CA: August 1990.

Messenger, M. *A Review of Recent Proposals to Increase the Level of Utility Commitment to the Energy Conservation Market*, Presented to the Western Economic Association, San Diego, CA: July 1990.

Messenger, M. *How to Cut Costs and Maintain Market Share: The Dilemma of Electric Utilities*, Public Utilities Fortnightly, December 10, 1987.

Messenger, M. and Mike Martin. *Staff Report on Proposed Revision of Appliance Efficiency Standards for Central Air Conditioners*, California Energy Commission, April 1985.

Messenger, M. and Michael Martin. *Technical Analysis of the Conservation Potential of Refrigerator/Freezers*, California Energy Commission, May 1984.

Messenger, M. *Trends in Energy Use in California Since the Oil Embargo: How Much Conservation and Why?* ACEEE Summer Study on Energy Efficiency in Buildings, Santa Cruz, CA: 1982.

Messenger, M. *A High Technology, Low Energy Demand Future for Western Europe*, Energy, Vol. 6(12), December 1981.

Messenger, M. *Biomass and Hydrogen: An Answer to the Liquid Fuel Crisis in the Twenty-First Century?* IIASA Research Report, February 1982.

Expert Witness Testimony

"Testimony on Proposed Energy Efficiency Programs for Program Year 2000 for Pacific Gas and Electric Company, Southern California Edison Company, San Diego Gas and Electric Company and The Gas Company," before the CPUC, December 1999.

“Testimony on Proposed Shareholder Incentive Mechanisms for Energy Efficiency Programs in Program Year 2000,” before the CPUC, September 1999.

"Testimony on Pacific Gas and Electric Company’s Proposed Shareholder Incentives for Demand Side Management Programs,” May 1992.

"Testimony on Demand Side Management Programs for the San Diego Gas and Electric Company Service Area,” March 15, 1988.

"Analysis of Pacific Gas and Electric Company’s Proposed Funding Levels and Conservation Program Design," before the CPUC, May 1986.

"Analysis of Philadelphia Electric Company's Long Term Forecast for Electricity," before the Pennsylvania Public Utilities Commission, March 1985.

"Measuring the Cost Effectiveness of Appliance Incentive Programs" before the CPUC, April 1984.

Honors and Special Achievements

AESP Special Achievement Award for Work in Developing the California Evaluation Framework in 2005

Memberships/Associations

- President, Association of Energy Service Professionals Foundation
- Executive Vice President of the Association of Energy Service Professionals
- Planning Committee, International Energy Program Evaluation Conference
- Chair of the Market Effects Committee of the California Measurement Advisory Council, (CADMAC)
- Member of the Association of Energy Economists

Overview of Alternative Approaches to Engage Stakeholders in Energy Efficiency Program Planning and Evaluation Activities

Mike Messenger
Senior Principal Consultant
Itron
Union Gas Bay St. Offices
Toronto, Canada

August 19, 2011

My experience

- Served as lead facilitator of many stakeholder groups starting in early 1980's covering program design/funding, evaluation protocols, market transformation and developing deemed savings data bases or TRM, plus 50 yr world forecast in 1979.
- Thirty plus years of developing EE and DR programs and evaluating them, and developing building and appliance efficiency Standards
- Worked on California Board for Energy Efficiency and developed seminal works on defining market transformation and developing performance metrics.

2

Overview of Talk

- Desired Outcomes of Stakeholder Engagement (SE)
- Key Stakeholder Capabilities needed for Success
- Provide Summary of Stakeholder Engagement Models used in jurisdictions across North America
- Strengths and Weaknesses of Alternative SE models
- Criteria for use in evaluating which SE model might be best for three key Ontario Tasks
- Principles to Guide development of SE process
- Recommended SEM and requirements for each task
- Next Steps

3

Desired Outputs of SE

- Independent review of key savings and cost assumptions based on recent evaluations/ market research
- Independent audit of reported participation, cost, and savings results
- Recommendations on More Efficient Program Designs (more participants, more Cost Effective)

4

Desired Outcomes of SE

4. Buy in from Stakeholders on Program Objectives and Likely Results
5. Increased confidence for Regulators that Ratepayer funds are well spent
6. Creative Recommendations to develop New Performance Metrics or Program Designs

5

Are their other Desired Outcomes for Stakeholder Engagement?

- Solicit Audience feedback
- Does group agree with proposed outputs and outcomes from previous slides?

6

Key Group Capabilities needed for SEM to Work

- Critical Thinking Skills
- Evaluation/Engineering Experience
- Program Design Experience
- DSM Policy Experience
- Sampling/Audit Experience
- Social Marketing Experience
- Good Manners/Ground rules

7

Alternative Stakeholder Process Models for EE planning and implementation

- Five Generic Stakeholder Engagement models (SEM)for Review/Development of Energy Efficiency Programs
  - Utility/Program Admin (PA) Lead
  - Regulatory Lead-PA Support
  - Independent Facilitator Lead- PA support
  - Intervener(s) Lead
  - Government Energy Agency Lead
- Examples Drawn from Northwest, CA, MD and Texas

8

Definitions

- Lead- Organization that takes a set of desired outputs and outcomes to be produced by a Stakeholder group and designs a process to achieve them. Lead is responsible for completing the project on time and ensuring effective communication.
- Stakeholders: trade allies, gas customers, groups, or individuals who have expressed an interest in DSM matters to the Gas Companies or to the OEB
- Interveners: stakeholders who have been granted intervener status by the Board for a particular proceeding

Regulatory Lead SE Examples

Key Task	Key Output	Primary Audience	Decision making	Membership
Review of Program Designs	Recommended Program Design Changes	Regulators and Program Managers	Consensus	Interveners by invitation
Review of Program inputs for Cost Effectiveness Analysis	Independent review of Cost Effectiveness of Programs	Regulators and Program Managers	Experts produce program specific analysis, editor merges	Commission staff and interveners by public notice

Examples from California PUC processes in 1995 and 2004

Regulatory Lead SE Examples

Key Task	Key Output	Primary Audience	Decision making	Membership
Development of Program Designs and Portfolios to meet Empower savings goals	Comments on Proposed Program Designs and Funding levels	Regulators	Compendium of comments only	Commission staff and interveners
Develop common list of EE measures and track cost, savings, and saturation	Deemed Savings Database on Web Annual and five year reports to NWPPC	Implementers and Regulators	60 % vote	Engineers and Implementers

Examples from Maryland and Northwest Power Planning Council

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Utility/PA Lead Examples

Key Task	Key Output	Audience	Decision making	Membership
Review Program/ Portfolio Design and funding	Recommended Program Funding and Savings Targets	Utility Program Managers	Majority/Minority Reports	Interveners by public notice
Review of Deemed Savings Analysis and Proposals from PA	"Approved" Deemed Savings Values/ Equations	Regulators and Program Managers	Consensus	Program Managers and Implementer Engineers

Examples from California and Texas

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Utility/PA Lead Examples

Key Task	Key Output	Audience	Decision making	Membership
Develop Strategic Plan to transform market for next Decade	Recommended Public Private Initiatives	State Agencies and Regulators	Volunteers draft chapters, editors collate	Commission staff, program managers, implementers
Jump start programs & Develop Performance Mechanism	Proposed Shareholder Incentive Performance Mechanisms	Regulators	Consensus	Stakeholder by public notice and selected consultants hired by PA's

Examples from California CEC and CPUC

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Independent Facilitator Lead

Key Task	Key Output	Audience	Decision making	Membership
Development of Measurement Protocols	Recommended Protocols and Waiver Provisions	Regulators/ Program Administrators	Consensus	Experts by invitation
Development of Program Designs and verification of cost effectiveness	Recommendations to Regulatory Board	Regulatory Board	Consensus	Stakeholders by Notice and Experts by invitation

Examples from CPUC in 1992 and 2007

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Advisory Board-Intervener Leads

Key Task	Key Output	Audience	Decision making	Membership
Develop rules for transition to Market Transformation Programs	Policy Rules and Model RFP to select program administrators	Regulators and Legislators	Majority Vote	by regulatory appointment
Independent Review of Program Design and Evaluation Results	Recommendations to Regulators on program design and funding	Regulators	Consensus	Some appointed , some volunteer

Examples from CBEE in 1998 and Massachusetts in 2006

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Government Energy Agency Lead Examples

Key Task	Key Output	Audience	Decision making	Membership
New Approach to Integrate Programs with Market Actors/Profits	Strategic Plan to Transform Energy Markets	California Trade Allies and Program Managers	Committees draft chapters, Staff final report	Program Managers, Implementers and Regulatory staff
New Funding Mechanisms for EE post restructuring	Recommend ed PGC for EE funding	Legislature	Consensus with Minority reports	Program Managers and Interveners

Examples from California Energy Commission and California Public Utility Commission

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Strengths and Weaknesses

Model	Strengths	Weaknesses
Regulatory Lead	Strong link to Commission (Com) Policy direction & schedule needs	Unwilling to make quick policy decisions or opine on likely Com direction
Utility Lead	Strong focus on addressing Com directives and meeting PM needs	Conflicting Org objectives make it hard to listen to outside of the box proposals

Comments or Suggestions of other Strengths/Weaknesses ???

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Strengths and Weaknesses (2)

Model	Strengths	Weaknesses
Intervener Lead	DSM Experience and Willingness to work cooperatively with others	Commitment to Achieving Client Needs may impair objectivity Potential anti PA bias
Independent Lead	Objectivity and willingness to discuss issues group wants to explore	Lack of stake in game and understanding of province experience
Government Energy Agency Lead	Policy leaders	Bias towards more energy efficiency

Comments or Other Suggested Weaknesses/Strengths?

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Desired Outputs in Ontario

1. Technical Review of recent evaluations to determine needed changes to Key Measure Cost and Savings Assumptions
2. Oversight of Audit of Programs and Recommended Research Projects
3. Review & Suggestions on New Programs/Designs

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Six Principles to Guide Development of Stakeholder Engagement Models

1. Effective Writing and Communication Skills available for final report
2. Expected value orientation used in review of evaluation and cost effectiveness studies- agreement on how to treat uncertainty
3. Effective Time Management/Meeting Management
4. Clear Process to Achieve Member Support for Group Reports/Products
5. Be willing to explore innovative ideas/concepts
6. Final report inclusive of a variety of perspectives

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Criteria to Evaluate Successful SE Engagement Process

- Increase Probability of Quick Regulatory Approval
- Opportunity to Build Strong Consensus on Recommendations
- Make effective use of technical resources between meetings
- Group kept on point by effective facilitation
- Programs improve customer reach and depth of energy savings
- Program Administrators rewarded for outstanding performance

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Discussion of Principles

- Feedback from Audience
- Additional Principles that should be listed to develop successful SEM?

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Technical Review Task 1 Requirements

- Clear guidance on scope of review and expected outputs from panel- template?
- Engineering Expertise in defined Market Areas
- Sample size/ precision guidance
- Foreshadow controversial areas
- Decision Making process- ensure effective communication between tech panel and managers/interveners

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SE Models to Consider for Task 1

- Independent Facilitator/Technical Panel
- Intervener Facilitator
- Advisory Board/ Committee (PA, Reg. Staff and Intervener) oversight of technical panel
- Not recommended- Utility or Regulator lead due to perceived conflicts on changes

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Apply Criteria to Task 1 model

- Assume Technical Panel
- Review each of six success criteria from slide 19 against this SEM model

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Task 2- Oversight of Audit Requirements

- Clear Scope of what is to be Audited and Purpose of Audit
- Sampling/Auditing Expertise
- Understanding of Key Drivers of Cost Effectiveness Equations
- Clear review schedule

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SE Models to Consider for Task 2

- Regulatory or Intervener Lead?
- Important to have direct link between Board policy desires and Audit content
- Utility Lead or Independent Facilitator hired by Utility could have perceived conflicts
- Review success criteria against proposed model (Intervener lead?)

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Task 3 Program Design Review Requirements

- Program Design Experience (in many jurisdictions)
- Social Marketing Experience
- Willingness to Pilot New Approaches
- Trade ally participation may be beneficial- not necessarily in meetings

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SEM models to consider for Task 3

- Utility or Independent Facilitator
- Rationale- PA's have good insight into where programs need improvement and different ways to recruit/ reward trade allies, can invite market experts to encourage new approaches
- Review model against success criteria

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Synthesis of SE Models for Ontario

Desired Output	Desired Outcome	Stakeholder Engagement Model
Confidence that utilities' claims for DSMVA, LRAM and performance incentive are reasonable and accurate.	Independent Audit Report of annual DSM results	Intervener lead-Audit Committee including representation from interveners and the utilities
Confidence that the input assumptions and savings calculations are sound and based on best available information.	Technical Resource Manual updated regularly	Utility/Intervener Lead-Technical Panel including representation from the interveners and the utilities
Effective DSM programs	New programs developed during the multi-year plan	Utility lead- Open meetings to discuss program design by market sector?

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Next Steps

- Agree on Roles and a process to recruit participants for each of the three tasks
- Gas companies draft written proposal or Draft charters for each of the groups and schedule for products/outputs
- Get feedback and prepare final terms of reference for the OEB

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Contact Information

Please send Additional Questions or comments to:

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Senior Principal Consultant, Itron

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509-891-3186

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DSM PROGRAM SURVEY FOR RATE T1 AND RATE 100 CUSTOMERS

DSM Program Survey for T1/Rate 100 Customers

Topline Report

Background

On June 30th 2011, the Ontario Energy Board issued the *Demand Side Management Guidelines for Natural Gas Utilities* that will serve as a framework for Union Gas to design its natural gas DSM program for the next three years. DSM programs for large industrial customers that are ratepayer funded are no longer mandatory and, will be considered by the Board based on its merits.

Union Gas must file a new DSM plan by September 15th, 2011 for the three year period commencing January 1st 2012, therefore, Union is currently reviewing potential program options for Rate 100 and T1 customers.

Objective

The goal of this study is to understand the overall perspective of T1/Rate 100 customers related to Union's Enersmart energy efficiency program.

This report highlights the findings of a short survey conducted in August 2011. It includes a total of 39 survey respondents from a population of 56 T1 customers and a total of 12 survey respondents from a population of 15 Rate 100 customers. In total, the survey response rate of this study is 72%. The results are accurate within 7.3% at 95% confidence level.

Key Findings

- In total, 69% of respondents show support for the program by identifying program elements they would like to see in 2012 and beyond.
- Overall, 55% of all the survey respondents support Union's DSM program offering and are willing to fund at some level; 14% are in support of Union's DSM program offering but are not willing to fund at any level; 18% are not interested in DSM program offerings and are not willing to fund at any level.
- 35% of the survey respondents would support paying the approximate current level as part of a rate payer funded program. 16% would support paying some amount between 0.5 cents per GJ to 2.0 cents per GJ.
- The level of support also varies by type of industry. 73% of Industrial/Institutional customers have shown full or partial interest in Union's DSM program offerings. Power customers are significantly less willing to support Union's DSM programs.
- The most common natural gas focused energy efficiency programs that Union's customers would like to see in 2012 and beyond are incentives for new equipment and incentives for process improvement studies. The least common is Union Gas support of onsite energy teams.

Detailed Results

Figure 1: Overall level of support for DSM program by Rate Type *(Q2 & Q3)*

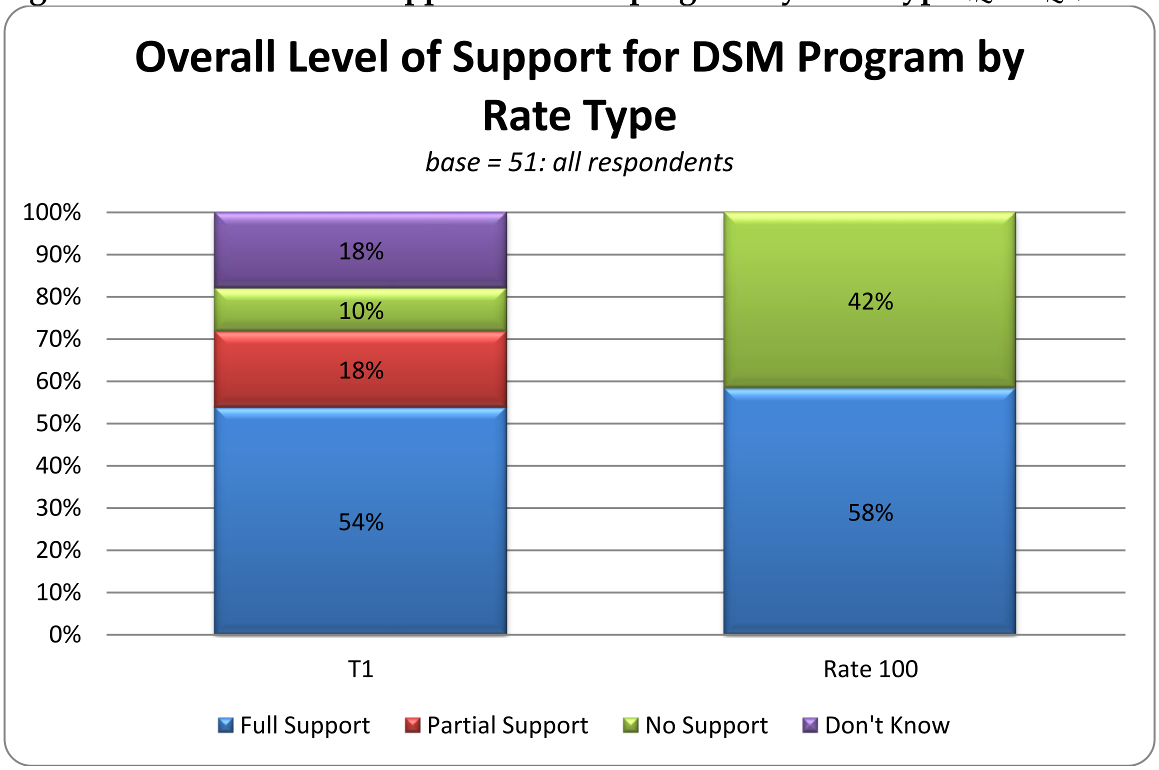
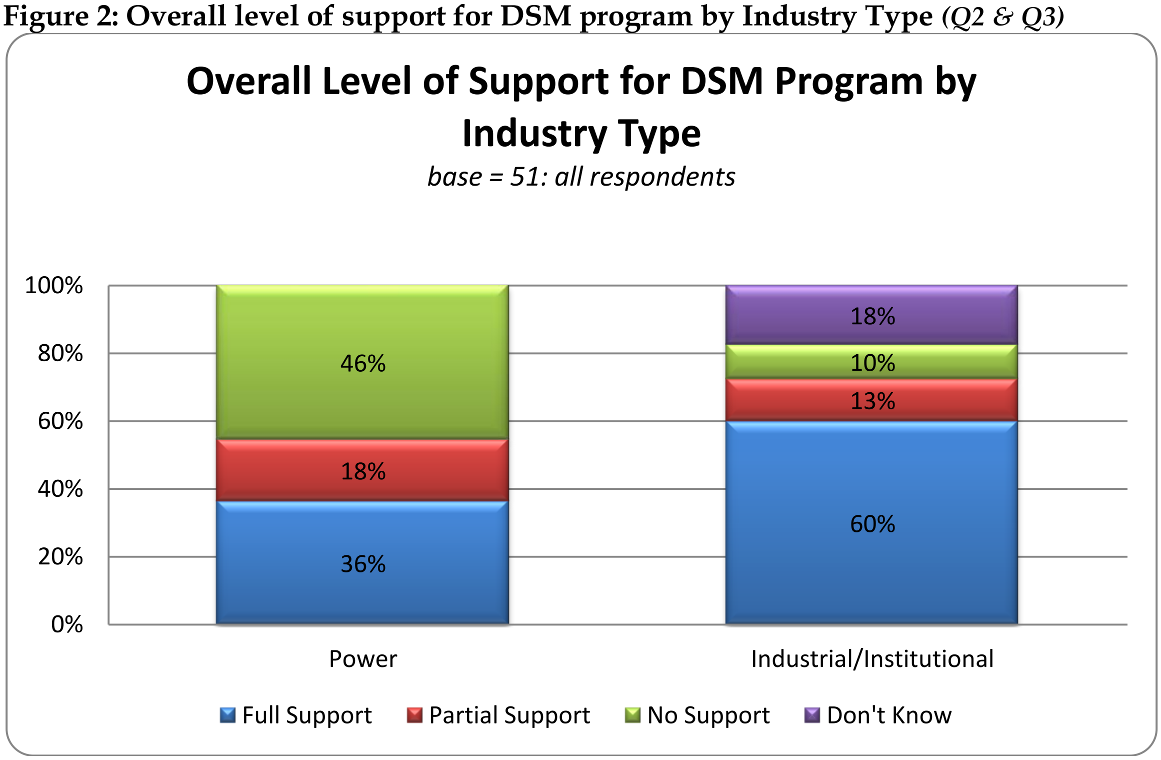


Figure 2: Overall level of support for DSM program by Industry Type *(Q2 & Q3)*



**Full Support: Support for program offering (customer identified desired program elements) and funding at some level*
Partial Support: Support for program offering (customer identified desired program elements) but no funding at any level
No Support: No support for program offering and funding at any level

Table 1: Aspect of Enersmart program that has provided most/least value *(Q1)*

Most Value	Least Value
Equipment Incentives	**Energy audits**
Energy reduction incentives	**Program funding in rates**
Technical Resources	**Cap on incentives per project**
Training	
Operations and maintenance based programs	

Table 2: Natural Gas focused energy efficiency programs customers would like to see *(Q2)*

	T1	R 100	Total
Equipment incentives to offset capital cost	79%	58%	**76%**
Incentives for process improvement studies	74%	50%	**71%**
Targeted energy management programs	53%	58%	**59%**
Union Gas sponsored and/or participant in energy efficiency focused training programs	50%	50%	**55%**
Union's technical resources serving as an EE advisor/consultant	59%	42%	**54%**
Union Gas support of onsite energy teams	47%	33%	**44%**

Figure 3: Support for ratepayer funded program *(Q3)*

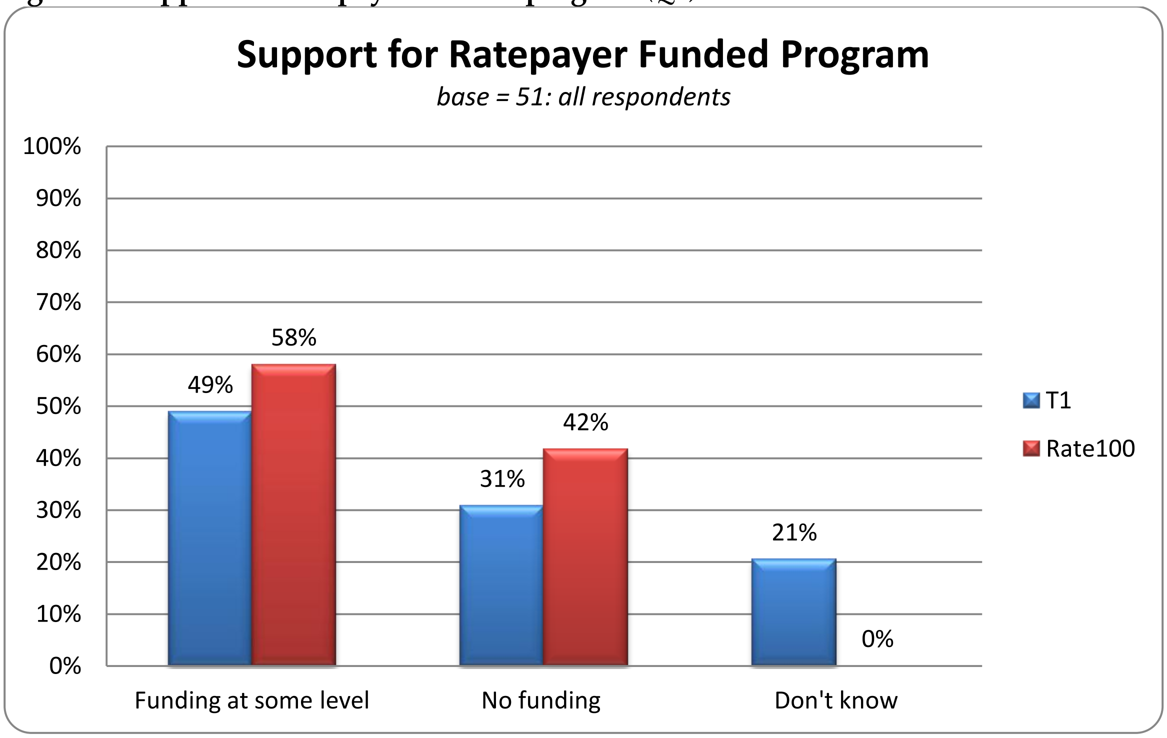
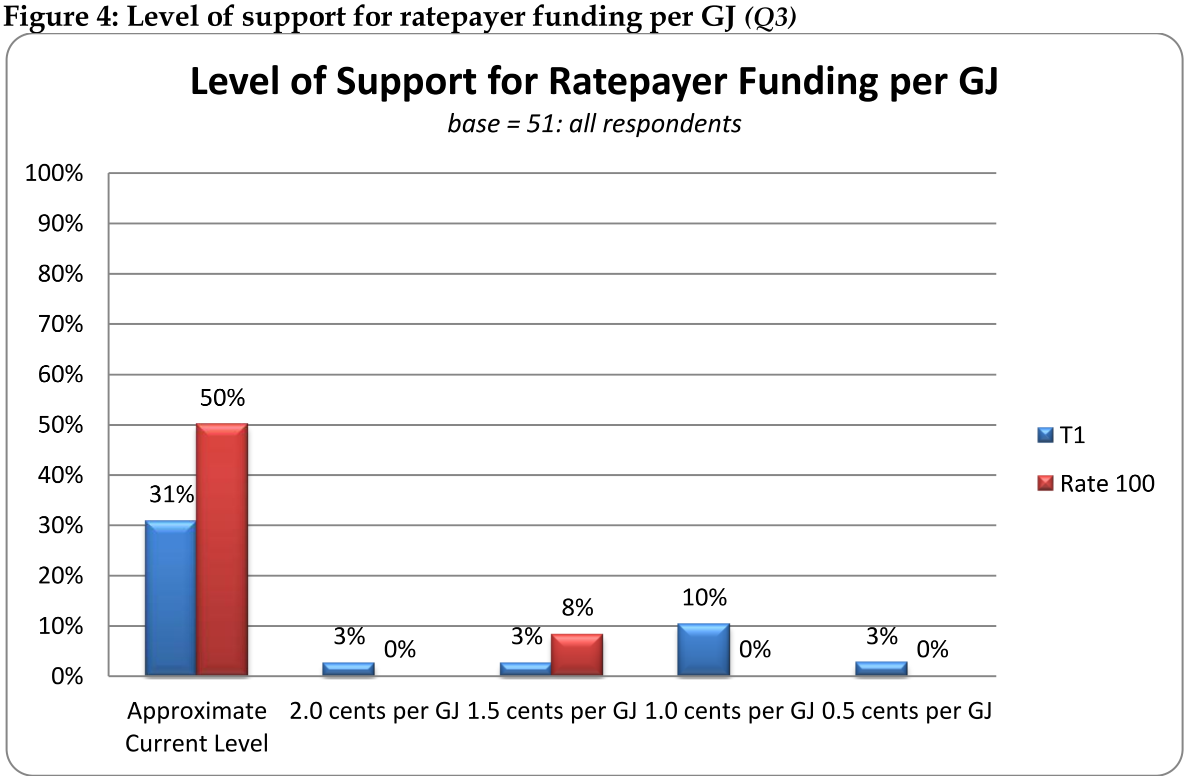


Figure 4: Level of support for ratepayer funding per GJ *(Q3)*



Appendix: Survey Instrument

Customer Name: Date: ________

Further to my recent email regarding the Ontario Energy Board's Guidelines for Union's 2012 DSM program, I would like to ask you a few questions to ensure we understand your perspective related to our Enersmart energy efficiency program.

Working collaboratively with our industrial customers over the last 10 years, Union's Enersmart program has helped our customers save over 29 million GJs per year.

Q1. Reflecting on our current Enersmart DSM program, what aspect of our Enersmart program has provided your company with the <u>most</u> value? ________________________

____

and the <u>least</u> value? ____

Q2. If Union were to offer an energy efficiency program for T1 customers in 2012 and beyond, what natural gas focused energy efficiency programs would you like to see Union Gas offer?

Examples program elements include (select all that are of interest):

- ☐ Incentives for process improvement studies (including support for related natural gas metering)
- ☐ Union Gas support of onsite energy teams (active participant on customer energy teams)
- ☐ Equipment incentives to offset capital cost associated with purchasing new equipment
- ☐ Union's technical resources serving as an energy efficiency advisor/consultant, including site and equipment assessments and loaned flow measurement devices
- ☐ Targeted energy management programs focused on reducing day to day operating costs (i.e. steam savings programs)
- ☐ Union Gas sponsored and/or participant in energy efficiency focused training programs
- ☐ Other: ____

Based on total natural consumption and total DSM program costs in 2010, the total average cost of our Enersmart program to T1 customers was about 2.3 cents per GJ (less any DSM related incentives amounts received from Union).

Q3. What level of average cost associated with a proposed new T1 program would you support paying as part of a rate payer funded program (i.e. gross cost before incentives)?

- ☐ 2.5 cents per GJ (i.e. approximate current level)
- ☐ 2.0 cents per GJ
- ☐ 1.5 cents per GJ
- ☐ 1.0 cents per GJ
- ☐ 0.5 cents per GJ
- ☐ No funding at any level

DSM Program Survey for R100 Customers

Customer Name: ________________________________ Date: ___________________

Further to my recent email regarding the Ontario Energy Board's Guidelines for Union's 2012 DSM program, I would like to ask you a few questions to ensure we understand your perspective related to our Enersmart energy efficiency program.

Working collaboratively with our industrial customers over the last 10 years, Union's Enersmart program has helped our customers save over 29 million GJs per year.

Q. Reflecting on our current Enersmart DSM program, what aspect of our Enersmart program has provided your company with the most value? ____
____
and the least value? ____

Q. If Union were to offer an energy efficiency program for R100 customers in 2012 and beyond, what natural gas focused energy efficiency programs would you like to see Union Gas offer?

Examples program elements include (select all that are of interest):

- ☐ Incentives for process improvement studies (including support for related natural gas metering)
- ☐ Union Gas support of onsite energy teams (active participant on customer energy teams)
- ☐ Equipment incentives to offset capital cost associated with purchasing new equipment
- ☐ Union's technical resources serving as an energy efficiency advisor/consultant, including site and equipment assessments and loaned flow measurement devices
- ☐ Targeted energy management programs focused on reducing day to day operating costs (i.e. steam savings programs)
- ☐ Union Gas sponsored and/or participant in energy efficiency focused training programs
- ☐ Other: ____

  ____

Based on total natural consumption and total DSM program costs in 2010, the total average cost of our Enersmart program to R100 customers was about 5.1 cents per GJ (less any DSM related incentives amounts received from Union).

Q. What level of average cost associated with a proposed new R100 program would you support paying as part of a rate payer funded program (i.e. gross cost before incentives)?

- ☐ 5 cents per GJ (i.e. approximate current level)
- ☐ 2.5 cents per GJ
- ☐ 1.5 cents per GJ
- ☐ 1.0 cents per GJ
- ☐ 0.5 cents per GJ
- ☐ No funding at any level

DSM Program Survey for T1 Customers

Customer Name: ______________________________ Date: __________________

Further to my recent email regarding the Ontario Energy Board's Guidelines for Union's 2012 DSM program, I would like to ask you a few questions to ensure we understand your perspective related to our Enersmart energy efficiency program.

Working collaboratively with our industrial customers over the last 10 years, Union's Enersmart program has helped our customers save over 29 million GJs per year.

Q. Reflecting on our current Enersmart DSM program, what aspect of our Enersmart program has provided your company with the most value? ____
____

and the least value? ____

Q. If Union were to offer an energy efficiency program for T1 customers in 2012 and beyond, what natural gas focused energy efficiency programs would you like to see Union Gas offer?

Examples program elements include (select all that are of interest):

- ☐ Incentives for process improvement studies (including support for related natural gas metering)
- ☐ Union Gas support of onsite energy teams (active participant on customer energy teams)
- ☐ Equipment incentives to offset capital cost associated with purchasing new equipment
- ☐ Union's technical resources serving as an energy efficiency advisor/consultant, including site and equipment assessments and loaned flow measurement devices
- ☐ Targeted energy management programs focused on reducing day to day operating costs (i.e. steam savings programs)
- ☐ Union Gas sponsored and/or participant in energy efficiency focused training programs
- ☐ Other: ____
  ____

Based on total natural consumption and total DSM program costs in 2010, the total average cost of our Enersmart program to T1 customers was about 2.3 cents per GJ (less any DSM related incentives amounts received from Union).

Q. What level of average cost associated with a proposed new T1 program would you support paying as part of a rate payer funded program (i.e. gross cost before incentives)?

- ☐ 2.5 cents per GJ (i.e. approximate current level)
- ☐ 2.0 cents per GJ
- ☐ 1.5 cents per GJ
- ☐ 1.0 cents per GJ
- ☐ 0.5 cents per GJ
- ☐ No funding at any level

UNION AND ENBRIDGE INPUT ASSUMPTIONS

	Indicates a variation from the board approved list of input assumptions

Target Market		Union	Equipment Details				Annual Resource Savings			Other				
Sector	New/Existing	Deep Measure	Efficient Equipment	Details of Efficient Equipment	Base Equipment	Details of Base Equipment	Natural Gas (m3)	Electricity (kWh)	Water (L)	EUL	Incremental Cost ($)	Free Rider (%)	Utility Measure Applies to	Reference
Residential Space Heating														
Residential	Existing	X	Attic Insulation	upgrade to R-40	R-10		105	105	0	20	$580	33%	UG	New Measure added by Union
Residential	Existing	X	Basement Wall Insulation	upgrade to R-12	R-1		261	145	0	25	$1654	33%	UG	New Measure added by Union
Residential	Existing		Draft Proofing Kit	(1) Spray Foam, can (1) Caulk, tube (30 ft) Foam Tape (4) Energy Saver Gasket with 2 child safety inserts	No Draft Proofing Kit		236	27	0	1	$20	55%	UG	New Measure added by Union
Residential	New	X	Energy Star Home	version 3	Home built to OBC 2006		1018	1450	0	25	$3200	48%	EGD	Assumption Updated in Enbridge 2011 update. Free Ridership consistent with 2009 Audit.
Residential	Existing		Fireplace intermittent ignition control retrofit		Natural gas fireplace with a pilot		104	-31	0	8	$150	1%	UG	
Residential	Existing	X	High Efficiency Condensing Furnace	AFUE 96	High-Efficiency Furnace	AFUE 90	129	0	0	18	$1767	0%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	New	X	High Efficiency Fireplace with Pilotless Ignition	Freestanding, Minimum 70% EnerGuide Rating	Freestanding fireplace	65% median efficiency	110	-31	0	20	$135	17%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	New	X	High Efficiency Fireplace with Pilotless Ignition	Insert, Minimum 60% EnerGuide Rating	Insert	55% median efficiency	109	-31	0	20	$135	17%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	New	X	High Efficiency Fireplace with Pilotless Ignition	Zero Clearance, >= 40 kBtu.h =Minimum 60% EnerGuide Rating	Zero Clearance		122	-31	0	20	$135	17%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	New	X	High Efficiency Fireplace with Pilotless Ignition	Zero Clearance, < 40 kBtu.h =Minimum 70% EnerGuide Rating	Zero Clearance		108	-31	0	20	$135	17%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	Existing	X	High Efficiency Fireplace with Pilotless Ignition	Freestanding, Minimum 70% EnerGuide Rating	Freestanding fireplace	65% median efficiency	110	-31	0	20	$135	17%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	Existing	X	High Efficiency Fireplace with Pilotless Ignition	Insert, Minimum 60% EnerGuide Rating	Insert	55% median efficiency	109	-31	0	20	$135	17%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	Existing	X	High Efficiency Fireplace with Pilotless Ignition	Zero Clearance, >= 40 kBtu.h =Minimum 60% EnerGuide Rating	Zero Clearance		122	-31	0	20	$135	17%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	Existing	X	High Efficiency Fireplace with Pilotless Ignition	Zero Clearance, < 40 kBtu.h =Minimum 70% EnerGuide Rating	Zero Clearance		108	-31	0	20	$135	17%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	New		Programmable Thermostat		Standard Thermostat		53	54	0	15	$25	10%	UG	
Residential	Existing		Programmable Thermostat		Standard Thermostat		53	54	0	15	$25	43%	UG	
Residential	New		Programmable Thermostat		Standard Thermostat		53	54	0	15	$53.22	10%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	Existing		Programmable Thermostat		Standard Thermostat		53	54	0	15	$50	43%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	Existing		Reflector Panels		No reflector panels		143	0	0	18	$229	0%	UG	
Residential	Existing		Reflector Panels		Radiant heat w/o reflector panels		143	0	0	18	$238	0%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential Water Heating														
Residential	New		Faucet Aerator	Bathroom, 1.5 GPM, (3) aerators	Average Existing Stock	2.2 GPM	18	0	6012	10	$2.72	31%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	New		Faucet Aerator	Bathroom, 1.0 GPM	Ontario Building Code 2006	2.2 GPM	10	0	3,435	10	$0.59	33%	UG	Costs as per utility program costs, bulk purchase.
Residential	Existing		Faucet Aerator	Bathroom, 1.0 GPM	Average existing stock	2.2 GPM	10	0	3,435	10	$0.59	33%	UG	Costs as per utility program costs, bulk purchase.
Residential	Existing		Faucet Aerator	Bathroom, 1.0 GPM	Replace existing 1.5 GPM	1.5 GPM	4		1,432	10	$0.59	33%	UG	New Measure added by Union
Residential	New/Existing		Faucet Aerator	Bathroom, 1.5 GPM	Average existing stock	2.2 GPM	6	0	2,004	10	$0.49	33%	UG	Costs as per utility program costs, bulk purchase.
Residential	New		Faucet Aerator	Kitchen, 1.0 GPM	Ontario Building Code 2006	2.2 GPM	32	0	10,631	10	$1.59	33%	UG	
Residential	Existing		Faucet Aerator	Kitchen, 1.0 GPM	Average existing stock	2.5 GPM	35	0	11,694	10	$1.59	33%	UG	
Residential	Existing		Faucet Aerator	Kitchen, 1.5 GPM	Average existing stock	2.5 GPM	23	0	7,797	10	$1.29	33%	UG	Costs as per utility program costs, bulk purchase.
Residential	New		Faucet Aerator	Kitchen, 1.5 GPM	Ontario Building Code 2006	2.2 GPM	19	0	6,201	10	$1.29	33%	UG	Costs as per utility program costs, bulk purchase.
Residential	New		Faucet Aerator (Distributed)	Bathroom, 1.0 GPM	Ontario Building Code 2006	2.2 GPM	10	0	3435	10	$0.55	31%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	Existing		Faucet Aerator (Distributed)	Bathroom, 1.0 GPM	Average Existing Stock	2.2 GPM	10	0	3435	10	$0.55	31%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	Existing		Faucet Aerator (Distributed)	Bathroom, 1.5 GPM	Average Existing Stock	2.2 GPM	6	0	2004	10	$1	31%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	New		Faucet Aerator (Distributed)	Kitchen, 1.0 GPM	Ontario Building Code 2006	2.2 GPM	32	0	10631	10	$1	31%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	Existing		Faucet Aerator (Distributed)	Kitchen, 1.0 GPM	Average Existing Stock	2.5 GPM	35	0	11694	10	$1	31%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	New		Faucet Aerator (Distributed)	Kitchen, 1.5 GPM	Average Existing Stock	2.5 GPM	23	0	7797	10	$1.65	31%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	Existing		Faucet Aerator (Distributed)	Kitchen, 1.5 GPM	Average Existing Stock	2.5 GPM	23	0	7797	10	$1	31%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	New		Low-flow showerhead	1.25 & 1.5 GPM (Per Household)	Average Existing Stock	2.5 GPM	48	0	14391	10	$16.76	10%	EGD	Assumption Updated in Enbridge 2011 update
Residential	Existing		Low-flow showerhead	1.25 GPM	Replace existing 2.0 GPM	2.0 GPM	33		11,584	10	$3.79	10%	UG	as per Union Filing June 15, 2011 (EB-2011-0225), with updated utility costs
Residential	New		Low-flow showerhead	1.25 GPM (Per household)	Average Existing Stock	2.5 GPM	53	0	17187	10	$4.26	10%	EGD	Assumption Updated in Enbridge 2011 update
Residential	New		Low-flow showerhead	1.5 GPM (Per Household)	Average Existing Stock	2.5 GPM	43	0	11596	10	$12.5	10%	EGD	Assumption Updated in Enbridge 2011 update
Residential	Existing		Low-flow showerhead (Contractor Installed)	1.25 GPM	2.0 -2.5 GPM Showerhead	2.25 GPM	46	0	14294	10	$3.79	10%	UG	Costs as per utility program costs, bulk purchase.
Residential	Existing		Low-flow showerhead (Contractor Installed)	1.25 GPM	2.6 + GPM Showerhead	3.0 GPM	88	0	22580	10	$3.79	10%	UG	Costs as per utility program costs, bulk purchase.
Residential	Existing		Low-flow showerhead (Distributed)	1.25 GPM	2.6 + GPM Showerhead	3.07 GPM	82	0	23374	10	$4.26	10%	EGD	Assumption Updated in Enbridge 2011 update
Residential	Existing		Low-flow showerhead (Distributed)	1.25 GPM	2.0 -2.5 GPM Showerhead	2.45 GPM	50	0	16631	10	$4.26	10%	EGD	Assumption Updated in Enbridge 2011 update
Residential	New/Existing		Low-flow showerhead (Distributed)	1.25 GPM	Average existing stock	2.2 GPM	44	0	13,885	10	$3.79	10%	UG	Costs as per utility program costs, bulk purchase.
Residential	Existing		Low-flow showerhead (Installed)	1.25 GPM	2.0 -2.5 GPM Showerhead	2.45 GPM	50	0	16631	10	$19	10%	EGD	Assumption Updated in Enbridge 2011 update
Residential	Existing		Low-flow showerhead (Installed)	1.25 GPM	2.6 + GPM Showerhead	3.07 GPM	82	0	23374	10	$19	10%	EGD	Assumption Updated in Enbridge 2011 update
Residential	Existing		Pipe Insulation		Water Heater w/o pipe insulation		18	0	0	10	$2/$4	4%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Residential	Existing		Pipe Wrap (R-4)	Insulation for DWH outlet pipe	Uninsulated DHW outlet pipes	R-1	18	0	0	10	$0.98	4%	UG	Costs as per utility program costs, bulk purchase.
Residential	Existing	X	Solar Pool Heaters		Natural gas pool heater		1,116	-57	0	20	$1,450	10%	Both	
Residential	New/Existing	X	Tankless Water Heater	EF 0.82	Storage Tank Water Heater		142	0	0	18	$750	2%	UG	New Measure added by Union
Residential	Existing	X	Tankless Water Heater		Storage Tank Water Heater		130	0	0	18	$750	2%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Low-Income Space Heating														
Low-Income	Existing	X	Early Furnace Replacement - 60% AFUE	90% AFUE Furnace	60% AFUE Furnace		781			3	$518	0%	UG	New Measure added by Union

Indicates a variation from the board approved list of input assumptions

Target Market		Union	Equipment Details				Annual Resource Savings			Other				
Sector	New/Existing	Deep Measure	Efficient Equipment	Details of Efficient Equipment	Base Equipment	Details of Base Equipment	Natural Gas (m3)	Electricity (kWh)	Water (L)	EUL	Incremental Cost ($)	Free Rider (%)	Utility Measure Applies to	Reference
Low-Income	Existing	X	Early Furnace Replacement - 70% AFUE	90% AFUE Furnace	70% AFUE Furnace		466			3	$518	0%	UG	New Measure added by Union
Low-Income	Existing		Programmable Thermostat		Standard manual thermostat		53	54	0	15	$26.95	1%	UG	Costs as per utility program costs, bulk purchase.
Low Income	Existing		Programmable Thermostat		Standard Thermostat		53	54	0	15	$69.18	1%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)

Low Income Water Heating

Low-Income	Existing	X	Early Hot Water Heater Replacement (0.575 to 0.62 EF)	0.62 EF Water Heater	0.575 EF Water Heater		80			3	$168.00	0%	UG	New Measure added by Union
Low-Income	Existing		Faucet Aerator	Bathroom, 1.0 GPM	Average existing stock	2.2 GPM	10	0	3,435	10	$0.59	1%	UG	Costs as per utility program costs, bulk purchase.
Low-Income	Existing		Faucet Aerator	Bathroom, 1.0 GPM	Replace existing 1.5 GPM	1.5 GPM	4	0	1,432	11	$0.59	1%	UG	New Measure added by Union
Low-Income	Existing		Faucet Aerator	Bathroom, 1.5 GPM	Average existing stock	2.2 GPM	6	0	2,004	10	$0.49	1%	UG	Costs as per utility program costs, bulk purchase.
Low-Income	Existing		Faucet Aerator	Kitchen, 1.0 GPM	Average existing stock	2.5 GPM	35	0	11,694	10	$1.59	1%	UG	Costs as per utility program costs, bulk purchase.
Low-Income	Existing		Faucet Aerator	Kitchen, 1.5 GPM	Average existing stock	2.5 GPM	23	0	7,797	10	$1.29	1%	UG	Costs as per utility program costs, bulk purchase.
Low Income	Existing		Faucet Aerator	Bathroom, 1.0 GPM	Average Existing Stock	2.2 GPM	10	0	3435	10	$0.55	1%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Low Income	Existing		Faucet Aerator	Bathroom, 1.5 GPM	Average Existing Stock	2.2 GPM	6	0	2004	10	$0.46	1%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Low Income	Existing		Faucet Aerator	Kitchen, 1.0 GPM	Average Existing Stock	2.5 GPM	35	0	11694	10	$1	1%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Low Income	Existing		Faucet Aerator	Kitchen, 1.5 GPM	Average Existing Stock	2.5 GPM	23	0	7797	10	$0.94	1%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Low Income	Existing		Low-flow showerhead	1.25 GPM (Installed)	2.0 -2.5 GPM Showerhead	2.45 GPM	50	0	16631	10	$18.71	5%	EGD	Assumption Updated in Enbridge 2011 update
Low Income	Existing		Low-flow showerhead	1.25 GPM (Installed)	2.6 + GPM Showerhead	3.07 GPM	82	0	23374	10	$18.71	5%	EGD	Assumption Updated in Enbridge 2011 update
Low-Income	Existing		Low-flow showerhead (Contractor installed)	1.25 GPM	Average existing stock	2.25 GPM	46	0	14,294	10	$3.79	1%	UG	Costs as per utility program costs, bulk purchase.
Low-Income	Existing		Low-flow showerhead (Contractor installed)	1.25 GPM	Average existing stock	3.0 GPM	88	0	22,580	10	$3.79	1%	UG	Costs as per utility program costs, bulk purchase.
Low-Income	Existing		Pipe insulation for DHW outlet pipe	R-4 insulation	Uninsulated DHW outlet pipes (R-1)	R-1	18	0	0	10	$0.98	1%	UG	

Commercial Cooking

Commercial	New/Existing	X	Energy Star Fryer	Energy Star	Standard fryer		1083	17	0	12	$1,028	20%	Both	Enbridge Updated Assumption to match approved values from Union Gas's EAC.
Commercial	New/Existing	X	Energy Star Convection Ovens - Full Size	Energy Star	Standard Convection Oven		847	1		12	$875	20%	Both	Measure added by Enbridge in EGD's 2011 update
Commercial	New/Existing	X	Energy Star Steam Cookers	Energy Star	Standard Efficiency Steam Cooker		3224	162	42812	10	$2,000.00	20%	Both	Measure added by Enbridge in EGD's 2011 update
Commercial	New/Existing	X	High Efficiency Under-Fired Broilers		Standard Efficiency Broiler		1677			12	$1,270	20%	Both	Measure added by Enbridge in EGD's 2011 update

Commercial Space Heating

Commercial	Existing	X	Air Curtains	Double door	Non-air curtain doors		1,529	1,023	0	15	$2,500	5%	Both	
Commercial	New/Existing	X	Air Curtains	Shipping and Receiving Doors (10 x 10)	Non-air curtain doors		20605	-936		15	$10,170	5%	Both	New Measure added by Enbridge in EGD's 2011 update
Commercial	New/Existing	X	Air Curtains	Shipping and Receiving Doors (8 x 10)	Non-air curtain doors		9457	-5220		15	$8,242	5%	Both	New Measure added by Enbridge in EGD's 2011 update
Commercial	New/Existing	X	Air Curtains	Shipping and Receiving Doors (8 x 8)	Non-air curtain doors		7565	-5380		15	$8,242	5%	Both	New Measure added by Enbridge in EGD's 2011 update
Commercial	Existing	X	Air Curtains	Single door	Non-air curtain doors		667	172	0	15	$1,650	5%	Both	
Commercial	New	X	Condensing Boiler - Space (Under 300 MBH, 90% or greater AFUE)		Non-condensing Boiler	80% AFUE	.0108 m3/(Btu/hr)		0	25	<100 MBH = $1,475, 100-199 MBH = $2,414, 200-299 MBH = $3,227	5%	Both	New Measure added by Enbridge in EGD's 2011 update
Commercial	Existing	X	Condensing Boiler - Space (Under 300 MBH, 90% or greater AFUE)		Non-condensing Boiler	80% AFUE	.0108 m3/(Btu/hr)			25	<100 MBH = $2,045, 100-199 MBH = $2,984, 200-299 MBH = $3,797	5%	Both	New Measure added by Enbridge in EGD's 2011 update
Commercial	New/Existing	X	Condensing Boilers - Space Heating, 300 and above MBTUH	88% seasonal efficiency	Non-condensing boiler	76% estimated seasonal efficiency	0.0104 m3/ Btu/hr	0	0	25	$12/Kbtu/hr	5%	UG	Minimum boiler capacity added
Commercial	New/Existing	X	Condensing Make Up Air Unit - MR and LTC		Conventional MUA with constant speed drive		.84 m3/cfm - 2.92 m3/cfm	(0-1.48) kwh/cfm		15	$870 + (.66 - 1.02) per cfm	5%	Both	New Measure added by Enbridge in EGD's 2011 update
Commercial	New/Existing	X	Condensing Make Up Air Unit - Retail and Comm		Conventional MUA with constant speed drive		.41 m3/cfm - 2.07 m3/cfm	(0- .48) kwh/cfm		15	$870 + (.66 - 1.02) per cfm	5%	Both	New Measure added by Enbridge in EGD's 2011 update
Commercial	New/Existing	X	Condensing Unit Heater		% Sales Weighted Average model	78% Annually Efficient	0.00631 m3/Btu/hr	(-)0.00186 kwh/Btu/hr	0	18	$0.0129 /Btu/hr	0%	Both	
Commercial	New/Existing	X	Demand Control Kitchen Ventilation	0 - 4,999 CFM	Kitchen ventilation without DCKV		4,801	13,521	0	15	$10,000	5%	Both	
Commercial	New/Existing	X	Demand Control Kitchen Ventilation	10,000 - 15,000 CFM	Kitchen ventilation without DCKV		18,924	49,102	0	15	$20,000	5%	Both	
Commercial	New/Existing	X	Demand Control Kitchen Ventilation	5,000 - 9,999 CFM	Kitchen ventilation without DCKV		11,486	30,901	0	15	$15,000	5%	Both	
Commercial	New/Existing	X	Destratification Fans		No destratification fans		0.5 $m3/ft^2$	(-)0.0034 kwh/ft^2	0	15	$7,021	10%	Both	
Commercial	New	X	Energy Recovery Ventilation (Multi-Family, Health Care, Nursing Home)	Ventilation with ERV	Ventilation without ERV		5.77 m3/CFM	0	0	14	$3.18/CFM	5%	Both	Enbridge Updated Assumption & Enbridge's 2011 Update to match approved values from Union Gas's EAC.
Commercial	Existing	X	Energy Recovery Ventilation (Multi-Family, Health Care, Nursing Home)	Ventilation with ERV	Ventilation without ERV		6.12 m3/CFM	0	0	14	$3.18/CFM	5%	Both	Enbridge Updated Assumption & Enbridge's 2011 Update to match approved values from Union Gas's EAC.
Commercial	New	X	Energy Recovery Ventilation (Hotel, Restaurant, Retail)	Ventilation with ERV	Ventilation without ERV		3.21 m3/CFM	0	0	14	$3.18/CFM	5%	Both	Enbridge Updated Assumption & Enbridge's 2011 Update to match approved values from Union Gas's EAC.
Commercial	Existing	X	Energy Recovery Ventilation (Hotel, Restaurant, Retail)	Ventilation with ERV	Ventilation without ERV		3.4 m3/CFM	0	0	14	$3.18/CFM	5%	Both	Enbridge Updated Assumption & Enbridge's 2011 Update to match approved values from Union Gas's EAC.
Commercial	New	X	Energy Recovery Ventilation (Office, Warehouse, School)	Ventilation with ERV	Ventilation without ERV		2.05 m3/CFM	0	0	14	$3.18/CFM	5%	Both	Enbridge Updated Assumption & Enbridge's 2011 Update to match approved values from Union Gas's EAC.
Commercial	Existing	X	Energy Recovery Ventilation (Office, Warehouse, School)	Ventilation with ERV	Ventilation without ERV		2.17 m3/CFM	0	0	14	$3.18/CFM	5%	Both	Enbridge Updated Assumption & Enbridge's 2011 Update to match approved values from Union Gas's EAC.

	Indicates a variation from the board approved list of input assumptions

Target Market		Union	Equipment Details				Annual Resource Savings			Other				
Sector	New/Existing	Deep Measure	Efficient Equipment	Details of Efficient Equipment	Base Equipment	Details of Base Equipment	Natural Gas (m3)	Electricity (kWh)	Water (L)	EUL	Incremental Cost ($)	Free Rider (%)	Utility Measure Applies to	Reference
Commercial	New	X	Heat Recovery Ventilation (Multi-Family, Health Care, Nursing Home)	Ventilation with HRV	Ventilation without HRV		4.28 m3/CFM	0	0	14	$3.61/CFM	5%	Both	Enbridge Updated Assumption & Enbridge's 2011 Update to match approved values from Union Gas's EAC.
Commercial	Existing	X	Heat Recovery Ventilation (Multi-Family, Health Care, Nursing Home)	Ventilation with HRV	Ventilation without HRV		4.70 m3/CFM	0	0	14	$3.61/CFM	5%	Both	Enbridge Updated Assumption & Enbridge's 2011 Update to match approved values from Union Gas's EAC.
Commercial	New	X	Heat Recovery Ventilation (Hotel, Restaurant, Retail)	Ventilation with HRV	Ventilation without HRV		2.38 m3/CFM	0	0	14	$3.61/CFM	5%	Both	Enbridge Updated Assumption & Enbridge's 2011 Update to match approved values from Union Gas's EAC.
Commercial	Existing	X	Heat Recovery Ventilation (Hotel, Restaurant, Retail)	Ventilation with HRV	Ventilation without HRV		2.61 m3/CFM	0	0	14	$3.61/CFM	5%	Both	Enbridge Updated Assumption & Enbridge's 2011 Update to match approved values from Union Gas's EAC.
Commercial	New	X	Heat Recovery Ventilation (Office, Warehouse, School)	Ventilation with HRV	Ventilation without HRV		1.52 m3/CFM	0	0	14	$3.61/CFM	5%	Both	Enbridge Updated Assumption & Enbridge's 2011 Update to match approved values from Union Gas's EAC.
Commercial	Existing	X	Heat Recovery Ventilation (Office, Warehouse, School)	Ventilation with HRV	Ventilation without HRV		1.67 m3/CFM	0	0	14	$3.61/CFM	5%	Both	Enbridge Updated Assumption & Enbridge's 2011 Update to match approved values from Union Gas's EAC.
Commercial	New	X	High Efficiency Boiler - Space Heating (< 100 Mbtu/h)		Non-condensing Boiler, 80% AFUE		.00665 m3/(Btu/hr)	0	0	25	$1,238.00	5%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	Existing	X	High Efficiency Boiler - Space Heating (< 100 Mbtu/h)		Non-condensing Boiler, 80% AFUE		.00665 m3/(Btu/hr)	0	0	25	$1,808.00	5%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	New	X	High Efficiency Boiler - Space Heating (100 to 199 Mbtu/h)		Non-condensing Boiler, 80% AFUE		.00665 m3/(Btu/hr)	0	0	25	$1,544.00	5%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	Existing	X	High Efficiency Boiler - Space Heating (100 to 199 Mbtu/h)		Non-condensing Boiler, 80% AFUE		.00665 m3/(Btu/hr)	0	0	25	$2,114.00	5%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	New	X	High Efficiency Boiler - Space Heating (200 to 299 Mbtu/h)		Non-condensing Boiler, 80% AFUE		.00665 m3/(Btu/hr)	0	0	25	$1,388.00	5%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	Existing	X	High Efficiency Boiler - Space Heating (200 to 299 Mbtu/h)		Non-condensing Boiler, 80% AFUE		.00665 m3/(Btu/hr)	0	0	25	$1,958.00	5%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	Existing	X	High Efficiency Condensing Furnace	96% AFUE	AFUE 90%		1.7/kBtu/hr	0	0	18	$8.4/kBtu/hr	17.5%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	New/Existing	X	Infrared Heaters	0 - 49,999 BTU/hr	Regular Unit Heater		0.0159 /Btu/hr	16	0	20	$0.0122 /BTUh	33%	Both	Assumption Updated in Union 2010 audit results
Commercial	New/Existing	X	Infrared Heaters	165,000 - 300,000 BTU/hr	Regular Unit Heater		0.0159 /Btu/hr	873	0	20	$0.0122 /BTUh	33%	Both	Assumption Updated in Union 2010 audit results
Commercial	New/Existing	X	Infrared Heaters	50,000 - 164,999 BTU/hr	Regular Unit Heater		0.0159 /Btu/hr	409	0	20	$0.0122 /BTUh	33%	Both	Assumption Updated in Union 2010 audit results
Commercial	New	X	Prescriptive Higher Efficiency Boiler - Space Heating	83-84% Efficient, 300-2000 MBH	Space Heating Boiler	80% Combustion Efficiency	2,105-16,452	0	0	25	$3900-$4950	10/12/20%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	Existing	X	Prescriptive Higher Efficiency Boiler - Space Heating	83-84% Efficient, 300-2000 MBH	Space Heating Boiler	80% Combustion Efficiency	2,105-16,452	0	0	25	$3900-$4950	10/12/20%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	New	X	Prescriptive Higher Efficiency Boiler - Space Heating	85-88% Efficient, 300-2000 MBH	Space Heating Boiler	80% Combustion Efficiency	3,125-24,431	0	0	25	$4500-$7050	10/12/20%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	Existing	X	Prescriptive Higher Efficiency Boiler - Space Heating	85-88% Efficient, 300-2000 MBH	Space Heating Boiler	80% Combustion Efficiency	3,125-24,431	0	0	25	$4500-$7050	10/12/20%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	Existing	X	Prescriptive Schools - Elementary	hydronic boiler with 83%+ efficiency	hydronic boiler with 80%-82% efficiency		10,830	0	0	25	$8,646	27%	UG	
Commercial	Existing	X	Prescriptive Schools - Elementary	hydronic boiler with 83%+ efficiency	Space Heating, Hydronic Boiler	Comb. Eff. Of 80%-82%.	10830	0	0	25	$8,646	12%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	Existing	X	Prescriptive Schools - Secondary	hydronic boiler with 83%+ efficiency	hydronic boiler with 80%-82% efficiency		43,859	0	0	25	$14,470	27%	UG	
Commercial	Existing	X	Prescriptive Schools - Secondary	hydronic boiler with 83%+ efficiency	Space Heating, Hydronic Boiler	Comb. Eff. Of 80%-82%.	43859	0	0	25	$14,470	12%	EGD	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	Existing		Programmable Thermostat		Standard thermostat		13 - 108**	15 - 77**	0	15	$110	20%	UG	Costs as per utility program costs, bulk purchase.
Commercial	Existing		Programmable Thermostat	Educational - School	Standard thermostat		65	8	0	15	$110	20%	EGD	Assumption Updated in Enbridge 2011 update.
Commercial	Existing		Programmable Thermostat	Educational - University/College	Standard thermostat		58	57	0	0	$110	20%	EGD	Assumption Updated in Enbridge 2011 update.
Commercial	Existing		Programmable Thermostat	Food Service - Restaurant/Tavern	Standard thermostat		69	77	0	15	$110	20%	EGD	Assumption Updated in Enbridge 2011 update.
Commercial	Existing		Programmable Thermostat	Hotel/Motel	Standard thermostat		10	11	0	0	$110	20%	EGD	Assumption Updated in Enbridge 2011 update.
Commercial	Existing		Programmable Thermostat	Large Hotel	Standard thermostat		10	14	0	0	$110	20%	EGD	Assumption Updated in Enbridge 2011 update.
MultiFamily	Existing		Programmable Thermostat	Multi Family	Standard thermostat		15	13	0	15	$80	20%	Both	Assumption Updated in Enbridge 2011 update.
Commercial	Existing		Programmable Thermostat	Recreation - Small Fitness / Spa	Standard thermostat		35	87	0	15	$110	20%	EGD	Assumption Updated in Enbridge 2011 update.
Commercial	Existing		Programmable Thermostat	Retail - Food	Standard thermostat		22	16	0	15	$110	20%	EGD	Assumption Updated in Enbridge 2011 update.
Commercial	Existing		Programmable Thermostat	Retail - Mall	Standard thermostat		14	19	0	15	$110	20%	EGD	Assumption Updated in Enbridge 2011 update.
Commercial	Existing		Programmable Thermostat	Retail - Strip Mall	Standard thermostat		11	19	0	15	$110	20%	EGD	Assumption Updated in Enbridge 2011 update.
Commercial	Existing		Programmable Thermostat	Small Office	Standard thermostat		39	43	0	0	$110	20%	EGD	Assumption Updated in Enbridge 2011 update.
Commercial	Existing		Programmable Thermostat	Warehouse / Wholesale	Standard thermostat		132	9	0	15	$110	20%	EGD	Assumption Updated in Enbridge 2011 update.
Commercial	New/Existing	X	Rooftop Unit	Two-stage rooftop unit	Single stage rooftop unit		255	0	0	15	$375	5%	Both	

Commercial Water Heating

Commercial	New/Existing	X	Commercial Laundry Washing Equipment with Ozone	Washer extractor – 60 lbs	Commercial Laundry Washing Equipment without Ozone		0.0328 m3/lbs/yr	0.00219 kwh/lbs/yr	2.01 L/lbs/yr	15	$10,970	8%	Both	
Commercial	New/Existing	X	Commercial Laundry Washing Equipment with Ozone	Washer extractor – 500 lbs	Commercial Laundry Washing Equipment without Ozone		0.0328 m3/lbs/yr	0.00219 kwh/lbs/yr	2.01 L/lbs/yr	15	$30,270	8%	Both	
Commercial	New/Existing	X	Commercial Laundry Washing Equipment with Ozone	Tunnel Washer – 120 lbs	Commercial Laundry Washing Equipment without Ozone		0.0240 m3/lbs/yr	0.00152 kwh/lbs/yr	1.22 L/lbs/yr	15	$49,667	8%	Both	
Commercial	New/Existing	X	Commercial Laundry Washing Equipment with Ozone	Tunnel Washer – 500 lbs	Commercial Laundry Washing Equipment without Ozone		0.0240 m3/lbs/yr	0.00152 kwh/lbs/yr	1.22 L/lbs/yr	15	$160,065	8%	Both	
Commercial	Existing	X	Condensing Boiler - DHW	Under 300 MBH, 90% or greater AFUE	Non-condensing Boiler	80% AFUE	<100 MBH = .03579, 100-199 MBH = .02196, 200-299 MBH = .01643 m3/(Btu/hr)	0	0	25	<100 MBH = $2,045, 100-199 MBH = $2,984, 200-299 MBH = $3,797	5%	Both	New Measure added by Enbridge in EGD's 2011 update

	Indicates a variation from the board approved list of input assumptions

Target Market		Union	Equipment Details				Annual Resource Savings			Other				
Sector	New/Existing	Deep Measure	Efficient Equipment	Details of Efficient Equipment	Base Equipment	Details of Base Equipment	Natural Gas (m3)	Electricity (kWh)	Water (L)	EUL	Incremental Cost ($)	Free Rider (%)	Utility Measure Applies to	Reference
Commercial	New	X	Condensing Boiler - DHW	Under 300 MBH, 90% or greater AFUE	Non-condensing Boiler	80% AFUE	<100 MBH = .03579, 100-199 MBH = .02196, 200-299 MBH = .01643 m3/(Btu/hr)	0	0	25	<100 MBH = $1,475, 100-199 MBH = $2,414, 200-299 MBH = $3,227	5%	Both	New Measure added by Enbridge in EGD's 2011 update
Commercial	New/Existing	X	Condensing Gas Water Heater (1,000gal/day)	95% thermal efficiency	Conventional storage tank water heater	80% efficiency, 91 gal. tank.	1,551	0	0	13	$2,230	5%	Both	
Commercial	New/Existing	X	Condensing Gas Water Heater (100gal/day)	95% thermal efficiency	Conventional storage tank water heater	80% efficiency, 91gal. tank.	332	0	0	13	$2,230	5%	Both	
Commercial	New/Existing	X	Condensing Gas Water Heater (500gal/day)	95% thermal efficiency	Conventional storage tank water heater	80% efficiency, 91 gal. tank.	873	0	0	13	$2,230	5%	Both	
Commercial	New	X	Drain Water Heat Recovery (DWHR)	Laundromat	No DWHR		49735	0	0	25	$37,211.00	5%	Both	as per Union Filing June 15, 2011 (EB-2011-0225)
Commercial	New	X	Drain Water Heat Recovery (DWHR)	Entertainment, Arena	No DWHR		394 per Showerhead	0	0	25	$776 per Showerhead	5%	Both	as per Union Filing June 15, 2011 (EB-2011-0225)
Commercial	New	X	Drain Water Heat Recovery (DWHR)	University/College Cafeterias - Dishwashing	No DWHR		4.6 per Meal Served/Day	0	0	25	$3.41 per Meal Served/Day	5%	Both	as per Union Filing June 15, 2011 (EB-2011-0225)
Commercial	New	X	Drain Water Heat Recovery (DWHR)	Hospital - Dishwashing	No DWHR		12 per Bed	0	0	25	$11.88 per Bed	5%	Both	as per Union Filing June 15, 2011 (EB-2011-0225)
Commercial	New	X	Drain Water Heat Recovery (DWHR)	Hospital - Laundry	No DWHR		295 Per Bed	0	0	25	$250 per Bed	5%	Both	as per Union Filing June 15, 2011 (EB-2011-0225)
Commercial	New	X	Drain Water Heat Recovery (DWHR)	Nursing Home - Dishwashing	No DWHR		12 per Bed	0	0	25	$16.54 per Bed	5%	Both	as per Union Filing June 15, 2011 (EB-2011-0225)
Commercial	Existing	X	Drain Water Heat Recovery (DWHR)	Laundromat	No DWHR		49735	0	0	25	$40,811.00	5%	Both	as per Union Filing June 15, 2011 (EB-2011-0225)
Commercial	Existing	X	Drain Water Heat Recovery (DWHR)	Entertainment, Arena	No DWHR		394 per Showerhead	0	0	25	$1209 per Showerhead	5%	Both	as per Union Filing June 15, 2011 (EB-2011-0225)
Commercial	Existing	X	Drain Water Heat Recovery (DWHR)	University/College Cafeterias - Dishwashing	No DWHR		11.6 Meal Served per Day	0	0	25	$6.26 per Meal Served per day	5%	Both	as per Union Filing June 15, 2011 (EB-2011-0225)
Commercial	Existing	X	Drain Water Heat Recovery (DWHR)	Hospital - Dishwashing	No DWHR		31 per Bed	0	0	25	$18.19 per Bed	5%	Both	as per Union Filing June 15, 2011 (EB-2011-0225)
Commercial	Existing	X	Drain Water Heat Recovery (DWHR)	Hospital - Laundry	No DWHR		295 per Bed	0	0	25	$274 per Bed	5%	Both	as per Union Filing June 15, 2011 (EB-2011-0225)
Commercial	Existing	X	Drain Water Heat Recovery (DWHR)	Nursing Home - Dishwashing	No DWHR		31 per Bed	0	0	25	$25.33 per Bed	5%	Both	as per Union Filing June 15, 2011 (EB-2011-0225)
Commercial	New/Existing	X	Energy Star Dishwasher	Undercounter – High Temperature	Non-Energy Star Dishwasher		801	3,754	112,795	10	(-)$13	40%	Both	
Commercial	New/Existing	X	Energy Star Dishwasher	Undercounter – Low Temperature	Non-Energy Star Dishwasher		326	559	45,891	10	(-)$13	40%	Both	
Commercial	New/Existing	X	Energy Star Dishwasher	Stationary Rack, (Door type, or Single rack) – High Temperature	Non-Energy Star Dishwasher		619	3,553	87,119	15	(-)$350	20%	Both	
Commercial	New/Existing	X	Energy Star Dishwasher	Stationary Rack, (Door type, or Single rack) – Low Temperature	Non-Energy Star Dishwasher		841	855	118,369	15	(-)$350	20%	Both	
Commercial	New/Existing	X	Energy Star Dishwasher	Rack Conveyor, Single (Tank) – High Temperature	Non-Energy Star Dishwasher		2,203	9,811	310,271	20	$2,375	27%	Both	
Commercial	New/Existing	X	Energy Star Dishwasher	Rack Conveyor, Multi (Tank) – High Temperature	Non-Energy Star Dishwasher		3,708	15,822	522,192	20	$288	27%	Both	
Commercial	New	X	High Efficiency Boiler - DHW only (< 100 Mbtu/h)		Non-Condensing Boiler	80% AFUE	0.0243 m3/(BTU/H)	0	0	25	$1,238.00	5%	Both	New Measure added by Enbridge in EGD's 2011 update
Commercial	Existing	X	High Efficiency Boiler - DHW only (< 100 Mbtu/h)		Non-Condensing Boiler	80% AFUE	0.0243 m3/(BTU/H)	0	0	25	$1,808.00	5%	Both	New Measure added by Enbridge in EGD's 2011 update
Commercial	New	X	High Efficiency Boiler - DHW only (100 to 199 Mbtu/h)		Non-Condensing Boiler	80% AFUE	0.01491 m3/(BTU/H)	0	0	25	$1,544.00	5%	Both	New Measure added by Enbridge in EGD's 2011 update
Commercial	Existing	X	High Efficiency Boiler - DHW only (100 to 199 Mbtu/h)		Non-Condensing Boiler	80% AFUE	0.01491 m3/(BTU/H)	0	0	25	$2,114.00	5%	Both	New Measure added by Enbridge in EGD's 2011 update
Commercial	New	X	High Efficiency Boiler - DHW only (200 to 299 Mbtu/h)		Non-Condensing Boiler	80% AFUE	0.01115 m3/(BTU/H)	0	0	25	$1,388.00	5%	Both	New Measure added by Enbridge in EGD's 2011 update
Commercial	Existing	X	High Efficiency Boiler - DHW only (200 to 299 Mbtu/h)		Non-Condensing Boiler	80% AFUE	0.01115 m3/(BTU/H)	0	0	25	$1,958.00	5%	Both	New Measure added by Enbridge in EGD's 2011 update
Commercial	Existing		Pre-Rinse Spray Nozzle	1.24 GPM	Standard pre-rinse spray nozzle	3.0 GPM	190 - 886**	0	36,484 - 170,326**	5	$60	12.40%	UG	
Commercial	New		Pre-Rinse Spray Nozzle (Full Service)	0.64 GPM	Pre-rinse spray nozzle	3.0 GPM	1286	0	252000	5	$150	0%	EGD	Assumption Updated in Enbridge 2011 update
Commercial	Existing		Pre-Rinse Spray Nozzle (Full Service)	0.64 GPM	Pre-rinse spray nozzle	3.0 GPM	1286	0	252000	5	$150	0%	Both	Assumption Updated in Enbridge 2011 update
Commercial	Existing		Pre-Rinse Spray Nozzle (Full Service)	0.64 GPM	Pre-rinse spray nozzle	1.6 GPM	457	0	97,292	5	$150	0%	Both	
Commercial	New		Pre-Rinse Spray Nozzle (Limited)	0.64 GPM	Pre-rinse spray nozzle	3.0 GPM	339	0	66400	5	$150	0%	EGD	Assumption Updated in Enbridge 2011 update
Commercial	Existing		Pre-Rinse Spray Nozzle (Limited)	0.64 GPM	Pre-rinse spray nozzle	3.0 GPM	339	0	66400	5	$150	0%	Both	Assumption Updated in Enbridge 2011 update
Commercial	Existing		Pre-Rinse Spray Nozzle (Limited)	0.64 GPM	Pre-rinse spray nozzle	1.6 GPM	90	0	19,197	5	$150	0%	Both	
Commercial	New		Pre-Rinse Spray Nozzle (Other)	0.64 GPM	Pre-rinse spray nozzle	3.0 GPM	318	0	62200	5	$150	0%	EGD	Assumption Updated in Enbridge 2011 update
Commercial	Existing		Pre-Rinse Spray Nozzle (Other)	0.64 GPM	Pre-rinse spray nozzle	3.0 GPM	318	0	62200	5	$150	0%	Both	Assumption Updated in Enbridge 2011 update
Commercial	Existing		Pre-Rinse Spray Nozzle (Other)	0.64 GPM	Pre-rinse spray nozzle	1.6 GPM	109	0	23,166	5	$150	0%	Both	
Commercial	New	X	Prescriptive Higher Efficiency Boiler - DWH	83-84% Efficient, 300-1500 MBH	DWH Boiler	80% Combustion Efficiency	1,075-4,317	0	0	25	$3900 -$5900	10/12/20%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	New	X	Prescriptive Higher Efficiency Boiler - DWH	85-88% Efficient, 300-1500 MBH	DWH Boiler	80% Combustion Efficiency	1,766-7,095	0	0	25	$4500-$7400	10/12/20%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	Existing	X	Prescriptive Higher Efficiency Boiler - DWH	83-84% Efficient, 300-1500 MBH	DWH Boiler	80% Combustion Efficiency	1,075-4,317	0	0	25	$3900 -$5900	10/12/20%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	Existing	X	Prescriptive Higher Efficiency Boiler - DWH	85-88% Efficient, 300-1500 MBH	DWH Boiler	80% Combustion Efficiency	1,766-7,095	0	0	25	$4500-$7400	10/12/20%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)
Commercial	New	X	Tankless Water Heater	100 USG/day, 84% thermal efficiency	Conventional Storage Tank Water Heater	80% thermal efficiency	154	0	0	18	(-)$1,102	2%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)

	Indicates a variation from the board approved list of input assumptions

Target Market		Union	Equipment Details				Annual Resource Savings			Other				
Sector	New/Existing	Deep Measure	Efficient Equipment	Details of Efficient Equipment	Base Equipment	Details of Base Equipment	Natural Gas (m3)	Electricity (kWh)	Water (L)	EUL	Incremental Cost ($)	Free Rider (%)	Utility Measure Applies to	Reference
Commercial	Existing	X	Tankless Water Heater	100 USG/day, 84% thermal efficiency	Conventional Storage Tank Water Heater	80% thermal efficiency	154	0	0	18	(-)$1,102	2%	Both	from Enbridge 2011 update (EB-2011-0254, July 4, 2011)

Multi-Family Water Heating

Multi-Family	New/Existing	X	CEE Tier 2 Front-Loading Clothes Washer	MEF=2.20, WF=5.1	Conventional top-loading, vertical axis clothes washer	MEF=1.26, WF=9.5	117	396	58,121	11	$600	10%	Both	
Multi-Family	New/Existing	X	Energy Star Front-Loading Clothes Washer	MEF=1.72 ,WF=8.0	Conventional top loading vertical axis washers	MEF = 1.26, WF=9.5	76	201	19,814	11	$150	48%	UG	
MultiFamily	Existing		Faucet Aerator	Bathroom, 1.0 GPM	Average Existing Stock		7	0	2371	10	$1.5	10%	EGD	
MultiFamily	Existing		Faucet Aerator	Bathroom, 1.5 GPM	Average Existing Stock		4	0	1382	10	$2.	10%	EGD	
MultiFamily	Existing		Faucet Aerator	Kitchen, 1.0 GPM	Average Existing Stock		24	0	8072	10	$2.	10%	EGD	
Multi-Family	New		Faucet Aerator	Kitchen, 1.0 GPM	Ontario Building Code 2006	2.2 GPM	22	0	7,337	10	$1.59	10%	UG	Costs as per utility program costs, bulk purchase.
MultiFamily	Existing		Faucet Aerator	Kitchen, 1.5 GPM	Average Existing Stock		16	0	5377	10	$2.	10%	EGD	
Multi-Family	New		Faucet Aerator	Bathroom, 1.0 GPM	Ontario Building Code 2006	2.2 GPM	7	0	2,371	10	$0.59	10%	UG	Costs as per utility program costs, bulk purchase.
Multi-Family	Existing		Faucet Aerator	Bathroom, 1.0 GPM	Average existing stock	2.2 GPM	7	0	2,371	10	$0.59	10%	UG	Costs as per utility program costs, bulk purchase.
Multi-Family	New		Faucet Aerator	Bathroom, 1.5 GPM	Ontario Building Code 2006	2.2 GPM	4	0	1,382	10	$0.49	10%	UG	Costs as per utility program costs, bulk purchase.
Multi-Family	Existing		Faucet Aerator	Bathroom, 1.5 GPM	Average existing stock	2.2 GPM	4	0	1,382	10	$0.49	10%	UG	Costs as per utility program costs, bulk purchase.
Multi-Family	New		Faucet Aerator	Kitchen 1.5 GPM	Ontario Building Code 2006	2.2 GPM	13	0	4,280	10	$1.29	10%	UG	Costs as per utility program costs, bulk purchase.
Multi-Family	Existing		Faucet Aerator	Kitchen, 1.0 GPM	Average existing stock	2.5 GPM	24	0	8,072	10	$1.59	10%	UG	Costs as per utility program costs, bulk purchase.
Multi-Family	Existing		Faucet Aerator	Kitchen, 1.5 GPM	Average existing stock	2.5 GPM	16	0	5,377	10	$1.29	10%	UG	Costs as per utility program costs, bulk purchase.
Multi-Family	New/Existing		Low-Flow Showerhead - (MF ONLY)	1.25gpm	replacing existing 2.0gpm	2.0 GPM	24	0	7,933	10	$3.79	10%	UG	as per Union Filing June 15, 2011 (EB-2011-0225), with updated utility costs
Multi-Family	New		Low-flow showerhead (Distributed)	1.25 GPM	Average existing stock	2.2 GPM	32	0	9,585	10	$3.79	10%	UG	Costs as per utility program costs, bulk purchase.
Multi-Family	Existing		Low-flow showerhead (Distributed)	1.25 GPM	Average existing stock	2.2 GPM	32	0	9,585	10	$3.79	10%	UG	Costs as per utility program costs, bulk purchase.
Multi-Family	New		Low-flow showerhead (Distributed)	1.5 GPM		2.2 GPM	33	0	5,228	10	$6	10%	UG	Costs as per utility program costs, bulk purchase.
Multi-Family	Existing		Low-flow showerhead (Distributed)	1.5 GPM	Average existing stock	2.2 GPM	33	0	5,228	10	$6	10%	UG	Costs as per utility program costs, bulk purchase.
MultiFamily	New		Low-Flow Showerhead (Per household, Installed)	1.25 GPM		2.5 GPM	36	-	11587	10	$12.5	10%	EGD	New Measure added by Enbridge in EGD's 2011 update
MultiFamily	New		Low-Flow Showerhead (Per household, Installed)	1.5 GPM		2.5 GPM	29	-	7818	10	$12.5	10%	EGD	New Measure added by Enbridge in EGD's 2011 update
MultiFamily	Existing		Low-Flow Showerhead (Per household, Installed)	1.5 GPM	2.0 -2.5 GPM showerhead	2.25 GPM	21	0	5931	10	$12.5	10%	EGD	Assumption Updated in Enbridge 2011 update.
MultiFamily	Existing		Low-Flow Showerhead (Per household, Installed)	1.5 GPM	2.6 -3.0 GPM GPM showerhead	2.8 GPM	40	0	10036	10	$12.5	10%	EGD	Assumption Updated in Enbridge 2011 update.
MultiFamily	Existing		Low-Flow Showerhead (Per household, Installed)	1.5 GPM	3.1 - 3.5 GPM showerhead	3.3 GPM	58	0	13621	10	$12.5	10%	EGD	Assumption Updated in Enbridge 2011 update.
MultiFamily	Existing		Low-Flow Showerhead (Per household, Installed)	1.5 GPM	3.6 GPM and above	3.6 GPM	69	0	15705	10	$12.5	10%	EGD	Assumption Updated in Enbridge 2011 update.

* Efficiency ratings and natural gas savings will vary by fireplace type. Please see substantiation sheet for type specific efficiency ratings and savings.

** Savings will vary for different segments. Please see substantiation sheet for segment specific savings.

Union Gas Custom Projects

Sector	Union Deep Measure	Free Rider (%)
Agriculture	X	54%
Industrial	X	54%
Commercial	X	54%
Multi-Residential	X	54%
New Construction	X	54%
Low-Income - Weatherization	X	0%

Enbridge Custom Projects

Sector	Free Rider (%)
Agriculture	40%
Industrial	50%
Commercial	12%
Multi-Residential	20%
New construction	26%

Union Gas Ltd.'s Custom Offering
Equipment Useful Life (EUL) and Base Case Assumptions

Equipment Type	Sector	EUL		Base Case	
		Years	Source	Description	Source
Boilers					
Industrial Process - greater than 2500 MBHp	Industrial	20	2	80% thermal efficiency	7
Space heating - Under 300 MBHp	Commercial & Multi-Residential	20*	4	83% thermal efficiency	7
Space heating - 300 to 2500 MBHp	Commercial & Multi-Residential	20*	4	81% thermal efficiency	7
Domestic Hot Water	Commercial & Multi-Residential	20*	4		
Controls	All	20*			
Combustion Tune-Up	Industrial & Commercial	1			
Air Makeup (line)	Industrial	20			
Oxy-Fuel	Industrial	20			
Low NOx Boiler	Industrial	20			
Building Optimization					
Building Optimization Program - Behavioral Savings Project	Commercial	5	3		
Economizers					
New with boiler - conventional and condensing	Industrial & Commercial	20			
Retrofit - conventional and condensing	Industrial & Commercial	10	2		
Repair	Industrial & Commercial	5	2	No repair	
Electronic Burner Controls					
Linkage-Less Controls, Modulating Motors, Mod Motors		20			
Agriculture					
IR Poly	Greenhouse	4		Double Poly	
Energy Curtains	Greenhouse	5	1	No Energy Curtain	
Grain Dryer	Commercial	20	5		
HVAC					
Air Curtains (single and double door)	Commercial	15	2		
Building Automation System - New	Commercial	15	2		
Cooling tower for HVAC systems	Commercial	15	1		
Combustion Tune-Up	Industrial & Commercial	1	5	No tune up	
Demand Control Ventilation	Commercial & Multi-Residential	15	5		
Dessicant Cooling	Commercial	15	6		
Exhaust Fan Controls	Commercial	15	5		
Heat Recovery	Industrial & Commercial	15			
Infiltration Controls - Dock Seals, Air Doors	Commercial	15	2		
Make-Up Air	All	15			
Novitherm panels	Commercial & Multi-Residential	15		No panels	
VFD retrofit on MUA	Commercial & Multi-Residential	10			
Turndown controls on Modulating Boiler	Commercial	20	5		
Heat Exchangers					
Plate - Plate or Tube-Tube	Industrial & Commercial	14	2		
Air -Air	Commercial	14	2		
Insulation					
Roof/Ceiling insulation	Industrial & Commercial	20	2	OBC for Year built	
Outside Pipe - exposed to the environment, properly protected	Industrial & Commercial	20			
Building Weatherization - Air sealing	Commercial	15	1		
Tank Exterior Insulation	Industrial & Commercial	15	2		
Ovens and Thermal oxidizers					
Low Temperature (less than 300°C)	Industrial	20			
Medium Temperature (300°C - 1000°C)	Industrial	20			
High Temperature (>1000°C)	Industrial	15			
Process Controls					
Electronic Loop Controllers	Industrial	20			
PLC's	Industrial	20			
Flame Supervision (relays)	Industrial	20			

Flame Detectors (UV-Flame Rods)	Industrial	5			

Steam Distribution

Steam Traps	Industrial & Commercial	7		Do not replace	
Steam Piping Leaks	Industrial & Commercial	20	5		
Steam Valve	Industrial Food Services	5	5, 8		

Water Conditioners

Reverse Osmosis (RO)	Industrial	20			
Ion Exchange	Industrial	20			

References

*	Useful Life estimates are most dependent on the application and quality of maintenance. Any equipment life that was reported higher than 20 years was reduced to 20 years to conform to Union Gas's 20 year limit.
1	2011 Commercial Opportunity Screening Report May 02 2011, Navigant for Union Gas
2	DEER EUL Summary 2010-1-08
3	Measure Life for Retro-Commissioning and Continuous Commissioning Projects, Finn Projects for Enbridge
4	ASHRAE
5	Union Gas 2010 DSM Annual report filing
6	Enbridge Approved IA
7	2011 Commercial Hydronic Boiler System Baseline Study, ICF Marbek for Enbridge
8	Confirmation of high quality feed water required for 10 year life

Enbridge Gas Distribution's Custom Offering
Equipment Useful Life (EUL) Assumptions

Equipment Type	Sector	EUL	
		Years	**Source**
Boiler Related			
Boilers – DHW	Commercial, Multi-Residential	25	1
Boilers - Industrial Process	Industrial	20	
Boilers – Space Heating	Commercial, Industrial, Multi-Residential	25	1
Combustion Tune-up	Commercial, Industrial	5	
Controls	Commercial, Industrial, Multi-Residential	15	
Steam pipe/tank insulation	Industrial	15	
Steam trap	Commercial, Industrial	6	3
Building Related			
Building envelope	Commercial, Industrial, Multi-Residential	25	
Windows	Commercial, Industrial, Multi-Residential	25	
Greenhouse curtains	Industrial	10	
Double Poly greenhouse	Industrial	5	
HVAC Related			
Dessicant cooling	Commercial	15	
Heat Recovery	Commercial, Industrial	15	
Infra-red heaters	Commercial, Industrial	10	
Make-up Air	Commercial, Industrial, Multi-Residential	15	
Novitherm panels	Commercial, Multi-Residential	15	
Furnaces (gas-fired)	Commercial, Multi-Residential	18	2
Re-Commissioning			
Re-Commissioning	Commercial, Multi-Residential	5	4
Process Related			
Furnaces (gas-fired)	Industrial	18	2

References

1	ASHRAE
2	ASHRAE updated in EB-2006-0021
3	Enbridge Gas Distribution 2008 DSM EAC Audit Summary Report.
4	Measure Life For Retro-Commissioning And Continuous Commissioning Projects, Finn Projects

Substantiation Documents

Substantiation Documents

Table of Contents

Residential Space Heating

Ceiling Insulation (R-40), UG

Revision #	Description/Comment	Date Revised
		August 5, 2011

Efficient Equipment and Technologies Description
Ceiling insulation R-40
Base Equipment and Technologies Description
Ceiling insulation R-10

Decision Type	Target Market(s)	End Use
Retrofit	Existing Residential (Pre-1980s)	Space Heating

Codes, Standards, and Regulations

The minimum R value required by Ontario Building Code[1] for ceiling below attic or roof space is 40.

Resource Savings Assumptions

Annual Natural Gas Savings	105 m^3

- Navigant Consulting used HOT2000[2] to model energy savings resulting from the energy efficient upgrade. The following input assumptions where based on a candidate house for a typical pre-1980 home[3].

House Characteristics using HOT2000	
Location	Toronto, ON
Storeys	2
Above Grade Wall Insulation	R-Value = 3.42
Below Grade Wall Insulation	R-Value = 1.13
Attic Insulation	R-Value = 12.90
Foundation Floor Insulation	R-Value = 2.68
Air Leakage (ACH)	8.0
Number of Windows	8 on the main floor, 4 in the basement
Ceiling Area (ft^2)	829
Main Level Wall Area (ft^2)	944
Living Space Area (ft^2)	1,658
Basement Wall Area (ft^2)	827
Basement Floor Area (ft^2)	829
Base Loads Use	Defaults
Furnace Efficiency (AFUE)	80
Furnace Capacity (Btu/hr)	58,006.4 (Calculated)
Fans Mode	Auto
A/C Efficiency (SEER)	10
A/C Capacity (Btu/hr)	13000†

† The current version of HOT2000 has limitation on A/C capacities under specified conditions. 13000 Btu/hr is the maximum value it allows.

- Based on the above assumptions, the following results are obtained:

HOT2000 Simulation Results	Space Heating NG Consumption (m^3)	Space Cooling Consumption (kWh)	Annual Furnace Fan Consumption (kWh)
Base Case	3,331	697	665
Ceiling Upgrade	3,126	679	626
Savings	205	17	39
Savings%	**6.2%**	**2.5%**	**5.9%**

[1] Ontario Regulations 350/06, 2006 Building Code
[2] NRCan, http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/software_tools/hot2000.html
[3] Candidate home characteristics are based on previous weatherization study completed by Marbek in 2008 for Union Gas and Navigant Consulting input assumptions.

- Annual natural gas savings for space heating is 6.2%.
- Applying the 6.2% savings calculated in the table above to the average annual consumption of natural gas:

  Natural Gas Savings = 1700 m^3 x 6.2% = 105 m^3

Annual Electricity Savings	105 kWh

Annual electricity savings are derived from two sources:

1. Space cooling consumption
2. Furnace fan consumption

Space cooling consumption:

- Assuming that baseline house is equipped with a SEER 10, 2.5 ton[4] A/C unit and is used 500 hours per year[5], this implies that:

  Base A/C electricity use = 500 (cooling hours)*[30,000 (Btu/hr)/(10 (SEER)* 1,000)] = 1,500 kWh
- Applying the 2.5% savings calculated in the table in the previous section to the average annual consumption of electricity cited directly above yields:

  Electricity savings (A/C) = 2.5% x 1,500 kWh/year = 37.5 kWh.

Furnace fan consumption:

- Annual furnace fan consumption for a typical Toronto home with a non-continuous mid-efficiency furnace = 1,150 kWh[6]
- Applying the 5.9% savings calculated in the table in the previous section to the annual furnace fan electricity consumption cited directly above yields:

  Electricity savings (furnace fan) = 5.9% x 1150 kWh = 67.85 kWh

Total Electricity Savings:

- Total electricity savings are the sum of furnace fan savings and air conditioner savings:

  Total electricity savings = 37.5 kWh + 67.85 kWh = 105.4 kWh

Annual Water Savings	0 L

N/A

Other Input Assumptions

Effective Useful Life (EUL)	20 Years

The EUL is reported to be 25 years by the Iowa Utilities Board[7] and 30 years by Puget Sound Energy[8]. The OPA reports the EUL as 20 years. Navigant Consulting is assuming 20 years.

Base & Incremental Conservation Measure Equipment and O&M Costs	$580

Based on communication with various local vendors, the incremental cost of ceiling insulation from R-10 to R-40 is approximately 70 cents per ft^2. For the candidate home, the incremental cost is estimated to

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[4] Implying input of 30,000 Btu/hr, Energy Star Savings Calculator, http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls

[5] Number of full-load cooling hours provided by http://energyexperts.org/ac%5Fcalc/ and based on the assumption that Ontario's climate is sufficiently similar to that of the north-eastern U.S.

[6] The Canadian Center for Housing Technologies, "Final Report on the Effects of ECM Furnace Motors on Electricity and Gas Use: Results from the CCHT Research Facility and Projections" http://irc.nrccnrc.gc.ca/pubs/fulltext/nrcc38500/nrcc38500.pdf

[7] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2

[8] Quantec, Puget Sound Energy Demand-Side Management Resource Assessment

be \$580 (\$0.70 x 829 ft^2 = \$580).

Basement Wall Insulation (R-12), UG

Revision #	Description/Comment	Date Revised
		August 5, 2011

Efficient Equipment and Technologies Description
Basement wall insulation R-12
Base Equipment and Technologies Description
Basement wall insulation R-1

Decision Type	Target Market(s)	End Use
Retrofit	Existing Residential (Pre-1980)	Space Heating
The minimum R value required by Ontario Building Code[1] for foundation wall is R-12.		

[1] Ontario Regulations 350/06, 2006 Building Code

Resource Savings Assumptions

Annual Natural Gas Savings	261 m^3

- Navigant Consulting used HOT2000[2] to model energy savings resulting from the energy efficient upgrade. The following input assumptions where based on a candidate house for a typical pre-1980 home[3].

House Characteristics using HOT2000	
Location	Toronto, ON
Storeys	2
Above Grade Wall Insulation	R-Value = 3.42
Below Grade Wall Insulation	R-Value = 1.13
Attic Insulation	R-Value = 12.90
Foundation Floor Insulation	R-Value = 2.68
Air Leakage (ACH)	8.0
Number of Windows	8 on the main floor, 4 in the basement
Ceiling Area (ft^2)	829
Main Level Wall Area (ft^2)	944
Living Space Area (ft^2)	1,658
Basement Wall Area (ft^2)	827
Basement Floor Area (ft^2)	829
Base Loads Use	Defaults
Furnace Efficiency (AFUE)	80
Furnace Capacity (Btu/hr)	58,006.4 (Calculated)
Fans Mode	Auto
A/C Efficiency (SEER)	10
A/C Capacity (Btu/hr)	13000†

† The current version of HOT2000 has limitation on A/C capacities under specified conditions. 13000 Btu/hr is the maximum value it allows.

- Based on the above assumptions, the following results are obtained:

HOT2000 Simulation Results	Space Heating NG Consumption (m^3)	Space Cooling Consumption (kWh)	Annual Furnace Fan Consumption (kWh)
Base Case	3,331	697	665
Basement Wall Upgrade	2,817	699	579
Savings	514	-2	86
Savings%	**15.4%**	**-0.3%**	**13.0%**

- Annual natural gas savings for space heating is 15.4%.
- Applying the 15.4% savings calculated in the table above to the average annual consumption of natural gas cited directly above yields:

$$\text{Natural Gas Savings} = 1700\ m^3 \times 15.4\% = 261 m^3$$

Annual Electricity Savings	145 kWh

[2] NRCan, http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/software_tools/hot2000.html

[3] Candidate home characteristics are based on previous weatherization study completed by Marbek in 2008 for Union Gas and Navigant Consulting input assumptions.

Annual electricity savings are derived from two sources: 1. Space cooling consumption 2. Furnace fan consumption *Space cooling consumption:* • Assuming that baseline house is equipped with a SEER 10, 2.5 ton[4] A/C unit and is used 500 hours per year[5], this implies that: Base A/C electricity use = 500 (cooling hours)*[30,000 (Btu/hr)/(10 (SEER)* 1,000)] = 1,500 kWh • Applying the -0.3% savings calculated in the table in the previous section to the average annual consumption of electricity cited directly above yields: Electricity savings (A/C) = -0.3% x 1,500 kWh/year = - 4.5 kWh. *Furnace fan consumption:* • Annual furnace fan consumption for a typical Toronto home with a non-continuous mid-efficiency furnace = 1,150 kWh[6] • Applying the 13.0% savings calculated in the table in the previous section to the annual furnace fan electricity consumption cited directly above yields: Electricity savings (furnace fan) = 13% x 1150 kWh = 149.5 kWh *Total Electricity Savings:* • Total electricity savings are the sum of furnace fan savings and air conditioner savings: Total electricity savings = -4.5 kWh + 149.5 kWh = 145 kWh

Annual Water Savings	**0 L**
N/A	

Other Input Assumptions

Effective Useful Life (EUL)	**25 Years**
The EUL is reported to be 25 years by the Iowa Utilities Board[7]. Navigant Consulting estimates an EUL of 25 years.	
Base & Incremental Conservation Measure Equipment and O&M Costs	**$1,654**
Based on communication with various local vendors, the incremental cost of wall insulation from R-1 to R-12 is approximately $2 per ft^2, which includes only the insulation material and labour but not the costs of wall removal and reconstruction required for installation. For the candidate home, the incremental cost is estimated to be $1,654 ($2.00 x 827 ft^2 = $1,654).	

[4] Implying input of 30,000 Btu/hr, Energy Star Savings Calculator, http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls
[5] Number of full-load cooling hours provided by http://energyexperts.org/ac%5Fcalc/ and based on the assumption that Ontario's climate is sufficiently similar to that of the north-eastern U.S.
[6] The Canadian Center for Housing Technologies, "Final Report on the Effects of ECM Furnace Motors on Electricity and Gas Use: Results from the CCHT Research Facility and Projections" http://irc.nrccnrc.gc.ca/pubs/fulltext/nrcc38500/nrcc38500.pdf
[7] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2

Draft Proofing Kit

Existing Homes,UG

Efficient Technology & Equipment Description
Draft Proofing Kit: (1) Spray Foam, can (1) Caulk, tube (30 ft) Foam Tape (4) Energy Saver Gasket with 2 child safety inserts
Base Technology & Equipment Description
No Draft Proofing kit

Resource Savings Assumptions

Natural Gas	**236 m^3**
Gas savings is based on a 70/30 UG South/North split, weatherization results and crack dimensions from years of field work and calculations provided by Steve Tratt, CanAm Building Envelope and "Standards and Guidelines - Energy Conservation" - Technical Information EC128 1980 by Don Hampton H&V Specialist, Appendix B - Spray Foam (1 can) coverage of 61' @ 1/64" wide crack - Caulk (1 tube) coverage of 14' @1/4" yield/tube - Foam tape (approx 30ft) 1/16" crack, for example for an attic hatch, door perimeters, and casement windows - Energy Saver Gasket with 2 child safety inserts (4 sets) assuming1 square inch crack associated with the electrical outlet	
Electricity	**27 kWh**
See above	
Water	**0 L**

Other Input Assumptions

Equipment Life	**1 Year**
The components are expected to last one year.	
Incremental Cost	**$ 20**

Based on utility costs.

ENERGY STAR FOR NEW HOMES (VERSION 3)

Residential, New Construction, EGD

Efficient Technology & Equipment Description
Energy Star for New Homes, version 3, qualified home
Base Technology & Equipment Description
New Home built in Ontario, compliant to OBC-2006, permits issued prior to March 31, 2009.

Resource Savings Assumptions

Natural Gas	**1018 m^3**
As approved in EB 2008-0384 & 0385. Gas savings is based on a simple average of a new reference house, a 1 storey house, and a 2 storey house[1] with London's climate, and another set in North Bay's climate. The sample houses are three houses which represent the mid-range of new homes built in UG Territory. The results were weighted 70% UG South and 30% UG North. The software used for analysis is HOT2000 version 9.34b. This is the same software that is currently in use for application of the EnerQuality Version 3.0 Energy Star Criteria, which is what's mandatory to evaluate homes for ESNH. A mix of 90% AFUE furnace (weighted 80%) and 80% AFUE combo heater (weighted 20%) was assumed as the base case heating system. The upgrade system was a 92% AFUE. A 3.57 ACH50 air leakage was used to describe the simply OBC-2006 houses (default present in HOT2000), which is representative of average new home construction[2]	
Electricity	**1450 kWh**
As approved in EB 2008-384 & 0384. Electrical savings is based on a simple average of a new reference house, a 1 storey house, and a 2 storey house[1] with London's climate, and another set in North Bay's climate. The sample houses are three houses which represent the mid-range of new homes built in UG Territory.[1] The results were weighted 70% UG South and 30% UG North. The software used for analysis is HOT2000 version 9.34b. This is the same software that is currently in use for application of the EnerQuality Version 3.0 Energy Star Criteria, which is what's mandatory to evaluate homes for ESNH. A 3.57 ACH50 air leakage was used to describe the simply OBC-2006 houses (default present in HOT2000), which is representative of average new home construction[3]	
Water	**n/a L**

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[1] Based on *Comparison of EnergyStar vs.Ontario Building Code 2006 Energy Use*, spreadsheets, from July and August, 2008, by Bowser Technical Inc.

[2] Conversation with Jennifer Tausman, ESNH files coordinator, NRCAN OEE, July 21, 2008

[3]The EnerQuality EnergyStar Version 4.0 Prescriptive options are not applicable to homes North of the Muskoka climate zone. Upgrades are based on the performance Compliance Method (section 5.1) as set out in the EnerQuality EnergyStar for New Homes Technical Specification Version 4.0, February '09..

Other Input Assumptions

Equipment Life	**25 years**
As approved in EB 2008-0384 & 0385. Energy Star homes have an estimated service life of 25 years (before major renovations are expected)	
Incremental Cost (Installed)	**$3,200**
As per Costing Analysis of Energy Star version 3 Specifications over the 2006 Ontario Building Code by Lio & Associates, May 2011.	
Free Ridership	**48 %**
As per 2009 Audit recommendation. Based on Auditors review of the Salt River Project (SRP) Powerwise Homes program (FY2009) in Arizona.	

FIREPLACE INTERMITTENT IGNITION CONTROL RETROFIT

Residential – Existing Homes, UG

Efficient Technology & Equipment Description
Retrofitting a fireplace with a intermittent ignition control
Base Technology & Equipment Description
Natural gas fireplace with a pilot

Resource Savings Assumptions

Natural Gas	**104 m3/yr**

Gas savings were based on gas normally consumed by a pilot flame during the winter and the non-heating season discounted by the fraction of people who shut off their fireplace gas pilot in the non-heating season according to the NRCAN SHEU study. The pilot flame is estimated to consume 700 Btu/hr (which is at the lower end of the published values).[1],[2] The table below[3] shows approximately how much gas is consumed by a pilot flame in the heating and non-heating seasons.

Operation Mode	Btu/hr	~m3/hr	Annual hours	m3 Gas Per Year
Pilot Light- Heating Season	700	0.02	4,932[4]	96.6
Pilot Light - Non-Heating Season	700	0.02	3,650[5]	71.5

The table below shows the effects on the gas savings estimates from fireplace owners who shut off their pilot lights during the non-heating season.

	Annual m3	Percent of Fireplace Owners	Weighted Average (m3/yr)
Standing Pilot Use in Heating Season	96.6	100%	96.6
Standing Pilot Use in Non-Heating Season	71.5	38%[6]	27.2

[1] Leapfrog Energy Technologies, Market Assessment for Potential Natural Gas Fireplace DSM Initiatives, 2007, Union Gas Fireplace Consolodated Presentation 071221.ppt, slide 18.

[2] "A pilot light…can consume from 600 to 1500 Btu of gas per hour and, if left to run continuously, can significantly increase your annual energy costs." – "All About Gas Fireplaces", Office of Energy Efficiency, Natural Resources Canada – March 2004

[3] From Fireplace Backup Calculations for Pete 071221.xls

[4] The heating season was estimated to last for 7 months. The time that the pilot light runs during the heating season is 7 months/12 months X 365 days X 24 hours MINUS the number of hours when the fireplace is actually running.

[5] The non-heating hours per year are equivalent to 8760 minus the time that the fireplace is running and minus the time when the pilot flame is running during the heating season.

[6] Table 3.4 "NRCan - 2003 Survey of Household Energy Use" – 38% of households in Ontario do not extinguish pilot lights in non-heating season.

A small portion of the winter time pilot gas heat is assumed to contribute to space heating during the heating season, however the actual value is unknown. A nominal value of 20% was estimated by Skip Hayden of NRCAN[7]. 104 m3/yr = 27.2 m3/yr + (96.6 m3/yr * 80%)	
Electricity	**(-) 31 kWh/yr**
Intermittent ignition systems actually increase electricity consumption. The power supply for the electronic fireplace ignition consumes standby power anywhere from 2 Watts[8] to 5 Watts[9]. Power is drawn continuously through the year (8760 hours). The corresponding annual power consumption ranges from 17.5 to 43.8 kWh. 31 kWh/yr is the average between 17.5 and 43.8 kWh	
Water	**NA**

Other Input Assumptions

Equipment Life	**8 yrs**
The intermittent ignition control equipment life was estimated from manufacturer technical service reps to last the lifetime of the fireplace (~20 years).[10] The average fireplace age is 12 years[11]. The Equipment life is estimated to be 8 years based on how many years the fireplaces are expected to operate with the intermittent ignition control (20 yrs – 12 yrs = 8 yrs).	
Incremental Cost	**$150**
It is estimated that the capital cost for an intermittent ignition system is $75 and the cost of the labour is $75[12]. The total cost for retrofitting a fireplace would be approximately $150.	
Free Ridership	**1 %**
For Retrofitting a fireplace with intermittent ignition, free ridership was estimated using market penetration according to a NRCAN survey. According to an NRCAN survey[13], approximately 0% of survey respondents said they have intermittent ignition. Two percent of existing fireplaces owners weren't sure if their fireplaces have them. Since the range of market penetration is between 0 and 2%, 1% is used for the current market penetration of intermittent ignition in fireplaces.	

[7] Agreed upon at UG EAC meeting April 15, 2010.
[8] LeapFrog Energy Technology's phone conversations with Jatin at Majestic Fireplace technical services on 30/01/08.
[9] LeapFrog Energy Technology's phone conversations with Stan at ESA Heating Products technical services 30/01/08.
[10] LeapFrog Energy Technology's phone conversations with Jatin at Majestic Fireplace technical services on 30/01/08 and to Stan at ESA Heating Products technical services 30/01/08
[11] Union Gas Ltd., 2009 RESIDENTIAL SINGLE-FAMILY PENETRATION SURVEY, Pg 5
[12] Direct Energy verbal quote (888) 393-5553 November 12/2007
[13] Table 3.4 "2003 Survey of Household Energy Use" – Natural Resources Canada 2006

HIGH EFFICIENCY CONDENSING FURNACE

Residential Existing Homes, EGD

Efficient Technology & Equipment Description
High efficiency condensing furnace with regular PSC motor – AFUE 96
Base Technology & Equipment Description
Minimum standard gas fired furnace AFUE 90

Resource Savings Assumptions

Natural Gas	**129 m^3**
As approved in EB 2008-0346	
Electricity	**n/a kWh**
Water	**n/a L**

Other Input Assumptions

Equipment Life	**18 years**
As approved in EB 2008-0346	
Incremental Cost (Contractor Install)	**$1767.00**
As approved in EB 2008-0346	
Free Ridership (Updated)	**N/A**

HIGH EFFICIENCY FIREPLACE WITH PILOTLESS IGNITION

Residential – New Homes, EGD

Efficient Technology & Equipment Description	
A new high efficiency fireplace with intermittent (pilotless) ignition	
Type	EnerGuide Rating *(Minimum)*
Freestanding fireplace	70%
Insert	60%
Zero Clearance >= 40 kBtu/h	60%
Zero Clearance < 40 kBtu/h	70%
Base Technology & Equipment Description	
A typical natural gas fireplace based on the median fireplace model	
Type	Median Efficiency
Freestanding fireplace	65%
Insert	55%
Zero Clearance >= 40 kBtu/h	55%
Zero Clearance < 40 kBtu/h	65%

Resource Savings Assumptions

Natural Gas	**See Below**
Type	**Gas Savings (m3/yr)**
Freestanding fireplace	**110**
Insert	**109**
Zero Clearance >= 40 kBtu/h[1]	**122**
Zero Clearance < 40 kBtu/h[2]	**108**

The savings above is based on

1. A 5-percentage point efficiency increase above the median model efficiency according to the EnerGuide Rating
2. Pilotless (intermittent) ignition (i.e. gas saved from the standing pilot burner)

The table below shows gas use from the main burner (not including the standing pilot) and the EnerGuide ratings mentioned above.

Type	Input (BTU/H)[3]	Oper. Hours[4]	Base (m3/yr)	Heat Load (BTU/yr)	Upgrade (m3/yr)	Savings (m3/yr)
Freestanding	32,000	178	161	3,702,400	150	12
Insert	25,000	178	126	2,447,500	116	11

[1] Calculated at 55 kBtu/h

[2] Calculated at 25 kBtu/h

[3] Median fireplace input capacity, from LeapFrog Consulting, Market Assessment for Potential Natural Gas Fireplace DSM Initiatives by Union Gas in Ontario, Union Gas Fireplace Consolodated Presentation 071221.ppt slide 24

[4] 178 hrs/yr = 8.9 hrs/week for 20 weeks (~5 months) of use, according to Leapfrog Energy Technologies' conversations with retailers and fireplace owners and weighted average use behavior per week from NRCAN 2003 Survey of Household Energy Use results(as per slide 19 of Leapfrog's presentation, Market Assessment for Potential Natural Gas Fireplace DSM Initiatives by Union Gas in Ontario, 2007

Zero Clearance	55,000	178	277	5,384,500	254	23
Zero Clearance	25,000	178	126	2,892,500	117	9

The EnerGuide rating uses the CSA P.4.1-02 Efficiency Standard, which is supposed to include the pilot light. However the average efficiency point improvement between an intermittent ignition and a standing pilot light ignition according to this rating is only about 2 percentage points. This was based on looking at the average difference between Vermont Casting fireplace models with & without intermittent ignition.[5] The efficiency values include only a small portion of the gas consumption from the pilot (5.5 m3/yr). This portion is subtracted off in the gas savings calculation so as to not double count the intermittent ignition savings.

The intermittent ignition gas savings value is based on the gas normally consumed by a pilot flame during the winter and the non-heating season discounted by the fraction of households who shut off their gas pilot in the non-heating season according to the NRCAN SHEU study[6]. The pilot flame is estimated to consume 700 Btu/hr (which is at the lower end of the published values).[7],[8] The table below[9] shows approximately how much gas is consumed by a pilot flame in the heating and non-heating seasons.

Operation Mode	Btu/hr	~m3/hr	Annual hours	m3 Gas Per Year
Pilot Light- Heating Season	700	0.02	4,932[10]	96.6
Pilot Light - Non-Heating Season	700	0.02	3,650[11]	71.5

The table below shows the effects on the gas savings estimates from fireplace owners who shut off their pilot lights during the non-heating season.

	Annual m3	Percent of Fireplace Owners	Weighted Average (m3/yr)
Standing Pilot Use in Heating Season	96.6	100%	96.6
Standing Pilot Use in Non-Heating Season	71.5	38%[12]	27.2

5 from slide 17, LeapFrog Consulting, Union Gas Fireplace Consolodated Presentation 071221.ppt

6 Table 3.4 “NRCan - 2003 Survey of Household Energy Use” – 38% of households in Ontario do not extinguish pilot lights in non-heating season

7 Leapfrog Energy Technologies, Market Assessment for Potential Natural Gas Fireplace DSM Initiatives, 2007, Union Gas Fireplace Consolodated Presentation 071221.ppt, slide 18.

8 “A pilot light…can consume from 600 to 1500 Btu of gas per hour and, if left to run continuously, can significantly increase your annual energy costs.” – “All About Gas Fireplaces”, Office of Energy Efficiency, Natural Resources Canada – March 2004

9 From Fireplace Backup Calculations for Pete 071221.xls

10 The heating season was estimated to last for 7 months. This value is also used in the CSA Fireplace Efficiency standard. The time that the pilot light runs during the heating season is 7 months/12 months X 365 days X 24 hours MINUS the number of hours when the fireplace is actually running.

11 The non-heating hours per year are equivalent to 8760 minus the time that the fireplace is running and minus the time when the pilot flame is running during the heating season.

A small portion of the wintertime pilot gas heat is assumed to contribute to space heating during the heating season; however, the actual value is unknown. A nominal value of 20% was estimated by Skip Hayden of NRCAN to be the highest likely value[13].

104 m3/yr = 27.2 m3/yr + (96.6 m3/yr * 80%)

Gas savings =

Savings from EnerGuide Rating improvement (*5 percentage points above median*)
+ (plus) intermittent (pilotless) ignition
– (minus) intermittent ignition savings already accounted for in the EnerGuide Rating[14]

Freestanding	110 m3/yr = 12 m3/yr + 104 m3/yr – 5.5 m3/yr
Insert	109 m3/yr = 11 m3/yr + 104 m3/yr – 5.5 m3/yr
Zero Clearance >= 40 kBtu/h[15]	122 m3/yr = 23 m3/yr + 104 m3/yr – 5.5 m3/yr
Zero Clearance < 40 kBtu/h[16]	109 m3/yr = 11 m3/yr + 104 m3/yr – 5.5 m3/yr

Electricity	**(-) 31 kWh/yr**

Intermittent ignition systems actually increase electricity consumption. The power supply for the electronic fireplace ignition consumes standby power anywhere from 2 Watts[17] to 5 Watts[18]. Power is drawn continuously through the year (8760 hours). The corresponding annual power consumption ranges from 17.5 to 43.8 kWh.

31 kWh/yr represents the average between 17.5 and 43.8 kWh

Water	**NA**

Other Input Assumptions

Equipment Life	**20 yrs**

Equipment life was estimated from manufacturer technical service reps.[19]

Incremental Cost	**$135**

The incremental cost for higher efficiency model fireplaces is 0 (Zero). Higher efficiency fireplaces don't cost more than lower efficiency fireplaces. Correlations were drawn and

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[12] Table 3.4 "NRCan - 2003 Survey of Household Energy Use" – 38% of households in Ontario do not extinguish pilot lights in non-heating season.
[13] Agreed upon at UG-EAC meeting April 15, 2010.
[14] 5.5 m3/yr = 1.98% * 280 m3/yr. "The average efficiency point improvement between an intermittent ignition and a standing pilot light ignition is approximately 2 percentage points." This was based on looking at the average difference between Vermont Casting fireplace models with the same fireboxes with & without intermittent ignition from slide 17, LeapFrog Consulting, *Union Gas Fireplace Consolodated Presentation 071221.ppt.* The UG fireplace NAC is 280 m3/yr, (Paul Gardiner UG forecasting, Oct 3, 2007 email to Pete Koepfgen).
[15] Calculated at 25 kBtu/h
[16] Calculated at 55 kBtu/h
[17] LeapFrog Energy Technology's phone conversations with Jatin at Majestic Fireplace technical services on 30/01/08.
[18] LeapFrog Energy Technology's phone conversations with Stan at ESA Heating Products technical services 30/01/08.
[19] LeapFrog Energy Technology's phone conversations with Jatin at Majestic Fireplace technical services on 30/01/08 and to Stan at ESA Heating Products technical services 30/01/08

the R^2 values were around 0.3-0.4. The incremental cost for new fireplace models that include an intermittent control are $120-150[20] above models with just a pilot light. The simple average of these values was used ($135).	
Free Ridership	**17 %**
Free ridership based on Enbridge research with builders regarding percentage of fireplaces with intermittent ignition installed in new homes and HPBAC (Hearth, Patio, Barbeque Association of Canada) information that 2009 sales of electronic spark fireplaces in Ontario is between 10-20%.	

[20] Fireplace Retailer survey within Union Gas franchise territory by LeapFrog Energy in Oct-Nov 2007

HIGH EFFICIENCY FIREPLACE WITH PILOTLESS IGNITION

Residential –Existing Homes, EGD

Efficient Technology & Equipment Description	
A new high efficiency fireplace with intermittent (pilotless) ignition	
Type	EnerGuide Rating *(Minimum)*
Freestanding fireplace	70%
Insert	60%
Zero Clearance >= 40 kBtu/h	60%
Zero Clearance < 40 kBtu/h	70%
Base Technology & Equipment Description	
A typical natural gas fireplace based on the median fireplace model	
Type	Median Efficiency
Freestanding fireplace	65%
Insert	55%
Zero Clearance >= 40 kBtu/h	55%
Zero Clearance < 40 kBtu/h	65%

Resource Savings Assumptions

Natural Gas	**See Below**
Type	**Gas Savings (m3/yr)**
Freestanding fireplace	**110**
Insert	**109**
Zero Clearance >= 40 kBtu/h[1]	**122**
Zero Clearance < 40 kBtu/h[2]	**108**

The savings above is based on

1. A 5-percentage point efficiency increase above the median model efficiency according to the EnerGuide Rating
2. Pilotless (intermittent) ignition (i.e. gas saved from the standing pilot burner)

The table below shows gas use from the main burner (not including the standing pilot) and the EnerGuide ratings mentioned above.

Type	Input (BTU/H)[3]	Oper. Hours[4]	Base (m3/yr)	Heat Load (BTU/yr)	Upgrade (m3/yr)	Savings (m3/yr)
Freestanding	32,000	178	161	3,702,400	150	12
Insert	25,000	178	126	2,447,500	116	11

[1] Calculated at 55 kBtu/h

[2] Calculated at 25 kBtu/h

[3] Median fireplace input capacity, from LeapFrog Consulting, Market Assessment for Potential Natural Gas Fireplace DSM Initiatives by Union Gas in Ontario, Union Gas Fireplace Consolodated Presentation 071221.ppt slide 24

[4] 178 hrs/yr = 8.9 hrs/week for 20 weeks (~5 months) of use, according to Leapfrog Energy Technologies' conversations with retailers and fireplace owners and weighted average use behavior per week from NRCAN 2003 Survey of Household Energy Use results(as per slide 19 of Leapfrog's presentation, Market Assessment for Potential Natural Gas Fireplace DSM Initiatives by Union Gas in Ontario, 2007

Zero Clearance	55,000	178	277	5,384,500	254	23
Zero Clearance	25,000	178	126	2,892,500	117	9

The EnerGuide rating uses the CSA P.4.1-02 Efficiency Standard, which is supposed to include the pilot light. However the average efficiency point improvement between an intermittent ignition and a standing pilot light ignition according to this rating is only about 2 percentage points. This was based on looking at the average difference between Vermont Casting fireplace models with & without intermittent ignition.[5] The efficiency values include only a small portion of the gas consumption from the pilot (5.5 m3/yr). This portion is subtracted off in the gas savings calculation so as to not double count the intermittent ignition savings.

The intermittent ignition gas savings value is based on the gas normally consumed by a pilot flame during the winter and the non-heating season discounted by the fraction of households who shut off their gas pilot in the non-heating season according to the NRCAN SHEU study[6]. The pilot flame is estimated to consume 700 Btu/hr (which is at the lower end of the published values).[7],[8] The table below[9] shows approximately how much gas is consumed by a pilot flame in the heating and non-heating seasons.

Operation Mode	Btu/hr	~m3/hr	Annual hours	m3 Gas Per Year
Pilot Light- Heating Season	700	0.02	4,932[10]	96.6
Pilot Light - Non-Heating Season	700	0.02	3,650[11]	71.5

The table below shows the effects on the gas savings estimates from fireplace owners who shut off their pilot lights during the non-heating season.

	Annual m3	Percent of Fireplace Owners	Weighted Average (m3/yr)
Standing Pilot Use in Heating Season	96.6	100%	96.6
Standing Pilot Use in Non-Heating Season	71.5	38%[12]	27.2

[5] from slide 17, LeapFrog Consulting, Union Gas Fireplace Consolodated Presentation 071221.ppt

[6] Table 3.4 "NRCan - 2003 Survey of Household Energy Use" – 38% of households in Ontario do not extinguish pilot lights in non-heating season

[7] Leapfrog Energy Technologies, Market Assessment for Potential Natural Gas Fireplace DSM Initiatives, 2007, Union Gas Fireplace Consolodated Presentation 071221.ppt, slide 18.

[8] "A pilot light…can consume from 600 to 1500 Btu of gas per hour and, if left to run continuously, can significantly increase your annual energy costs." – "All About Gas Fireplaces", Office of Energy Efficiency, Natural Resources Canada – March 2004

[9] From Fireplace Backup Calculations for Pete 071221.xls

[10] The heating season was estimated to last for 7 months. This value is also used in the CSA Fireplace Efficiency standard. The time that the pilot light runs during the heating season is 7 months/12 months X 365 days X 24 hours MINUS the number of hours when the fireplace is actually running.

[11] The non-heating hours per year are equivalent to 8760 minus the time that the fireplace is running and minus the time when the pilot flame is running during the heating season.

A small portion of the wintertime pilot gas heat is assumed to contribute to space heating during the heating season; however, the actual value is unknown. A nominal value of 20% was estimated by Skip Hayden of NRCAN to be the highest likely value[13]. 104 m3/yr = 27.2 m3/yr + (96.6 m3/yr * 80%) Gas savings = Savings from EnerGuide Rating improvement (*5 percentage points above median*) + (plus) intermittent (pilotless) ignition – (minus) intermittent ignition savings already accounted for in the EnerGuide Rating[14] Freestanding — 110 m3/yr = 12 m3/yr + 104 m3/yr – 5.5 m3/yr Insert — 109 m3/yr = 11 m3/yr + 104 m3/yr – 5.5 m3/yr Zero Clearance >= 40 kBtu/h[15] — 122 m3/yr = 23 m3/yr + 104 m3/yr – 5.5 m3/yr Zero Clearance < 40 kBtu/h[16] — 109 m3/yr = 11 m3/yr + 104 m3/yr – 5.5 m3/yr

Electricity	**(-) 31 kWh/yr**
Intermittent ignition systems actually increase electricity consumption. The power supply for the electronic fireplace ignition consumes standby power anywhere from 2 Watts[17] to 5 Watts[18]. Power is drawn continuously through the year (8760 hours). The corresponding annual power consumption ranges from 17.5 to 43.8 kWh. 31 kWh/yr represents the average between 17.5 and 43.8 kWh	
Water	**NA**

Other Input Assumptions

Equipment Life	**20 yrs**
Equipment life was estimated from manufacturer technical service reps.[19]	
Incremental Cost	**$135**
The incremental cost for higher efficiency model fireplaces is 0 (Zero). Higher efficiency fireplaces don't cost more than lower efficiency fireplaces. Correlations were drawn and	

[12] Table 3.4 "NRCan - 2003 Survey of Household Energy Use" – 38% of households in Ontario do not extinguish pilot lights in non-heating season.
[13] Agreed upon at UG-EAC meeting April 15, 2010.
[14] 5.5 m3/yr = 1.98% * 280 m3/yr. "The average efficiency point improvement between an intermittent ignition and a standing pilot light ignition is approximately 2 percentage points." This was based on looking at the average difference between Vermont Casting fireplace models with the same fireboxes with & without intermittent ignition from slide 17, LeapFrog Consulting, *Union Gas Fireplace Consolodated Presentation 071221.ppt.* The UG fireplace NAC is 280 m3/yr, (Paul Gardiner UG forecasting, Oct 3, 2007 email to Pete Koepfgen).
[15] Calculated at 25 kBtu/h
[16] Calculated at 55 kBtu/h
[17] LeapFrog Energy Technology's phone conversations with Jatin at Majestic Fireplace technical services on 30/01/08.
[18] LeapFrog Energy Technology's phone conversations with Stan at ESA Heating Products technical services 30/01/08.
[19] LeapFrog Energy Technology's phone conversations with Jatin at Majestic Fireplace technical services on 30/01/08 and to Stan at ESA Heating Products technical services 30/01/08

the R^2 values were around 0.3-0.4. The incremental cost for new fireplace models that include an intermittent control are $120-150[20] above models with just a pilot light. The simple average of these values was used ($135).	
Free Ridership	**17 %**
Free ridership based on Enbridge research with builders regarding percentage of fireplaces with intermittent ignition installed in new homes and HPBAC (Hearth, Patio, Barbeque Association of Canada) information that 2009 sales of electronic spark fireplaces in Ontario is between 10-20%.	

[21] Calculated at 55 kBtu/h
[22] Calculated at 25 kBtu/h
[23] Median fireplace input capacity, from LeapFrog Consulting, Market Assessment for Potential Natural Gas Fireplace DSM Initiatives by Union Gas in Ontario, Union Gas Fireplace Consolodated Presentation 071221.ppt slide 24
[24]178 hrs/yr = 8.9 hrs/week for 20 weeks (~5 months) of use, according to Leapfrog Energy Technologies' conversations with retailers and fireplace owners and weighted average use behavior per week from NRCAN 2003 Survey of Household Energy Use results(as per slide 19 of Leapfrog's presentation, Market Assessment for Potential Natural Gas Fireplace DSM Initiatives by Union Gas in Ontario, 2007
[25] from slide 17, LeapFrog Consulting, Union Gas Fireplace Consolodated Presentation 071221.ppt
[26] Table 3.4 “NRCan - 2003 Survey of Household Energy Use” – 38% of households in Ontario do not extinguish pilot lights in non-heating season
[27] Leapfrog Energy Technologies, Market Assessment for Potential Natural Gas Fireplace DSM Initiatives, 2007, Union Gas Fireplace Consolodated Presentation 071221.ppt, slide 18.
[28] “A pilot light…can consume from 600 to 1500 Btu of gas per hour and, if left to run continuously, can significantly increase your annual energy costs.” – “All About Gas Fireplaces”, Office of Energy Efficiency, Natural Resources Canada – March 2004
[29] From Fireplace Backup Calculations for Pete 071221.xls
[30] The heating season was estimated to last for 7 months. This value is also used in the CSA Fireplace Efficiency standard. The time that the pilot light runs during the heating season is 7 months/12 months X 365 days X 24 hours MINUS the number of hours when the fireplace is actually running.
[31]The non-heating hours per year are equivalent to 8760 minus the time that the fireplace is running and minus the time when the pilot flame is running during the heating season.
[32]Table 3.4 “NRCan - 2003 Survey of Household Energy Use” – 38% of households in Ontario do not extinguish pilot lights in non-heating season.
[33] Agreed upon at UG-EAC meeting April 15, 2010.
[34]5.5 m3/yr = 1.98% * 280 m3/yr. “The average efficiency point improvement between an intermittent ignition and a standing pilot light ignition is approximately 2 percentage points." This was based on looking at the average difference between Vermont Casting fireplace models with the same fireboxes with & without intermittent ignition from slide 17, LeapFrog Consulting, *Union Gas Fireplace Consolodated Presentation 071221.ppt.* The UG fireplace NAC is 280 m3/yr, (Paul Gardiner UG forecasting, Oct 3, 2007 email to Pete Koepfgen).
[35] Calculated at 25 kBtu/h
[36] Calculated at 55 kBtu/h
[37] LeapFrog Energy Technology’s phone conversations with Jatin at Majestic Fireplace technical services on 30/01/08.
[38] LeapFrog Energy Technology’s phone conversations with Stan at ESA Heating Products technical services 30/01/08.
[39] LeapFrog Energy Technology’s phone conversations with Jatin at Majestic Fireplace technical services on 30/01/08 and to Stan at ESA Heating Products technical services 30/01/08

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[20] Fireplace Retailer survey within Union Gas franchise territory by LeapFrog Energy in Oct-Nov 2007

[40] Fireplace Retailer survey within Union Gas franchise territory by LeapFrog Energy in Oct-Nov 2007

PROGRAMMABLE THERMOSTAT

Residential New Construction, UG

Efficient Technology & Equipment Description
Programmable thermostat
Base Technology & Equipment Description
Standard thermostat

Resource Savings Assumptions

Natural Gas	**53 m^3**
EB 2009-0154	
Electricity	**54 kWh**
EB 2009-0154	
Water	**n/a L**

Other Input Assumptions

Equipment Life	**15 Years**
EB 2009-0154	
Incremental Cost	**$25.00**
EB 2009-0154	
Free Ridership	**10 %**
Pre-screening will be conducted to ensure builders who install a programmable thermostat as standard are not targeted. Measure will not be delivered to Energy Star Labeled Homes. A builder survey will be conducted immediately prior to launch of the program in order to capture the majority of builders in the franchise area.	

Programmable Thermostat - Residential, UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
Programmable thermostat.
Base Equipment and Technologies Description
Standard thermostat.

Decision Type	Target Market(s)	End Use
Retrofit	Residential existing homes	Space Heating

Codes, Standards, and Regulations

- For a programmable thermostat to receive Energy Star® qualification, it must meet specific criteria such as having at least two different programming periods (for weekday and weekend programming), at least four possible temperature settings and allow for temporary overriding by the user.
- In Canada, applicable CSA standards can be found in CSA C828-99- CAN/CSA Performance Requirements for Thermostats used with Individual Room Electric Space Heating Devices.

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	53	54	0	25	0
2	53	54	0	0	0
3	53	54	0	0	0
4	53	54	0	0	0
5	53	54	0	0	0
6	53	54	0	0	0
7	53	54	0	0	0
8	53	54	0	0	0
9	53	54	0	0	0
10	53	54	0	0	0
11	53	54	0	0	0
12	53	54	0	0	0
13	53	54	0	0	0
14	53	54	0	0	0
15	53	54	0	0	0
TOTALS	**2,190**	**2,730**	**0**	**25**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	53 m^3

- Two utility studies[1] are used to determine savings resulting from residential programmable thermostats on natural gas consumptions.

  - In the ***GasNetworks*** study[2], 4,061 mail-in surveys and bills were analyzed. Results were normalized for temperature and the energy impacts were determined through a multivariate regression analysis. The study found that programmable thermostat saved 6 % of total household annual natural gas use. GasNetworks is proposing 75 ccf (212 m^3) natural gas savings based on a Non-Programmable Thermostat annual consumption of 1,253 ccf (3,548 m^3) natural gas.
  - In the ***Enbridge Billing Analysis***[3], 911 customers' natural gas consumption was analyzed in 2005. Enbridge determined an average savings of 159 m^3 for a house using 2,878 m^3 of natural gas.

- Canadian Centre for Housing Technology (CCHT) also conducted a study in 2005 on programmable thermostat natural gas savings[4]. The study was done in two identical research homes located in Ottawa to allow direct comparison of changes in operating conditions in a home. It reports a 6.5% predicted savings for 18°C night setback.
- Based on these three studies, Navigant Consulting is assuming an average saving at 6% for natural gas consumptions for full temperature set back.

Studies	Baseline Gas Consumption (m^3)	Gas Savings (m^3)	Gas Savings%
GasNetworks (2007)	3,548	212	6.0%
Enbridge (2005)	2,878	159	5.5%
CCHT (2005)	-	-	6.5%
NCI Average			6.0%

Taking into account behavioural changes:

- Based on a recent Statistics Canada report[5], approximately 41% of Ontario households with non-programmable or non-programmed thermostats manually set back their thermostat at night (19% lowered by 3 or more degrees, 21% lowered by 1 or 2 degrees) in the winter season, where as 59% did not lower their thermostat before going to sleep.
- Similar values were found based on a recent evaluation Ontario Power Authority's 2007 Hot and Cool Savings Program conservation program. A household survey determined that of the 59% of Ontario households with non-programmable thermostats who manually set back their thermostat, after installing their new programmable thermostat, 68% stated they continued with the same set back behaviour (no change), while 32% increased their set back temperate (19% by 3 or more degrees, 81% by 1 or 2 degrees)[6].
- Furthermore, Navigant Consulting also determined from the survey that of the 41% of households who previously did not have a programmable thermostat and did not lower their thermostat at night, 67% of households changed their behaviour by programming their thermostat to lower the

[1] "Resource Savings Values in Selected Residential DSM Prescriptive Programs", Summit Blue Consulting, June 2008.
[2] RLW Analytics, Validating the impact of programmable thermostats: final report. Prepared for GasNetworks by RLW Analytics. Middletown, CT, January 2007.
[3] "Resource Savings Values in Selected Residential DSM Prescriptive Programs", Summit Blue Consulting, June 2008.
[4] The Effects of Thermostat Setting on Seasonal Energy Consumption at the CCHT Research Facility, Manning, Swinton, Szadkowski, Gusdorf, Ruest, February 14, 2005, http://irc.nrc-cnrc.gc.ca/pubs/rr/rr191/rr191.pdf
[5] Statistics Canada, Household and Environment Survey, 2006
[6] Navigant Consulting, Evaluation Report: 2007 Hot and Cool Savings Programs, prepared for the Ontario Power Authority (OPA), July 2008.

temperature at night when they sleep (44% by 3 or more degrees, 56% by 1 or 2 degrees).

- Therefore, using Statistics Canada values for typical winter behaviour of non-programmable thermostat households and Navigant Consulting findings for post installation of a programmable thermostat, the following natural gas savings should be attributed for each installed programmable thermostat:

Savings	*Distribution of Households*	*Natural Gas Savings*
No change in behaviour or no set back	47%	0%
Full change in behaviour - 3 + degrees set back	20%	6%
Partial change in behaviour: 1 -2 degrees set back	33%	3%

Using Enbridge's baseline natural gas consumption of 2,436 m^3 for mid-efficiency furnaces, NCI estimates the following natural gas savings from the installation of programmable thermostats:

$$2{,}436\ m^3 \times (47\% \times 0\% + 20\% \times 6\% + 33\% \times 3\%) = 53\ m^3$$

- This represents an overall savings of 2% over the baseline (53 m^3 / 2436 m^3 = 2%)

Annual Electricity Savings — 54 kWh

Heating Season Savings (Furnace fan)

- The following table is based on the CCHT study analysing furnace fan consumption in relation to set back temperatures from programmable thermostats[7].

Temp Set Back	*Total Winter Furnace Electricity Consumption (kWh)*	*Seasonal Savings (%)*
None (22C)	2,314	0 %
18 C night time set back	2,295	0.8%
18 C daytime and night time set back	2,2,70	1.9%

- Using the CCHT study results from a full night-time set back of 4 degrees:
  Approximate savings is expected for the winter season[8] = 2,314 – 2,295 = 19 kWh/year
- Applying the same behaviour changes as presented above (natural gas savings), furnace fan savings during the heating season are estimated to be as follows:
  47% x 0 kWh + 20% x 19 kWh + 33% x 9.5 kWh = 7 kWh

Cooling Season Savings

- A side-by-side housing study conducted by the CCHT[9] determined seasonal energy savings for a residential unit from a programmable thermostat as follows:

CAC:**

Temp Set Back	*Total Summer Furnace and CAC Electricity Consumption (kWh)*	*Seasonal Savings (%)*
None (22C)	3,099	0
25 C daytime set back	2,767	11
24 C daytime set back	2,376	23

** 12 SEER , 2 ton capacity CAC, 362 cooling degree days (18C)

[7] The Effects of Thermostat Setting on Seasonal Energy Consumption at the CCHT Research Facility, Manning, Swinton, Szadkowski, Gusdorf, Ruest, February 14, 2005, http://irc.nrc-cnrc.gc.ca/pubs/rr/rr191/rr191.pdf

[8] Although furnace fan consumption is significantly higher than reported by other studies, the change in electricity consumption by using a programmable thermostat is assumed to be appropriate for this analysis.

[9] The Effects of Thermostat Setting on Seasonal Energy Consumption at the CCHT Research Facility, Manning, Swinton, Szadkowski, Gusdorf, Ruest, February 14, 2005, http://irc.nrc-cnrc.gc.ca/pubs/rr/rr191/rr191.pdf

- A BC Hydro study[10] reports savings between 10% and 15% for 4°C set back during night and unoccupied periods, Energy Star Calculator[11] reports 6% saving per degree (Fahrenheit) for *cooling season*.
- Assuming that baseline house is equipped with a SEER 10, 2.5 ton A/C unit[12] and is used 500 hours per year[13], this implies that:

  Base A/C electricity use = 500 (cooling hours)*[30,000 (Btu/hr)/(10 (SEER)* 1,000)] = 1,500 kWh

Taking into Account Changes in Behaviour (Cooling Season)

- Based on the same program evaluation survey for the OPA[14], NCI determined that of the households who previously had non-programmable thermostats and did not manually adjust the thermostat to increase when they were away from home, 46% of respondents indicated they changed their behaviour when they installed a programmable thermostat by raising the temperature of their home when they were away (55% by 3 or more degrees, 45% by 1 or 2 degrees).
- Of the households who previously had non-programmable thermostats and manually adjusted their thermostat in the summer when they were away, 32% indicated they have increased their thermostats setting[15], where as 68% of respondents indicated they had no change in temperature settings.
- Therefore, using Statistics Canada values for typical summer behaviour of non-programmable thermostat households and Navigant Consulting findings for post installation of a programmable thermostat, the following electricity savings should be attributed to each installed programmable thermostat:

Savings	*Distribution of Households*	*Natural Gas Savings*
No change in behaviour or no set back	60%	0%
Full change in behaviour - 3 + degrees set back	17%	11%
Partial change in behaviour: 1 -2 degrees set back	23%	5.5%

- Assuming that baseline house is equipped with a SEER 10, 2.5 ton[16] A/C unit and is used 500 hours per year[17], this implies that:

  Base A/C electricity use = 500 (cooling hours)*[30,000 (Btu/hr)/(10 (SEER)* 1,000)] = 1,500 kWh
- NCI estimates the following cooling season electricity savings for each programmable thermostat installed in households with central air conditioning:

  1,500 kWh x (60% x 0% + 17% x11% +23% x 5.5%) = 47 kWh

- However, assuming a penetration rate of central air conditioners in Ontario = 57%[18], NCI estimates that the average home in Ontario will save the following in electricity during the cooling savings:

  57% x 47 kWh = 26.8 kWh

[10] Marbek Resource Consultants, The Sheltair Group Inc , BC Hydro BC Hydro Conservation Potential Review 2002, Residential Sector Report (Base Year: Fiscal 2000/01) (Revision 1) Submitted to: BC Hydro, June 2003
[11] US EPA (EPA Energy Star® Simple Savings Calculator – Programmable Thermostat), http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorProgrammableThermostat.xls
[12] Ontario Power Authority, 2009 OPA Measures and Assumptions Lists (Mass Market), November 2008, referenced from: Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI), 2006 Cool Savings Rebate Program, Prepared for the Ontario Power Authority, April 2007.
[13] US EPA (EPA Energy Star® Simple Savings Calculator – Programmable Thermostat), http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorProgrammableThermostat.xls
[14] Navigant Consulting, Evaluation Report: 2007 Hot and Cool Savings Programs, prepared for the Ontario Power Authority (OPA), July 2008.
[15] Although the survey results did not indicate the change in degree-value in temperature for summer behaviour, Navigant Consulting is assuming it is the same as the winter change in behaviour (e.g., 19% by 3 or more degrees, 81% by 1-2 degrees).
[16] Implying input of 30,000 Btu/hr, Energy Star Savings Calculator, http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls
[17] Number of full-load cooling hours provided by http://energyexperts.org/ac%5Fcalc/ and based on the assumption that Ontario's climate is sufficiently similar to that of the north-eastern U.S.
[18] Natural Resource Canada, Survey of Household Energy Use (SHEU), December 2005

• Total electricity savings for both heating (furnace fan) and cooling savings for an average Ontario home are estimated to be 54 kWh (7 kWh + 47 kWh = 54 kWh).	
Annual Water Savings	**0 L**
N/A	

Other Input Assumptions

Effective Useful Life (EUL)	**15 Years**
Navigant Consulting is estimating 15 years as the effective useful life based on the average lifetime of programmable thermostat from Energy Star ® website.	
Base & Incremental Conservation Measure Equipment and O&M Costs	**$ 25**
Average incremental cost of programmable thermostats determined to be $25 based on average cost of non-programmable and programmable thermostats from Home Depot and Canadian Tire website in 2008.	
Customer Payback Period (Natural Gas Only)[19]	**0.9 Years**
Using an 5-year average commodity cost (avoided cost)[20] of $0.38 / m^3 and an average residential distribution cost[21] of $0.14 / m^3, the payback period for natural gas savings is determined to be 0.9 years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = $25/ (53 m^3/year * $0.52 / m^3) = 0.9 years	
Market Penetration	**65%**
Due to the number of conservation programs in Ontario currently offering programmable thermostats and based on previous research conducted for the OPA[22], Navigant Consulting estimates the penetration of programmable thermostats amongst single family residents in Ontario to be 65%.	

[19] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.
[20] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.
[21] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).
[22] Navigant Consulting, Inc. for the Ontario Power Authority, *Residential Rebate Program: Participation Forecast and Incentive Bundling Strategy – Key Findings Summary*, December 2008

PROGRAMMABLE THERMOSTAT

Residential New Construction - ESK kit, EGD

Efficient Technology & Equipment Description
Programmable thermostat
Base Technology & Equipment Description
Standard thermostat

Resource Savings Assumptions

Natural Gas	**53 m^3**
EB 2009-0154	
Electricity	**54 kWh**
EB 2009-0154	
Water	**n/a L**

Other Input Assumptions

Equipment Life	**15 Years**
EB 2009-0154	
Incremental Cost	**$53.22**
Bulk purchase of programmable thermostats for new construction ESK + Packaging etc.	
Free Ridership	**10 %**
Pre-screening will be conducted to ensure builders who install a programmable thermostat as standard are not targeted. Measure will not be delivered to Energy Star Labeled Homes. A builder survey will be conducted immediately prior to launch of the program in order to capture the majority of builders in the franchise area.	

PROGRAMMABLE THERMOSTAT

Residential Existing, EGD

Efficient Technology & Equipment Description
Programmable thermostat
Base Technology & Equipment Description
Standard manual thermostat

Resource Savings Assumptions

Natural Gas (Updated)	**53 m^3**
Savings recommended by Navigant Consulting.[1]	
Electricity (Updated)	**54 kWh**
Savings recommended by Navigant Consulting.[1]	
Water	**n/a L**

Other Input Assumptions

Equipment Life	**15 years**
Equipment life recommended by Summit Blue Consulting and as approved in EB 2008-0384 & 0385.[1]	
Incremental Cost (Contr. Install) (EGD)	**$50.00**
As per utility program costs.	
Free Ridership	**43 %**
As per EB 2008-0384 & 0385.	

[1] Draft Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, Appendix C: Substantiation Sheets, pg. B-112-115, Feb. 6, 2009.

Heat Reflective Panels, UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
A saw tooth panel made of clear PVC with a reflective surface placed behind a gas radiator reducing heat lost to poorly insulated exterior walls.
Base Equipment and Technologies Description
Existing housing with gas radiant heat with no reflecting panels.

Decision Type	Target Market(s)	End Use
Existing	Existing single family residential homes (pre-1980)	Space Heating

Codes, Standards, and Regulations

No code or standard exists for heat reflective panels.

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	143	0	0	229	0
2	143	0	0	0	0
3	143	0	0	0	0
4	143	0	0	0	0
5	143	0	0	0	0
6	143	0	0	0	0
7	143	0	0	0	0
8	143	0	0	0	0
9	143	0	0	0	0
10	143	0	0	0	0
11	143	0	0	0	0
12	143	0	0	0	0
13	143	0	0	0	0
14	143	0	0	0	0
15	143	0	0	0	0
16	143	0	0	0	0
17	143	0	0	0	0
18	143	0	0	0	0
TOTALS	**2,574**	**0**	**0**	**229**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	143 m^3
A 2006 Enbridge Gas Distribution Load Research Study[1] reports an average boiler consumption of 3,493 m^3 for single family homes. A 2008 heat reflective panel pilot study conducted by Enbridge determined an annual gas savings of 4.1% in a single family environment[2]. Applying this savings to the average annual gas consumption results in an annual gas savings of 143 m^3 (3,493 m^3 x 4.1%).	
Annual Electricity Savings	**0 kWh**
No electricity savings result from heat reflective panels.	
Annual Water Savings	**0 L**
No water savings result from heat reflective panels.	

Other Input Assumptions

Effective Useful Life (EUL)	18 Years
Reflective panels are assumed to have the same effective useful life as a furnace. The US DOE reports an 18 year measure life for gas furnaces, according to a Lawrence Berkeley National Laboratory study[3]. Furthermore, ACEEE[4] and State of Iowa[5] both estimate an effective useful life of furnaces to be 18 years. Puget Sound Energy[6] and New England State Program Working Group (SPWG)[7] also suggest 18 years for high efficiency furnaces.	
Base & Incremental Conservation Measure Equipment and O&M Costs	**$229**
The manufacturer of heat reflective panels, Novitherm, provides the average price for reflectors in a single family home (typically installed by the homeowner)[8].	
Customer Payback Period (Natural Gas Only)	**3.1 Years**
Using an 5-year average commodity cost (avoided cost)[9] of \$0.38 / m^3 and an average residential distribution cost[10] of \$0.14 / m^3, the payback period for natural gas savings is determined to be 3.1 years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = \$229/ (143 m^3/year * \$0.52 / m^3) = 3.1 years	

[1] Enbridge Gas Distribution. Residential Boiler Consumption Research: Summary.
[2] Ibid.
[3] US DOE Energy Star Program. Lifecycle Cost Estimate for an Energy Star Qualified Residential Furnace. Assumptions Tab. http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_Furnaces.xls
[4] Powerful Priorities: Updating Energy Efficiency Standards for Residential Furnaces, Commercial Air Conditioners, and Distribution Transformers. ACEEE, September 2004.
[5] Joint Assessment Study, MidAmerican Energy Company, Appendix C. State of Iowa Utilities Board Docket No. EEP-08-2, 2008, C-131
[6] Quantec, Comprehensive Demand-Side Management Resource Assessment, Prepared for Puget Sound Energy, May 2007
[7] GDS Associates, Inc., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, Prepared for The New England State Program Working Group (SPWG), For use as an Energy Efficiency Measures/Programs Reference Document for the ISO Forward Capacity Market (FCM), June 2007
[8] Novitherm Heat Reflectors, Residential - Reduce Heating Costs www.novitherm.com, Cost excludes any additional shipping requirements.
[9] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.
[10] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).

Market Penetration[11]	Low
Given the relative novelty of this technology, Navigant Consulting estimates the penetration in Ontario to be low.	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/ Market Share
N/A	N/A	N/A	N/A	N/A
Comments N/A				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/ Market Share**
N/A	N/A	N/A	N/A	N/A
Comments N/A				

[11] Navigant Consulting is defining "Low" as below 5%, "Medium" as between 5-50%, and "High" as above 50%,

HEAT REFLECTOR PANELS

Residential Existing Homes, EGD

Efficient Technology & Equipment Description
A saw tooth panel made of clear PVC with a reflective surface placed behind a radiator, thereby reducing heat lost to poorly insulated exterior walls.
Base Technology & Equipment Description
Existing housing with radiant heat with no reflector panels.

Resource Savings Assumptions

Natural Gas	**143 m^3**
As approved in EB 2008-0346.	
Electricity	**kWh**
Water	**L**

Other Input Assumptions

Equipment Life	**18 Years**
As approved in EB 2008-0346	
Incremental Cost (Customer Install)	**$238**
As per utility program costs. (Cost of panels plus shipping)	
Free Ridership	**0 %**
Product not currently available to end-use consumers through typical retail channels. As approved in EB 2008-0346 & 0385.	

Residential Water Heating

1.5 GAL/MIN FAUCET AERATOR (BATHROOM)

Residential New Construction – ESK kit, EGD

Efficient Technology & Equipment Description
Faucet Aerator (Bathroom) (1.5 GPM)
Base Technology & Equipment Description
Average existing stock (2.2 GPM)

Resource Savings Assumptions

Natural Gas	**18 m^3**
6 m3 x 3 aerators being installed as approved in EB 2009-0154.	
Electricity	**n/a kWh**
Water	**6012 L**
2004 L x 3 aerators being installed as approved in EB 2009-0154.	

Other Input Assumptions

Equipment Life	**10 Years**
EB 2009-0154	
Incremental Cost (Installed)	**$2.72**
Bulk purchase for bathroom aerators for new construction ESK + Packaging x 3 aerators being installed.	
Free Ridership	**31 %**
EB 2009-0154	

1.0 GAL/MIN FAUCET AERATOR (BATHROOM)

Residential New/Existing Homes, UG

Efficient Technology & Equipment Description
Faucet Aerator (Bathroom) (1.0 GPM)
Base Technology & Equipment Description
Average existing stock & Ontario Building Code 2006 (2.2 GPM)

Resource Savings Assumptions

Natural Gas (Updated)	**10 m^3**
Savings recommended by Navigant Consulting[1] adjusted for 1.0 GPM efficient technology	
Electricity	**n/a kWh**
Water (Updated)	**3,435 L**
Savings recommended by Navigant Consulting[1] adjusted for 1.0 GPM efficient technology	

Other Input Assumptions

Equipment Life	**10 Years**
Faucet aerators have an estimated service life of 10 years.[1, 2] As approved in EB 2008-0384 & EB 2008-0385.	
Incremental Cost	**$0.59**
As per utility program costs, bulk purchase of aerators.	
Free Ridership	**33 %**
Free Ridership rate recommended by Summit Blue Consulting.[3] As approved in EB 2008-0384 & EB 2008-0385.	

[1] Final Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, April 16, 2009

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

[3] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

1.0 GAL/MIN FAUCET AERATOR (BATHROOM)

Residential, Existing, UG

Efficient Technology & Equipment Description
Faucet Aerator (Bathroom) (1.0 GPM)
Base Technology & Equipment Description
1.5 GPM (Participants who previously received a 1.5gpm Bathroom Faucet Aerator from Union)

Resource Savings Assumptions

Natural Gas (Updated)	**4 m^3**
Savings recommended by Navigant Consulting[1] adjusted for 1.0 GPM efficient technology. 1.0 efficient - 2.2 basecase GPM; GPM savings = 1.2 ΔGPM 1.0 efficient - 1.5 basecase GPM; GPM savings = 0.5 ΔGPM Savings ratio: 0.5/1.2 = 41.7% or a 58.3% drop in gas (m3/yr) savings from the 1.0 GPM (2.2 basecase) measure. 4 m3/yr = 41.7% * 10 m3/yr	
Electricity	**n/a kWh**
Water (Updated)	**1,432 L**
Savings recommended by Navigant Consulting[1] adjusted for 1.0 GPM efficient technology. 1.0 efficient - 2.2 base GPM; GPM savings = 1.2 ΔGPM 1.0 efficient - 1.5 base GPM; GPM savings = 0.5 ΔGPM Savings ratio: 0.5/1.2 = 41.7% or a 58.3% drop in water (L/yr) savings from the 1.0 GPM (2.2 basecase) measure. 1,432 L/yr = 41.7% * 3,435 L/yr	

Other Input Assumptions

Equipment Life	**10 Years**
Faucet aerators have an estimated service life of 10 years.[1, 2] As approved in EB 2008-0384 & EB 2008-0385.	

Incremental Cost	**$0.59**
As per utility program costs, bulk purchase of aerators.	
Free Ridership	**33 %**
Free Ridership rate recommended by Summit Blue Consulting.[3] As approved in EB 2008-0384 & 0385.	

[1] Final Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, April 16, 2009

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

[3] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

1.5 GAL/MIN FAUCET AERATOR (BATHROOM)

Residential New/Existing Homes, UG

Efficient Technology & Equipment Description
Faucet Aerator (Bathroom) (1.5 GPM)
Base Technology & Equipment Description
Average existing stock & Ontario Building Code 2006 maximum allowed (2.2 GPM)

Resource Savings Assumptions

Natural Gas (Updated)	**6 m^3**
Savings recommended by Navigant Consulting.[1]	
Electricity	**n/a kWh**
Water (Updated)	**2,004 L**
Savings recommended by Navigant Consulting.[1]	

Other Input Assumptions

Equipment Life	**10 Years**
Faucet aerators have an estimated service life of 10 years.[1, 2] As approved in EB 2008-0384 & 0385.	
Incremental Cost	**$0.49**
As per utility program costs, bulk purchase of aerators.	
Free Ridership	**33 %**
Free Ridership rate recommended by Summit Blue Consulting.[3] As approved in EB 2008-0384 & 0385.	

[1] Final Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, April 16, 2009

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

[3] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

1.0 GAL/MIN FAUCET AERATOR (KITCHEN)

Residential New Homes, UG

Efficient Technology & Equipment Description
Faucet Aerator (Kitchen) (1.0 GPM)
Base Technology & Equipment Description
Ontario Building Code 2006 (2.2 GPM)

Resource Savings Assumptions

Natural Gas	**32 m^3**
Savings based on the Navigant Report[1], except using 2.2 USGPM base case (opposed to 2.5) and 1.0 GPM efficient technology case	
Electricity	**n/a kWh**
Water	**10,631 L**
Savings based on the Navigant Report[1], except using 2.2 USGPM base case (opposed to 2.5) and 1.0 GPM efficient technology case	

Other Input Assumptions

Equipment Life	**10 years**
Faucet aerators have an estimated service life of 10 years.[2] As approved in EB 2008-0384 & EB 2008-0385.	
Incremental Cost	**$1.59**
As per utility program costs, bulk purchase of aerators.	
Free Ridership	**33 %**
Free Ridership rate recommended by Summit Blue Consulting.[3] As approved in EB 2008-0384 & EB 2008-0385.	

[1] Final Report “Measures and Assumptions for Demand Side Management (DSM) Planning”, Navigant Consulting Inc., Ontario Energy Board, Appendix C: Substantiation Sheets, pg. C60-63, April 16, 2009.

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

[3] “Residential Measure Free Ridership And Inside Spillover Study - Final Report”, Summit Blue Consulting, June 2008.

1.0 GAL/MIN FAUCET AERATOR (KITCHEN)

Residential Existing Homes, UG

Efficient Technology & Equipment Description
Faucet Aerator (Kitchen) (1.0 GPM)
Base Technology & Equipment Description
Average existing stock – 2.5 GPM Faucet Aerator (Kitchen)

Resource Savings Assumptions

Natural Gas	**35 m^3**
Savings based on the Navigant Report[1], except using a 1.0 GPM efficient technology case	
Electricity	**n/a kWh**
Water	**11,694 L**
Savings based on the Navigant Report[1], except using a 1.0 GPM efficient technology case	

Other Input Assumptions

Equipment Life	**10 years**
Faucet aerators have an estimated service life of 10 years.[2] As approved in EB 2008-0384 & EB 2008-0385.	
Incremental Cost	**$1.59**
As per utility program costs, bulk purchase of aerators.	
Free Ridership	**33 %**
Free Ridership rate recommended by Summit Blue Consulting.[3] As approved in EB 2008-0384 & EB 2008-0385.	

[1] Final Report “Measures and Assumptions for Demand Side Management (DSM) Planning”, Navigant Consulting Inc., Ontario Energy Board, Appendix C: Substantiation Sheets, pg. C60-63, April 16, 2009.

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

[3] “Residential Measure Free Ridership And Inside Spillover Study - Final Report”, Summit Blue Consulting, June 2008.

Faucet Aerator (Residential Kitchen), UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description

Faucet Aerator (kitchen) (1.5 GPM)

Base Equipment and Technologies Description

Average existing stock (2.5 GPM)[1]

Decision Type	Target Market(s)	End Use
Retrofit	Residential (existing)	Water heating

Codes, Standards, and Regulations

Ontario Building Code (2006)[2] requires bathroom and kitchen faucets to have a maximum flow of 2.2 GPM (8.35 L/min).

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	23	0	7,797	1.29	
2	23	0	7,797	0	0
3	23	0	7,797	0	0
4	23	0	7,797	0	0
5	23	0	7,797	0	0
6	23	0	7,797	0	0
7	23	0	7,797	0	0
8	23	0	7,797	0	0
9	23	0	7,797	0	0
10	23	0	7,797	0	0
TOTALS	**230**	**0**	**77,970**	**1.29**	

[1] From on-site audit data. Resource Management Strategies, Inc. *Regional Municipality of York Water Efficiency Master Plan Update,* 2007. Cited in: Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, June 2008.

[2] Ontario Regulations 350/06, 2006 Building Code

Resource Savings Assumptions

Annual Natural Gas Savings	23 m^3

Assumptions and inputs:

- Average faucet water temperature: 30 °C (86 °F)[3]
- Average water inlet temperature: 9.33 °C (48.8 °F)[4]
- Average water heater energy factor: 0.76[5]

Annual gas savings calculated as follows:

$$Savings = W * 8.33 * (T_{out} - T_{in}) * \frac{1}{EF} * 10^{-6} * 27.8$$

Where:

W = Water savings (gallons)
8.33 = Energy content of water (Btu/gallon/°F)
T_{out} = Faucet water temperature (°F)
T_{in} = Water inlet temperature (°F)
EF = Water heater recovery efficiency
10^{-6} = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to m^3

Gas savings were determined to be 20% over base case:

$$Percent\ Savings = \frac{(G_{base} - G_{new})}{G_{base}}$$

Where:

G_{eff} = Annual natural gas use with efficient equipment, 94 m^3
G_{base} = Annual natural gas use with base equipment, 117 m^3

Annual Electricity Savings	0 kWh

N/A

Annual Water Savings	7,797 L

Assumptions and inputs:

- Average household size: 3.1 persons[6]
- Baseline faucet use (all faucets) per capita per day: 53 litres (14 gallons)[7]
- Kitchen faucet use as a percentage of total faucet use: 65%[8]
- Point estimate of quantity of water that goes straight down the drain: 50%[9]

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[3] Average of findings in two studies, adjusted for Toronto inlet temperature. Mayer, P. W. et al, *Residential Indoor Water Conservation Study: Evaluation of High Efficiency Indoor Plumbing Fixture Retrofits in Single-Family Homes in East Bay Municipal Utility District Service Area,* 2003 and Skeel, T. and Hill, S. *Evaluation of Savings from Seattle's "Home Water Saver" Apartment/Condominium Program*, 1994. Both cited in: Summit Blue (2008).

[4] Cited in the following as personal communication with City of Toronto Works Dept.
VEIC, *Comments on Navigant's Draft Gas Measure Characterizations*, March 2009

[5] Assumption used by Energy Center Wisconsin,citing GAMA,
Pigg, Scott. *Water Heating Savings Calculator,* 2003. www.doa.state.wi.us/docs_view2.asp?docid=2249

[6] Summit Blue (2008).

[7] Ibid.

[8] DeOreo, W. and P. Mayer, *The End Uses of Hot Water in Snigle Family Homes from Flow Trace Analysis*, 1999 cited in Summit Blue (2008).

[9] Summit Blue (2008).

Annual water savings calculated as follows:

$$Savings = Fu * Ppl * 365 * Ba * \left(\frac{Fl_{base} - Fl_{eff}}{Fl_{base}} \right) * Dr$$

Where:

Fu = Faucet use per capita (gallons)
Ppl = Number of people per household
365 = Days per year
Dr = Percentage of water that goes straight down the drain
Ki = Kitchen faucet use as a percentage of total faucet use
Fl_{base} = Flow rate of base equipment (GPM)
Fl_{eff} = Flow rate of efficient equipment (GPM)

Water savings was determined to be 20% over base case:

$$Percent Savings = \frac{(W_{base} - W_{eff})}{W_{base}}$$

Where:

W_{eff} = Annual water use with efficient equipment: 38,986 litres (10,297 gallons)
W_{base}= Annual water use with base equipment: 31,188 litres (8,237 gallons)

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
The U.S. DOE assumes a 10 year life for faucet aerators[10].	
Base & Incremental Conservation Measure Equipment and O&M Costs	**1.29 $**
Average equipment cost based on utility bulk purchase order costs.This does not include installation costs.	
Customer Payback Period (Natural Gas Only)[11]	**0.11 Years**

Using a 5-year average commodity cost (avoided cost)[12] of $0.38 / m^3 and an average residential distribution cost[13] of $0.14 / m^3, the payback period for natural gas savings is determined to be 0.17 years, based on the following:

Payback Period = Incremental cost / (natural gas savings x natural gas cost)
= $1.29/ (23 m^3/year * $0.52 / m^3)
= 0.11 years

[10] U.S. Department of Energy, Federal Energy Management Program, *FEMP Designated Product: Lavatory Faucets* http://www1.eere.energy.gov/femp/procurement/eep_faucets.html

[11] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.

[12] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.

[13] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).

Market Penetration	90%
Based on previous research conducted for the OPA, Navigant Consulting estimates penetration of faucet aerators (bathroom and kitchen) across all sectors to be 90%[14].	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Puget Sound Energy[15]	8	5	N/A	45%
Comments For a switch from a 2.5 GPM to a 1.8 GPM aerator. Measure saves 1% of 759 m^3 required for water heating. Note that no distinction is made, in this study, between kitchen and bathroom faucet use.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/Market Share**
State of Iowa Utilities Board[16]	32	9	20 US$	90%
Comments For a switch from a 3.0 GPM to a 1.5 GPM aerator. Measure saves 6.2% of 514 m^3 required for water heating. Note that no distinction is made, in this study, between kitchen and bathroom faucet use. Note also that the flow rate reduction for this jurisdiction is more than twice that of the measure addressed by this substantiation sheet.				

[14] Navigant Consulting, Inc. for the Ontario Power Authority, *Residential Rebate Program: Participation Forecast and Incentive Bundling Strategy – Key Findings Summary*, December 2008
[15] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy
[16] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2

1.5 GAL/MIN FAUCET AERATOR (KITCHEN)

Residential New Homes, UG

Efficient Technology & Equipment Description
Faucet Aerator (Kitchen) (1.5 GPM)
Base Technology & Equipment Description
Ontario Building Code 2006 (2.2 GPM)

Resource Savings Assumptions

Natural Gas	**19 m^3**
Savings based on the Navigant Report[1], except using 2.2 USGPM base case (opposed to 2.5 GPM)	
Electricity	**n/a kWh**
Water	**6,201 L**
Savings based on the Navigant Report[1], except using 2.2 USGPM base case (opposed to 2.5 GPM)	

Other Input Assumptions

Equipment Life	**10 years**
Faucet aerators have an estimated service life of 10 years.[2] As approved in EB 2008-0384 & EB 2008-0385.	
Incremental Cost	**$1.29**
As per utility program costs, bulk purchase of aerators.	
Free Ridership	**33 %**
Free Ridership rate recommended by Summit Blue Consulting.[3] As approved in EB 2008-0384 & EB 2008-0385.	

[1] Final Report “Measures and Assumptions for Demand Side Management (DSM) Planning”, Navigant Consulting Inc., Ontario Energy Board, April 16, 2009

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

[3] “Residential Measure Free Ridership And Inside Spillover Study - Final Report”, Summit Blue Consulting, June 2008.

1.0 GAL/MIN FAUCET AERATOR (Bathroom)

Residential New Construction, EGD

Efficient Technology & Equipment Description
Faucet Aerator (Bathroom) (1.0 GPM)
Base Technology & Equipment Description
Average existing stock & Ontario Building Code 2006 maximum allowed (2.2 GPM)

Resource Savings Assumptions

Natural Gas (Updated)	10	m^3
Savings recommended by Navigant Consulting. [1] adjusted for 1.0 GPM		
Electricity	n/a	kWh
Water (Updated)	3,435	L
Savings recommended by Navigant Consulting[1] adjusted for 1.0 GPM		

Other Input Assumptions

Equipment Life	10	Years
Faucet aerators have an estimated service life of 10 years.[1, 2] As approved in EB 2008-0384 & 0385.		
Incremental Cost	$0.55	
As per utility program costs, bulk purchase of aerators.		
Free Ridership	31	%
Free Ridership rate recommended by Summit Blue Consulting.[3] As approved in EB 2008-0384 & 0385.		

[1] Final Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, April 16, 2009

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

[3] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

1.0 GAL/MIN FAUCET AERATOR (BATHROOM)

Residential Existing Homes, EGD

Efficient Technology & Equipment Description
Faucet Aerator (Bathroom) (1.0 GPM)
Base Technology & Equipment Description
Average existing stock & Ontario Building Code 2006 maximum allowed (2.2 GPM)

Resource Savings Assumptions

Natural Gas (Updated)	**10 m^3**
Savings recommended by Navigant Consulting.[1] adjusted for 1.0 GPM	
Electricity	**n/a kWh**
Water (Updated)	**3,435 L**
Savings recommended by Navigant Consulting[1] adjusted for 1.0 GPM	

Other Input Assumptions

Equipment Life	**10 Years**
Faucet aerators have an estimated service life of 10 years.[1, 2] As approved in EB 2008-0384 & 0385.	
Incremental Cost	**$0.55**
As per utility program costs, bulk purchase of aerators.	
Free Ridership	**31 %**
Free Ridership rate recommended by Summit Blue Consulting.[3] As approved in EB 2008-0384 & 0385.	

[1] Final Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, April 16, 2009

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

[3] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

1.5 GAL/MIN FAUCET AERATOR (BATHROOM)

Residential Existing Homes, EGD

Efficient Technology & Equipment Description
Faucet Aerator (Bathroom) (1.5 GPM)
Base Technology & Equipment Description
Average existing stock (2.2 GPM)

Resource Savings Assumptions

Natural Gas	**6 m^3**
As approved in EB 2008-0346	
Electricity	**n/a kWh**
Water (Updated)	**2,004 L**
As approved in EB 2008-0346	

Other Input Assumptions

Equipment Life	**10 Years**
As approved in EB 2008-0346	
Incremental Cost (Cust. Install) (EGD)	**$1**
As per utility program costs, bulk purchase of aerators.	
Free Ridership (EGD)	**31 %**
Free Ridership rate recommended by Summit Blue Consulting.[1] As approved in EB 2008-0384 & 0385.	

[1] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

1.0 GAL/MIN FAUCET AERATOR (Kitchen)

Residential New Construction, EGD

Efficient Technology & Equipment Description
Faucet Aerator (Kitchen) (1.0 GPM)
Base Technology & Equipment Description
Ontario Building Code 2006 (2.2 GPM)

Resource Savings Assumptions

Natural Gas	32 m^3
Savings based on Navigant's[1], except using 2.2 USGPM base case (opposed to 2.5) and 1.0 GPM efficient technology case	
Electricity	n/a kWh
Water	10,631 L
Savings based on Navigant's[1], except using 2.2 USGPM base case (opposed to 2.5) and 1.0 GPM efficient technology case	

Other Input Assumptions

Equipment Life	10 years
Faucet aerators have an estimated service life of 10 years.[2] As approved in EB 2008-0384 & 0385.	
Incremental Cost	$1.00
As per utility program costs, bulk purchase of aerators.	
Free Ridership	31 %
Free Ridership rate recommended by Summit Blue Consulting.[3] As approved in EB 2008-0384 & 0385.	

[1] Final Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, Appendix C: Substantiation Sheets, pg. C60-63, April 16, 2009.

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

[3] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

1.0 GAL/MIN FAUCET AERATOR (KITCHEN)

Residential Existing Homes, EGD

Efficient Technology & Equipment Description
Faucet Aerator (Kitchen) (1.0 GPM)
Base Technology & Equipment Description
Average existing stock – 2.5 GPM Faucet Aerator (Kitchen)

Resource Savings Assumptions

Natural Gas	**35 m^3**
Savings based on Navigant's[1], except using a 1.0 GPM efficient technology case	
Electricity	**n/a kWh**
Water	**11,694 L**
Savings based on Navigant's[1], except using a 1.0 GPM efficient technology case	

Other Input Assumptions

Equipment Life	**10 years**
Faucet aerators have an estimated service life of 10 years.[2] As approved in EB 2008-0384 & 0385.	
Incremental Cost	**$1.00**
As per utility program costs, bulk purchase of aerators.	
Free Ridership	**31 %**
Free Ridership rate recommended by Summit Blue Consulting.[3] As approved in EB 2008-0384 & 0385.	

[1] Final Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, Appendix C: Substantiation Sheets, pg. C60-63, April 16, 2009.

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

[3] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

1.5 GAL/MIN FAUCET AERATOR (KITCHEN)

Residential New Construction – ESK kit, EGD

Efficient Technology & Equipment Description
Faucet Aerator (Kitchen) (1.5 GPM)
Base Technology & Equipment Description
Average existing stock (2.5 GPM)

Resource Savings Assumptions

Natural Gas	**23 m^3**
EB 2009-0154	
Electricity	**n/a kWh**
Water	**7,797 L**
EB 2009-0154	

Other Input Assumptions

Equipment Life	**10 Years**
EB 2009-0154	
Incremental Cost (Installed)	**$1.65**
Bulk purchase of kitchen aerators for new construction ESK + Packaging	
Free Ridership	**31 %**
EB 2009-0154	

1.5 GAL/MIN FAUCET AERATOR (KITCHEN)

Residential Existing Homes, EGD

Efficient Technology & Equipment Description
Faucet Aerator (Kitchen) (1.5 GPM)
Base Technology & Equipment Description
Average existing stock (2.5 GPM)

Resource Savings Assumptions

Natural Gas	**23 m^3**
As approved in EB 2008-0346	
Electricity	**n/a kWh**
Water (Updated)	**7,797 L**
As approved in EB 2008-0346	

Other Input Assumptions

Equipment Life	**10 years**
As approved in EB 2008-0346	
Incremental Cost (Cust. Install) (EGD)	**$1**
As per utility program costs, bulk purchase of aerators.	
Free Ridership (EGD)	**31 %**
Free Ridership rate recommended by Summit Blue Consulting.[1] As approved in EB 2008-0384 & 0385.	

[1] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

Low-Flow Showerhead (Various GPM, Enbridge TAPS, ESK and Multi-Family), EGD

Revision #	Description/Comment	Date Revised
		September 20, 2010

Efficient Equipment and Technologies Description	
Low-flow Showerhead (1.25 or 1.5 GPM) – distributed to participants under Enbridge's TAPS program, Enbridge's ESK program, Enbridge's Multi-Family program and Enbridge's Low-Income program.	
Base Equipment and Technologies Description	
Enbridge TAPS (existing only)	– 2.45 GPM or – 3.07 GPM[1]
Enbridge ESK (new only)	– Maximum allowable by OBC (2.5 GPM)
Enbridge Multi-Family (MF) (existing only)	– 2.25 GPM – 2.8 GPM – 3.3 GPM – 3.6 GPM[2]
Enbridge Multi-Family (MF) (new only)	– Maximum allowable by OBC (2.5 GPM)
Enbridge Low-Income	– 2.45 GPM or – 3.07[3]

Decision Type	Target Market(s)	End Use
Enbridge TAPS - Existing, Enbridge ESK – New Only, Enbridge MF – New and Existing	Residential, Low-Income, Multi-family	Water heating

[1] Enbridge load research indicates that that the average bag-tested flow rate for showerheads that fall within the 2.0 – 2.5 GPM bucket is 2.45 GPM and that the average bag-tested flow rate for showerheads that fall within the >2.5 GPM bucket is 3.07.

[2] Enbridge contractors install the showerheads as part of the Enbridge Multi-Family program. The base measure is reported as falling in one of four buckets, 2.0 – 2.5 GPM, 2.6 – 3.0 GPM, 3.1 – 3.5 GPM and greater than 3.6 GPM. Navigant has assumed that in each case the average base technology GPM for each of the first three buckets is the mid-point and that the average GPM for the fourth bucket is the lowest possible value; 3.6 GPM

[3] The average GPM of low-income households' showerheads is assumed by Navigant to be no different than that of standard single family households'.

Codes, Standards, and Regulations

Ontario Building Code (2006)[4] requires shower heads to have a maximum flow of 2.5 GPM (9.5 L/min).

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	21 – 82	0	5,931 – 23,374	6	0
2	21 – 82	0	5,931 – 23,374	0	0
3	21 – 82	0	5,931 – 23,374	0	0
4	21 – 82	0	5,931 – 23,374	0	0
5	21 – 82	0	5,931 – 23,374	0	0
6	21 – 82	0	5,931 – 23,374	0	0
7	21 – 82	0	5,931 – 23,374	0	0
8	21 – 82	0	5,931 – 23,374	0	0
9	21 – 82	0	5,931 – 23,374	0	0
10	21 – 82	0	5,931 – 23,374	0	0
TOTALS	**215 - 815**	**0**	**59,307 – 233,744**	**EG TAPS 1.25 GPM = $19.00** **EG LI 1.25 GPM = $18.71** **EG ESK 1.25 GPM = $4.26** **EG ESK 1.5 GPM = $12.50** **EG ESK 1.5 & 1.25 GPM = $16.76** **EG Multi-Fam 1.5 GPM = $12.50** **EG Multi-Fam 1.25 GPM = $12.50**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	21 – 82 m^3

Enbridge Gas commissioned a study by the SAS Institute (Canada)[5] to estimate natural gas savings for low-flow showerheads in Enbridge territory. Data was collected August 31, 2007 until August 31, 2009 for both treatment and control groups. Low flow showerheads were installed in treatment households between August 13, 2008 and October 30, 2008. There were 54 households with low-flow showerheads and 124 households without low-flow showerheads.

To calculate the gas savings, three different models were used to analyze the gas consumption data

1) a comparison made during the same time frame (post-installation) between a control set of households[6] and households that had them installed
2) a Pre & Post installation analysis on the same households, and
3) a complex time trend model analysis that factored in many household characteristics over the whole Pre & Post time period.

All three analyses agreed well with each other.[7]

Three buckets for pre-existing showerheads were originally proposed. However, the lowest flow bucket (2.0 GPM or less) had too few observations and are rare in the population of households. The natural gas savings for the other two buckets are estimated to be as follows:

[4] Ontario Regulations 350/06, 2006 Building Code
[5] Rothman, Lorne, SAS® PHASE II Analysis for Enbridge Gas Distribution Inc.: Estimating the Impact of Low-Flow Showerhead Installation; April 5, 2010
[6] Where no low-flow showerheads were ever installed
[7] Model 1 – a blended rate of 71.3 m3/yr (only models II and II provided bucketed savings estimates)
Model 2 – a blended rate of 67.4 m3/yr (45.4 m3/yr for 2 to 2.5 GPM bucket and 87.8 m3/yr for over 2.5 GPM), and
Model 3 – a blended rate of 77.2 m3/yr (46.4 m3/yr for 2 to 2.5 GPM bucket and 87.9 m3/yr for over 2.5 GPM).

Table 1 - SAS Study Results

Bucket for Base Showerhead	Average Flow Rate of SAS Sample (GPM)	Annual Natural Gas Savings (m3)
2.0 to 2.5 GPM	2.36	46
> 2.5 GPM	3.19	88

To extrapolate the savings estimates reported in the SAS study to the base technologies under consideration several steps are required.

1. Estimate the "as-used" flow of the base and efficient technologies.

In its report on showerhead savings, Summit Blue[8], notes that the actual flow-rate as used in showers has been found to differ somewhat from the nominal flow-rate. Citing a 1994 California study, they provide an equation for calculating the "as-used" flow:

As-used flow rate (GPM) = 0.691 + 0.542*Nominal flow rate (GPM)

Navigant notes that applying this equation to a showerhead with a 1.25 GPM flow rate would result in an as-used flow rate that is greater than the nominal flow rate. Navigant has therefore applied a somewhat modified version of the equation above to determine the as-used flow rate. The as-used flow rate is estimated to be the minimum of either the result of the equation above or the nominal flow rate.

Applying the modified equation to Table 1, above, we obtain the following:

Table 2 - As-Used Flow

Nominal Flow (GPM)		As-Used Flow (GPM)		Delta As-Used Flow (GPM)	Observed Savings (m^3)
Base Technology	Efficient Measure	Base Technology	Efficient Measure		
2.36	1.25	1.97	1.25	0.72	46
3.19	1.25	2.42	1.25	1.17	88

2. Estimate the average annual natural gas consumption of a 1.25 GPM showerhead.

Based on the values above, Navigant has estimated that the annual natural gas consumption of the 1.25 GPM showerhead is 87 m^3 per year.

Table 3 - Annual Natural Gas Consumption of a 1.25 GPM Showerhead

Delta As-Used Flow (GPM)	Observed Savings (m^3)	Efficient Technology As-Used Flow (GPM)	Implied Annual Gas Consumption of Efficient Technology (m^3)	Average (m^3)
A	B	C	D = (C/A)*B	E = Average(D)
0.72	46	1.25	80	87
1.17	88	1.25	94	

8 Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, prepared for Union Gas and Enbridge Gas Distribution, June 2008

3. Extrapolate the implied annual natural gas consumption of showerheads in both buckets identified by the SAS Institute.

Extrapolating these values is simply a matter of adding the estimated savings by bucket to the estimated annual consumption of the 1.25 GPM showerhead.

Table 4 - Implied Annual Natural Gas Consumption by Showerhead Flow Rate

Nominal Flow Rate (GPM)	Implied Annual Natural Gas Consumption (m3)
1.25	87
2.36	133
3.19	175

4. Estimate an equation from which the annual natural gas consumption of showerheads with flow rates different to those above may be extrapolated.

Fitting a polynomial equation to the three data-points in Table 4 above delivers the following equation which may be used to extrapolate the annual natural gas consumption of a given showerhead:

$$y = 49.06 + 24.39x + 4.72x^2$$

Where:

y = Annual natural gas consumption (m^3)
x = Nominal GPM of showerhead

Navigant notes that given the manner in which this equation was derived, and the values of the parameters, it may be inappropriate to use this equation to extrapolate the annual natural gas consumption of showerheads with a nominal flow rate that is less than 1.25 GPM.

In multi-family homes, Navigant has adjusted savings based on number of occupants per household to reflect differences in patterns of use. The adjustment factor is the fraction of average number of occupants per household in an apartment building over the average number of occupants per household in a single-detached house[9]. This factor is (2/2.9) = 69% for buildings over 5 stories and (1.9/2.9) = 66% for buildings of five stories or less. The average of these two factors, weighted by the number of each type of household is 68%.

It should be noted that the savings below are per household and predicated on the assumption that all showers taken in that household are taken using a shower with the low-flow showerhead. In the program measurement and verification stage, Enbridge will undertake to determine what proportion of showers per household were taken with the efficient measure and apply this factor to previously calculated savings.

[9] Statistics Canada. *Structural Type of Dwelling (10) and Household Size (9) for Occupied Private Dwellings of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2006 Census - 100% Data* (Table) *Census 2006.* Last updated Dec 6, 2008.
http://www12.statcan.ca/english/census06/data/topics/RetrieveProductTable.cfm?ALEVEL=3&APATH=3&CATNO=&DETAIL=0&DIM=&DS=99&FL=0&FREE=0&GAL=0&GC=99&GID=837983&GK=NA&GRP=1&IPS=&METH=0&ORDER=1&PID=89071&PTYPE=88971&RL=0&S=1&SUB=0&ShowAll=No&StartRow=1&Temporal=2006&Theme=69&VID=0&VNAMEE=&VNAMEF=

Table 5 - Natural Gas Savings

Program	Applicable Customer Group	Base Flow Rate	Efficient Measure Flow Rate	Annual Gas Savings (m^3)	Lifetime Gas Savings (m^3)
EG TAPS	Standard Res	2.45	1.25	50	502
EG TAPS	Standard Res	3.07	1.25	82	815
EG Low-Income	LIA	2.45	1.25	50	502
EG Low-Income	LIA	3.07	1.25	82	815
EG ESK (New Only)	Standard Res	2.50	1.25	53	526
EG ESK (New Only)	Standard Res	2.50	1.50	43	433
EG ESK (New Only)	Standard Res	2.50	1.25 & 1.5*	48	480
EG MF (New Only)	Multi-Family	2.50	1.25	36	358
EG MF (New Only)	Multi-Family	2.50	1.50	29	294
EG MF	Multi-Family	2.25	1.50	21	215
EG MF	Multi-Family	2.80	1.50	40	395
EG MF	Multi-Family	3.30	1.50	58	576
EG MF	Multi-Family	3.60	1.50	69	692

** Participants in Enbridge's ESK program receive both a 1.25 and 1.5 GPM showerhead. Navigant has assumed that both are used equally and that resultant household savings are equivalent to the average savings of a household that receives only 1.5 GPM showerheads and a household that receives only 1.25 GPM showerheads. Enbridge has indicated that in the future new households may receive either only 1.5 or 1.25 GPM showerheads. These households would attain the corresponding savings shown above.*

Annual Electricity Savings	**0 kWh**

N/A

Annual Water Savings	**5,931 – 23,374 L**

Since the SAS report did not look at water savings, Navigant Consulting proposes the following method for calculating resulting water savings:

Assumptions and inputs:

- As-used flow rate with base and efficient equipment:

Base Technology	
Nominal GPM	As-Used GPM
2.45	2.02
3.07	2.35
2.5	2.05
2.25	1.91
2.8	2.21
3.3	2.48
3.6	2.64

Efficient Technology	
Nominal GPM	As-Used GPM
1.25	1.25
1.5	1.50

- Average household size: 3.1 persons (Standard Res and LIA)[10], 2.09 persons (Multi-family)[11]

[10] Summit Blue (2008).

[11] To maintain consistency with Summit Blue number but to reflect the fact that apartments are generally occupied by fewer people than houses, the Summit Blue number was degraded by the ratio of the average number of inhabitants per apartment (1.96) to the average number of inhabitants of a fully detached house in Ontario (2.9). Statistics Canada. No date. *Structural Type of Dwelling (10) and Household Size (9) for Occupied Private Dwellings of Canada, Provinces, Territories, Census Metropolitan Areas and*

- Showers per capita per day: 0.75[12]
- Average showering time per capita per day with base and efficient equipment[13]:

Base Technology	
As-Used GPM	Showering Time
2.02	7.28
2.35	7.13
2.05	7.27
1.91	7.33
2.21	7.20
2.48	7.08
2.64	7.01

Efficient Technology	
As-Used GPM	Showering Time
1.25	7.62
1.5	7.51

Annual water savings calculated as follows:

$$Savings = Ppl * Sh * 365 * \left(T_{base} * Fl_{base} - T_{eff} * Fl_{eff}\right)$$

Where:

Ppl = Number of people per household
Sh = Showers per capita per day
365 = Days per year
T_{base} = Showering time with base equipment (minutes)
T_{eff} = Showering time with efficient equipment (minutes)
Fl_{base} = As-used flow rate with base equipment (GPM)
Fl_{eff} = As-used flow rate with efficient equipment (GPM)

Census Agglomerations, 2006 Census - 100% Data (Table) *Census 2006.* Last updated Dec 6, 2008. http://www12.statcan.ca/english/census06/data/topics/RetrieveProductTable.cfm?ALEVEL=3&APATH=3&CATNO=&DETAIL=0&DIM=&DS=99&FL=0&FREE=0&GAL=0&GC=99&GID=837983&GK=NA&GRP=1&IPS=&METH=0&ORDER=1&PID=89071&PTYPE=88971&RL=0&S=1&SUB=0&ShowAll=No&StartRow=1&Temporal=2006&Theme=69&VID=0&VNAMEE=&VNAMEF=

[12] Summit Blue (2008), based on data from: Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007

[13] Relationship modeled as: Average shower length = 8.17 – 0.448 * as-used GPM. From Energy Center of Wisconsin Analysis of data from Resource Management Strategies, Inc., *Regional Municipality of York Water Efficiency Master Plan Update,* April 2007. Cited in Summit Blue (2008)

Table 6 - Annual Water Savings

Program	Applicable Customer Group	Base Flow Rate	Efficient Measure Flow Rate	Base Flow Rate (as-used)	Efficient Measure Flow Rate (as-used)	Annual Water Savings (L)	Lifetime Water Savings (L)
EG TAPS	Standard Res	2.45	1.25	2.02	1.25	16,631	166,309
EG TAPS	Standard Res	3.07	1.25	2.35	1.25	23,374	233,744
EG Low-Income	LIA	2.45	1.25	2.02	1.25	16,631	166,309
EG Low-Income	LIA	3.07	1.25	2.35	1.25	23,374	233,744
EG ESK (New Only)	Standard Res	2.50	1.25	2.05	1.25	17,187	171,866
EG ESK (New Only)	Standard Res	2.50	1.50	2.05	1.50	11,596	115,958
EG ESK (New Only)	Standard Res	2.50	1.25 & 1.5*	2.05	1.38	14,391	143,912
EG MF (New Only)	Multi-Family	2.50	1.25	2.05	1.25	11,587	115,871
EG MF (New Only)	Multi-Family	2.50	1.50	2.05	1.50	7,818	78,178
EG MF	Multi-Family	2.25	1.50	1.91	1.50	5,931	59,307
EG MF	Multi-Family	2.80	1.50	2.21	1.50	10,036	100,362
EG MF	Multi-Family	3.30	1.50	2.48	1.50	13,621	136,214
EG MF	Multi-Family	3.60	1.50	2.64	1.50	15,705	157,054

** Participants in Enbridge's ESK program receive both a 1.25 and 1.5 GPM showerhead. Navigant has assumed that both are used equally and that resultant household savings are equivalent to the average savings of a household that receives only 1.5 GPM showerheads and a household that receives only 1.25 GPM showerheads. Enbridge has indicated that in the future new households may receive either only 1.5 or 1.25 GPM showerheads. These households would attain the corresponding savings shown above.*

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
Summit Blue (2008) suggests an EUL of 10 years based on a survey of five studies of showerheads in other jurisdictions (California – two studies, New England, Vermont, Arkansas).	
Incremental Costs	**EG TAPS 1.25 GPM = $19.00** **EG LI 1.25 GPM = $18.71** **EG ESK 1.25 GPM = $4.26** **EG ESK 1.5 GPM = $12.50** **EG ESK 1.5 & 1.25 GPM = $16.76** **EG Multi-Fam 1.5 GPM = $12.50** **EG Multi-Fam 1.25 GPM = $12.50**
Incremental cost for EG TAPS, ESK, LI and Multi-Family based on utility bulk purchase costs.	

Low-Flow Showerhead (1.25 GPM replacing 2.0 GPM, Residential, Distributed, per Household), UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
Low-flow Showerhead (1.25 GPM) – distributed to participants under Union Gas' ESK program. One showerhead distributed per ESK Kit.

Base Equipment and Technologies Description
2.0 GPM (Participants who previously received a 2.0gpm showerhead from Union)

Decision Type	Target Market(s)	End Use
Retrofit	Residential	Water heating

Resource Savings Table

Year (EUL=)	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	33	0	11,584	3.79	0
2	33	0	11,584	0	0
3	33	0	11,584	0	0
4	33	0	11,584	0	0
5	33	0	11,584	0	0
6	33	0	11,584	0	0
7	33	0	11,584	0	0
8	33	0	11,584	0	0
9	33	0	11,584	0	0
10	33	0	11,584	0	0
TOTALS	330	**0**	**115,840**	**3.79**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	33 m^3

Enbridge Gas commissioned a study by the SAS Institute (Canada)[1] to estimate natural gas savings for low-flow showerheads in Enbridge territory. Data was collected August 31, 2007 until August 31, 2009 for both treatment and control groups. Low flow showerheads were installed in treatment households between August 13, 2008 and October 30, 2008. There were 54 households with low-flow showerheads and 124 households without low-flow showerheads.

To calculate the gas savings, three different models were used to analyze the gas consumption data

1) a comparison made during the same time frame (post-installation) between a control set of households[2] and households that had them installed
2) a Pre & Post installation analysis on the same households, and
3) a complex time trend model analysis that factored in many household characteristics over the whole Pre & Post time period.

All three analyses agreed well with each other.[3]

[1] Rothman, Lorne, SAS® PHASE II Analysis for Enbridge Gas Distribution Inc.: Estimating the Impact of Low-Flow Showerhead Installation; April 5, 2010

[2] where no low-flow showerheads were ever installed

[3] Model 1 – a blended rate of 71.3 m3/yr (only models II and II provided bucketed savings estimates)
Model 2 – a blended rate of 67.4 m3/yr (45.4 m3/yr for 2 to 2.5 GPM bucket and 87.8 m3/yr for over 2.5 GPM), and

Three buckets for pre-existing showerheads were originally proposed. However, the lowest flow bucket (2.0 GPM or less) had too few observations and are rare in the population of households. The natural gas savings for the other two buckets are estimated to be as follows:

Baseline Flow rate (GPM)	Energy Efficient Flow Rate (GPM)	Change in GPM	Annual Natural Gas Savings (m^3)	Annual Natural Gas Savings (m^3 per GPM)
2.25[4]	1.25	1.0	46	46
3[5]	1.25	1.75	88	50

For base flow/efficient flow showerhead types not explicitly tested in the SAS study, gas savings have been extrapolated in the following manner:

1. The results of the SAS institute study indicate that gas savings increase at an increasing rate as the difference between efficient and base GPM increases.
2. Fitting a polynomial function with no intercept (no change in GPM = no gas savings) delivers the following function (where ΔGPM = Base GPM – Efficient GPM):

$$\text{Annual Gas Savings } (m^3) = 40.29 * \Delta GPM + 5.71 * \Delta GPM^2$$
$$= 40.29*(2.0-1.25) + 5.71*(2.0-1.25)^2$$
$$= 33$$

These savings values assume that 100% of household showering is reduced to 1.25 gpm. A survey determining the percentage of showering affected by the program should be used to adjust the year end program results.

Annual Electricity Savings	**0 kWh**

N/A

Annual Water Savings	**11,584 L**

Since the SAS report did not look at water savings, Navigant Consulting proposes the following method for calculating resulting water savings:

Assumptions and inputs:

- As-used flow rate with base equipment: 1.78 GPM[6]
- Average household size: 3.1 persons[7]
- Showers per capita per day: 0.75[8]
- Average showering time per capita per day with base equipment: 7.37 minutes
- Average showering time per capita per day with new technology: 7.61 minutes[9]

Model 3 – a blended rate of 77.2 m3/yr (46.4 m3/yr for 2 to 2.5 GPM bucket and 87.9 m3/yr for over 2.5 GPM).

[4] Average of 2.0 GPM and 2.5 GPM

[5] Assumed average low flow showerhead which is greater than 2.5 GPM.

[6] As-used flow is calculated as a function of "full-on" or label flow: as-used flow = min{ 0.691+0.542*full-on flow, full-on flow}. Proctor, J. Gavelis, B. and Miller, B. *Savings and Showers: It's All in the Head*, (PGE) Home Energy Magazine, July/Aug 1994. Cited in Summit Blue (2008). .

[7] Summit Blue (2008).

[8] Ibid, based on data from: Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007

[9] Relationship modeled as: Average shower length = 8.17 – 0.448 * as-used GPM. From Energy Center of Wisconsin Analysis of data from Resource Management Strategies, Inc., *Regional Municipality of York Water Efficiency Master Plan Update,* April 2007. Cited in Summit Blue (2008)

Annual water savings calculated as follows:

$$Savings = Ppl * Sh * 365 * (T_{base} * Fl_{base} - T_{eff} * Fl_{eff})$$

Where:

Ppl = Number of people per household
Sh = Showers per capita per day
365 = Days per year
T_{base} = Showering time with base equipment (minutes)
T_{eff} = Showering time with efficient equipment (minutes)
Fl_{base} = As-used flow rate with base equipment (GPM)
Fl_{eff} = As-used flow rate with efficient equipment (GPM)

Savings = 3,060 gallons or 11,584 litres

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
Summit Blue (2008) suggests an EUL of 10 years based on a survey of five studies of showerheads in other jurisdictions (California – two studies, New England, Vermont, Arkansas).	
Incremental Costs	**$3.79**
As per utility program costs, bulk purchase of showerheads.	
Free-Ridership	**10%**
Free Ridership rate recommended by Summit Blue Consulting.[10]	

[10] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

Low-Flow Showerhead (1.25 GPM, Residential, Installed, per Household), UG

Revision #	Description/Comment	Date Revised
		October 28, 2010

Efficient Equipment and Technologies Description

One Low-flow Showerhead (1.25 GPM) – Installed by Union-designated contractors.

Base Equipment and Technologies Description

Average existing stock within one of three ranges.

Range mid-points used as point estimates:

- Scenario A – 2.25 GPM
- Scenario B – 3.0 GPM

When new showerheads are installed contractors use a bag-test to determine base equipment flow-rate.

Decision Type	Target Market(s)	End Use
Retrofit	Residential (Existing)	Water heating

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	**A:**46 **B:** 88	0	**A:** 14,294 **B:** 22,580	3.79	0
2	**A:**46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
3	**A:**46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
4	**A:**46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
5	**A:**46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
6	**A:**46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
7	**A:**46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
8	**A:**46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
9	**A:**46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
10	**A:**46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
TOTALS	**A: 460 B: 880**	**0**	**A: 142,940 B: 225,800**	**3.79**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	**A: 46 m^3 B: 88 m^3**

Enbridge Gas commissioned a study by the SAS Institute (Canada)[13] to estimate natural gas savings for low-flow showerheads in Enbridge territory. Data was collected August 31, 2007 until August 31, 2009 for both treatment and control groups. Low flow showerheads were installed in treatment households between August 13, 2008 and October 30, 2008. There were 54 households with low-flow showerheads and 124

[13] Rothman, Lorne, SAS® PHASE II Analysis for Enbridge Gas Distribution Inc.: Estimating the Impact of Low-Flow Showerhead Installation; April 5, 2010

households without low-flow showerheads.

To calculate the gas savings, three different models were used to analyze the gas consumption data

1) a comparison made during the same time frame (post-installation) between a control set of households[14] and households that had them installed
2) a Pre & Post installation analysis on the same households, and
3) a complex time trend model analysis that factored in many household characteristics over the whole Pre & Post time period.

All three analyses agreed well with each other.[15]

Three buckets for pre-existing showerheads were originally proposed. However, the lowest flow bucket (2.0 GPM or less) had too few observations and are rare in the population of households. The natural gas savings for the other two buckets are estimated to be as follows:

Baseline Flow rate (GPM)	Energy Efficient Flow Rate (GPM)	Change in GPM	Annual Natural Gas Savings (m^3)	Annual Natural Gas Savings (m^3 per GPM)
2.25[16]	1.25	1.0	46	46
3[17]	1.25	1.75	88	50

For base flow/efficient flow showerhead types not explicitly tested in the SAS study, gas savings have been extrapolated in the following manner:

1. The results of the SAS institute study indicate that gas savings increase at an increasing rate as the difference between efficient and base GPM increases.
2. Fitting a polynomial function with no intercept (no change in GPM = no gas savings) delivers the following function (where ΔGPM = Base GPM – Efficient GPM):

$$\text{Annual Gas Savings } (m^3) = 40.29 * \Delta GPM + 5.71 * \Delta GPM^2$$
$$= 40.29*(2.25-1.25) + 5.71*(2.25-1.25)^2$$
$$= 46$$

$$\text{Annual Gas Savings } (m^3) = 40.29 * \Delta GPM + 5.71 * \Delta GPM^2$$
$$= 40.29*(3.0-1.25) + 5.71*(3.0-1.25)^2$$
$$= 88$$

These savings values assume that 100% of household showering is reduced to 1.25 gpm. A survey determining the percentage of showering affected by the program should be used to adjust the year end program results.

Annual Electricity Savings	**0 kWh**
N/A	
Annual Water Savings	**A: 14,294 L** **B: 22,580 L**

Since the SAS report did not look at water savings, Navigant Consulting proposes the following method for calculating resulting water savings:

[14] where no low-flow showerheads were ever installed
[15] Model 1 – a blended rate of 71.3 m3/yr (only models II and II provided bucketed savings estimates)
Model 2 – a blended rate of 67.4 m3/yr (45.4 m3/yr for 2 to 2.5 GPM bucket and 87.8 m3/yr for over 2.5 GPM), and
Model 3 – a blended rate of 77.2 m3/yr (46.4 m3/yr for 2 to 2.5 GPM bucket and 87.9 m3/yr for over 2.5 GPM).
[16] Average of 2.0 GPM and 2.5 GPM
[17] Assumed average low flow showerhead which is greater than 2.5 GPM.

Assumptions and inputs:

- As-used flow rate with base equipment[18]:
  Scenario **A:** 1.91 GPM
  Scenario **B:** 2.32 GPM
- Average household size: 3.1 persons[19]
- Showers per capita per day: 0.75[20]
- Average showering time per capita per day with base equipment:
  Scenario **A:** 7.31 minutes
  Scenario **B:** 7.13 minutes
- Average showering time per capita per day with new technology: 7.61 minutes[21]

Annual water savings calculated as follows:

$$Savings = Ppl * Sh * 365 * \left(T_{base} * Fl_{base} - T_{eff} * Fl_{eff}\right)$$

Where:

Ppl = Number of people per household.
Sh = Showers per capita per day.
365 = Days per year.
T_{base} = Showering time with base equipment (minutes)
T_{eff} = Showering time with efficient equipment (minutes).
Fl_{base} = As-used flow rate with base equipment (GPM)
Fl_{eff} = As-used flow rate with efficient equipment (GPM)

Scenario **A:** Savings = 3,776 gallons or 14,294 litres
Scenario **B:** Savings = 5,965 gallons or 22,580 litres

Other Input Assumptions

Effective Useful Life (EUL)	**10 Years**
Summit Blue (2008) suggests an EUL of 10 years based on a survey of five studies of showerheads in other jurisdictions (California – two studies, New England, Vermont, Arkansas).	
Incremental Costs	**$3.79**
As per utility program costs, bulk purchase of showerheads.	
Free-Ridership	**10%**
Free Ridership rate recommended by Summit Blue Consulting.[22]	

[18] As-used flow is calculated as a function of "full-on" or label flow: as-used flow = min{ 0.691+0.542*full-on flow, full-on flow}. Proctor, J. Gavelis, B. and Miller, B. *Savings and Showers: It's All in the Head*, (PGE) Home Energy Magazine, July/Aug 1994. Cited in Summit Blue (2008)..
[19] Summit Blue (2008).
[20] Ibid, based on data from: Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007
[21] Relationship modeled as: Average shower length = 8.17 – 0.448 * as-used GPM. From Energy Center of Wisconsin Analysis of data from Resource Management Strategies, Inc., *Regional Municipality of York Water Efficiency Master Plan Update,* April 2007. Cited in Summit Blue (2008)
[22] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

Low-Flow Showerhead (1.25 GPM, Residential, Distributed, per Household), UG

Revision #	Description/Comment	Date Revised
		October 28, 2010

Efficient Equipment and Technologies Description

Low-flow Showerhead (1.25 GPM) – distributed to participants under Union Gas' ESK program. One showerhead distributed per ESK Kit.

Base Equipment and Technologies Description

Average existing stock (2.21 GPM)[1].

Decision Type	Target Market(s)	End Use
New/Retrofit	Residential	Water heating

Codes, Standards, and Regulations

Ontario Building Code (2006)[2] requires shower heads to have a maximum flow of 2.5 GPM (9.5 L/min)

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	44	0	13,885	3.79	0
2	44	0	13,885	0	0
3	44	0	13,885	0	0
4	44	0	13,885	0	0
5	44	0	13,885	0	0
6	44	0	13,885	0	0
7	44	0	13,885	0	0
8	44	0	13,885	0	0
9	44	0	13,885	0	0
10	44	0	13,885	0	0
TOTALS	440	**0**	**138,850**	**3.79**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	44 m^3

Enbridge Gas commissioned a study by the SAS Institute (Canada)[3] to estimate natural gas savings for low-flow showerheads in Enbridge territory. Data was collected August 31, 2007 until August 31, 2009 for both treatment and control groups. Low flow showerheads were installed in treatment households between August 13, 2008 and October 30, 2008. There were 54 households with low-flow showerheads and 124 households without low-flow showerheads.

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[1] Shower-heads distributed under Union Gas's ESK program are installed by homeowners rather than Union contractors. No observation is made of the base equipment's GPM. It is therefore assumed to be the full-on flow rate corresponding to the as-used flow from York Region monitoring study calculated using the equation cited below. Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007. Cited by: Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, June 2008.

[2] Ontario Regulations 350/06, 2006 Building Code

[3] Rothman, Lorne, SAS® PHASE II Analysis for Enbridge Gas Distribution Inc.: Estimating the Impact of Low-Flow Showerhead Installation; April 5, 2010

To calculate the gas savings, three different models were used to analyze the gas consumption data

1) a comparison made during the same time frame (post-installation) between a control set of households[4] and households that had them installed
2) a Pre & Post installation analysis on the same households, and
3) a complex time trend model analysis that factored in many household characteristics over the whole Pre & Post time period.

All three analyses agreed well with each other.[5]

Three buckets for pre-existing showerheads were originally proposed. However, the lowest flow bucket (2.0 GPM or less) had too few observations and are rare in the population of households. The natural gas savings for the other two buckets are estimated to be as follows:

Baseline Flow rate (GPM)	Energy Efficient Flow Rate (GPM)	Change in GPM	Annual Natural Gas Savings (m^3)	Annual Natural Gas Savings (m^3 per GPM)
2.25[6]	1.25	1.0	46	46
3[7]	1.25	1.75	88	50

For base flow/efficient flow showerhead types not explicitly tested in the SAS study, gas savings have been extrapolated in the following manner:

1. The results of the SAS institute study indicate that gas savings increase at an increasing rate as the difference between efficient and base GPM increases.
2. Fitting a polynomial function with no intercept (no change in GPM = no gas savings) delivers the following function (where ΔGPM = Base GPM – Efficient GPM):

$$\text{Annual Gas Savings } (m^3) = 40.29 * \Delta GPM + 5.71 * \Delta GPM^2$$
$$= 40.29*(2.21-1.25) + 5.71*(2.21-1.25)^2$$
$$= 44$$

These savings values assume that 100% of household showering is reduced to 1.25 gpm. A survey determining the percentage of showering affected by the program should be used to adjust the year end program results.

Annual Electricity Savings	**0 kWh**

N/A

Annual Water Savings	**13,885 L**

Since the SAS report did not look at water savings, Navigant Consulting proposes the following method for calculating resulting water savings:

Assumptions and inputs:

- As-used flow rate with base equipment: 1.89 GPM[8]
- Average household size: 3.1 persons[9]
- Showers per capita per day: 0.75[10]
- Average showering time per capita per day with base equipment: 7.32 minutes
- Average showering time per capita per day with new technology: 7.61 minutes[11]

[4] where no low-flow showerheads were ever installed
[5] Model 1 – a blended rate of 71.3 m3/yr (only models II and II provided bucketed savings estimates)
Model 2 – a blended rate of 67.4 m3/yr (45.4 m3/yr for 2 to 2.5 GPM bucket and 87.8 m3/yr for over 2.5 GPM), and
Model 3 – a blended rate of 77.2 m3/yr (46.4 m3/yr for 2 to 2.5 GPM bucket and 87.9 m3/yr for over 2.5 GPM).
[6] Average of 2.0 GPM and 2.5 GPM
[7] Assumed average low flow showerhead which is greater than 2.5 GPM.
[8] As-used flow is calculated as a function of "full-on" or label flow: as-used flow = min{ 0.691+0.542*full-on flow, full-on flow}. Proctor, J. Gavelis, B. and Miller, B. *Savings and Showers: It's All in the Head*, (PGE) Home Energy Magazine, July/Aug 1994. Cited in Summit Blue (2008). .
[9] Summit Blue (2008).
[10] Ibid, based on data from: Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007
[11] Relationship modeled as: Average shower length = 8.17 – 0.448 * as-used GPM. From Energy Center of Wisconsin Analysis of data from Resource Management Strategies, Inc., *Regional Municipality of York Water Efficiency Master Plan Update,* April 2007. Cited in Summit Blue (2008)

Annual water savings calculated as follows:

$$Savings = Ppl * Sh * 365 * (T_{base} * Fl_{base} - T_{eff} * Fl_{eff})$$

Where:

Ppl = Number of people per household
Sh = Showers per capita per day
365 = Days per year
T_{base} = Showering time with base equipment (minutes)
T_{eff} = Showering time with efficient equipment (minutes)
Fl_{base} = As-used flow rate with base equipment (GPM)
Fl_{eff} = As-used flow rate with efficient equipment (GPM)

Savings = 3,668 gallons or 13,885 litres

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
Summit Blue (2008) suggests an EUL of 10 years based on a survey of five studies of showerheads in other jurisdictions (California – two studies, New England, Vermont, Arkansas).	
Incremental Costs	**$3.79**
As per utility program costs, bulk purchase of showerheads.	
Free-Ridership	**10%**
Free Ridership rate recommended by Summit Blue Consulting.[12]	

[12] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

Pipe Wrap (R-4), EGD

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
Insulated hot water pipe for conventional gas storage tank-type hot water heater (R-4).
Base Equipment and Technologies Description
Conventional gas storage tank-type hot water heater without pipe wrap (R-1).

Decision Type	Target Market(s)	End Use
Retrofit	Residential (Existing)	Water heating

Codes, Standards, and Regulations

N/A

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	18	0	0	2	0
2	18	0	0	0	0
3	18	0	0	0	0
4	18	0	0	0	0
5	18	0	0	0	0
6	18	0	0	0	0
7	18	0	0	0	0
8	18	0	0	0	0
9	18	0	0	0	0
10	18	0	0	0	0
TOTALS	**180**	**0**	**0**	**2**	

Resource Savings Assumptions

Annual Natural Gas Savings	18 m^3

Assumptions and inputs:

- Gas savings calculated using method set out in 2006 Massachusetts study[1] except where noted.
- Average water heater recovery efficiency: 0.76[2]
- Average household size: 3.1 persons[3]
- Assumed diameter of pipe to be wrapped: 0.75 inches
- Length of pipe to be wrapped: 6 feet.
- Surface area of pipe to be wrapped: 1.18 square feet.
- Ambient temperature around pipes: 16 ^oC (60 ^oF) [4]
- Average water heater set point temperature: 54 ^oC (130 ^oF)[5]
- Hot water temperature in outlet pipe: 52 ^oC (125 ^oF)[6]

Annual gas savings calculated as follows:

$$Savings = \left(\frac{1}{R_{base}} - \frac{1}{R_{eff}} \right) * Sa * \left(T_{pipe} - T_{amb} \right) * 24 * 365 * \frac{1}{EF} * 10^{-6} * 27.8$$

Where:

R_{base} = R-value of base equipment
R_{eff} = R-value of efficient equipment
Sa = Surface area of outlet pipe (ft^2)
T_{pipe} = Temperature of water in outlet pipe (^oF)
T_{amb} = Ambient temperature around pipe (^oF)
24 = Hours per day
365 = Days per year
EF = Water heater energy factor
10^{-6} = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to m^3

Gas savings were determined to be 75% over base measure

[1] RLW Analytics, *Final Market Potential Report Of Massachusetts Owner Occupied 1-4 Unit Dwellings*, July 2006 http://www.cee1.org/eval/db_pdf/575.pdf
[2] Assumption used by Energy Center of Wisconsin, citing GAMA,
Pigg, Scott, *Water Heater Savings* Calculator, 2003 , www.doa.state.wi.us/docs_view2.asp?docid=2249
[3] Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, June 2008.
[4] RLW Analytics (2006). Given geographic proximity, Massachusetts temperatures used unchanged for Ontario.
[5] As suggested by NRCan: http://oee.nrcan.gc.ca/residential/personal/new-homes/water-conservation.cfm?attr=4
[6] From source: "It is common to find a 5 - 10 F temperature drop from the water heater to the furthest fixtures in the house." Chinnery, G. *Policy recommendations for the HERS Community to consider regarding HERS scoring credit due to enhanced effective energy factors of water heaters resulting from volumetric hot water savings due to conservation devices/strategies,* EPA Energy Star for Homes, Sept 2006 http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/Volumetric_Hot_Water_Savings_Guidelines.pdf

$$Percent\ Savings = \frac{(G_{base} - G_{eff})}{G_{base}}$$ Where: G_{eff} = Annual natural gas use with efficient equipment, 8 m^3 G_{base} = Annual natural gas use with base equipment, 33 m^3	
Annual Electricity Savings	**0 kWh**
N/A	
Annual Water Savings	**0 L**
Navigant has assumed that adopting the measure would not affect the quantity of water consumed.	

Other Input Assumptions

Effective Useful Life (EUL)	**10 Years**
Based on the estimated measure lifetimes used in four other jurisdictions (Iowa - 15 years, Puget Sound Energy - 10 years, Efficiency Vermont – 10 years, and NYSERDA[7] – 10 years) Navigant recommends using an EUL of 10 years.	
Base & Incremental Conservation Measure Equipment and O&M Costs	**2 $**
Average equipment cost (for six feet of pipe wrap) based on communication with local hardware stores. This does not include installation costs.	
Customer Payback Period (Natural Gas Only)[8]	**0.2 Years**
Using an 5-year average commodity cost (avoided cost)[9] of \$0.38 / m^3 and an average residential distribution cost[10] of \$0.14 / m^3, the payback period for natural gas savings is determined to be 0.2 years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = \$2/ (18 m^3/year * \$0.52 / m^3) = 0.2 years	
Market Penetration	**47%**
Based on previous research conducted for the OPA, Navigant Consulting estimates penetration of this measure to be 47%[11].	

[7] NYSERDA, New York Energy Smart Programs, *Deemed Savings Database*
[8] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.
[9] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.
[10] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).
[11] Navigant Consulting, Inc. for the Ontario Power Authority, *Residential Rebate Program: Participation Forecast and Incentive Bundling Strategy – Key Findings Summary*, December 2008

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
State of Iowa Utilities Board[12]	21	15	113 US$	52%
Comments For addition of R-4 insulation to previously un-insulated pipes. Measure saves 4% of 514 m^3 required for water heating.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/Market Share**
Puget Sound Energy, 2007[13]	8	10	8 US$	38%
Comments For addition of R-4 insulation to previously un-insulated pipes. Measure saves 1% of 759 m^3 required for water heating.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/Market Share**
Midwest Energy Efficiency Alliance, 2003[14]	36	N/A	N/A	10.4%
Comments No indication given of percentage savings or base natural gas consumption for water heating.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/Market Share**
Efficiency Vermont, 2006[15]	N/A	10	15 US$	N/A
Comments Only electricity savings reported (33 kWh) for an electric hot water system. Insulation upgrade not specified. No indication given of percentage savings or base natural gas consumption for water heating.				

[12] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2
[13] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy
[14] Midwest Energy Efficiency Alliance, *Illinois Residential Market Analysis, Final Report*, May 12, 2003. http://www.cee1.org/eval/db_pdf/390.pdf
[15] Efficiency Vermont, *Technical Reference User Manual (TRM)*, February 2006

Pipe Wrap (R-4), UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
Insulated hot water pipe for conventional gas storage tank-type hot water heater (R-4).
Base Equipment and Technologies Description
Conventional gas storage tank-type hot water heater without pipe wrap (R-1).

Decision Type	Target Market(s)	End Use
Retrofit	Residential (Existing)	Water heating

Codes, Standards, and Regulations

N/A

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	18	0	0	0.98	
2	18	0	0	0	0
3	18	0	0	0	0
4	18	0	0	0	0
5	18	0	0	0	0
6	18	0	0	0	0
7	18	0	0	0	0
8	18	0	0	0	0
9	18	0	0	0	0
10	18	0	0	0	0
TOTALS	**180**	**0**	**0**	**0.98**	

Resource Savings Assumptions

Annual Natural Gas Savings	18 m^3

Assumptions and inputs:

- Gas savings calculated using method set out in 2006 Massachusetts study[1] except where noted.
- Average water heater recovery efficiency: 0.76[2]
- Average household size: 3.1 persons[3]
- Assumed diameter of pipe to be wrapped: 0.75 inches
- Length of pipe to be wrapped: 6 feet.
- Surface area of pipe to be wrapped: 1.18 square feet.
- Ambient temperature around pipes: 16 °C (60 °F) [4]
- Average water heater set point temperature: 54 °C (130 °F)[5]
- Hot water temperature in outlet pipe: 52 °C (125 °F)[6]

Annual gas savings calculated as follows:

$$Savings = \left(\frac{1}{R_{base}} - \frac{1}{R_{eff}}\right) * Sa * \left(T_{pipe} - T_{amb}\right) * 24 * 365 * \frac{1}{EF} * 10^{-6} * 27.8$$

Where:

R_{base} = R-value of base equipment
R_{eff} = R-value of efficient equipment
Sa = Surface area of outlet pipe (ft^2)
T_{pipe} = Temperature of water in outlet pipe (°F)
T_{amb} = Ambient temperature around pipe (°F)
24 = Hours per day
365 = Days per year
EF = Water heater energy factor
10^{-6} = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to m^3

Gas savings were determined to be 75% over base measure

$$PercentSavings = \frac{\left(G_{base} - G_{eff}\right)}{G_{base}}$$

Where:

G_{eff} = Annual natural gas use with efficient equipment, 8 m^3

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[1] RLW Analytics, *Final Market Potential Report Of Massachusetts Owner Occupied 1-4 Unit Dwellings*, July 2006 http://www.cee1.org/eval/db_pdf/575.pdf
[2] Assumption used by Energy Center of Wisconsin, citing GAMA,
Pigg, Scott, *Water Heater Savings* Calculator, 2003 , www.doa.state.wi.us/docs_view2.asp?docid=2249
[3] Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, June 2008.
[4] RLW Analytics (2006). Given geographic proximity, Massachusetts temperatures used unchanged for Ontario.
[5] As suggested by NRCan: http://oee.nrcan.gc.ca/residential/personal/new-homes/water-conservation.cfm?attr=4
[6] From source: "It is common to find a 5 - 10 F temperature drop from the water heater to the furthest fixtures in the house." Chinnery, G. *Policy recommendations for the HERS Community to consider regarding HERS scoring credit due to enhanced effective energy factors of water heaters resulting from volumetric hot water savings due to conservation devices/strategies,* EPA Energy Star for Homes, Sept 2006 http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/Volumetric_Hot_Water_Savings_Guidelines.pdf

G_{base} = Annual natural gas use with base equipment, 33 m^3	
Annual Electricity Savings	**0 kWh**
N/A	
Annual Water Savings	**0 L**
Navigant has assumed that adopting the measure would not affect the quantity of water consumed.	

Other Input Assumptions

Effective Useful Life (EUL)	**10 Years**
Based on the estimated measure lifetimes used in four other jurisdictions (Iowa - 15 years, Puget Sound Energy - 10 years, Efficiency Vermont – 10 years, and NYSERDA[7] – 10 years) Navigant recommends using an EUL of 10 years.	
Base & Incremental Conservation Measure Equipment and O&M Costs	**0.98 $**
Average equipment cost (for six feet of pipe wrap) based on utility bulk purchase order cost. This does not include installation costs.	
Customer Payback Period (Natural Gas Only)[8]	**0.1 Years**
Using an 5-year average commodity cost (avoided cost)[9] of \$0.38 / m^3 and an average residential distribution cost[10] of \$0.14 / m^3, the payback period for natural gas savings is determined to be 0.2 years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = \$0.98/ (18 m^3/year * \$0.52 / m^3) = 0.1 years	
Market Penetration	**47%**
Based on previous research conducted for the OPA, Navigant Consulting estimates penetration of this measure to be 47%[11].	

[7] NYSERDA, New York Energy Smart Programs, *Deemed Savings Database*
[8] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.
[9] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.
[10] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).
[11] Navigant Consulting, Inc. for the Ontario Power Authority, *Residential Rebate Program: Participation Forecast and Incentive Bundling Strategy – Key Findings Summary*, December 2008

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
State of Iowa Utilities Board[12]	21	15	113 US$	52%
Comments For addition of R-4 insulation to previously un-insulated pipes. Measure saves 4% of 514 m^3 required for water heating.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/Market Share**
Puget Sound Energy, 2007[13]	8	10	8 US$	38%
Comments For addition of R-4 insulation to previously un-insulated pipes. Measure saves 1% of 759 m^3 required for water heating.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/Market Share**
Midwest Energy Efficiency Alliance, 2003[14]	36	N/A	N/A	10.4%
Comments No indication given of percentage savings or base natural gas consumption for water heating.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/Market Share**
Efficiency Vermont, 2006[15]	N/A	10	15 US$	N/A
Comments Only electricity savings reported (33 kWh) for an electric hot water system. Insulation upgrade not specified. No indication given of percentage savings or base natural gas consumption for water heating.				

[12] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2
[13] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy
[14] Midwest Energy Efficiency Alliance, *Illinois Residential Market Analysis, Final Report*, May 12, 2003. http://www.cee1.org/eval/db_pdf/390.pdf
[15] Efficiency Vermont, *Technical Reference User Manual (TRM)*, February 2006

Solar Pool Heater

Residential Existing Homes,UG & EGD

Efficient Technology & Equipment Description
Solar Panels for pool heating
Qualifier/Restriction
Old gas pool heaters must be removed to qualify
Base Technology & Equipment Description
Natural Gas Heater

Resource Savings Assumptions

Natural Gas (Updated)	**1,116 m^3**
Based on Enbridge Territory Load Research results: 2007 – 14 directly metered natural gas pools = 1330 m3 2008 – 6 directly metered natural gas pools = 901m3 Average natural gas savings from a customer choosing a solar pool heater alternative = 1116 m3 (100% of natural gas pool heater use)	
Electricity	**-57 kWh**
2009 Board Approved assumption filed by Navigant April 16, 2009 page c 83	
Water	**L**

Other Input Assumptions

Equipment Life	**20 Years**
2009 Board Approved assumption filed by Navigant April 16, 2009 page c 81-84	
Incremental Cost (Contractor Installed)	**$ 1,450**
2009 Board Approved assumption filed by Navigant April 16, 2009 page c 83	
Free Ridership	**10 %**
NRCAN, Renewable Energy, Residential Solar Pool Heating Systems; A Buyer Guide page 3, 6	

Tankless Gas Water Heater, UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
Tankless Gas Water Heater (EF = 0.82)
Base Equipment and Technologies Description
Conventional gas 50 gallon storage tank water heater (EF = 0.575)

Decision Type	Target Market(s)	End Use
New / Replacement	Residential (Existing and New Construction)	Water heating

Codes, Standards, and Regulations

Ontario's Energy Efficiency Act[1] requires that gas-fired water storage heaters with nominal inputs of 75,000 Btu or less capable of storing between 20 and 100 US gallons have a minimum energy factor of 0.67 - (0.0019*X)
Where X is the capacity (in gallons) of the storage tank.

[1] http://www.energy.gov.on.ca/english/pdf/conservation/2006%20-%20EEA%20Guide%20C%20-%20Water%20Heaters.pdf

Resource Savings Assumptions

Annual Natural Gas Savings	142 m^3

Assumptions and inputs:

- Following a 2006 recommendation to the California Energy Commission that the Alternative Calculation Method (ACM) be amended to recognise the disparity between the nominal Energy Factor of tankless water heaters drawing less than 11 gallons and the actual energy efficiency, savings are calculated using an energy factor degraded by 8.8%[2]
- Adjusted energy factor[3]: 0.77
- Daily average household hot water use: 179 litres (47 gallons)[4]
- Average water inlet temperature: 9.33 C (48.8 F)[5]
- Average water heater set point temperature: 54 C (130 F)[6]

Annual gas savings calculated as follows:

$$Savings = W * 8.33 * (T_{out} - T_{in}) * \left(\frac{1}{EF_{base}} - \frac{1}{EF_{eff}} \right) * 10^{-6} * 27.8$$

Where:

W = Annual hot water use (gallons)
8.33 = Energy content of water (Btu/gallon/^oF)
T_{out} = Water heater set point temperature (^oF)
T_{in} = Water inlet temperature (^oF)
EF_{base} = Energy factor of base equipment
EF_{eff} = Adjusted energy factor of efficient equipment
10^{-6} = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to metres cubed

Savings = 142 m3/yr

Annual Electricity Savings	0 kWh

N/A

Annual Water Savings	0 L

Navigant has assumed that adopting the measure would not affect the quantity of water consumed.

Other Input Assumptions

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[2] Davis Energy Group, *Measure Information Template: Tankless Gas Water Heaters*, April 2008 http://www.energy.ca.gov/title24/2008standards/prerulemaking/documents/2006-05-18_workshop/2006-05-11_GAS_WATER.PDF

[3] It should be noted that an alternative study, by Exelon Services for Okaloosa Gas, conducted carefully controlled tests to determine the thermal efficiency of a tankless and a storage tank gas water heater. This study found that the listed energy factor *underestimated* the tankless water heater's true thermal efficiency. This result is not reflected in this substantiation sheet due to the more recent findings cited above, based on a larger sample than the Okaloosa study.
Exelon Services and Okaloosa Gas District, Performance Comparison of Residential Water Heating Systems,December 2002

[4] From sample of 150 Enbridge customers whose gas consumption is monitored by Enbridge. Correspondence with Enbridge.

[5] Chinnery, Glen. *Policy Recommendations for the HERS Community to Consider regarding HERS point credit for Waste Water Heat Recovery Devices,*EPA, Energy Star for homes, March 2004 http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/Waste_Water_Heat_Recovery_Guidelines.pdf

[6] As suggested by NRCan: http://oee.nrcan.gc.ca/residential/personal/new-homes/water-conservation.cfm?attr=4

Effective Useful Life (EUL)	18 Years
Navigant Consulting recommends using an EUL of 18 years, the mean of estimated measure lifetimes used two other jurisdictions (Iowa[7], 20 years, and Puget Sound Energy[8], 13 years) and that quoted by an academic paper[9] (20 years).	
Base & Incremental Conservation Measure Equipment and O&M Costs	**750 $**
Cost of tankless water heater determined to be $1,500[10]. Average price for a 50 gallon conventional storage tank water heater $750[11].	
Customer Payback Period (Natural Gas Only)[12]	**11 Years**
Using a 5-year average commodity cost (avoided cost)[13] of $0.38 / m^3 and an average residential distribution cost[14] of $0.14 / m^3, the payback period for natural gas savings is determined to be 11 years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = $750/ (130 m^3/year * $0.52 / m^3) = 10.5 years	
Market Penetration[15]	**Low**
Based on the observation of low penetration in two other jurisdictions (Washington State[16] – 10%, Iowa[17] – 1%) and communications with local contractors, Navigant Consulting estimates the penetration in Ontario to be low.	

[7] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2

[8] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy

[9] Aguilar, C., White, D.J., and Ryan, David L. *Domestic Water Heating and Water Heater Energy Consumption in Canada*, April 2005

[10] Based on online prices from Home Depot for a Paloma Whole Home 7.4 GPM, www.homedepot.ca

[11] Based on average prices from Home Depot, www.homedepot.ca

[12] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.

[13] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.

[14] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).

[15] Navigant Consulting is defining “Low” as below 5%, “Medium” as between 5-50%, and “High” as above 50%,

[16] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy

[17] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Puget Sound Energy, 2007[18]	152	13	350 US$	10%
Comments Assuming base equipment to be a conventional water tank with an EF=0.64. Measure saves 20% of 759 m^3 required for water heating.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/Market Share**
State of Iowa Utilities Board[19]	207	20	685 US$	1%
Comments Assuming base equipment to be a conventional water tank with an EF = 0.59. Measure saves 40.2% of 514 m^3 required for water heating.				

[18] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy
[19] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2

TANKLESS WATER HEATERS

Residential New Homes, EGD

Efficient Technology & Equipment Description
Tankless water heater (EF = 0.82)
Base Technology & Equipment Description
Storage tank water heater (EF = 0.575)

Resource Savings Assumptions

Natural Gas	**130 m^3**
As approved in EB 2008-0346	
Electricity	**kWh**
Water	**N/A L**

Other Input Assumptions

Equipment Life	**18 Years**
As approved in EB 2008-0346	
Incremental Cost (Contractor Installation)	**$750**
As approved in EB 2008-0346	
Free Ridership	**2 %**
Free ridership rate will remain as filed in EB 2008-0384 & 0385.	

Low-Income Space Heating

Furnace Early Replacement (60% AFUE)

Low Income, UG

Efficient Technology & Equipment Description
Replace an old convention furnace early with a condensing model 90+% AFUE Furnace [1]
Qualifier/Restriction
Furnace must still be useable for another 3 years, and be between 58% to 62% AFUE
Base Technology & Equipment Description
Continue operating old conventional furnace (AFUE 60%) for 3 years, then replace it with a new furnace (90%+ AFUE)

Resource Savings Assumptions

Natural Gas	781 m^3
2,202 m3/yr = gas consumption of old device (60% AFUE) 1,421 m3/yr = gas consumption of typical condensing furnace (93% AFUE) These consumption values were based on typical expected gas consumption values for space heating in UG territory from gas consumption data, normalized for weather. According to AESP[2], the gas saved for an early replacement measure is determined using the following method: (for remaining expected life of old device) (m3/yr old device - m3/yr new device) + (after normal replacement time for old device)[3] m3/yr standard device - m3/yr of efficient device)[4] 2,343 m3 saved = 3 yrs *(2,202 – 1,421) + (18-3) years * (1,421 – 1,421) 781 m3/yr average gas saved = 2,343 m3 / 3 yrs	
Electricity	**0 kWh**
Water	**0 L**

[1] 93% AFUE is assumed typical for purposes of the savings calculation

[2] AESP, Final Presentation Waltham 2010-E2.pdf, pg 80; based on OPA Cost Effectiveness Guide (Advanced OPA Model)

[3] This is taken to be expected life of new furnace 18 years (condensing furnace EUL from Navigant, Measures and Assumptions for DSM Planning, Final Report April 2009).

[4] In this case the standard and efficient cases are the same

Other Input Assumptions

Equipment Life	**3 Years**
According to survey trends of UG customers, conventional furnace penetration will reach zero by about 2019. Assuming an even distribution of failures and this trend doesn't change significantly, the average remaining life at the beginning of the 2012 plan would be 3.5 years = (2019 – 2012)/2. The average life remaining at the end of the 2012 plan would be 2.5 years = (2019-2014)/2. A simple average of these two remaining lives was used (3 years).	
Incremental Cost	**$ 518**
Incremental Installed Costs were based on the installed cost of the upgrade – Net Present Value (NPV) of the basecase. $518 = $4,500 - $3,982 Costs came from discussion from furnace suppliers	
Free Ridership	**0 %**
As per the historic low income rate.	

Furnace Early Replacement (70% AFUE)

Low Income, UG

Efficient Technology & Equipment Description
Replace an old convention furnace early with a condensing model 90+% AFUE Furnace [1]
Qualifier/Restriction
Furnace must still be useable for another 3 years, and be between 68% to 72% AFUE
Base Technology & Equipment Description
Continue operating old conventional furnace (AFUE 70%) for 3 years, then replace it with a new furnace (90%+ AFUE)

Resource Savings Assumptions

Natural Gas	466 m^3

1,887 m3/yr = gas consumption of old device (70% AFUE)
1,421 m3/yr = gas consumption of typical condensing furnace (93% AFUE)
These consumption values were based on typical expected gas consumption values for space heating in UG territory from gas consumption data, normalized for weather.

According to AESP[2], the gas saved for an early replacement measure is determined using the following method:

(for remaining expected life of old device)
(m3/yr old device - m3/yr new device)
+
(after normal replacement time for old device)[3]
m3/yr standard device - m3/yr of efficient device)[4]

1,398 m3 saved = 3 yrs *(1,887 – 1,421) + (18-3) years * (1,421 – 1,421)
466 m3/yr saved = 1,398 m3 / 3 yrs

Electricity	0 kWh

Water	0 L

Other Input Assumptions

Equipment Life	3 Years
The typical remaining life is estimated to be 3 years.	

[1] 93% AFUE is assumed typical for purposes of the savings calculation
[2] AESP, Final Presentation Waltham 2010-E2.pdf, pg 80; based on OPA Cost Effectiveness Guide (Advanced OPA Model)
[3] This is taken to be expected life of new furnace 18 years (condensing furnace EUL from Navigant, Measures and Assumptions for DSM Planning, Final Report April 2009).
[4] In this case the standard and efficient cases are the same

Incremental Cost	**$ 518**
Incremental Installed Costs were based on the installed cost of the upgrade – Net Present Value (NPV) of the basecase. $518 = $4,500 - $3,982 Costs came from discussion from furnace suppliers.	
Free Ridership	**0 %**
As per the historic low income rate.	

Programmable Thermostat (LIA), UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
Programmable thermostat.
Base Equipment and Technologies Description
Standard thermostat.

Decision Type	Target Market(s)	End Use
Retrofit	Residential existing homes	Space Heating

Codes, Standards, and Regulations

- For a programmable thermostat to receive Energy Star® qualification, it must meet specific criteria such as having at least two different programming periods (for weekday and weekend programming), at least four possible temperature settings and allow for temporary overriding by the user.
- In Canada, applicable CSA standards can be found in CSA C828-99- CAN/CSA Performance Requirements for Thermostats used with Individual Room Electric Space Heating Devices.

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	53	54	0	26.95	0
2	53	54	0	0	0
3	53	54	0	0	0
4	53	54	0	0	0
5	53	54	0	0	0
6	53	54	0	0	0
7	53	54	0	0	0
8	53	54	0	0	0
9	53	54	0	0	0
10	53	54	0	0	0
11	53	54	0	0	0
12	53	54	0	0	0
13	53	54	0	0	0
14	53	54	0	0	0
15	53	54	0	0	0
TOTALS	**2,190**	**2,730**	**0**	**26.95**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	53 m³

- Two utility studies[1] are used to determine savings resulting from residential programmable thermostats on natural gas consumptions.

  - In the ***GasNetworks*** study[2], 4,061 mail-in surveys and bills were analyzed. Results were normalized for temperature and the energy impacts were determined through a multivariate regression analysis. The study found that programmable thermostat saved 6 % of total household annual natural gas use. GasNetworks is proposing 75 ccf (212 m^3) natural gas savings based on a Non-Programmable Thermostat annual consumption of 1,253 ccf (3,548 m^3) natural gas.
  - In the ***Enbridge Billing Analysis***[3], 911 customers' natural gas consumption was analyzed in 2005. Enbridge determined an average savings of 159 m^3 for a house using 2,878 m^3 of natural gas.

- Canadian Centre for Housing Technology (CCHT) also conducted a study in 2005 on programmable thermostat natural gas savings[4]. The study was done in two identical research homes located in Ottawa to allow direct comparison of changes in operating conditions in a home. It reports a 6.5% predicted savings for 18°C night setback.
- Based on these three studies, Navigant Consulting is assuming an average saving at 6% for natural gas consumptions for full temperature set back.

Studies	Baseline Gas Consumption (m^3)	Gas Savings (m^3)	Gas Savings%
GasNetworks (2007)	3,548	212	6.0%
Enbridge (2005)	2,878	159	5.5%
CCHT (2005)	-	-	6.5%
NCI Average			6.0%

Taking into account behavioural changes:

- Based on a recent Statistics Canada report[5], approximately 41% of Ontario households with non-programmable or non-programmed thermostats manually set back their thermostat at night (19% lowered by 3 or more degrees, 21% lowered by 1 or 2 degrees) in the winter season, where as 59% did not lower their thermostat before going to sleep.
- Similar values were found based on a recent evaluation Ontario Power Authority's 2007 Hot and Cool Savings Program conservation program. A household survey determined that of the 59% of Ontario households with non-programmable thermostats who manually set back their thermostat, after installing their new programmable thermostat, 68% stated they continued with the same set back behaviour (no change), while 32% increased their set back temperate (19% by 3 or more degrees, 81% by 1 or 2 degrees)[6].
- Furthermore, Navigant Consulting also determined from the survey that of the 41% of households who previously did not have a programmable thermostat and did not lower their thermostat at night, 67% of households changed their behaviour by programming their thermostat to lower the

[1] "Resource Savings Values in Selected Residential DSM Prescriptive Programs", Summit Blue Consulting, June 2008.
[2] RLW Analytics, Validating the impact of programmable thermostats: final report. Prepared for GasNetworks by RLW Analytics. Middletown, CT, January 2007.
[3] "Resource Savings Values in Selected Residential DSM Prescriptive Programs", Summit Blue Consulting, June 2008.
[4] The Effects of Thermostat Setting on Seasonal Energy Consumption at the CCHT Research Facility, Manning, Swinton, Szadkowski, Gusdorf, Ruest, February 14, 2005, http://irc.nrc-cnrc.gc.ca/pubs/rr/rr191/rr191.pdf
[5] Statistics Canada, Household and Environment Survey, 2006
[6] Navigant Consulting, Evaluation Report: 2007 Hot and Cool Savings Programs, prepared for the Ontario Power Authority (OPA), July 2008.

temperature at night when they sleep (44% by 3 or more degrees, 56% by 1 or 2 degrees).

- Therefore, using Statistics Canada values for typical winter behaviour of non-programmable thermostat households and Navigant Consulting findings for post installation of a programmable thermostat, the following natural gas savings should be attributed for each installed programmable thermostat:

Savings	*Distribution of Households*	*Natural Gas Savings*
No change in behaviour or no set back	47%	0%
Full change in behaviour - 3 + degrees set back	20%	6%
Partial change in behaviour: 1 -2 degrees set back	33%	3%

Using Enbridge's baseline natural gas consumption of 2,436 m^3 for mid-efficiency furnaces, NCI estimates the following natural gas savings from the installation of programmable thermostats:

$2{,}436\ m^3 \times (47\% \times 0\% + 20\% \times 6\% + 33\% \times 3\%) = 53\ m^3$

- This represents an overall savings of 2% over the baseline ($53\ m^3 / 2436\ m^3 = 2\%$)

Annual Electricity Savings — **54 kWh**

Heating Season Savings (Furnace fan)

- The following table is based on the CCHT study analysing furnace fan consumption in relation to set back temperatures from programmable thermostats[7].

Temp Set Back	*Total Winter Furnace Electricity Consumption (kWh)*	*Seasonal Savings (%)*
None (22C)	2,314	0 %
18 C night time set back	2,295	0.8%
18 C daytime and night time set back	2,2,70	1.9%

- Using the CCHT study results from a full night-time set back of 4 degrees:

  Approximate savings is expected for the winter season[8] = 2,314 – 2,295 = 19 kWh/year

- Applying the same behaviour changes as presented above (natural gas savings), furnace fan savings during the heating season are estimated to be as follows:

  47% x 0 kWh + 20% x 19 kWh + 33% x 9.5 kWh = 7 kWh

Cooling Season Savings

- A side-by-side housing study conducted by the CCHT[9] determined seasonal energy savings for a residential unit from a programmable thermostat as follows:

CAC:**

Temp Set Back	*Total Summer Furnace and CAC Electricity Consumption (kWh)*	*Seasonal Savings (%)*
None (22C)	3,099	0
25 C daytime set back	2,767	11
24 C daytime set back	2,376	23

** 12 SEER , 2 ton capacity CAC, 362 cooling degree days (18C)

[7] The Effects of Thermostat Setting on Seasonal Energy Consumption at the CCHT Research Facility, Manning, Swinton, Szadkowski, Gusdorf, Ruest, February 14, 2005, http://irc.nrc-cnrc.gc.ca/pubs/rr/rr191/rr191.pdf

[8] Although furnace fan consumption is significantly higher than reported by other studies, the change in electricity consumption by using a programmable thermostat is assumed to be appropriate for this analysis.

[9] The Effects of Thermostat Setting on Seasonal Energy Consumption at the CCHT Research Facility, Manning, Swinton, Szadkowski, Gusdorf, Ruest, February 14, 2005, http://irc.nrc-cnrc.gc.ca/pubs/rr/rr191/rr191.pdf

- A BC Hydro study[10] reports savings between 10% and 15% for 4°C set back during night and unoccupied periods, Energy Star Calculator[11] reports 6% saving per degree (Fahrenheit) for *cooling season*.
- Assuming that baseline house is equipped with a SEER 10, 2.5 ton A/C unit[12] and is used 500 hours per year[13], this implies that:

  Base A/C electricity use = 500 (cooling hours)*[30,000 (Btu/hr)/(10 (SEER)* 1,000)] = 1,500 kWh

Taking into Account Changes in Behaviour (Cooling Season)

- Based on the same program evaluation survey for the OPA[14], NCI determined that of the households who previously had non-programmable thermostats and did not manually adjust the thermostat to increase when they were away from home, 46% of respondents indicated they changed their behaviour when they installed a programmable thermostat by raising the temperature of their home when they were away (55% by 3 or more degrees, 45% by 1 or 2 degrees).
- Of the households who previously had non-programmable thermostats and manually adjusted their thermostat in the summer when they were away, 32% indicated they have increased their thermostats setting[15], where as 68% of respondents indicated they had no change in temperature settings.
- Therefore, using Statistics Canada values for typical summer behaviour of non-programmable thermostat households and Navigant Consulting findings for post installation of a programmable thermostat, the following electricity savings should be attributed to each installed programmable thermostat:

Savings	*Distribution of Households*	*Natural Gas Savings*
No change in behaviour or no set back	60%	0%
Full change in behaviour - 3 + degrees set back	17%	11%
Partial change in behaviour: 1 -2 degrees set back	23%	5.5%

- Assuming that baseline house is equipped with a SEER 10, 2.5 ton[16] A/C unit and is used 500 hours per year[17], this implies that:

  Base A/C electricity use = 500 (cooling hours)*[30,000 (Btu/hr)/(10 (SEER)* 1,000)] = 1,500 kWh
- NCI estimates the following cooling season electricity savings for each programmable thermostat installed in households with central air conditioning:

  1,500 kWh x (60% x 0% + 17% x11% +23% x 5.5%) = 47 kWh

- However, assuming a penetration rate of central air conditioners in Ontario = 57%[18], NCI estimates that the average home in Ontario will save the following in electricity during the cooling savings:

  57% x 47 kWh = 26.8 kWh

[10] Marbek Resource Consultants, The Sheltair Group Inc , BC Hydro BC Hydro Conservation Potential Review 2002, Residential Sector Report (Base Year: Fiscal 2000/01) (Revision 1) Submitted to: BC Hydro, June 2003

[11] US EPA (EPA Energy Star® Simple Savings Calculator – Programmable Thermostat), http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorProgrammableThermostat.xls

[12] Ontario Power Authority, 2009 OPA Measures and Assumptions Lists (Mass Market), November 2008, referenced from: Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI), 2006 Cool Savings Rebate Program, Prepared for the Ontario Power Authority, April 2007.

[13] US EPA (EPA Energy Star® Simple Savings Calculator – Programmable Thermostat), http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorProgrammableThermostat.xls

[14] Navigant Consulting, Evaluation Report: 2007 Hot and Cool Savings Programs, prepared for the Ontario Power Authority (OPA), July 2008.

[15] Although the survey results did not indicate the change in degree-value in temperature for summer behaviour, Navigant Consulting is assuming it is the same as the winter change in behaviour (e.g., 19% by 3 or more degrees, 81% by 1-2 degrees).

[16] Implying input of 30,000 Btu/hr, Energy Star Savings Calculator, http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/Calc_CAC.xls

[17] Number of full-load cooling hours provided by http://energyexperts.org/ac%5Fcalc/ and based on the assumption that Ontario's climate is sufficiently similar to that of the north-eastern U.S.

[18] Natural Resource Canada, Survey of Household Energy Use (SHEU), December 2005

- Total electricity savings for both heating (furnace fan) and cooling savings for an average Ontario home are estimated to be 54 kWh (7 kWh + 47 kWh = 54 kWh).

Annual Water Savings	0 L
N/A	

Other Input Assumptions

Effective Useful Life (EUL)	15 Years
Navigant Consulting is estimating 15 years as the effective useful life based on the average lifetime of programmable thermostat from Energy Star ® website.	
Base & Incremental Conservation Measure Equipment and O&M Costs	**$ 26.95**
Average incremental cost of programmable thermostats determined to be $26.95 based on utility bulk purchase order cost.	
Customer Payback Period (Natural Gas Only)[19]	**1 Years**
Using an 5-year average commodity cost (avoided cost)[20] of $0.38 / m^3 and an average residential distribution cost[21] of $0.14 / m^3, the payback period for natural gas savings is determined to be 0.9 years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = $26.95/ (53 m^3/year * $0.52 / m^3) = 1 years	
Market Penetration	**65%**
Due to the number of conservation programs in Ontario currently offering programmable thermostats and based on previous research conducted for the OPA[22], Navigant Consulting estimates the penetration of programmable thermostats amongst single family residents in Ontario to be 65%.	

[19] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.

[20] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.

[21] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).

[22] Navigant Consulting, Inc. for the Ontario Power Authority, *Residential Rebate Program: Participation Forecast and Incentive Bundling Strategy – Key Findings Summary*, December 2008

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
State of Iowa Utilities Board[23]	276	15	$25	46% (single family)
Comments Measure provides savings of 11.5% over 2,399 m^3 required for space heating with base equipment. Behavioural adjustments were not included in results.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/Market Share**
Ontario Power Authority[24]	182	15	$140	N/A
Comments Based on gas savings from Canadian Centre for Housing Technology study for an 80% AFUE gas furnace using standard PCS motor and furnace size of 67,500 BTU/hr, using 4761 heating degree hours. Behavioural adjustments were not included in results.				

[23] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2
[24] Ontario Power Authority, 2009 OPA Measures and Assumptions Lists (Mass Market), November 2008

PROGRAMMABLE THERMOSTAT

Low Income, EGD

Efficient Technology & Equipment Description
Programmable thermostat
Base Technology & Equipment Description
Standard manual thermostat

Resource Savings Assumptions

Natural Gas (Updated)	**53 m^3**
Savings recommended by Navigant Consulting.[1]	
Electricity (Updated)	**54 kWh**
Savings recommended by Navigant Consulting.[1]	
Water	**n/a L**

Other Input Assumptions

Equipment Life	**15 years**
Equipment life recommended by Summit Blue Consulting and as approved in EB 2008-0384 & 0385.[1]	
Incremental Cost (Contr. Install) (UG/EGD)	**$69.18**
As per utility program costs.	
Free Ridership	**1 %**
As per EB 2008-0384 & 0385.	

[1] Draft Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, Appendix C: Substantiation Sheets, pg. B-112-115, Feb. 6, 2009.

Low-Income Water Heating

Water Heater Early Replacement

Low Income, UG

Efficient Technology & Equipment Description
Replace a 0.575 EF Hot Water Heater early with a more efficient model (0.67 EF)
Qualifier/Restriction
Water Heater must still be useable for another 3 years and between 0.56 EF and 0.59 EF.
Base Technology & Equipment Description
Continue operating a Hot Water Heater (0.575 EF), then upgrade to a 0.67 EF after 3 years

Resource Savings Assumptions

Natural Gas	**80 m^3**

Gas savings[1] = (Tout-Tin) * 8.33 * HW usage * ((1/Effbase)-(1/Effupgrade)) * 10^-6 * 27.8

80 m3/yr = (130 degF - 48.8 degF)*8.33 * 47 USG/day * 365 days/yr * ((1/0.575)-(1/.67)) * 10^-6 * 27.8

According to AESP[2], the gas saved for an early replacement measure:

(for remaining expected life of old device)

(m3/yr old device - m3/yr new device)

+

(after normal replacement time for old device)[3]

m3/yr standard device - m3/yr of efficient device)

240 m3 saved = 3 yrs * 80 m3/yr + 13 years * 0 m3/yr

or 80 m3/yr

Electricity	**0 kWh**
Water	**0 L**

Other Input Assumptions

Equipment Life	**3 Years**
The typical remaining life was estimated to be 3 years.	
Incremental Cost	**$ 168**

[1] Based on the Res'l Tankless measure from Navigant, Measures and Assumptions for DSM Planning, Final Report April 2009.

[2] AESP, Final Presentation Waltham 2010-E2.pdf, pg 80; based on OPA Cost Effectiveness Guide (Advanced OPA Model)

[3] This value is based on the commercial condensing hot water heater measure life (13 years) from Navigant, Measures and Assumptions for DSM Planning, Final Report April 2009.

Incremental installed costs were based on the installed cost of the upgrade – NPV of the basecase. $168 = $1,460 - $1,292 Costs based on discussions from water heater suppliers.	
Free Ridership	**0 %**
As per the historic low income rate.	

1.0 GAL/MIN FAUCET AERATOR (Bathroom)

Low Income, Existing, UG

Efficient Technology & Equipment Description
1.0 GPM Faucet Aerator
Base Technology & Equipment Description
2.2 GPM Faucet Aerator

Resource Savings Assumptions

Natural Gas (Updated)	**10 m^3**
Based on Navigant savings calculation adjusted for a 1.0 GPM unit. Using the following values as per Navigant Final Report: Faucet water temperature: 30 degC (86 degF) Water inlet temperature: 9.33 deg C (48.8 degF) Water heater energy factor: 0.76 Occupants per household: 3.1	
Electricity	**n/a kWh**
Water (Updated)	**3,435 L**
Based on Navigant savings calculation adjusted for a 1.0 GPM unit.	

Other Input Assumptions

Equipment Life	**10 years**
As recommended by Navigant.	
Incremental Cost	**$0.59**
As per utility program costs.	
Free Ridership	**1 %**
Free ridership – EB 2009-0102	

1.0 GAL/MIN FAUCET AERATOR (BATHROOM)

Low Income, UG

Efficient Technology & Equipment Description
Faucet Aerator (Bathroom) (1.0 GPM)
Base Technology & Equipment Description
1.5 GPM (Participants who previously received a 1.5pgm Bathroom Faucet Aerator from Union)

Resource Savings Assumptions

Natural Gas (Updated)	**4 m^3**
Savings recommended by Navigant Consulting[1] adjusted for 1.0 GPM efficient technology	
Electricity	**n/a kWh**
Water (Updated)	**1,432 L**
Savings recommended by Navigant Consulting[1] adjusted for 1.0 GPM efficient technology	

Other Input Assumptions

Equipment Life	**10 Years**
Faucet aerators have an estimated service life of 10 years.[1, 2] As approved in EB 2008-0384 & EB 2008-0385.	
Incremental Cost	**$0.59**
As per utility program costs, bulk purchase of aerators.	
Free Ridership	**1 %**
Free Ridership rate recommended by Summit Blue Consulting.[3] As approved in EB 2008-0384 & EB 2008-0385.	

[1] Final Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, April 16, 2009

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

[3] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

Faucet Aerator (Bathroom) (LIA), UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
Faucet Aerator (Bathroom) (1.5 GPM)

Base Equipment and Technologies Description
Average existing stock (2.2 GPM)[1]

Decision Type	Target Market(s)	End Use
Retrofit	Low-Income Residential (existing)	Water heating

Codes, Standards, and Regulations

Ontario Building Code (2006)[2] requires bathroom and kitchen faucets to have a maximum flow of 2.2 GPM (8.35 L/min).

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	6	0	**2,004**	0.49	
2	6	0	**2,004**	0	0
3	6	0	**2,004**	0	0
4	6	0	**2,004**	0	0
5	6	0	**2,004**	0	0
6	6	0	**2,004**	0	0
7	6	0	**2,004**	0	0
8	6	0	**2,004**	0	0
9	6	0	**2,004**	0	0
10	6	0	**2,004**	0	0
TOTALS	**60**	**0**	**20,040**	**0.49**	

[1] From on-site audit data. Resource Management Strategies, Inc. *Regional Municipality of York Water Efficiency Master Plan Update,* 2007. Cited in: Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, June 2008.

[2] Ontario Regulations 350/06, 2006 Building Code

Resource Savings Assumptions

Annual Natural Gas Savings	6 m³

Assumptions and inputs:

- Lacking any conclusive empirical data to suggest otherwise, Navigant Consulting has applied the same behavioural and base/efficient equipment assumptions to the Low-Income sector as to the Residential sector.
- Average faucet water temperature: 30 °C (86 °F)[3]
- Average water inlet temperature: 9.33 °C (48.8 °F)[4]
- Average water heater energy factor: 0.76[5]

Annual gas savings calculated as follows:

$$Savings = W * 8.33 * (T_{out} - T_{in}) * \frac{1}{EF} * 10^{-6} * 27.8$$

Where:

W = Water savings (gallons)
8.33 = Energy content of water (Btu/gallon/°F)
T_{out} = Faucet water temperature (°F)
T_{in} = Water inlet temperature (°F)
EF = Water heater recovery efficiency
10^{-6} = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to m^3

Gas savings were determined to be 22% over base case:

$$Percent\ Savings = \frac{(G_{base} - G_{new})}{G_{base}}$$

Where:

G_{eff} = Annual natural gas use with efficient equipment, 27 m^3
G_{base} = Annual natural gas use with base equipment, 21 m^3

Annual Electricity Savings	0 kWh

N/A

Annual Water Savings	2,004 L

Assumptions and inputs:

- Average household size: 3.1 persons[6]
- Baseline faucet use (all faucets) per capita per day: 53 litres (14 gallons)[7]
- Bathroom faucet use as a percentage of total faucet use: 15%[8]

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[3] Average of findings in two studies, adjusted for Toronto water inlet temperature. Mayer, P. W. et al, *Residential Indoor Water Conservation Study: Evaluation of High Efficiency Indoor Plumbing Fixture Retrofits in Single-Family Homes in East Bay Municipal Utility District Service Area,* 2003 and Skeel, T. and Hill, S. *Evaluation of Savings from Seattle's "Home Water Saver" Apartment/Condominium Program*, 1994. Both cited in: Summit Blue (2008).

[4] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, *Comments on Navigant's Draft Gas Measure Characterizations,* March 2009

[5] Assumption used by Energy Center of Wisconsin, citing GAMA, Pigg, Scott. *Water Heater Savings Calculator*, 2003 www.doa.state.wi.us/docs_view2.asp?docid=2249

[6] Summit Blue (2008).

[7] Ibid.

[8] DeOreo, W. and P. Mayer, *The End Uses of Hot Water in Snigle Family Homes from Flow Trace Analysis*, 1999 cited in Summit Blue (2008).

- Point estimate of quantity of water that goes straight down the drain: 70%[9]

Annual water savings calculated as follows:

$$Savings = Fu * Ppl * 365 * Ba * \left(\frac{Fl_{base} - Fl_{eff}}{Fl_{base}} \right) * Dr$$

Where:

Fu = Faucet use per capita (gallons)
Ppl = Number of people per household
365 = Days per year
Dr = Percentage of water that goes straight down the drain
Ba = Individual bathroom faucet use as a percentage of total faucet use
Fl_{base} = Flow rate of base equipment (GPM)
Fl_{eff} = Flow rate of efficient equipment (GPM)

Water savings was determined to be 22% over base case:

$$Percent Savings = \frac{(W_{base} - W_{eff})}{W_{base}}$$

Where:

W_{eff} = Annual water use with efficient equipment: 6,993 litres (1,847 gallons)
W_{base}= Annual water use with base equipment: 8,997 litres (2,376 gallons)

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
The U.S. DOE assumes a 10 year life for faucet aerators[10].	
Base & Incremental Conservation Measure Equipment and O&M Costs	**0.49 $**
Average equipment cost based on utility bulk purchase order cost. This does not include installation costs.	
Customer Payback Period (Natural Gas Only)[11]	**0.16 Years**
Using a 5-year average commodity cost (avoided cost)[12] of \$0.38 / m^3 and an average residential distribution cost[13] of \$0.14 / m^3, the payback period for natural gas savings is determined to be 0.6 years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost)	

[9] Summit Blue (2008).
[10] U.S. Department of Energy, Federal Energy Management Program, *FEMP Designated Product: Lavatory Faucets* http://www1.eere.energy.gov/femp/procurement/eep_faucets.html
[11] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.
[12] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.
[13] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).

= $0.49/ (6 m^3/year * $0.52 / m^3) = 0.16 years

Market Penetration[14]	**90%**
Based on previous research conducted for the OPA, Navigant Consulting estimates penetration of faucet aerators (bathroom and kitchen) across all sectors to be 90%[15].	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Puget Sound Energy[16]	8	5	N/A	45%

Comments

For a switch from a 2.5 GPM to a 1.8 GPM aerator. Measure saves 1% of 759 m^3 required for water heating.

Note that no distinction is made, in this study, between kitchen and bathroom faucet use.

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
State of Iowa Utilities Board[17]	36	9	20 US$	90%

Comments

For a switch from a 3.0 GPM to a 1.5 GPM aerator for the Low-Income sector.

Measure saves 6.2% of 584 m^3 required for water heating.

Note that no distinction is made, in this study, between kitchen and bathroom faucet use. Note also that the flow rate reduction in this jurisdiction is more than twice that of the measure addressed by this substantiation sheet.

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[14] Navigant Consulting is defining “Low” as below 5%, “Medium” as between 5-50%, and “High” as above 50%,

[15] Navigant Consulting, Inc. for the Ontario Power Authority, *Residential Rebate Program: Participation Forecast and Incentive Bundling Strategy – Key Findings Summary*, December 2008

[16] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy

[17] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2

1.0 GAL/MIN FAUCET AERATOR (Kitchen)

Low Income, Existing, UG

Efficient Technology & Equipment Description
1.0 GPM Faucet Aerator
Base Technology & Equipment Description
2.5 GPM Faucet Aerator

Resource Savings Assumptions

Natural Gas (Updated)	**35 m^3**
Based on Navigant savings calculation adjusted for a 1.0 GPM unit. Using the following values as per Navigant Final Report: Faucet water temperature: 30 degC (86 degF) Water inlet temperature: 9.33 deg C (48.8 degF) Water heater energy factor: 0.76 Occupants per household: 3.1	
Electricity	**n/a kWh**
Water (Updated)	**11,694 L**
Based on Navigant savings calculation adjusted for a 1.0 GPM unit.	

Other Input Assumptions

Equipment Life	**10 years**
As recommended by Navigant.	
Incremental Cost	**$1.59**
As per utility program costs.	
Free Ridership	**1 %**
Free ridership – EB 2009-0102	

Faucet Aerator (Kitchen) (LIA), UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description

Faucet Aerator (kitchen) (1.5 GPM)

Base Equipment and Technologies Description

Average existing stock (2.5 GPM)[1]

Decision Type	Target Market(s)	End Use
Retrofit	Low-Income Residential (existing)	Water heating

Codes, Standards, and Regulations

Ontario Building Code (2006)[2] requires bathroom and kitchen faucets to have a maximum flow of 2.2 GPM (8.35 L/min).

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year	Natural Gas	Electricity	Water		
(EUL=)	(m^3)	(kWh)	(L)	($)	($)
1	23	0	**7,797**	1.29	0
2	23	0	**7,797**	0	0
3	23	0	**7,797**	0	0
4	23	0	**7,797**	0	0
5	23	0	**7,797**	0	0
6	23	0	**7,797**	0	0
7	23	0	**7,797**	0	0
8	23	0	**7,797**	0	0
9	23	0	**7,797**	0	0
10	23	0	**7,797**	0	0
TOTALS	**230**	**0**	**77,970**	**1.29**	**0**

[1] From on-site audit data. Resource Management Strategies, Inc. *Regional Municipality of York Water Efficiency Master Plan Update,* 2007. Cited in: Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, June 2008.
[2] Ontario Regulations 350/06, 2006 Building Code

Resource Savings Assumptions

Annual Natural Gas Savings	23 m^3

Assumptions and inputs:

- Lacking any conclusive empirical data to suggest otherwise, Navigant Consulting has applied the same behavioural and base/efficient equipment assumptions to the Low-Income sector as to the Residential sector.
- Average faucet water temperature: 30 °C (86 F)[3]
- Average water inlet temperature: 9.33 °C (48.8 F)[4]
- Average water heater energy factor: 0.76[5]

Annual gas savings calculated as follows:

$$Savings = W * 8.33 * (T_{out} - T_{in}) * \frac{1}{EF} * 10^{-6} * 27.8$$

Where:

W = Water savings (gallons)
8.33 = Energy content of water (Btu/gallon/°F)
T_{out} = Faucet water temperature (°F)
T_{in} = Water inlet temperature (°F)
EF = Water heater recovery efficiency
10^{-6} = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to m^3

Gas savings were determined to be 20% over base case:

$$Percent\ Savings = \frac{(G_{base} - G_{new})}{G_{base}}$$

Where:

G_{eff} = Annual natural gas use with efficient equipment, 94 m^3
G_{base} = Annual natural gas use with base equipment, 117 m^3

Annual Electricity Savings	0 kWh

N/A

Annual Water Savings	7,797 L

Assumptions and inputs:

- Average household size: 3.1 persons[6]
- Baseline faucet use (all faucets) per capita per day: 53 litres (14 gallons)[7]
- Kitchen faucet use as a percentage of total faucet use: 65%[8]

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[3] Average of findings in two studies, adjusted for Toronto water inlet temperature. Mayer, P. W. et al, *Residential Indoor Water Conservation Study: Evaluation of High Efficiency Indoor Plumbing Fixture Retrofits in Single-Family Homes in East Bay Municipal Utility District Service Area,* 2003 and Skeel, T. and Hill, S. *Evaluation of Savings from Seattle's "Home Water Saver" Apartment/Condominium Program*, 1994. Both cited in:
Summit Blue (2008).
[4] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, *Comments on Navigant's Draft Gas Measure Characterizations*, March 2009
[5] Assumption used by Energy Center of Wisconsin, citing GAMA, Pigg, Scott, *Water Heater Savings Calculator* 2003. www.doa.state.wi.us/docs_view2.asp?docid=2249
[6] Summit Blue (2008).
[7] Ibid.
[8] DeOreo, W. and P. Mayer, *The End Uses of Hot Water in Snigle Family Homes from Flow Trace Analysis*, 1999 cited in Summit Blue (2008).

- Point estimate of quantity of water that goes straight down the drain: 50%[9]

Annual water savings calculated as follows:

$$Savings = Fu * Ppl * 365 * Ba * \left(\frac{Fl_{base} - Fl_{eff}}{Fl_{base}} \right) * Dr$$

Where:

Fu = Faucet use per capita (gallons)
Ppl = Number of people per household
365 = Days per year
Dr = Percentage of water that goes straight down the drain
Ki = Kitchen faucet use as a percentage of total faucet use
Fl_{base} = Flow rate of base equipment (GPM)
Fl_{eff} = Flow rate of efficient equipment (GPM)

Water savings was determined to be 20% over base case:

$$PercentSavings = \frac{(W_{base} - W_{eff})}{W_{base}}$$

Where:

W_{eff} = Annual water use with efficient equipment: 38,986 litres (10,297 gallons)
W_{base}= Annual water use with base equipment: 31,188 litres (8,237 gallons)

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
The U.S. DOE assumes a 10 year life for faucet aerators[10].	
Base & Incremental Conservation Measure Equipment and O&M Costs	**1.29 $**
Average equipment cost based on utility bulk purchase order cost. This does not include installation costs.	
Customer Payback Period (Natural Gas Only)[11]	**0.11 Years**
Using a 5-year average commodity cost (avoided cost)[12] of \$0.38 / m^3 and an average residential distribution cost[13] of \$0.14 / m^3, the payback period for natural gas savings is determined to be 0.17 years, based on the following:	

[9] Summit Blue (2008).
[10] U.S. Department of Energy, Federal Energy Management Program, *FEMP Designated Product: Lavatory Faucets* http://www1.eere.energy.gov/femp/procurement/eep_faucets.html
[11] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.
[12] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.
[13] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).

Payback Period = Incremental cost / (natural gas savings x natural gas cost) = $1.29/ (23 m^3/year * $0.52 / m^3) = 0.11 years

Market Penetration	90%
Based on previous research conducted for the OPA, Navigant Consulting estimates penetration of faucet aerators (bathroom and kitchen) across all sectors to be 90%[14].	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Puget Sound Energy[15]	8	5	N/A	45%

Comments

For a switch from a 2.5 GPM to a 1.8 GPM aerator. Measure saves 1% of 759 m^3 required for water heating.

Note that no distinction is made, in this study, between kitchen and bathroom faucet use.

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
State of Iowa Utilities Board[16]	36	9	20 US$	90%

Comments

For a switch from a 3.0 GPM to a 1.5 GPM aerator for the Low-Income sector.

Measure saves 6.2% of 584 m^3 required for water heating.

Note that no distinction is made, in this study, between kitchen and bathroom faucet use. Note also that the flow reduction in this jurisdiction is more than twice that of the measure addressed by this substantiation sheet.

[14] Navigant Consulting, Inc. for the Ontario Power Authority, *Residential Rebate Program: Participation Forecast and Incentive Bundling Strategy – Key Findings Summary*, December 2008
[15] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy
[16] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2

1.0 GAL/MIN FAUCET AERATOR (BATHROOM)

Low Income Residential Existing Homes, EGD

Efficient Technology & Equipment Description
Faucet Aerator (Bathroom) (1.0 GPM)
Base Technology & Equipment Description
Average existing stock & Ontario Building Code 2006 maximum allowed (2.2 GPM)

Resource Savings Assumptions

Natural Gas (Updated)	**10 m^3**
Savings recommended by Navigant Consulting.[1] adjusted for 1.0 GPM	
Electricity	**n/a kWh**
Water (Updated)	**3,435 L**
Savings recommended by Navigant Consulting[1] adjusted for 1.0 GPM	

Other Input Assumptions

Equipment Life	**10 Years**
Faucet aerators have an estimated service life of 10 years.[1, 2] As approved in EB 2008-0384 & 0385.	
Incremental Cost	**.55** $
As per utility program costs, bulk purchase of 1.0 aerators for new/existing market via Union.	
Free Ridership	**1 %**
As approved in EB 2009-0103 for 1.5 gpm aerators.	

[1] Final Report “Measures and Assumptions for Demand Side Management (DSM) Planning”, Navigant Consulting Inc., Ontario Energy Board, April 16, 2009

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

1.5 GAL/MIN FAUCET AERATOR (Bathroom)

Low Income (Distributed), EGD

Efficient Technology & Equipment Description
Faucet Aerator (Bathroom) (1.5 GPM)
Base Technology & Equipment Description
Average existing stock (2.2 GPM)

Resource Savings Assumptions

Natural Gas (Updated)	6 m^3
Savings recommended by Navigant Consulting.[1]	
Electricity	**n/a kWh**
Water (Updated)	**2,004 L**
Savings recommended by Navigant Consulting.[1]	

Other Input Assumptions

Equipment Life	10 years
Faucet aerators have an estimated service life of 10 years.[1, 2] Savings recommended by Navigant Consulting.[1]	
Incremental Cost **Customer Install**	**$.46**
As per utility program costs.	
Free Ridership	**1 %**
As per EB 2009-0103	

[1] Draft Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, Appendix C: Substantiation Sheets, pg. B-108-111, Feb. 6, 2009.

[28] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

1.0 GAL/MIN FAUCET AERATOR (KITCHEN)

Low Income Residential Existing Homes, EGD

Efficient Technology & Equipment Description
Faucet Aerator (Kitchen) (1.0 GPM)
Base Technology & Equipment Description
Average existing stock – 2.5 GPM Faucet Aerator (Kitchen)

Resource Savings Assumptions

Natural Gas	**35** m^3
Savings based on Navigant's[1], except using a 1.0 GPM efficient technology case	
Electricity	**n/a kWh**
Water	**11,694 L**
Savings based on Navigant's[1], except using a 1.0 GPM efficient technology case	

Other Input Assumptions

Equipment Life	**10 years**
Faucet aerators have an estimated service life of 10 years.[2] As approved in EB 2008-0384 & 0385.	
Incremental Cost	**1.00** $
As per utility program costs, bulk purchase of 1.0 aerators for new/existing market.	
Free Ridership	**1 %**
As approved in EB 2009-0103 for 1.5 gpm aerators	

[1] Draft Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, Appendix C: Substantiation Sheets, pg. B-65-68, Feb. 6, 2009.

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

1.5 GAL/MIN FAUCET AERATOR (Kitchen)

Low Income (Distributed), EGD

Efficient Technology & Equipment Description
Faucet Aerator (Kitchen) (1.5 GPM)
Base Technology & Equipment Description
Average existing stock (2.5 GPM)

Resource Savings Assumptions

Natural Gas (Updated)	**23 m^3**
Savings recommended by Navigant Consulting.[1]	
Electricity	**n/a kWh**
Water (Updated)	**7,797 L**
Savings recommended by Navigant Consulting.[1]	

Other Input Assumptions

Equipment Life	**10 years**
Faucet aerators have an estimated service life of 10 years.[1, 2] Recommended by Navigant Consulting.[1]	
Incremental Cost **Customer Install**	**$.94**
As per utility program costs.	
Free Ridership	**1 %**
As per EB 2009-0103	

[1] Draft Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, Appendix C: Substantiation Sheets, pg. B-112-115, Feb. 6, 2009.

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

Low Flow Showerheads, 1.25 GPM
Low Income, EGD

Please see the low flow showerhead substantiation document in the Residential Water Heating section.

Low-Flow Showerhead (1.25 Gpm, Low Income, Installed, per Household), UG

Revision #	Description/Comment	Date Revised
		October 28, 2010

Efficient Equipment and Technologies Description

Low-flow Showerhead (1.25 Gpm) – One or more showerheads are installed by Union-designated contractors.

Base Equipment and Technologies Description

Average existing stock within one of three ranges.

Range mid-points used as point estimates:

- Scenario **A** – 2.25 GPM
- Scenario **B** – 3.0 GPM

When new showerheads are installed contractors use a bag-test to determine base equipment flow-rate.

Decision Type	Target Market(s)	End Use
Retrofit	Low Income Residential (Existing)	Water heating

Resource Savings Table

Year (EUL=)	Electricity and Other Resource Savings: Natural Gas (m^3)	Electricity (kWh)	Water (L)	Equipment & O&M Costs of Conservation Measure ($)	Equipment & O&M Costs of Base Measure ($)
1	**A:** 46 **B:** 88	0	**A:** 14,294 **B:** 22,580	3.79	0
2	**A:** 46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
3	**A:** 46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
4	**A:** 46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
5	**A:** 46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
6	**A:** 46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
7	**A:** 46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
8	**A:** 46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
9	**A:** 46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
10	**A:** 46 **B:** 88	0	**A:** 14,294 **B:** 22,580	0	0
TOTALS	**A: 460** **B: 880**	**0**	**A:** 142,940 **B:** 225,800	**3.79**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	**A: 46 m^3** **B: 88 m^3**

Enbridge Gas commissioned a study by the SAS Institute (Canada)[23] to estimate natural gas savings for low-flow showerheads in Enbridge territory. Data was collected August 31, 2007 until August 31, 2009 for both treatment and control groups. Low flow showerheads were installed in treatment households between

[23] Rothman, Lorne, SAS® PHASE II Analysis for Enbridge Gas Distribution Inc.: Estimating the Impact of Low-Flow Showerhead Installation; April 5, 2010

August 13, 2008 and October 30, 2008. There were 54 households with low-flow showerheads and 124 households without low-flow showerheads.

To calculate the gas savings, three different models were used to analyze the gas consumption data

1) a comparison made during the same time frame (post-installation) between a control set of households[24] and households that had them installed
2) a Pre & Post installation analysis on the same households, and
3) a complex time trend model analysis that factored in many household characteristics over the whole Pre & Post time period.

All three analyses agreed well with each other.[25]

Three buckets for pre-existing showerheads were originally proposed. However, the lowest flow bucket (2.0 GPM or less) had too few observations and are rare in the population of households. The natural gas savings for the other two buckets are estimated to be as follows:

Baseline Flow rate (GPM)	Energy Efficient Flow Rate (GPM)	Change in GPM	Annual Natural Gas Savings (m^3)	Annual Natural Gas Savings (m^3 per GPM)
2.25[26]	1.25	1.0	46	46
3[27]	1.25	1.75	88	50

For base flow/efficient flow showerhead types not explicitly tested in the SAS study, gas savings have been extrapolated in the following manner:

1. The results of the SAS institute study indicate that gas savings increase at an increasing rate as the difference between efficient and base GPM increases.
2. Fitting a polynomial function with no intercept (no change in GPM = no gas savings) delivers the following function (where ΔGPM = Base GPM – Efficient GPM):

$$\text{Annual Gas Savings } (m^3) = 40.29 * \Delta GPM + 5.71 * \Delta GPM^2$$
$$= 40.29*(2.25-1.25) + 5.71*(2.25-1.25)^2$$
$$= 46$$

$$\text{Annual Gas Savings } (m^3) = 40.29 * \Delta GPM + 5.71 * \Delta GPM^2$$
$$= 40.29*(3.0-1.25) + 5.71*(3.0-1.25)^2$$
$$= 88$$

These savings values assume that 100% of household showering is reduced to 1.25 gpm. A survey determining the percentage of showering affected by the program should be used to adjust the year end program results.

Annual Electricity Savings	**0 kWh**

N/A

Annual Water Savings	**A: 14,294 L** **B: 22,580 L**

Since the SAS report did not look at water savings, Navigant Consulting proposes the following method for calculating resulting water savings:

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24 where no low-flow showerheads were ever installed

25 Model 1 – a blended rate of 71.3 m3/yr (only models II and II provided bucketed savings estimates)
Model 2 – a blended rate of 67.4 m3/yr (45.4 m3/yr for 2 to 2.5 GPM bucket and 87.8 m3/yr for over 2.5 GPM), and
Model 3 – a blended rate of 77.2 m3/yr (46.4 m3/yr for 2 to 2.5 GPM bucket and 87.9 m3/yr for over 2.5 GPM).

26 Average of 2.0 GPM and 2.5 GPM

27 Assumed average low flow showerhead which is greater than 2.5 GPM.

Assumptions and inputs:

- As-used flow rate with base equipment[28]:
  Scenario **A:** 1.91 GPM
  Scenario **B:** 2.32 GPM
- Average household size: 3.1 persons[29]
- Showers per capita per day: 0.75[30]
- Average showering time per capita per day with base equipment:
  Scenario **A:** 7.31 minutes
  Scenario **B:** 7.13 minutes
- Average showering time per capita per day with new technology: 7.61 minutes[31]

Annual water savings calculated as follows:

$$Savings = Ppl * Sh * 365 * (T_{base} * Fl_{base} - T_{eff} * Fl_{eff})$$

Where:

Ppl = Number of people per household.
Sh = Showers per capita per day.
365 = Days per year.
T_{base} = Showering time with base equipment (minutes)
T_{eff} = Showering time with efficient equipment (minutes).
Fl_{base} = As-used flow rate with base equipment (GPM)
Fl_{eff} = As-used flow rate with efficient equipment (GPM)

Scenario **A:** Savings = 3,776 gallons or 14,294 litres
Scenario **B:** Savings = 5,965 gallons or 22,580 litres

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
Summit Blue (2008) suggests an EUL of 10 years based on a survey of five studies of showerheads in other jurisdictions (California – two studies, New England, Vermont, Arkansas).	
Incremental Costs	**$3.79**
As per utility program costs, bulk purchase of showerheads.	
Free-Ridership	**1%**
Free Ridership rate recommended by Summit Blue Consulting.[32]	

[28] As-used flow is calculated as a function of "full-on" or label flow: as-used flow = min{ 0.691+0.542*full-on flow, full-on flow}. Proctor, J. Gavelis, B. and Miller, B. *Savings and Showers: It's All in the Head*, (PGE) Home Energy Magazine, July/Aug 1994. Cited in Summit Blue (2008).
[29] Summit Blue (2008).
[30] Ibid, based on data from: Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007
[31] Relationship modeled as: Average shower length = 8.17 – 0.448 * as-used GPM. From Energy Center of Wisconsin Analysis of data from Resource Management Strategies, Inc., *Regional Municipality of York Water Efficiency Master Plan Update,* April 2007. Cited in Summit Blue (2008)
[32] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

Pipe Wrap – R4 (LIA), UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
Insulated hot water pipe for conventional gas storage tank-type hot water heater (R-4).
Base Equipment and Technologies Description
Conventional gas storage tank-type hot water heater without pipe wrap (R-1).

Decision Type	Target Market(s)	End Use
Retrofit	Low-Income Residential (Existing)	Water heating

Codes, Standards, and Regulations

N/A

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	18	0	0	0.98	
2	18	0	0	0	0
3	18	0	0	0	0
4	18	0	0	0	0
5	18	0	0	0	0
6	18	0	0	0	0
7	18	0	0	0	0
8	18	0	0	0	0
9	18	0	0	0	0
10	18	0	0	0	0
TOTALS	**180**	**0**	**0**	**0.98**	

Resource Savings Assumptions

Annual Natural Gas Savings	18 m^3

Assumptions and inputs:

- Lacking any conclusive empirical data to suggest otherwise, Navigant Consulting has applied the same behavioural and base/efficient equipment assumptions to the Low-Income sector as to the Residential sector.
- Gas savings calculated using method set out in 2006 Massachusetts study[1] except where noted.
- Average water heater recovery efficiency: 0.76[2]
- Average household size: 3.1 persons[3]
- Assumed diameter of pipe to be wrapped: 0.75 inches
- Length of pipe to be wrapped: 6 feet.
- Surface area of pipe to be wrapped: 1.18 square feet.
- Ambient temperature around pipes: 16 ^oC (60 ^oF) [4]
- Average water heater set point temperature: 54 ^oC (130 ^oF)[5]
- Hot water temperature in outlet pipe: 52 ^oC (125 ^oF)[6]

Annual gas savings calculated as follows:

$$Savings = \left(\frac{1}{R_{base}} - \frac{1}{R_{eff}} \right) * Sa * \left(T_{pipe} - T_{amb} \right) * 24 * 365 * \frac{1}{EF} * 10^{-6} * 27.8$$

Where:

R_{base} = R-value of base equipment
R_{eff} = R-value of efficient equipment
Sa = Surface area of outlet pipe (ft^2)
T_{pipe} = Temperature of water in outlet pipe (^oF)
T_{amb} = Ambient temperature around pipe (^oF)
24 = Hours per day
365 = Days per year
EF = Water heater energy factor
10^{-6} = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to m^3

Gas savings were determined to be 75% over base measure

$$PercentSavings = \frac{\left(G_{base} - G_{eff} \right)}{G_{base}}$$

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[1] RLW Analytics, *Final Market Potential Report Of Massachusetts Owner Occupied 1-4 Unit Dwellings*, July 2006 http://www.cee1.org/eval/db_pdf/575.pdf

[2] Assumption used by Energy Center of Wisconsin, citing GAMA, Pigg, Scott, *Water Heater Savings Calculator*, 2003 www.doa.state.wi.us/docs_view2.asp?docid=2249

[3] Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, June 2008.

[4] RLW Analytics (2006). Given geographic proximity, Massachusetts temperatures used unchanged for Ontario.

[5] As suggested by NRCan: http://oee.nrcan.gc.ca/residential/personal/new-homes/water-conservation.cfm?attr=4

[6] From source: "It is common to find a 5 - 10 F temperature drop from the water heater to the furthest fixtures in the house." Chinnery, G. *Policy recommendations for the HERS Community to consider regarding HERS scoring credit due to enhanced effective energy factors of water heaters resulting from volumetric hot water savings due to conservation devices/strategies,* EPA Energy Star for Homes, Sept 2006 http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/Volumetric_Hot_Water_Savings_Guidelines.pdf

Where: G_{eff} = Annual natural gas use with efficient equipment, 8 m^3 G_{base} = Annual natural gas use with base equipment, 33 m^3	
Annual Electricity Savings	**0 kWh**
N/A	
Annual Water Savings	**0 L**
Navigant has assumed that adopting the measure would not affect the quantity of water consumed.	

Other Input Assumptions

Effective Useful Life (EUL)	**10 Years**
Based on the estimated measure lifetimes used in four other jurisdictions (Iowa - 15 years, Puget Sound Energy - 10 years, Efficiency Vermont – 10 years, and NYSERDA[7] – 10 years) Navigant recommends using an EUL of 10 years.	
Base & Incremental Conservation Measure Equipment and O&M Costs	**0.98 $**
Average equipment cost (for six feet of pipe wrap) based on utility bulk purchase order cost.	
Customer Payback Period (Natural Gas Only)[8]	**0.1 Years**
Using an 5-year average commodity cost (avoided cost)[9] of $0.38 / m^3 and an average residential distribution cost[10] of $0.14 / m^3, the payback period for natural gas savings is determined to be 0.2 years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = $0.98/ (18 m^3/year * $0.52 / m^3) = 0.1 years	
Market Penetration	**47%**
Based on previous research conducted for the OPA, Navigant Consulting estimates the market penetration of this measure to be 47%[11].	

7 NYSERDA, New York Energy Smart Programs, *Deemed Savings Database*

8 Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.

9 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.

10 Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).

11 Navigant Consulting, Inc. for the Ontario Power Authority, *Residential Rebate Program: Participation Forecast and Incentive Bundling Strategy – Key Findings Summary*, December 2008

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
State of Iowa Utilities Board[12]	23	15	115 US$	41%
Comments For addition of R-4 insulation to previously un-insulated pipes in the Low-Income sector. Measure saves 4% of 584 m^3 required for water heating.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/Market Share**
Puget Sound Energy, 2007[13]	8	10	8 US$	38%
Comments For addition of R-4 insulation to previously un-insulated pipes. Measure saves 1% of 759 m^3 required for water heating.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/Market Share**
Midwest Energy Efficiency Alliance, 2003[14]	36	N/A	N/A	10.4%
Comments No indication given of percentage savings or base natural gas consumption for water heating.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/Market Share**
Efficiency Vermont, 2006[15]	N/A	10	15 US$	N/A
Comments Only electricity savings reported (33 kWh) for an electric hot water system. Insulation upgrade not specified. No indication given of percentage savings or base natural gas consumption for water heating.				

[12] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2
[13] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy
[14] Midwest Energy Efficiency Alliance, *Illinois Residential Market Analysis, Final Report*, May 12, 2003. http://www.cee1.org/eval/db_pdf/390.pdf
[15] Efficiency Vermont, *Technical Reference User Manual (TRM)*, February 2006

Commercial Cooking

Energy Star Fryers

Commercial – New/Existing, EGD & UG

Efficient Technology & Equipment Description
Energy Star Fryer
Qualifier/Restriction
No restriction
Base Technology & Equipment Description
Standard-efficiency fryer:

Resource Savings Assumptions

Natural Gas	1,083 m^3

The gas savings were based on FSTC's calculator,[1] updated by studies conducted by NGTC including a survey of facilities in UG territory, using the inputs below. [2,3,4]

	Fryers	Inputs		Source
	Definitions	Base	HE	
Nb_{days}	Number of operating days per year	365	365	FSTC Life cycle calculator
Er_i	Idle energy rate (Btu/hr)	14,000	9,000	
N_p	Number of preheats per day	1	1	
E_p	Preheat energy (Btu)	16,000	15,500	
E_{food}	Energy transferred to food (Btu/lb)	565	565	
P_{hr}	Production capacity (lbs/hr)	60	65	
Eff	Cooking efficiency	35%	50%	

[1] Food Service Technology Center – Life-Cycle and Energy Cost Calculators - http://www.fishnick.com/saveenergy/tools/calculators/, visited in the fall of 2010

[2] NGTC, DSM Opportunities Associated with Gas-Fired Food Service Equipment, Final Report, Ver 2, June 22, 2010

[3] NGTC, Phase 3-jan14 2011 steamer corrected.xlsx

[4] NGTC,Characterizing the Demand-Side Management Potential of Gas-Fired Commercial Food Service Equipment. 2006

Prod	Daily production (lbs/day)	100	100	NGTC 2006 report, corroborated by fryer load data in UG territory (FSTC calculator has 150 lbs/day).
$Elec_p$	Electricity consumption for preheat (kWh)	0.07	0.07	Average values from technical specifications from various manufacturers
P_i	Electric power in idle mode (kW)	0.13	0.13	
P_h	Electric power in heavy load mode (kW)	0.41	0.41	
n%	Used to calculate time in idle mode on UG territory	84%	85%	% of time in idle mode based on results of NGTC telephone survey of full service restaurants, limited service restaurants and institutional establishments (schools, colleges, universities and hospitals) on UG territory
t_{daily}	Number of operating hours per day (hrs)	12	12	Based on NGTC telephone survey
t_p	Preheat time (hrs)	0.175	0.175	Based on FSTC appliance test reports for fryers
t_i	Hours per day in idle mode (hrs)	9.933	10.099	Calculated from $t_i = n\% * (t_{daily} - t_p)$
t_h	Time in heavy load mode, i.e. cooking time (hrs)	1.892	1.726	Calculated from $t_h = t_{daily} - (t_p + t_i)$
E_h	Daily heavy-load natural gas consumption (Btu)	Calculated		
E_i	Daily idle natural gas consumption (Btu)	Calculated		
E_{annual}	Annual natural gas consumption (Btu/year)	Calculated		

$$Savings = Nb_{days} * \left[E_{food} * \left(\frac{P_{hr_{base}} * t_{h_{base}}}{Eff_{base}} - \frac{P_{hr_{HE}} * t_{h_{HE}}}{Eff_{HE}}\right) + \left(Er_{i_{base}} * t_{i_{base}} - Er_{i_{HE}} * t_{i_{HE}}\right) + N_p * \left(E_{p_{base}} - E_{p_{HE}}\right)\right]$$	
Electricity	**17 kWh**
$Elec_{savings} = Nb_{days} * \left[\left(t_{i_{base}} - t_{i_{HE}}\right) * P_i + \left(t_{h_{base}} - t_{h_{HE}}\right) * P_h\right]$ Electrical savings are based on the inputs above.	
Water	**0 L**
None	

Other Input Assumptions

Equipment Life	**12 Years**
Savings attributed to the measures are expected to last the life expectancy of the equipment. Source of effective useful life: FSTC savings calculator as referenced in NGTC, DSM OPPORTUNITIES ASSOCIATED WITH GAS-FIRED FOOD SERVICE EQUIPMENT, Final Report Ver 2, April 20, 2010.	
Incremental Cost	**$ 1,028**
High-efficiency and standard-efficiency equipment (base case) purchase prices were obtained from list prices in Canadian dollars obtained from Ontarian distributors. High-efficiency price and base case prices are for Pitco comparables (Source for list prices: W.D. College). Base Case cost - $6,400 Upgrade cost - $7,428 Installation costs of high-efficiency and standard-efficiency equipment are considered to be identical. Similarly, maintenance costs of high-efficiency and standard-efficiency equipment are considered to be identical (Source: W.D. College). Hence, the installation and maintenance costs were not taken into account in the resource savings table[5].	

[5] NGTC, "DSM Opportunities Associated with Gas-Fired Food Service Equipment", Final Report, Ver 2, June 22, 2010, pg 9

Energy Star Convection Ovens (Full Size)

Commercial – New/Existing, EGD & UG

Efficient Technology & Equipment Description
Energy Star convection oven.
Qualifier/Restriction
No restriction
Base Technology & Equipment Description
Standard-efficiency convection oven. Model used for savings calculation corresponds to default FSTC calculator full size standard-efficiency convection oven

Resource Savings Assumptions

Natural Gas	**847 m^3**

The gas savings were based on FSTC's calculator, [11] updated by studies conducted by NGTC including a survey of facilities in UG territory, using the inputs below. [12,13,14]

	Convection ovens (full size)	**Inputs**		**Source**
	Definitions	**Base**	**HE**	
Nb_{days}	Number of operating days per year	365	365	FSTC Life cycle calculator
Er_i	Idle energy rate (Btu/hr)	18,000	13,000	
N_p	Number of preheats per day	1	1	
E_p	Preheat energy (Btu)	19,000	11,000	
E_{food}	Energy transferred to food (Btu/lb)	250	250	
P_{hr}	Production capacity (lbs/hr)	70	80	
Eff	Cooking efficiency	30%	44%	
Prod	Daily	100	100	

[11] Food Service Technology Center – Life-Cycle and Energy Cost Calculators - http://www.fishnick.com/saveenergy/tools/calculators/, visited in the fall of 2010

[12] NGTC, DSM Opportunities Associated with Gas-Fired Food Service Equipment, Final Report, Ver 2, June 22, 2010

[13] NGTC, Phase 3-jan14 2011 steamer corrected.xlsx

[14] NGTC,Characterizing the Demand-Side Management Potential of Gas-Fired Commercial Food Service Equipment. 2006

	production (lbs/day)			
$Elec_p$	Electricity consumption for preheat (kWh)	0.41	0.41	Average values from technical specifications from various manufacturers
P_i	Electric power in idle mode (kW)	0.54	0.54	
P_h	Electric power in heavy load mode (kW)	0.55	0.55	
$n\%$	Used to calculate time in idle mode on UG territory	88%	89%	% of time in idle mode based on results of NGTC telephone survey of full service restaurants, limited service restaurants and institutional establishments (schools, colleges, universities and hospitals) on UG territory
t_{daily}	Number of operating hours per day (hrs)	12	12	Based on NGTC telephone survey
t_p	Preheat time (hrs)	0.4	0.4	Based on FSTC appliance test reports for convection ovens
t_i	Hours per day in idle mode (hrs)	10.171	10.324	Calculated from $t_i = n\% * (t_{daily} - t_p)$
t_h	Time in heavy load mode, i.e. cooking time (hrs)	1.429	1.276	Calculated from $t_h = t_{daily} - (t_p + t_i)$
E_h	Daily heavy-load natural gas consumption (Btu)	Calculated values		
E_i	Daily idle natural gas consumption (Btu)	Calculated values		
E_{annual}	Annual natural gas consumption (Btu/year)	Calculated		

$$Savings = Nb_{days} * \left[E_{food} * \left(\frac{P_{hr_{base}} * t_{h_{base}}}{Eff_{base}} - \frac{P_{hr_{HE}} * t_{h_{HE}}}{Eff_{HE}}\right) + \left(Er_{i_{base}} * t_{i_{base}} - Er_{i_{HE}} * t_{i_{HE}}\right) + N_p * (E_{p_{base}} - E_{p_{HE}})\right]$$

Electricity	**1 kWh**
$Elec_{savings} = Nb_{days} * \left[\left(t_{i_{base}} - t_{i_{HE}}\right) * P_i + \left(t_{h_{base}} - t_{h_{HE}}\right) * P_h\right]$	
Water	**0 L**
None	

Other Input Assumptions

Equipment Life	**12 Years**
Savings attributed to the measures are expected to last the life expectancy of the equipment. Source of effective useful life: FSTC savings calculator as referenced in NGTC, DSM OPPORTUNITIES ASSOCIATED WITH GAS-FIRED FOOD SERVICE EQUIPMENT, Final Report Ver. 2, April 20, 2010.	
Incremental Cost	**$ 875**
Incremental costs are estimated using US list prices divided by 1.3, based on ratio of US and Canadian list prices for comparable Vulcan and Lang models, respectively. Installation costs of high-efficiency and standard-efficiency equipment are considered to be identical. Similarly, maintenance costs of high-efficiency and standard-efficiency equipment are considered to be identical (Source: W.D. College). Hence, the installation and maintenance costs were not taken into account[15].	

[15] NGTC, "DSM Opportunities Associated with Gas-Fired Food Service Equipment", Final Report, Ver 2, June 22, 2010, pg 9

Energy Star Steam Cookers

Commercial – New/Existing, EGD & UG

Efficient Technology & Equipment Description
Energy Star steam cooker.
Qualifier/Restriction
No restriction
Base Technology & Equipment Description
Standard-efficiency steam cooker: Model used for savings calculations corresponds to the FSTC default standard-efficiency 3-pan model.

Resource Savings Assumptions

Natural Gas	**3,224 m^3**

The gas savings were based on FSTC's calculator, [16] updated by studies conducted by NGTC including a survey of facilities in UG territory, using the inputs below. [17,18,19]

	Steamers	Inputs		Source
	Definitions	Base	HE	
Nb_{days}	Number of operating days per year	365	365	FSTC Life cycle calculator
Er_i	Idle energy rate (Btu/hr)	11,000	6,250	
N_p	Number of preheats per day	1	1	
E_p	Preheat energy (Btu)	18,000	7,000	
E_{food}	Energy transferred to food (Btu/lb)	107	107	
P_{hr}	Production capacity (lbs/hr)	50	55	
Eff	Cooking efficiency	15%	38%	
Prod	Daily production (lbs/day)	100	100	

[16] Food Service Technology Center – Life-Cycle and Energy Cost Calculators - http://www.fishnick.com/saveenergy/tools/calculators/, visited in the fall of 2010

[17] NGTC, DSM Opportunities Associated with Gas-Fired Food Service Equipment, Final Report, Ver 2, June 22, 2010

[18] NGTC, Phase 3-jan14 2011 steamer corrected.xlsx

[19] NGTC,Characterizing the Demand-Side Management Potential of Gas-Fired Commercial Food Service Equipment. 2006

$Elec_p$	Electricity consumption for preheat (kWh)	0.03	0.03	Average values from technical specifications from various manufacturers
P_i	Electric power in idle mode (kW)	0.02	0.02	
P_h	Electric power in heavy load mode (kW)	0.07	0.07	
gph	Hourly water consumption (gal/hr)	40	3	FSTC Life cycle calculator
n%	Used to calculate time in idle mode in UG territory	--	85%	% of time in idle mode based on results of NGTC telephone survey of full service restaurants, limited service restaurants and institutional establishments (schools, colleges, universities and hospitals) on UG territory
t_{daily}	Number of operating hours per day (hrs)	12	12	Based on NGTC telephone survey
t_p	Preheat time (hrs)	0.17	0.17	Based on FSTC appliance test reports for steamers
t_i	Hours per day in idle mode (hrs)	1.183	9.996	Calculated from $t_i = \left(t_{daily} - t_p\right) * 0{,}1$ for LE, and from $t_i = n\% * (t_{daily} - t_p)$ for HE.
t_h	Time in heavy load mode, i.e. cooking time (hrs)	10.647	1.834	Calculated from $t_h = \left(t_{daily} - t_p\right) * 0{,}9$ for LE and from $t_h = t_{daily} - (t_p + t_i)$ for HE. Note: LE steamers operate in constant steam mode (energy consumption equivalent to heavy load mode), 90% of the time (Reference: FSTC).
lpg	Conversion factor: liter per gallon (3,785)			
E_h	Daily heavy-load natural gas consumption (Btu)	Calculated values		
E_i	Daily idle natural gas consumption	Calculated values		

	(Btu)	
E_{annual}	Annual natural gas consumption (Btu/year)	Calculated
W_{annual}	Annual water consumption (L/year)	Calculated
$W_{savings}$	Annual water savings (L/year)	Calculated

$$Savings = Nb_{days} * \left[E_{food} * \left(\frac{P_{hr_{base}} * (t_{daily} - t_p) * 0{,}9}{Eff_{base}} - \frac{P_{hr_{HE}} * t_{h_{HE}}}{Eff_{HE}}\right) + \left(Er_{i_{base}} * (t_{daily} - t_p) * 0{,}1 - Er_{i_{HE}} * t_{i_{HE}}\right) + N_p * (E_{p_{base}} - E_{p_{HE}})\right]$$

Electricity	**162 kWh**
$Elec_{savings} = Nb_{days} * \left[(t_{i_{base}} - t_{i_{HE}}) * P_i + (t_{h_{base}} - t_{h_{HE}}) * P_h\right]$	
Water	**42,812 L**
$W_{savings} = Nb_{days} * t_{daily} * \frac{(gph_{base} - gph_{HE})}{lpg}$	

Other Input Assumptions

Equipment Life	**10 Years**
Savings attributed to the measures are expected to last the life expectancy of the equipment. Source of effective useful life: FSTC savings calculator as referenced in NGTC, DSM OPPORTUNITIES ASSOCIATED WITH GAS-FIRED FOOD SERVICE EQUIPMENT, Final Report Ver 2, April 20, 2010.	
Incremental Cost	**$ 2,000**
Too many discrepancies between standard-efficiency and high-efficiency Canadian list prices were observed to be able to give price estimates. Instead, the estimated incremental cost from The Berkshire Gas Company, D.P.U. 09-124 Technical Reference Manual for GasNetworks Measures: NYSERDA Deemed Savings Data (June 2009) is used. Canadian and US price increments are assumed to be identical. Installation costs of high-efficiency and standard-efficiency equipment are considered to be identical. Similarly, maintenance costs of high-efficiency and standard-efficiency equipment are considered to be identical (Source: W.D. College). Hence, the installation and maintenance costs were not taken into account[20].	

[20] NGTC, "DSM Opportunities Associated with Gas-Fired Food Service Equipment", Final Report, Ver 2, June 22, 2010, pg 9

High Efficiency Under-Fired Broilers

Commercial – New/Existing, EGD & UG

Efficient Technology & Equipment Description
High-efficiency broiler: Minimum 34% efficiency. In case of the 36" versions: Maximum Idle energy rate: 65,000 Btu/hr
Qualifier/Restriction
No restriction
Base Technology & Equipment Description
Standard-efficiency broiler: (FSTC calculator default broiler type)

Resource Savings Assumptions

Natural Gas	**1,677 m^3**

The gas savings were based on FSTC's calculator, [6] updated by studies conducted by NGTC including a survey of facilities in UG territory, using the inputs below. [7,8,9]

	Broilers	Inputs		Source
	Definitions	Base	HE	
Nb_{days}	Number of operating days per year	365	365	FSTC Life cycle calculators
N_p	Number of preheats per day	1	1	
E_p	Preheat energy (Btu)	32,000	27,000	
Er_i	Idle energy rate (Btu/hr)	80,000	65,000	
Eff	Cooking efficiency	30%	34%	
P	Electric power (kW)	0.00028	0.00028	Average values from technical specifications from various manufacturers
E_{food}	Energy transferred to food (Btu/lb)	374	374	From FSTC appliance test
P_{hr}	Production	47	47	Based on validation with FSTC

[6] Food Service Technology Center – Life-Cycle and Energy Cost Calculators - http://www.fishnick.com/saveenergy/tools/calculators/, visited in the fall of 2010

[7] NGTC, DSM Opportunities Associated with Gas-Fired Food Service Equipment, Final Report, Ver 2, June 22, 2010

[8] NGTC, Phase 3-jan14 2011 steamer corrected.xlsx

[9] NGTC,Characterizing the Demand-Side Management Potential of Gas-Fired Commercial Food Service Equipment. 2006

	capacity (lbs/hr)			calculator
$n\%$	Used to calculate time in idle mode on UG territory	82%	82%	% of time in idle mode based on results of NGTC telephone survey of full service restaurants, limited service restaurants and institutional establishments (schools, colleges, universities and hospitals) on UG territory
t_{daily}	Number of operating hours per day (hrs)	12	12	Based on NGTC telephone survey
t_p	Preheat time (hours)	0.333	0.333	Alto Shaam representative on UG territory
t_i	Hours per day in idle mode (hrs)	9.532	9.532	Calculated from $t_i = n\% * (t_{daily} - t_p)$
t_h	Time in heavy load mode, i.e. cooking time (hrs)	2.135	2.135	Calculated from $t_h = t_{daily} - (t_p + t_i)$
E_h	Daily heavy-load natural gas consumption (Btu)	Calculated		
E_i	Daily idle natural gas consumption (Btu)			
E_{annual}	Annual natural gas consumption (Btu/year)			

$$Savings = Nb_{days} * \left[E_{food} * \left(\frac{P_{hr_{base}} * t_{h_{base}}}{Eff_{base}} - \frac{P_{hr_{HE}} * t_{h_{HE}}}{Eff_{HE}}\right) + \left(Er_{i_{base}} * t_{i_{base}} - Er_{i_{HE}} * t_{i_{HE}}\right) + N_p * (E_{p_{base}} - E_{p_{HE}})\right]$$

Electricity	**0 kWh**
None	
Water	**0 L**

None

Other Input Assumptions

Equipment Life	**12 Years**
Savings attributed to the measures are expected to last the life expectancy of the equipment. Source of effective useful life: FSTC savings calculator as referenced in NGTC, DSM OPPORTUNITIES ASSOCIATED WITH GAS-FIRED FOOD SERVICE EQUIPMENT, Final Report Ver 2, April 20, 2010.	
Incremental Cost	**$ 1,270**
Incremental cost were calculated from list prices in Canadian dollars obtained from Ontarian distributors for 36 inch broilers. Base case and high-efficiency are Garland comparables. Installation and maintenance costs of high-efficiency and standard-efficiency equipment are considered to be identical. (Source: W.D. College representative). Hence, the installation and maintenance costs were not taken into account[10].	

[10] NGTC, "DSM Opportunities Associated with Gas-Fired Food Service Equipment", Final Report, Ver 2, June 22, 2010, pg 9

Commercial Space Heating

Air Curtains – Double Door (2 x 8' x 6'), EGD & UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
Air curtains in retail, office and institutional buildings are used to reduce infiltration of cold outside air through doorways. A reduction in air infiltration means a reduction in natural gas heating during heating season and a reduction in air conditioning during the summer season.
Base Equipment and Technologies Description
Retail, office and institutional buildings without air curtains.

Decision Type	Target Market(s)	End Use
Retrofit	Retail, Office and Institutional Buildings	Space Heating

Codes, Standards, and Regulations

N/A

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	1,529	1,023	0	2,500	0
2	1,529	1,023	0	0	0
3	1,529	1,023	0	0	0
4	1,529	1,023	0	0	0
5	1,529	1,023	0	0	0
6	1,529	1,023	0	0	0
7	1,529	1,023	0	0	0
8	1,529	1,023	0	0	0
9	1,529	1,023	0	0	0
10	1,529	1,023	0	0	0
11	1,529	1,023	0	0	0
12	1,529	1,023	0	0	0
13	1,529	1,023	0	0	0
14	1,529	1,023	0	0	0
15	1,529	1,023	0	0	0
TOTALS	**22,935**	**15,345**	**0**	**2,500**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	1,529 m^3

Natural gas savings reflect reduced heating load; less outside cold air passes through. Savings are estimated based on the following assumptions:

Variable Names	Symbol	Value	Source
Inside Temperature for heating season	T_{IH}	68 °F	NCI estimate
Inside Temperature for cooling season	T_{IC}	72 °F	NCI estimate
Average outside temperature in heating season	T_{OH}	29.27 °F	NCI estimate
Average outside temperature in cooling season	T_{OC}	77.00 °F	NCI estimate
Hours per day that door is open	HR	1 hour	NCI estimate
Days per week that door is in use	DPW	7 Days	NCI estimate
Door Height	H	8 '	NCI estimate
Door Width	W	2 x 6 '	NCI estimate
Total horsepower of air curtain	HP	0.5 hp	NCI estimate
Air curtain cfm at nozzle	Q_0	1005 cfm	NCI estimate
Air curtain nozzle depth	NZ	2.75 "	NCI estimate
Door coefficient	DC	0.3	NCI estimate
Days per heating season	DPS_H	120 Days	NCI estimate
Days per cooling season	DPS_C	100 Days	NCI estimate
Average wind velocity for heating season	V_{WH}	2.6 mph[1]	NCI estimate
Average wind velocity for cooling season	V_{WC}	2.1 mph	NCI estimate
Energy Efficiency Ratio for A/C Unit	EER	12 Btu/Watt-hour	NCI estimate

<u>During Heating Season</u>

Doorway Calculations Without Air Curtain for Heating Season:

- Air entering doorway due to wind[2], $Q_W = V_{WH} \times H \times W \times DC \times 88$ fpm/mph = 6,589 cfm
- Air entering doorway due to inside/outside temperature difference, QTD = $[68.094+0.4256(T_{IH} - T_{0H})] \times H \times W \times \sqrt{H(T_{IH} - T_{0H})/(T_{IH} + 460)}$ = 6,220 cfm
- Total air entering doorway, $Q_T = Q_W + Q_{TD}$ = 12,809 cfm
- Heat lost at doorway without air curtain $\mathbf{q_D} = 1.1 \times Q_T \times (T_{IH} - T_{0H})$ = 545,713 Btu/hr

Doorway Calculations With Air Curtain for Heating Season:

- Total air flow rate at the door, $Q_E = 0.4704\, Q_0 (\sqrt{H/NZ}) - Q_0$ = 1,788 cfm
- Heat lost at doorway using air curtain, $\mathbf{q_{AC}} = 1.1 \times Q_E \times (T_{IH} - T_{0H})$ = 76,183 Btu/hr

Heat Loss Prevented Per Year Using Air Curtain for Heating Season:

- **$q_S = (q_D - q_{AC}) \times HR \times DPS_H \times (DPW/7)$ = 56.34 MMBtu = 1,592 m^3 natural gas.**

- Baseline estimates of natural gas consumption: heat lost at doorway without air curtains = $q_D \times HR \times DPS_H \times (DPW/7)$ = 65.49 MMBtu = 1,851 m^3.
- Natural Gas Savings % = 1,529m^3 / 1,851m^3 = 86%

Annual Electricity Savings	1,023 kWh

- Electricity savings are a result of the following factors:

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[1] An average daily wind speed of 17 km/h for winter season and 14 km/h for summer season for Pearson Airport was estimated based on Environment Canada monitoring data (Environment Canada, http://www.climate.weatheroffice.ec.gc.ca/climateData/hourlydata_e.html?timeframe=1&Prov=ON&StationID=5097&Year=2009&Month=3&Day=29). To adjust for the appropriate height and geographic characteristics for a regular building door in Greater Toronto Area, a 25% factor is applied to estimate a typical urban wind speed

[2] ASHRAE Handbook 2001 Fundamentals Ch.26

- Reduced AC load
- Increased electricity use to operate air curtain.

- Based on the Enbridge 2007 DSM program Air Door projects at various small commercial sites, electricity savings were calculated using Agviro air door calculator. The average result is estimated to be 1,023 kWh.

Annual Water Savings	0 L
N/A	

Other Input Assumptions

Effective Useful Life (EUL)	15 Years
This EUL was developed in conjunction with equipment manufacturers by Union Gas. It is also confirmed by SEED Program Guidelines[3].	
Base & Incremental Conservation Measure Equipment and O&M Costs	**$ 2,500**
This O&M cost was developed in conjunction with equipment manufacturers by Union Gas.	
Customer Payback Period (Natural Gas Only)[4]	**3.3 Years**
Using a 5-year average commodity cost (avoided cost)[5] of \$0.38 / m^3 and an average commercial distribution cost[6] of \$0.12 / m^3, the payback period for natural gas savings is determined to be 3.3 years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = \$2500/ (1,529 m^3/year * \$0.5 / m^3) = 3.3 years	
Market Penetration[7]	**Medium**
Based on communication with local contractors, Navigant Consulting estimates a medium market penetration in Ontario.	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost (\$)	Penetration/Market Share
Berner Energy Calculator[8]	4,946	N/A	2,500	N/A

Comments

Based on the same assumptions used above, for a typical application during the winter season, the annual natural gas savings are determined to be 175 MMBtu, or 4,946 m^3.

[3] Cost Effectiveness Analysis, SEED Program Guidelines. http://www.oregon.gov/ENERGY/CONS/SEED/docs/AppendixJ.pdf
[4] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.
[5] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.
[6] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).
[7] Navigant Consulting is defining "Low" as below 5%, "Medium" as between 5-50%, and "High" as above 50%,
[8] Berner Calculator, http://www.berner.com/sales/energy.php5

AIR CURTAINS (SHIPPING & RECEIVING DOORS)

Commercial/Industrial – New/Existing, EGD & UG

Efficient Technology & Equipment Description
Air curtains are used to reduce infiltration of cold outside air through doorways. A reduction in air infiltration means a reduction in natural gas heating during heating season and a reduction in air conditioning during the summer season. For shipping/receiving doors with minimum size of 8' wide by 8' high, 8' wide by 10' high and 10' wide by 10' high located in warehousing, manufacturing, industrial or retail buildings with forced air space heating, including unit heaters.
Base Technology & Equipment Description
No air curtain.

Resource Savings Assumptions

Natural Gas			
	8' x 8'	**7,565**	**m^3**
	8' x 10'	**9,457**	**m^3**
	10' x 10'	**20,605**	**m^3**

Estimation Based on Agviro Study for Enbridge

- Based on Agviro's report[1], the energy analysis compares use of an air curtain versus a doorway without an air curtain. For the purposes of this analysis, the base case is assumed to be a doorway without any air restricting device. The following key input assumptions are used:

ETool Input	*Value*
Season of Operation	Winter, Spring, Fall
Door Location	Exterior
Motor Loading	85%
Motor Efficiency	80%
Curtain Effectiveness	70%
Outdoor Balance Point [Heating]	18C
Equipment Efficiency [Heating]	80%
Equipment Efficiency [Seasonal Reduction]	15%

- On a square footage per door basis, the natural gas savings for an 8' x 8' door $= 7{,}565\ m^3 / 64\ ft^2 = 118.2\ m^3 / ft^2$
- On a square footage per door basis, the natural gas savings for an 8' x 10' door $= 9{,}457\ m^3 / 80\ ft^2 = 118.2\ m^3 / ft^2$
- On a square footage per door basis, the natural gas savings for an 10' x 10' door $= 20{,}605\ m^3 / 100\ ft^2 = 206.1\ m^3 / ft^2$

The 8x8 and the 8x10 doors are considered back-up doors with various periods of either full or partial coverage by a van or trailer. This coverage reduces the Base Case airflow and thus the savings.

[1] Commercial/Industrial Air Curtain Program – Prescriptive Savings Analysis, Agviro Inc., Sep. 13, 2010

The 10x10 doors are drive-through doors. These doors are wide open and the Base Case has no restriction to airflow. More airflow provides more savings.

Electricity	**8' x 8'**	**-5,380**	**kWh**
	8' x 10'	**-5,220**	**kWh**
	10' x 10'	**-936**	**kWh**

- Installation and operation of air curtains results in a net increase in electricity consumption as a result of:
  - Increased electricity use to operate the air curtain.
- On a square footage per door basis, the electrical consumption for an 8' x 8' door = -5,380 kWh / 64 ft^2 = -84.1 kWh / ft^2
- On a square footage per door basis, the electrical consumption for an 8' x 10' door = -5,220 kWh / 80 ft^2 = -65.3 kWh / ft^2
- On a square footage per door basis, the electrical consumption for an 10' x 10' door = -936 kWh / 100 ft^2 = -9.36 kWh / ft^2

The smaller doors as discussed above are back-up doors with a van or trailer parked in front. The doors remain open during the entire loading period. This causes a larger electrical load since the air curtains are operating for the period the doors are open.

The 10x10 doors, being drive through doors, are only open while the vehicle is being driven through. The open period for the both the door and air curtain is much lower for these doors than the small doors.

Water	**0 L**

Other Input Assumptions

Equipment Life	**15 yrs**

- The estimated equipment life for air curtains was developed in conjunction with equipment manufacturers. It is also confirmed by SEED Program Guidelines[2].

Incremental Cost	**8' x 8'**	**$8,242**
	8' x 10'	**$8,242**
	10' x 10'	**$10,170**

- The costs are based on air curtain list prices plus installation cost. Installation cost includes both mechanical and electrical costs. The costs are an estimation based on discussions with an air curtain manufacturer and assuming electrical power is within 30' of the air curtain installation.
- On a square footage per door basis, the incremental cost for an 8' x 8' door = $8,242 / 64 ft^2 = 128.8 $ / ft^2

[2] Cost Effectiveness Analysis, SEED Program Guidelines. http://www.oregon.gov/ENERGY/CONS/SEED/docs/AppendixJ.pdf

- On a square footage per door basis, the incremental cost for an 8’ x 10’ door = $8,242 / 80 ft^2 = 103.0 $ / ft^2
- On a square footage per door basis, the incremental cost for an 10’ x 10’ door = $10,170 / 100 ft^2 = 101.7 $ / ft^2

The 8x8 and 8x10 air curtains are physically identical. The costs are also identical.

Air Curtains – Single Door (8' x 6'), EGD & UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
Air curtains in retail, office and institutional buildings are used to reduce infiltration of cold outside air through doorways. A reduction in air infiltration means a reduction in natural gas heating during heating season and a reduction in air conditioning during the summer season.
Base Equipment and Technologies Description
Retail, office and institutional buildings without air curtains.

Decision Type	Target Market(s)	End Use
Retrofit	Retail, Office and Institutional Buildings	Space Heating

Codes, Standards, and Regulations

N/A

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	667	172	0	1,650	0
2	667	172	0	0	0
3	667	172	0	0	0
4	667	172	0	0	0
5	667	172	0	0	0
6	667	172	0	0	0
7	667	172	0	0	0
8	667	172	0	0	0
9	667	172	0	0	0
10	667	172	0	0	0
11	667	172	0	0	0
12	667	172	0	0	0
13	667	172	0	0	0
14	667	172	0	0	0
15	667	172	0	0	0
TOTALS	**10,005**	**2,580**	**0**	**1,650**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	667 m^3

Natural gas savings reflect reduced heating load; less outside cold air passes through doors. Savings are estimated based on the following assumptions:

Variable Names	Symbol	Value	Source
Inside Temperature for heating season	T_{IH}	68 °F	NCI estimate
Inside Temperature for cooling season	T_{IC}	72 °F	NCI estimate
Average outside temperature in heating season	T_{OH}	29.27 °F	NCI estimate
Average outside temperature in cooling season	T_{OC}	77.00 °F	NCI estimate
Hours per day that door is open	HR	1 hour	NCI estimate
Days per week that door is in use	DPW	7 Days	NCI estimate
Door Height	H	8 feet	NCI estimate
Door Width	W	6 feet	NCI estimate
Total horsepower of air curtain	HP	0.5 hp	NCI estimate
Air curtain cfm at nozzle	Q_0	1005 cfm	NCI estimate
Air curtain nozzle depth	NZ	2.75 inches	NCI estimate
Door coefficient	DC	0.3	NCI estimate
Days per heating season	DPS_H	120 Days	NCI estimate
Days per cooling season	DPS_C	100 Days	NCI estimate
Average wind velocity for heating season	V_{WH}	2.6 mph[1]	NCI estimate
Average wind velocity for cooling season	V_{WC}	2.1 mph	NCI estimate
Energy Efficiency Ratio for A/C Unit	EER	12 Btu/Watt-hour	NCI estimate

During Heating Season

Doorway Calculations Without Air Curtain for Heating Season:

- Air entering doorway due to wind[2], $Q_W = V_{WH} \times H \times W \times DC \times 88$ fpm/mph = 3,295 cfm
- Air entering doorway due to inside/outside temperature difference, $QTD = [68.094+0.4256(T_i - T_{0H})] \times H \times W \times \sqrt{H(T_i - T_{0H})/(T_i + 460)}$ = 3,110 cfm
- Total air entering doorway, $Q_T = Q_W + Q_{TD}$ = 6,405 cfm
- Heat lost at doorway without air curtain $\mathbf{q_D} = 1.1 \times Q_T \times (T_i - T_{0H})$ = 272,856 Btu/hr

Doorway Calculations With Air Curtain for Heating Season:

- Total air flow rate at the door, $Q_E = 0.4704\ Q_0\ (\sqrt{H/NZ}) - Q_0$ = 1,788 cfm
- Heat lost at doorway using air curtain, $\mathbf{q_{AC}} = 1.1 \times Q_E \times (T_i - T_{0H})$ = 76,183 Btu/hr

Heat Loss Prevented Per Year Using Air Curtain for Heating Season:

- **$q_S = (q_D - q_{AC}) \times HR \times DPS_H \times (DPW/7)$ = 23.60 MMBtu = 667 m^3 natural gas.**

- Baseline estimates of natural gas consumption: heat lost at doorway without air curtains = $q_D \times HR \times DPS_H \times (DPW/7)$ = 32.74 MMBtu = 925 m^3.
- Natural Gas Savings % = 72.1%

Annual Electricity Savings	172 kWh

- Electricity savings are a result of the following factors:

[1] An average daily wind speed of 17 km/h for winter season and 14 km/h for summer season for Pearson Airport was estimated based on Environment Canada monitoring data (Environment Canada, http://www.climate.weatheroffice.ec.gc.ca/climateData/hourlydata_e.html?timeframe=1&Prov=ON&StationID=5097&Year=2009&Month=3&Day=29). To adjust for the appropriate height and geographic characteristics for a regular building door in Greater Toronto Area, a 25% factor is applied to estimate a typical urban wind speed

[2] ASHRAE Handbook 2001 Fundamentals Ch.26

- Reduced AC load - Increased electricity use to operate air curtain. • Based on the Enbridge 2007 DSM program Air Door projects for various small commercial sites, electricity savings were calculated using Agviro Air Door Calculator. Based on their reported results, the average savings is determined to be 172 kWh.

Annual Water Savings	0 L
N/A	

Other Input Assumptions

Effective Useful Life (EUL)	15 Years
This EUL was developed in conjunction with equipment manufacturers by Union Gas. It is also confirmed by SEED Program Guidelines[3].	
Base & Incremental Conservation Measure Equipment and O&M Costs	**$ 1,650**
This O&M cost was developed with conjunction with equipment manufacturers by Union Gas.	
Customer Payback Period (Natural Gas Only)[4]	**5 Years**
Using a 5-year average commodity cost (avoided cost)[5] of $0.38 / m^3 and an average commercial distribution cost[6] of $0.12 / m^3, the payback period for natural gas savings is determined to be 5 years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = $1,650/ (667 m^3/year * $0.5 / m^3) ≈ 5 years	
Market Penetration[7]	**Medium**
Based on communication with local contractors, Navigant Consulting estimates a medium market penetration in Ontario.	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Berner Energy Calculator[8]	2,092	N/A	2,000	N/A
Comments This is a typical application during winter months. Based on the same assumptions stated above in the Annual Electricity Savings table, the saved annual natural gas is 74 MMBtu, which is equivalent to 2,092 m^3.				

[3] Cost Effectiveness Analysis, SEED Program Guidelines. http://www.oregon.gov/ENERGY/CONS/SEED/docs/AppendixJ.pdf
[4] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.
[5] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.
[6] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).
[7] Navigant Consulting is defining "Low" as below 5%, "Medium" as between 5-50%, and "High" as above 50%,
[8] Berner Calculator, http://www.berner.com/sales/energy.php5

CONDENSING BOILERS UNDER 300 MBH

Small Commercial – New/Existing, EGD & UG

Efficient Technology & Equipment Description
Condensing boilers having annual fuel utilization efficiency (AFUE) of 90% or greater. Boiler input size is under 300,000 Btu/hr. Application is for seasonal or non-seasonal use. MBH is defined throughout this document as 1,000 Btu/hr.
Base Technology & Equipment Description
Non-condensing boiler having an AFUE of 80% for either seasonal or non-seasonal use. Boiler input size is under 300,000 Btu/hr.

Resource Savings Assumptions

Natural Gas	**<u>Seasonal</u>** **0.0108 m^3 /(Btu/hr Boiler Input)** **<u>Non-Seasonal</u>** **Boiler Input Under 100 MBH = 0.03579 m^3 /(Btu/hr Boiler Input)** **Boiler Input 100 To Under 200 MBH = 0.02196 m^3 /(Btu/hr)** **Boiler Input 200 To Under 300 MBH = 0.01643 m^3 /(Btu/hr)**

<u>Estimation Based on Agviro Study for Enbridge</u>

- Based on Agviro's report[1], the energy analysis compares use of a condensing boiler having an AFUE of 93% versus a base case non-condensing boiler having an AFUE of 80%.
- The normalized gas use for a seasonal base case boiler is determined by the relationship:

$$Normalized\ Gas\ Use = 77.575 \times BoilerIP$$

where:

BoilerIP = seasonal boiler input size (MBH)
Normalized Gas Use = normalized annual seasonal gas use (m3/yr)

- The gas savings for a non-seasonal base case boiler is determined by the relationship:

$$NonSeasonal\ Gas\ Use = 36.282 \times BoilerIP + 9256.9$$

where:

BoilerIP = seasonal boiler input size (MBH)
Non Seasonal Gas Use = annual non-seasonal gas use (m3/yr)

- The gas savings of the condensing versus the base case boiler is determined by the relationship:

$$Gas\ Savings = Gas\ Use \times (1 - \frac{\%Eff_{BC}}{\%Eff_{CE}})$$

[1] Prescriptive Savings Analysis – Condensing Boilers Under 300MBH, Agviro Inc., Jan 17, 2011

where:

GasUse = seasonal or non-seasonal gas use (m3)

$\%Eff_{BC}$ = Efficiency of the Base Case boiler

[seasonal = 80%; non-seasonal=66.2%]

$\%Eff_{CE}$ = Efficiency of the Condensing boiler

[seasonal = 93%; non-seasonal=85.32%]

GasSavings = annual gas savings (m3/yr)

- On a per Btu/hr boiler input basis, the natural gas savings is:
  - seasonal boiler = 0.0108 m^3 / (Btu/hr)
  - non-seasonal boiler =
    - Boiler Input Under 100 MBH = 0.03579 m^3 /(Btu/hr Boiler Input)
    - Boiler Input 100 To Under 200 MBH = 0.02196 m^3 /(Btu/hr)
    - Boiler Input 200 To Under 300 MBH = 0.01643 m^3 /(Btu/hr)

Electricity	**0 kWh**

Water	**0 L**

Other Input Assumptions

Equipment Life	**25 yrs**

-

Incremental Cost	**<u>Existing Construction</u>**	
	Boiler Input (MBH)	**Incremental Cost ($)**
	Under 100	**$2,045**
	100 To Under 200	**$2,984**
	200 To Under 300	**$3,797**
	<u>New Construction</u>	
	Boiler Input (MBH)	**Incremental Cost ($)**
	Under 100	**$1,475**
	100 To Under 200	**$2,414**
	200 To Under 300	**$3,227**

Incremental costs account for differences in venting, controls and labour.

<u>Incremental Cost – Existing Construction</u>

- Boiler Input Under 100 MBH = $2,045
- Boiler Input 100 To Under 200 MBH = $2,984
- Boiler Input 200 To Under 300 MBH = $3,797

Incremental Cost – New Construction

- Boiler Input Under 100 MBH = $1,475
- Boiler Input 100 To Under 200 MBH = $2,414
- Boiler Input 200 To Under 300 MBH = $3,227

Condensing Boilers, (300 MBTU/H and above), UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
Condensing boiler with 88% estimated seasonal efficiency
Base Equipment and Technologies Description
Non-condensing boiler with 76% estimated seasonal efficiency

Decision Type	Target Market(s)	End Use
Retrofit/New	Commercial buildings	Space Heating

Codes, Standards, and Regulations

- ASHRAE Standard 155P: test and calculation procedures result in an application-specific seasonal efficiency of commercial space heating boiler systems.
- ASHRAE Standard 90.1-2004: minimum boiler efficiencies for buildings except low-rise residential buildings.

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/Btu/hour)	Electricity (kWh)	Water (L)	($/kBtu/hour)	($)
1	0.01	0	0	12	0
2	0.01	0	0	0	0
3	0.01	0	0	0	0
4	0.01	0	0	0	0
5	0.01	0	0	0	0
6	0.01	0	0	0	0
7	0.01	0	0	0	0
8	0.01	0	0	0	0
9	0.01	0	0	0	0
10	0.01	0	0	0	0
11	0.01	0	0	0	0
12	0.01	0	0	0	0
13	0.01	0	0	0	0
14	0.01	0	0	0	0
15	0.01	0	0	0	0
16	0.01	0	0	0	0
17	0.01	0	0	0	0
18	0.01	0	0	0	0
19	0.01	0	0	0	0
20	0.01	0	0	0	0
21	0.01	0	0	0	0
22	0.01	0	0	0	0
23	0.01	0	0	0	0
24	0.01	0	0	0	0
25	0.01	0	0	0	0
TOTALS	**0.25**	**0**	**0**	**12**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	0.0104 m^3/Btu/hr

- The natural gas savings are based on the reduction in space heating gas consumption from using a condensing boiler instead of a non-condensing boiler.
- For condensing and non-condensing boilers, Fuel Consumption = Design Heat Loss (Btu/year) / Boiler efficiency / Natural Gas Low Heating Value[1] (Btu/m3)
- Estimated seasonal efficiency is 76% for non-condensing boilers and 88% for condensing boilers[2].
- Design Heat Loss is calculated using degree days analysis (full year) for London, ON and Sudbury, ON. The single saving number is weighted average of Union Gas South (London, 70%) and Union Gas North (Sudbury, 30%) based on the customer population of Union Gas service territories.

Example: a 300,000 Btu/hr condensing boiler located in London or Sudbury

Assuming the following specifications for a condensing boiler located in London, ON

Variables	Values
Boiler Input (Btu/hr)	300,000
Oversizing	1.2
Boiler Operating Factor	90%

- Heat Loss = (Boiler Input x Boiler Operating Factor) / Oversizing = 225,000 Btu/hr
- In general, Natural Gas Low Heating Value = 35,310 Btu/m^3
- Historically, London experiences 42 hours/year at -5^{o}F. Design Heat Loss per Year at this temperature = 225,000 Btu/hr x 42 hours = 9,450,000 Btu
- For conventional boilers (76% efficiency), natural gas consumption at -5^{o}F = 9,450,000 Btu / 76% / Natural Gas Low Heating Value = 352 m^3/year.
- For condensing boilers (88% efficiency), natural gas consumption at -5^{o}F = 9,450,000 Btu / 76% / Natural Gas Low Heating Value = 304 m^3/year.
- Design Heat Losses at different temperatures (t) are extrapolated based on assumed linear relationship with 225,000 Btu/hr (@-5^{o}F) using 225,000 Btu/hr x (65-t)/[65-(-5)]
- The following tables are constructed to calculate the natural gas consumptions at all temperatures for a whole year.

[1] Natural gas lower heating value – the lower heating value (also known as net calorific value, net CV, or LHV) of a fuel is defined as the amount of heat released by combusting a specified quantity (initially at 25 °C or another reference state) and returning the temperature of the combustion products to 150 °C, given as 35,310 Btu/m^3.

[2] Seasonal efficiencies are estimates based on "Boiler System Efficiency", Thomas H. Durkin, ASHRAE Journal, July 2006

Temperature Intervals		London	Design Heat Loss		Fuel Consumption Conventional Boiler	Fuel Consumption Condensing Boiler
Temp (*F)	Range	Hours	Btu/hr	Btu/year	m^3/yr	m^3/yr
-20	-15	4				
-15	-10	8				
-10	-5	17				
-5	0	42	225,000	9,450,000	352	304
0	5	87	208,929	18,176,786	677	585
5	10	152	192,857	29,314,286	1,092	943
10	15	281	176,786	49,676,786	1,851	1,599
15	20	337	160,714	54,160,714	2,018	1,743
20	25	435	144,643	62,919,643	2,345	2,025
25	30	584	128,571	75,085,714	2,798	2,416
30	35	948	112,500	106,650,000	3,974	3,432
35	40	735	96,429	70,875,000	2,641	2,281
40	45	634	80,357	50,946,429	1,898	1,640
45	50	622	64,286	39,985,714	1,490	1,287
50	55	643	48,214	31,001,786	1,155	998
55	60		32,143	0	0	0
60	65		16,071	0	0	0
			Total	**598,242,857**	**22,293**	**19,253**

- The operating hours for boilers in London are based on the Union Gas program record.
- Natural Gas savings for condensing boilers in London = 22,293 m^3 – 19,253 m^3 = 3,040 m^3
- The same calculation is repeated for a 300,000 Btu/hr boiler in Sudbury as below:

Temperature Intervals		Sudbury	Design Heat Loss		Fuel Consumption Conventional Boiler	Fuel Consumption Condensing Boiler
Temp (*F)	Range	Hours	Btu/hr	Btu/year	m^3/yr	m^3/yr
-35	-30	2				
-30	-25	7				
-25	-20	20				
-20	-15	46	225000	10350000	386	333
-15	-10	99	211765	20964705.88	781	675
-10	-5	159	198529	31566176.47	1176	1016
-5	0	221	185,294	40,950,000	1,526	1,318
0	5	272	172,059	46,800,000	1,744	1,506
5	10	345	158,824	54,794,118	2,042	1,763
10	15	380	145,588	55,323,529	2,062	1,780
15	20	437	132,353	57,838,235	2,155	1,861
20	25	502	119,118	59,797,059	2,228	1,924
25	30	658	105,882	69,670,588	2,596	2,242
30	35	748	92,647	69,300,000	2,582	2,230
35	40	584	79,412	46,376,471	1,728	1,493
40	45	537	66,176	35,536,765	1,324	1,144
45	50	605	52,941	32,029,412	1,194	1,031
50	55	665	39,706	26,404,412	984	850
55	60		26,471	0	0	0
60	65		13,235	0	0	0
			Total	**657,701,471**	**24,509**	**21,166**

- Natural Gas savings for condensing boilers in Sudbury = 24,509 m^3 – 21,166 m^3 = 3,342 m^3
- Based on 70% (London) and 30% (Sudbury) mix, the weighted average of natural gas savings = 70% x 3040 + 30% x 3342 = 3,131 m^3.
- Therefore, the natural gas savings = 3,131 m^3

- On a per Btu/hour basis, NG savings = 3,131 m^3 / 300,000 Btu/hour = 0.0104 m^3/Btu/hour.

- Baseline conventional boiler consumption = 70% x 22,293 + 30% x 24,509 = 22,958 m^3.
- Natural Gas Savings % = 3,131 m^3 / 22,958 m^3 = 13.6 %

Annual Electricity Savings	0 kWh
N/A	

Annual Water Savings	0 L
N/A	

Other Input Assumptions

Effective Useful Life (EUL)	25 Years
Condensing boilers have an estimated service life of 25 years[3].	

Base & Incremental Conservation Measure Equipment and O&M Costs	$ 12 / kBtu / hr
Local Canadian manufactures reported $9,800 for 230,000 Btu/hour condensing boilers[4], which is $43 / kBtu/hour. Baseline cost (conventional boilers) is $31/kBtu/hr. Incremental cost is $12 kBtu/hour.	

Customer Payback Period (Natural Gas Only)[5]	2.3 Years

Using a 5-year average commodity cost (avoided cost)[6] of $0.38 / m^3 and an average commercial distribution cost[7] of $0.12 / m^3, the payback period for natural gas savings is determined to be 2.3 years, based on the following:

On a per Btu/hr basis,

Payback Period = Incremental cost / (natural gas savings x natural gas cost)

= $0.012 / (0.0104 m^3/year * $0.5 / m^3)

= 2.3 years

Market Share[8]	High
Based on conversations with local contractors and the number of condensing boilers on the market, Navigant Consulting has determined that condensing boilers have a high market share in Ontario.	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m^3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
State of Iowa Utilities Board[9]	0.156 per ft^2	20	$35.80 (Large Office)	N/A

Comments

Base equipment has an 80% seasonal efficiency, efficient equipment has an 89% seasonal efficiency. Baseline usage reported on a square footage basis (eg 0.57 therms/sq.ft.for large offices). Estimated 10.2% savings over the baseline. Incremental costs are based on per 1,000 ft^2 basis. Equivalent natural gas savings is 10.2% x 0.57 therms/sq.ft. = 0.058 therms = 0.156 m^3 / ft^2.

[3] ASHRAE Applications Handbook – 2003, Chapter 36 – Owning and Operating Costs, Table 3

[4] Veissmann Group, http://www.viessmann.ca/en

[5] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.

[6] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.

[7] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).

[8] Navigant Consulting is defining “Low” as below 5%, “Medium” as between 5-50%, and “High” as above 50%,

[9] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2

Source	Annual Natural Gas Savings (m^3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Puget Sound Energy[10]	0.063 per ft^2	20	$0.10 (offices)	N/A

Comments

Base equipment is a standard central boiler with 75% seasonal efficiency and efficient equipment is a condensing boiler with 85% seasonal efficiency. Baseline usage reported on a square footage basis (eg 0.19 therms/sq.ft. for offices). Estimated 12% savings over the baseline. Incremental costs are based on per sqft basis. Equivalent natural gas savings is 12% x 0.19 therms/sq.ft. = 0.0228 therms = 0.063 m^3 / ft^2.

[10] Quantec, Comprehensive Demand-Side Management Resource Assessment, Prepared for Puget Sound Energy, May 2007

Condensing Make-Up Air (MUA) Unit, EGD & UG

Revision #	Description/Comment	Date Revised
		January 28, 2011

Efficient Equipment and Technologies Description

Condensing Make-up air unit (MUA) with:

a. Improved Efficiency (91%)
b. Improved Efficiency (91%) and 2 speed motor
c. Improved Efficiency (91%) and a variable frequency drive (VFD)

Base Equipment and Technologies Description

Conventional MUA unit with constant speed drive

Decision Type	Target Market(s)	End Use
New, Existing	Commercial	Space heating

Codes, Standards, and Regulations

-

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/cfm)	Electricity (kWh/cfm)	Water (L)	($)	($)
1	0.41-2.92	0-1.48			
2	0.41-2.92	0-1.48			
3	0.41-2.92	0-1.48			
4	0.41-2.92	0-1.48			
5	0.41-2.92	0-1.48			
6	0.41-2.92	0-1.48			
7	0.41-2.92	0-1.48			
8	0.41-2.92	0-1.48			
9	0.41-2.92	0-1.48			
10	0.41-2.92	0-1.48			
11	0.41-2.92	0-1.48			
12	0.41-2.92	0-1.48			
13	0.41-2.92	0-1.48			
14	0.41-2.92	0-1.48			
15	0.41-2.92	0-1.48			
TOTALS	**6.15-43.8**	**0-22.2**	**0**	**$(0.66-1.02) per cfm +$870**	

Resource Savings Assumptions

Annual Natural Gas Savings	MR & LTC 0.84 m^3/cfm – 2.92 m^3/cfm Retail & Comm 0.41 m^3/cfm– 2.07 m^3/cfm

To estimate the gas savings for this measure, Navigant relied on the results of evaluations, completed by Agviro Inc., of 18 projects in which condensing MUA with improved efficiencies and in some cases 2 speed or variable frequency drives were installed in commercial applications[1]. 14 of these projects were multi-residential, 1 for long term care, 2 for retail and 1 for other commercial.

The analysis considered several heating input ranges based on the available Make-up air (MUA) models.

The efficiency for the base case and for condensing MUA's is provided by manufacturers[1] for the various heating input ranges as shown below:

Input Range (MBH)	Combustion Efficiency (%)	
	Base Case (@ High Fire)	Condensing
100-200	82	91
200-400	82	91
450-600	80.5	91
600-1,000	80	91
1,100-1,400	80	91

Gas savings for each of the 18 projects were estimated by Agviro by applying project-specific inputs (e.g., air-flow, indoor set-point temperature, hours of operation, etc.) to the proprietary Enbridge ETools calculator[2].

The ETools calculator estimates gas savings in the following manner:

The annual heat requirement to maintain the set-point air temperature is the sum of the annual heat requirement to maintain the set-point temperature between midnight and 8am, 8am and 4pm and 4pm and midnight:

$$q_{vent} = q_{vent\,00-08} + q_{vent\,08-16} + q_{vent\,16-24} \quad (1)$$

Where:

q_{vent} = Annual heat requirement (Btu)
$q_{vent00-08}$ = Annual heat requirement (Btu) between midnight and 8am
$q_{vent09-16}$ = Annual heat requirement (Btu) between 8am and 4pm
$q_{vent16-24}$ = Annual heat requirement (Btu) between 4pm and midnight

Note that in the base case, when the circulating fan runs at a constant speed the above equation is equivalent to:

$$q_{vent} = q_{vent\,00-24} \quad (2)$$

The savings for three types of condensing MUA units have been evaluated:

1. A unit with improved efficiency (91%)
2. A unit with improved efficiency (91%) and a 2 speed motor
3. A unit with improved efficiency (91%) and a VFD.

[1] Prescriptive Condensing MUA Program Prescriptive Savings Analysis, Agviro Inc., Oct. 25, 2010 (Rev. 21-Jan-11).
[2] An external review of Enbridge's program processes, data tracking, and oversight activities has indicated that the development and continual improvement of the ETools custom project screening tool is reflective of industry best practices.
The Cadmus Group, *Independent Audit of 2008 DSM Program Results*, June 2009. Report filed with the OEB in connection with Enbridge's application to clear DSM deferral accounts for 2008, EB-2009-0341.

The condensing MUAs with 2 speed motors and VFDs do not run at a constant speed. Schedules of the percent airflow for Multi-Res, LTC and Other Commercial applications are included in Appendix A of this document.

The annual heating requirement, q_{vent}, is calculated as shown below:

$$q_{vent} = \sum_{-5}^{T_i} 1.08QH(T_i - T_o) \quad (3)$$

Where:

- q_{vent} = Annual heat requirement (Btu)
- Q = Ventilation rate (cfm)
- 1.08 = Energy required to raise the temperature of 1 ft^3 of air 1°F (Btu/°F/hour)
- T_i = Desired supply air temperature (°F)
- T_o = Outside temperature (°F)
- H = Total number of hours in a year which occur inside a specific 5° temperature range (as determined by average of 30 years)

The summation indicates that the equation above is calculated for a number of different outdoor temperature buckets each of five degrees C (e.g., -5 to 0, 0 to 5, etc.)

T_o and H vary with each term of the summation, where T_o is the mid-point of the given temperature bucket (e.g., for -5 to 0, T_o would be -2.5) and where H is the average number of hours in the year in which the temperature falls in the given bucket.

Gas savings are driven by the change in the annual heating requirement and the change in efficiency of the condensing MUA. The annual heating requirement for a condensing MUA with a VFD or with a 2 Speed motor can be calculated as follows:

$$q_{vent,VFD/2Speed} = (\%AirFlow_{VFD/2speed}) \times q_{vent} \quad (4)$$

Where:

$\%AirFlow_{VFD/2speed}$ = The average airflow following the installation of the VFD or 2 speed motor expressed as a percentage of the airflow when the base technology was in place found in Appendix A.

It should be noted that when a conventional MUA is replaced with a condensing MUA that has neither a 2 speed or VFD-controlled motor, there will not be a change in airflow. In this case equation 4 will not be required in order to estimate the annual heat requirements.

Gas savings for the condensing MUA are then determined using the following equation:

$$NG_E = \left(\frac{q_{vent}}{NG_{cal}(Eff_{Base}/100)} - \frac{q_{vent,VFD/2speed}}{NG_{cal}(Eff_{VFD/2speed}/100)} \right) \times \%FA \quad (5)$$

Where:

- NG_E = Annual gas consumption (m^3)
- q_{vent} = Annual heat requirement of the ventilation system (Btu)
- NG_{cal} = Calorific value of Natural Gas (35,000 Btu/m^3)
- Eff = Equipment efficiency (%)
- %FA = % of Fresh Air (for make-up air units this value will always be 100%)

Note that for the condensing MUA without a VFD or 2 speed fan, $q_{vent} = q_{vent,VFD/2speed}$, and gas savings are driven only by the increase in efficiency.

The savings obtained by Agviro[1] from the ETools calculator for the various cases are given below:

MUA Inputs		NG Savings m^3		
Airflow (cfm)	**MBH**	**Improved Efficiency**	**2 Speed Motor**	**VFD**
Multi-Residential				
1,700	150	1,249	3,124	4,791
3,300	300	2,424	6,064	9,300
6,000	525	5,238	11,855	17,740
9,000	800	8,282	18,208	27,036
14,000	1,250	12,884	28,324	42,055
Long Term Care				
1,700	150	1,269	3,167	4,868
3,300	300	2,539	6,335	9,735
6,000	525	5,229	11,810	17,704
9,000	800	8,269	18,139	26,980
14,000	1,250	12,934	28,372	42,200
Retail/Other Commercial				
1,700	150	616	2,047	3,425
3,300	300	1,197	3,974	6,649
6,000	525	2,586	7,635	12,499
9,000	800	4,089	11,663	18,958
14,000	1,250	6,361	18,143	29,491

MUA Inputs		Annual NG Savings m^3/cfm		
Airflow (cfm)	**MBH**	**Improved Efficiency**	**2 Speed Motor**	**VFD**
Multi-Residential				
1,700	150	0.73	1.84	2.82
3,300	300	0.73	1.84	2.82
6,000	525	0.87	1.98	2.96
9,000	800	0.92	2.02	3.00
14,000	1,250	0.92	2.02	3.00
Long Term Care				
1,700	150	0.75	1.86	2.86
3,300	300	0.77	1.92	2.95
6,000	525	0.87	1.97	2.95
9,000	800	0.92	2.02	3.00
14,000	1,250	0.92	2.03	3.01
MR & LTC Average				
1,700	150	0.74	1.84	2.82
3,300	300	0.74	1.84	2.83
6,000	525	0.87	1.98	2.96
9,000	800	0.92	2.02	3.00
14,000	1,250	0.92	2.02	3.00
MR & LTC Annual Gas Savings m^3/cfm		**0.84**	**1.94**	**2.92**
Retail/Other Commercial				
1,700	150	0.36	1.20	2.01
3,300	300	0.36	1.20	2.01
6,000	525	0.43	1.27	2.08
9,000	800	0.45	1.30	2.11
14,000	1,250	0.45	1.30	2.11
Retail/Commercial Annual Gas Savings m^3/cfm		**0.41**	**1.25**	**2.07**

In the case of the multi-residential and long term care sectors, the savings were averaged based on the number of cases in each sector to obtain the final gas savings in m^3/(cfm) for each type of condensing MUA. Enbridge has informed Navigant that the distribution of projects by sector is anticipated to be the same going forward as it has been in the past. Following program implementation if Enbridge finds the distribution of projects has changed in any significant way the savings should be re-calculated to reflect the actual distribution.

Annual Electricity Savings	MR&LTC (0-1.48)kWh per cfm Retail & Comm (0-0.48)kWh per cfm

The electricity savings for each of the 18 projects were estimated by Agviro[1] by applying project-specific inputs (e.g., air-flow, indoor set-point temperature, hours of operation, etc.) to the proprietary Enbridge ETools calculator.

No electricity savings are achieved by replacing a conventional MUA with a condensing MUA of improved efficiency. The annual electricity savings attained from installing a condensing MUA with a 2 speed motor or with a VFD is simply the difference between the electricity consumed by the constant speed drive and the 2 speed motor or the VFD.

The annual electricity consumed by the MUA motor is calculated in the following manner:

$$MotorkWh = \sum_{\%Flow_{Partial}}^{\%Flow_{Peak}} kW_{Peak,Partial} \times Operation_{Peak,Partial}(hrs/yr) \quad (6)$$

Where:
The annual electricity consumed by the motor is calculated in the following manner:

Where:

$kW_{Peak,Partial}$= The electrical demand (kW) of the motor at peak or partial air-flow. This is itself a function of the motor's horse-power, percent motor loading, motor efficiency and control factor.

$Operation_{Peak,Partial}$= The number of hours per year at which the motor/VFD operates at peak or partial airflow.

The summation indicates that the equation above is calculated for peak and partial airflow. Appendix 1 includes scheduling of the Base Case, 2-Stage and VFD motors for Multi-Res, LTC and Commercial applications.

The annual energy savings may then be calculated as the difference in motor energy use between the Base Case and 2-Stage or VFD.

The electricity savings achieved by either a condensing MUA with a 2 speed motor or a condensing MUA with a VFD as reported by Agviro[1] are presented below:

MUA Inputs			Annual Electricity Savings by Condensing MUA Type (kWh)		
Airflow (cfm)	**Motor HP**	**Input (MBH)**	**Improved Efficiency**	**2 Speed Motor**	**VFD**
Multi-Residential					
1,700	1	150	-	953	2,597
3,300	2	300	-	1,906	5,195
6,000	3	525	-	2,859	7,792
9,000	5	800	-	4,765	12,987
14,000	8.5	1,250	-	8,101	22,077
Long Term Care					
1,700	1	150	-	953	2,597
3,330	2	300	-	1,906	5,195
6,000	3	525	-	2,859	7,792
9,000	5	800	-	4,765	12,987
14,000	8.5	1,250	-	8,101	22,077
MR & LTC Average					
1,700	1	150	-	953	2,597
3,330	2	300	-	1,906	5,195
6,000	3	525	-	2,859	7,792
9,000	5	800	-	4,765	12,987
14,000	8.5	1,250	-	8,101	22,077
MR & LTC Annual Electricity Savings kWh/cfm			**-**	**0.54**	**1.48**
Retail/Other Commercial					
1,700	1	150	-	522	846
3,300	2	300	-	1,045	1,693
6,000	3	525	-	1,567	2,539
9,000	5	800	-	2,612	4,232
14,000	8.5	1,250	-	4,441	7,195
Retail/Comm Annual Electricity Savings kWh/cfm			**-**	**0.30**	**0.48**

These savings were averaged based on the number of cases in each sector to obtain the final electricity savings in kWh for each type of condensing MUA. Enbridge has informed Navigant that the distribution of projects by sector is anticipated to be the same going forward as it has been in the past. Following program implementation if Enbridge finds the distribution of projects has changed in any significant way the savings should be re-calculated to reflect the actual distribution.

Annual Water Savings	0 L
N/A	

Other Input Assumptions

Effective Useful Life (EUL)	15 Years

Measure life estimates for condensing MUAs are not currently available. It is expected that these units may last longer than conventional MUAs, but until robust estimates of condensing MUA EULs are available, the EUL of a conventional MUA will be used. The Iowa Utility association[3] and Puget Sound Energy[4] estimated the EUL for a conventional gas MUA to be 15 years.

Incremental Costs	$870 + ($0.66 to $1.02) per cfm

The total incremental costs versus the base case for the different units are included in the table below as given in the Agviro Inc. report[1]. The condensing MUA requires a neutralizer tank to adjust the pH of the condensate before going to the drain. The condensate must then have access to a drain. Drainage can be accomplished by a number of methods including plumbing to a roof drain or plumbing through the roof and into an interior drain. Costs for the neutralizer and plumbing to drain the condensate have also been included.

cfm	Incremental Costs vs. Base Case				
	Neutralizer	Drain	Improved Efficiency	Improved Efficiency & 2 Speed Motor	Improved Efficiency & VFD
1,700	$ 120	$ 750	$ 2,007	$ 3,060	$ 3,102
3,300	$ 120	$ 750	$ 2,250	$ 3,734	$ 3,793
6,000	$ 120	$ 750	$ 3,167	$ 4,615	$ 4,673
9,000	$ 120	$ 750	$ 4,196	$ 6,325	$ 6,410
14,000	$ 120	$ 750	$ 6,418	$ 8,764	$ 8,858
Average $/cfm			**$ 0.66**	**$ 1.01**	**$ 1.02**
Incremental Cost			**$870 + $0.66*cfm**	**$870 + $1.01*cfm**	**$870 + $1.02*cfm**

3 Summit Blue Consulting et al, Prepared for the Iowa Utility Association, *Assessment of Energy and Capacity Savings Potential in Iowa*, February, 2008.

4 Quantec, Prepared for Pudget Sound Energy, *Comprehensive Asssessment of Demand Side Resource Potentials,* May, 2007.

Appendix A:
(Taken from the Prescriptive Condensing MUA Program Prescriptive Savings Analysis, Agviro Inc., Oct.25, 2010(Rev. 21-Jan-11)

Base Case, 2 Speed, VFD

These inputs calculate the energy and electrical savings comparing the base case unit having a single speed motor to a condensing MUA having a 2-speed motor for multi-residential, long term care, and retail/other commercial facility types. Tables of the inputs are included in Appendix B & C of the Agviro report. A schedule of hourly percent of airflow for Multi-Res and LTC are shown in Table 6.

Table 7 shows the modelled airflow schedules for Retail and Other Commercial applications. This type of facility is considered to require MUA for 12 hrs/day, 6 days/week at 72F. The Base Case unit provides 100% airflow during this period. The 2-Speed Condensing unit is considered to operate on high-speed for half the time and low-speed for the remaining; resulting in an average of 75% of the airflow over the entire operational period versus the base case. The VFD calculation assumes 50% airflow versus the Base Case.

Table 6: Schedule of Multi-Res & LTC Applications

	Multi-Res & LTC		
Hr of Day	**Base Case**	**2 Stage**	**VFD***
0	100	50	50
1	100	50	50
2	100	50	50
3	100	50	50
4	100	50	50
5	100	50	50
6	100	100	100
7	100	100	100
8	100	100	70
9	100	100	70
10	100	100	70
11	100	100	100
12	100	100	100
13	100	100	70
14	100	100	70
15	100	100	70
16	100	100	100
17	100	100	100
18	100	100	100
19	100	100	100
20	100	50	50
21	100	50	50
22	100	50	50
23	100	50	50
Weighted Ave (%):	**100.0**	**79.2**	**71.7**

Table 7: Schedule of Commercial Applications

	Commercial		
Hr of Day	**Base Case**	**2 Stage**	**VFD**
0	0	0	0
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	0	0	0
8	100	75	50
9	100	75	50
10	100	75	50
11	100	75	50
12	100	75	50
13	100	75	50
14	100	75	50
15	100	75	50
16	100	75	50
17	100	75	50
18	100	75	50
19	100	75	50
20	0	0	0
21	0	0	0
22	0	0	0
23	0	0	0
Weighted Ave (%):	**50.0.**	**37.5**	**25.0**

CONDENSING UNIT HEATERS

Commercial – New/Existing, EGD & UG

Efficient Technology & Equipment Description
Condensing Unit Heaters
Base Technology & Equipment Description
% Sales Weighted Average model, equivalent in efficiency to a power-vented or separated combustion unit heater (78% Annually Efficient)[1]. For the Existing Building case, as it's not cost-effective to replace an existing unit heater prematurely, this measure is only applicable when existing equipment requires replacement (i.e., in cases of "natural" replacement).

Resource Savings Assumptions

Natural Gas	**0.00631 m3/(BTU/H)**

Gas savings is based on the NGTC report, but modified to use a % Annual Sales Weighted base case scenario.[2] NGTC used the BIN Method combined with ASHRAE weather data[3] to estimate the annual operating hours of two Ontario regions: South (London) and North (North Bay). An oversizing factor of 100% was applied according to design practices.[4],[5] Operating hours were based on an average of the UG Northern & Southern climates (see table below).

Annual Operating Hours (BIN Method)

Region	Design Temp.	Indoor Temp.	Operating Hours
UG South (London)	-18.8 (°C)	18.3 (°C)	1,347 (hr/year)
UG North (North Bay)	-27.9 (°C)	18.3 (°C)	1,392 (hr/year)
Average	N/A	18.3 (°C)	1,370 (hr/year)

It should be noted that NRCan indicates that a unit heater's typical duty is 2,122 hrs/yr[6]. This number is significantly higher than the one obtained using the recognized ASHRAE standard. The difference could be explained by the fact that numbers obtained by NGTC using the BIN method account for the industry practice, which is to oversize unit heaters by 100%. Since no detailed information exists about how NRCan calculated typical operating hours, and given that the BIN method is an industry-recognized standard, an average operating time of 1,370 hours per year will be used for the energy consumption

[1] based on NGTC, "DSM Opportunities Associated with Unit Heaters", April 22, 2009, pg 6 and TRC Test Bed - Feb 25 2010 426pm.xlsx

[2] based on NGTC, "DSM Opportunities Associated with Unit Heaters", April 22, 2009, pg 6 and TRC Test Bed - Feb 25 2010 426pm.xlsx

[3] ASHRAE. Weather Data Viewer: London and North Bay (Ontario). Version 3.0. 2005.

[4] Davis Energy Group. Analysis of Standards Options for Unit Heaters and Duct Furnaces. May 2004, 8 pages.

[5] NGTC. NGTC Review (no. 123807-02) - Unit Heaters Savings (retainer task for Union Gas). August 17, 2007, 9 pages.

[6] NRCan. Canada's Energy Efficiency Regulations: Gas-Fired Unit Heaters – April 2007. [On line]. October 2008. http://oee.nrcan.gc.ca/regulations/bulletin/gas-unit-heatersaprilr007. cfm?text=N&printview=N.

calculations. The annual savings was normalized using input capacity (BTU/H)	
Electricity	**(-)0.00186 kWh/(BTU/H)**
Electrical consumption will increase with the installation of condensing unit heaters. The electrical savings is based the NGTC report results modified to use a % Annual Sales Weighted base case scenario.[7] Electrical consumption values were based on manufacturer's specifications which were aggregated and summarized below. Electricity Consumption for Unit Heater[8]	

Technology	125 – 200 kBtu/hr	225 – 300 kBtu/hr
Gravity-vented	275 kWh	280 kWh
Power-vented	392 kWh	747 kWh
Separated-combustion	392 kWh	747 kWh
Condensing	657 kWh	1,020 kWh

The annual savings was normalized using input capacity (BTU/H)

Water	**NA**

Other Input Assumptions

Equipment Life	**18 yrs**
Equipment life is based on NGTC, "DSM Opportunities Associated with Unit Heaters", April 22, 2009, pg 7	

Lifetime (years)	Source
20-25	Gas Research Institute (GRI, 1998, US)
10-15	University of Wisconsin – greenhouse application, 2006
19 (North of US)	ACEEE (GRI source, 1997, US)
25 (South of US)	ACEEE (GRI source, 1997, US)
15	Davis Energy Group, 2004 (prepared for California)
21.5	DOE (average data from GRI, 1997, US)
18	NRCan, 2007
18	Ecotope, Inc., 2003, prepared for Oregon
18	NGTC's estimate

NGTC estimated 18 years for the average lifetime of unit heaters.

Incremental Cost	**$0.0129 /(BTU/H)**
Incremental costs were based equipment costs and installation costs found from Canadian manufacturers as well as a US website prices converted to Canadian currency.[9] The NGTC reported incremental costs were modified to use a % Sales Weighted average base case installed cost.	

[7] based on NGTC, "DSM Opportunities Associated with Unit Heaters", April 22, 2009, pg 6 and TRC Test Bed - Feb 25 2010 426pm.xlsx
[8] based on NGTC, "DSM Opportunities Associated with Unit Heaters", April 22, 2009, pg 5
[9] based on NGTC, "DSM Opportunities Associated with Unit Heaters", April 22, 2009, pg 7-8 and TRC Test Bed - Feb 25 2010 426pm.xlsx

The incremental installed cost was normalized by input capacity (BTU/H)	
Free Ridership	**0 %**
Free Ridership was estimated using % annual sales for Condensing Unit Heaters (~0.01-0.02%) in UG territory.[10]	

[10] NGTC, "DSM Opportunities Associated with Unit Heaters", April 22, 2009, pg iii

Demand Control Kitchen Ventilation (DCKV – 5,000 CFM)

EGD & UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description

Kitchen ventilation with DCKV hood exhaust (5000 CFM). Demand ventilation uses temperature and/or smoke sensing to adjust ventilation rates. This saves energy comparing with the traditional 100% on/off kitchen ventilation system.

Base Equipment and Technologies Description

Kitchen ventilation without DCKV.

Decision Type	Target Market(s)	End Use
New/Retrofit	New/Existing Commercial (Restaurants)	Space Heating

Codes, Standards, and Regulations

N/A

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	4,801	13,521	0	10,000	0
2	4,801	13,521	0	0	0
3	4,801	13,521	0	0	0
4	4,801	13,521	0	0	0
5	4,801	13,521	0	0	0
6	4,801	13,521	0	0	0
7	4,801	13,521	0	0	0
8	4,801	13,521	0	0	0
9	4,801	13,521	0	0	0
10	4,801	13,521	0	0	0
11	4,801	13,521	0	0	0
12	4,801	13,521	0	0	0
13	4,801	13,521	0	0	0
14	4,801	13,521	0	0	0
15	4,801	13,521	0	0	0
TOTALS	**72,015**	**202,815**	**0**	**10,000**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	4,801 m^3

- The demand control kitchen ventilation savings were determined using the method described in the Melink Detailed Energy Savings Report[1].
- Assuming the DCKV system is operating 16 hours/day, 7 days/week, 52 weeks/year, at 80% heating efficiency.
- Using design weather data from the Outdoor Airload Calculator[2], baseline net heating loads for an exhaust volume of 5,000 CFM were determined for two locations: London (Union South) and North Bay (Union North): London = 624,111 KBtu; and North Bay = 803,266 KBtu.
- Heating savings for both locations (London and North Bay) were calculated by multiplying the individual baseline heating loads with (*1 – estimated average make-up air RPM factor*), which represents the percent savings when using Demand Control Kitchen Ventilation.
- Weighted average natural gas savings is calculated by assigning 70% to Union Gas South consumption and 30% to Union Gas North consumption based on the customer population of Union Gas service territories.

NG Savings	Weight	Base Case Heating Load (kBTu)	Demand Ventilation Heating Load (kBTu)	Heating Savings (m^3)
Union South (London)	70%	624,111	464,963	4,421
Union North (North Bay)	30%	803,266	598,433	5,690
Weighted Average		**677,858**	**505,004**	**4,801**

- Baseline estimates of natural gas consumption = 677,858 kBtu = 18,829 m^3
- Natural Gas Savings % = 4801 m^3 / 677858 m^3 = 26 %

Annual Electricity Savings	13,521 kWh

- Electricity savings consists two parts: fan motor savings and cooling load savings.
- Main assumption include: Motor capacity is 5 HP at 90% efficiency level, Cooling system COP = 3.
- Total Operating Time per Year (G) = 16 hrs/day x 7 days/week x 52 weeks/year = 5,824 hours
- Baseline fan motor electricity consumption = 0.746 kW/HP x G / 0.9 = 4,827.4 kWh/HP
- DCKV fan motor electricity consumption is calculated as below:

[1] Detailed Energy Savings Report, Melink Corporation, http://www.melinkcorp.com/Intellihood/Energy_Analysis.pdf
[2] This freeware is available at www.archenergy.com/ckv/oac/default.htm.

% Rated RPM	% Run Time	Time HRS/YR	Output KW/HP	System Effic.	Input KW/HP	KWHR/ HP/YR
H	I	J=GxI	K	L	M=K/L	N=JxM
100	5	291.2	0.746	0.9	0.829	241
90	20	1164.8	0.544	0.9	0.604	704
80	25	1456	0.382	0.9	0.424	618
70	25	1456	0.256	0.9	0.284	414
60	15	873.6	0.161	0.9	0.179	156
50	10	582.4	0.093	0.9	0.103	60
40	0	0	0.048	0.9	0.053	0
30	0	0	0.020	0.9	0.022	0
20	0	0	0.015	0.9	0.017	0
10	0	0	0.010	0.90	0.011	0
O Total KWH/HP/YR (Total of Column N)						**2,194** kWh/HP

- The fan motor electricity savings = 5HP x (4,827.4 – 2,194) kWh/HP = 13,167.2 kWh.
- Cooling load savings are calculated using the same method as for heating load savings analysis. Baseline net cooling loads for London and North Bay are obtained using Outdoor Airload Calculator:
  - London = 17,801 kBtu; and
  - North Bay = 5,832 kBtu.
- Multiplying the baseline cooling loads by (*1 – estimated average make-up air RPM factor*), and then assigning 70% weight to London and 30% weight to North Bay, cooling load savings are calculated and shown below:

Cooling Electricity Consumption	Weight	Base Case Cooling (kWh)	DCKV Cooling (kWh)	Cooling Savings (kWh)
Union South (London)	70%	1,739	1,296	443
Union North (North Bay)	30%	570	424	145
Weighted Average		**1,388**	**1,034**	**354**

- Total electricity savings are calculated by combining the two components of electricity usages:

Total Electricity Savings	Weight	Cooling Savings (kWh)	Exhaust Fan Motor Electricity Savings (kWh)	Total Savings (kWh)
Union South (London)	70%	443	13,167	13,611
Union North (North Bay)	30%	145	13,167	13,313
Weighted Average		**354**	**13,167**	**13,521**

- Baseline estimates of electricity consumption = 5HP x 4,827.4 kWh/HP + 1,388 kWh = 25,526 kWh.
- Electricity Savings % = 13,521 kWh / 25,526 kWh = 53 %

Annual Water Savings	**0 L**

N/A

Other Input Assumptions

Effective Useful Life (EUL)	15 Years
Melink Canada representative George McGrath estimates their system life at 15 years [3].	
Base & Incremental Conservation Measure Equipment and O&M Costs	**$ 10,000**
Typical costing information was obtained from Melink Canada[4].	
Customer Payback Period (Natural Gas Only)[5]	**4.2 Years**
Using a 5-year average commodity cost (avoided cost)[6] of \$0.38 / m^3 and an average commercial distribution cost[7] of \$0.12 / m^3, the payback period for natural gas savings is determined to be 4.2 years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = \$10,000/ (4,801 m^3/year * \$0.5 / m^3) = 4.2 years	
Market Penetration[8]	**Low**
Based on the penetration rates in another jurisdiction (5% for Puget Sound Energy) and communication with local contractors, Navigant Consulting estimates a low market penetration in Ontario.	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Puget Sound Energy[9]	0.0385 per ft^2	15	0.28	5%

Comments

Baseline therm reported on a square footage basis (eg 0.14 therms/sq.ft. for restaurant). Estimated 10% savings for new energy efficient technology is reported as a percent saving over the baseline. Incremental costs are also based on per sqft basis. Equivalent natural gas savings is 10% x 0.14 therms/sq.ft. = 0.014 therms/sq.ft. = 0.0385 m^3 / sq.ft.

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[3] Melink Canada, February, 2009

[4] Melink Canada, http://melinkcanada.com/

[5] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.

[6] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.

[7] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).

[8] Navigant Consulting is defining “Low” as below 5%, “Medium” as between 5-50%, and “High” as above 50%,

[9] Quantec, Comprehensive Demand-Side Management Resource Assessment, Prepared for Puget Sound Energy, May 2007

Demand Control Kitchen Ventilation (DCKV – 10,000 CFM)

EGD & UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description

Kitchen ventilation with DCKV hood exhaust (10000 CFM). Demand ventilation uses temperature and/or smoke sensing to adjust ventilation rates. This saves energy comparing with the traditional 100% on/off kitchen ventilation system.

Base Equipment and Technologies Description

Kitchen ventilation without DCKV.

Decision Type	Target Market(s)	End Use
Retrofit/New	New/Existing Commercial (Restaurants)	Space Heating

Codes, Standards, and Regulations

N/A

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	11,486	30,901	0	15,000	0
2	11,486	30,901	0	0	0
3	11,486	30,901	0	0	0
4	11,486	30,901	0	0	0
5	11,486	30,901	0	0	0
6	11,486	30,901	0	0	0
7	11,486	30,901	0	0	0
8	11,486	30,901	0	0	0
9	11,486	30,901	0	0	0
10	11,486	30,901	0	0	0
11	11,486	30,901	0	0	0
12	11,486	30,901	0	0	0
13	11,486	30,901	0	0	0
14	11,486	30,901	0	0	0
15	11,486	30,901	0	0	0
TOTALS	**172,290**	**463,515**	**0**	**15,000**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	11,486 m^3

- The demand control kitchen ventilation savings were determined using the methodology described in the Melink Detailed Energy Savings Report[1].
- Assuming the DCKV system is operating 16 hours/day, 7 days/week, 52 weeks/year, at 80% heating efficiency.
- Using design weather data from the Outdoor Airload Calculator[2], baseline net heating loads for a exhaust volume of 10,000 CFM were determined for London (Union South) and North Bay (Union North). London:1,248,221 KBtu, North Bay: 1,660,531 KBtu
- Heating savings for London and North Bay are calculated by multiplying the individual baseline heating loads with (*1 – estimated average make-up air RPM factor*), which represents the savings% when using Demand Control Kitchen Ventilation.
- Weighted average natural gas savings is calculated by assigning 70% to Union Gas South consumption and 30% to Union Gas North consumption based on the customer population of Union Gas service territories.

NG Savings	Weight	Base Case Heating Load (kBTu)	Demand Ventilation Heating Load (kBTu)	Heating Savings (m^3)
Union South (London)	70%	1,248,221	867,514	10,575
Union North (North Bay)	30%	1,606,531	1,116,539	13,611
Weighted Average		**1,355,714**	**942,221**	**11,486**

- Baseline estimates of natural gas consumption = 1,355,714 kBtu = 37,659 m^3
- Natural Gas Savings % = 11,486 m^3 / 37, 659 m^3 = 31 %

Annual Electricity Savings	30,901 kWh

- Electricity savings consists two parts: fan motor savings and cooling load savings.
- Assuming the motor capacity is 10 HP at 90% efficiency level, cooling system COP = 3.
- Total Operating Time per Year (G) = 16 hrs/day x 7 days/week x 52 weeks/year = 5,824 hours
- Baseline fan motor electricity consumption = 0.746 kW/HP x G / 0.9 = 4,827.4 kWh/HP
- DCKV fan motor electricity consumption is calculated as below:

[1] Detailed Energy Savings Report, Melink Corporation, http://www.melinkcorp.com/Intellihood/Energy_Analysis.pdf
[2] This freeware is available at www.archenergy.com/ckv/oac/default.htm.

% Rated RPM	% Run Time	Time HRS/YR	Output KW/HP	System Effic.	Input KW/HP	KWHR/ HP/YR
H	I	J=GxI	K	L	M=K/L	N=JxM
100	5	291.2	0.746	0.9	0.829	241
90	10	582.4	0.544	0.9	0.604	352
80	20	1164.8	0.382	0.9	0.424	494
70	20	1164.8	0.256	0.9	0.284	331
60	30	1747.2	0.161	0.9	0.179	313
50	15	873.6	0.093	0.9	0.103	90
40	0	0	0.048	0.9	0.053	0
30	0	0	0.020	0.9	0.022	0
20	0	0	0.015	0.9	0.017	0
10	0	0	0.010	0.90	0.011	0
O Total KWH/HP/YR (Total of Column N)						**1,822** kWh/HP

- The fan motor electricity savings = 10HP x (4,827.4 – 1,822) kWh/HP = 30,054 kWh.
- Cooling load savings are calculated using the same method as for heating load savings analysis. Baseline net cooling loads for London and North Bay are obtained using Outdoor Airload Calculator:
  - London = 35,603 kBtu
  - North Bay = 11,663 kBtu.
- Multiplying the baseline cooling loads by (*1 – estimated average make-up air RPM factor*), and then assigning 70% weight to London and 30% weight to North Bay, cooling load savings are calculated.

Cooling Electricity Consumption	Weight	Base Case Cooling (kWh)	DCKV Cooling (kWh)	Cooling Savings (kWh)
Union South (London)	70%	3,478	2,417	1,061
Union North (North Bay)	30%	1,139	792	348
Weighted Average		**2,777**	**1,930**	**847**

- Total electricity savings are calculated by combining the two components of electricity usages:

Total Electricity Savings	Weight	Cooling Savings (kWh)	Exhaust Fan Motor Electricity Savings (kWh)	Total Savings (kWh)
Union South (London)	70%	1,061	30,054	31,115
Union North (North Bay)	30%	348	30,054	30,402
Weighted Average		**847**	**30,054**	**30,901**

- Baseline estimates of electricity consumption = 10HP x 4,817.4kWh/HP + 2,777 kWh = 51,051 kWh.
- Electricity Savings % = 30,901 kWh / 51,051 kWh = 61 %

Annual Water Savings	**0 L**

N/A

Other Input Assumptions

Effective Useful Life (EUL)	15 Years
Melink Canada representative George McGrath estimates their system life at 15 years [3].	
Base & Incremental Conservation Measure Equipment and O&M Costs	**$ 15,000**
Typical costing information was provided by Melink Canada[4].	
Customer Payback Period (Natural Gas Only)[5]	**2.6 Years**
Using a 5-year average commodity cost (avoided cost)[6] of \$0.38 / m^3 and an average commercial distribution cost[7] of \$0.12 / m^3, the payback period for natural gas savings is determined to be 2.6 years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = \$15,000/ (11,486 m^3/year * \$0.5 / m^3) = 2.6 years	
Market Penetration[8]	**Low**
Based on the penetration rate in another jurisdiction (5% for Puget Sound Energy) and communication with local contractors, Navigant Consulting estimates a low market penetration in Ontario.	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost (\$)	Penetration/Market Share
Puget Sound Energy[9]	0.0385 / sqft	15	0.28	5%
Comments Baseline therm reported on a square footage basis (eg 0.14 therms/sq.ft. for restaurant). Estimated 10% savings for new energy efficient technology is reported as a percent saving over the baseline. Incremental costs are based on per sqft basis. Equivalent natural gas savings is 10% x 0.14 therms/sq.ft = 0.014 therms/sq.ft = 0.0385 m^3 /sq.ft				

[3] Melink Canada, February, 2009
[4] Melink Canada, http://melinkcanada.com/
[5] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.
[6] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.
[7] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).
[8] Navigant Consulting is defining "Low" as below 5%, "Medium" as between 5-50%, and "High" as above 50%,
[9] Quantec, Comprehensive Demand-Side Management Resource Assessment, Prepared for Puget Sound Energy, May 2007

Demand Control Kitchen Ventilation (DCKV – 15,000 CFM)

EGD & UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description

Kitchen ventilation with DCKV hood exhaust (15000 CFM). Demand ventilation uses temperature and/or smoke sensing to adjust ventilation rates. This saves energy comparing with the traditional 100% on/off kitchen ventilation system.

Base Equipment and Technologies Description

Kitchen ventilation without DCKV.

Decision Type	Target Market(s)	End Use
Retrofit/New	New/Existing Commercial (Restaurants)	Space Heating

Codes, Standards, and Regulations

N/A

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	18,924	49,102	0	20,000	0
2	18,924	49,102	0	0	0
3	18,924	49,102	0	0	0
4	18,924	49,102	0	0	0
5	18,924	49,102	0	0	0
6	18,924	49,102	0	0	0
7	18,924	49,102	0	0	0
8	18,924	49,102	0	0	0
9	18,924	49,102	0	0	0
10	18,924	49,102	0	0	0
11	18,924	49,102	0	0	0
12	18,924	49,102	0	0	0
13	18,924	49,102	0	0	0
14	18,924	49,102	0	0	0
15	18,924	49,102	0	0	0
TOTALS	**283,860**	**736,530**	**0**	**20,000**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	18,924 m^3

- The demand control kitchen ventilation savings were determined using the method described in the Melink Detailed Energy Savings Report[1].
- Assuming the DCKV system is operating 16 hours/day, 7 days/week, 52 weeks/year, at 80% heating efficiency.
- Using design weather data from the Outdoor Airload Calculator[2], baseline net heating loads for London (Union South) and North Bay (Union North) at 15000 CFM exhaust volume are obtained. They are 1,872,332 kBtu and 2,409,797 kBtu respectively.
- Heating savings for London and North Bay are calculated by multiplying the individual baseline heating loads with (*1 – estimated average make-up air RPM factor*), which represents the savings% when using Demand Control Kitchen Ventilation.
- Weighted average natural gas savings is calculated by assigning 70% to Union Gas South consumption and 30% to Union Gas North consumption based on the customer population of Union Gas service territories.

NG Savings	Weight	Base Case Heating Load (kBTu)	Demand Ventilation Heating Load (kBTu)	Heating Savings (m^3)
Union South (London)	70%	1,872,332	1,245,101	17,423
Union North (North Bay)	30%	2,409,797	1,602,515	22,424
Weighted Average		**2,033,572**	**1,352,325**	**18,924**

- Baseline estimates of natural gas consumption = 2,033,572 kBtu = 56,488 m^3
- Natural Gas Savings % = 18,924 m^3 / 56,488 m^3 = 34 %

Annual Electricity Savings	49,102 kWh

- Electricity savings consists two parts: fan motor savings and cooling load savings.
- Assuming the motor capacity is 15 HP at 90% efficiency level, cooling system COP = 3.
- Total Operating Time per Year (G) = 16 hrs/day x 7 days/week x 52 weeks/year = 5,824 hours
- Baseline fan motor electricity consumption = 0.746 kW/HP x G / 0.9 = 4,827.4 kWh/HP
- DCKV fan motor electricity consumption is calculated as below:

[1] Detailed Energy Savings Report, Melink Corporation, http://www.melinkcorp.com/Intellihood/Energy_Analysis.pdf
[2] This freeware is available at www.archenergy.com/ckv/oac/default.htm.

% Rated RPM	% Run Time	Time HRS/YR	Output KW/HP	System Effic.	Input KW/HP	KWHR/ HP/YR
H	I	J=GxI	K	L	M=K/L	N=JxM
100	5	291.2	0.746	0.9	0.829	241
90	5	291.2	0.544	0.9	0.604	176
80	20	1164.8	0.382	0.9	0.424	494
70	20	1164.8	0.256	0.9	0.284	331
60	30	1747.2	0.161	0.9	0.179	313
50	10	582.4	0.093	0.9	0.103	60
40	10	582.4	0.048	0.9	0.053	31
30	0	0	0.020	0.9	0.022	0
20	0	0	0.015	0.9	0.017	0
10	0	0	0.010	0.90	0.011	0
O Total KWH/HP/YR (Total of Column N)						**1,647** kWh/HP

- The fan motor electricity savings = 15HP x (4,827.4 – 1,647) kWh/HP = 47,707 kWh.
- Cooling load savings are calculated using the same method as for heating load savings analysis. Baseline net cooling loads for London and North Bay are obtained using Outdoor Airload Calculator:
  - London = 53,404 kBtu
  - North Bay = 17,495 kBtu
- Multiplying the baseline cooling loads by (*1 – estimated average make-up air RPM factor*), and then assigning 70% weight to London and 30% weight to North Bay, cooling load savings are calculated.

Cooling Electricity Consumption	Weight	Base Case Cooling (kWh)	DCKV Cooling (kWh)	Cooling Savings (kWh)
Union South (London)	70%	5,217	3,469	1,748
Union North (North Bay)	30%	1,709	1,137	573
Weighted Average		**4,165**	**2,770**	**1,395**

- Total electricity savings are calculated by combining the two components of electricity usages:

Total Electricity Savings	Weight	Cooling Savings (kWh)	Exhaust Fan Motor Electricity Savings (kWh)	Total Savings (kWh)
Union South (London)	70%	1,748	47,707	49,455
Union North (North Bay)	30%	573	47,707	48,279
Weighted Average		**1,395**	**47,707**	**49,102**

- Baseline estimates of electricity consumption = 15HP x 4,827.4kWh/HP + 4,165 kWh = 76,577 kWh.
- Electricity Savings % = 49,102 kWh / 76,577 kWh = 64 %

Annual Water Savings **0 L**

N/A

Other Input Assumptions

Effective Useful Life (EUL)	15 Years
Melink Canada representative George McGrath estimates their system life at 15 years [3].	
Base & Incremental Conservation Measure Equipment and O&M Costs	**$ 20,000**
Typical costing information was provided by Melink Corp.	
Customer Payback Period (Natural Gas Only)[4]	**2.1 Years**
Using a 5-year average commodity cost (avoided cost)[5] of \$0.38 / m^3 and an average commercial distribution cost[6] of \$0.12 / m^3, the payback period for natural gas savings is determined to be 2.1 years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = \$20,000/ (18,924 m^3/year * \$0.5 / m^3) = 2.1 years	
Market Penetration[7]	**Low**
Based on the penetration rate in another jurisdiction (5% for Puget Sound Energy) and communication with local contractors, Navigant Consulting estimates a low market penetration in Ontario.	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Puget Sound Energy[8]	0.0385 per ft^2	15	0.28	5%

Comments

Baseline therm reported on a square footage basis (eg 0.14 therms/sq.ft. for restaurant). Estimated 10% savings for new energy efficient technology is reported as a percent saving over the baseline. Incremental costs are based on per sqft basis. Equivalent natural gas savings is 10% x 0.14 therms/sq.ft. = 0.014 therms / sqft = 0.0385 m^3 / sqft

[3] Melink Canada, February, 2009
[4] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.
[5] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.
[6] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).
[7] Navigant Consulting is defining "Low" as below 5%, "Medium" as between 5-50%, and "High" as above 50%,
[8] Quantec, Comprehensive Demand-Side Management Resource Assessment, Prepared for Puget Sound Energy, May 2007

Destratification Fan – New or Existing Commercial, EGD & UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description

Destratification Fan. For fans of with minimum diameter of 20’ located in warehousing, manufacturing, industrial or retail buildings[1] with forced air space heating, including unit heaters .

Base Equipment and Technologies Description

No destratification fan.

Decision Type	Target Market(s)	End Use
New, Replacement	Commercial (New or Existing)	Space Heating

Codes, Standards, and Regulations

N/A

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/ft^2)	Electricity (kWh/ft^2)	Water (L)	($)	($)
1	0.5	-0.0034	0	7,021	0
2	0.5	-0.0034	0	0	0
3	0.5	-0.0034	0	0	0
4	0.5	-0.0034	0	0	0
5	0.5	-0.0034	0	0	0
6	0.5	-0.0034	0	0	0
7	0.5	-0.0034	0	0	0
8	0.5	-0.0034	0	0	0
9	0.5	-0.0034	0	0	0
10	0.5	-0.0034	0	0	0
11	0.5	-0.0034	0	0	0
12	0.5	-0.0034	0	0	0
13	0.5	-0.0034	0	0	0
14	0.5	-0.0034	0	0	0
15	0.5	-0.0034	0	0	0
TOTALS	**7.5**	**-0.068**	**0**	**7,021**	**0**

[1] Buildings with a minimum of 25” ceilings.

Resource Savings Assumptions

Annual Natural Gas Savings	0.5 m^3 / ft^2

Estimation Based on Agviro Study for Enbridge

- Based on the Agviro's report[2], which was based largely on an analysis of energy savings due to destratification fans installed at the commercial manufacturing and warehousing facility of Hunter-Douglas during the winter of 2008[3], the following key assumptions are used:

Key Enbridge Input Assumptions	
Effective destratification area (ft^2)	13,270
Ceiling Height (ft)	30
Heater Height (ft)	20
Electric Motor Nameplate HP	1.5
Annual Operation Hours	5,186
Fan Diameter	24'
Thermostat Setpoint (^{o}F)	72
Thermostat Reduction [after detratification] (^{o}F)	2

- The Hunter-Douglas monitoring results provided important input assumptions for modeling purposes using Enbridge's ETool. However, certain factors in the monitoring were below industry standard. For example, the destratification fan was operated at speed of 15 Hz on site, which is slower than the typical or average fan speed at 20 Hz. When modeling the gas savings using ETool, Enbridge considered this factor, and revised fan speed up to 20 Hz. The modeled gas savings results are presented as follows:

Enbridge's ETool Modeling Results	
Electricity Consumption (kWh)	890
Auxiliary Electrical Savings (kWh)	767
Natural Gas Savings (m^3)	7,020

- However, due to Navigant Consulting's lack of access to ETool to verify the calculation process of natural gas savings, Navigant Consulting opted to use Union Gas destratification fan calculator based on Enbridge's input assumptions in the presented table.

Navigant Consulting Estimation Based on Union Gas Calculator

- Using the Destratification fan calculator provided by Union Gas and the same set of input assumptions used by Enbridge, natural gas savings are presented as follows:

Navigant Estimated Gas Savings Results	
Electricity Consumption (kWh)	812
Auxiliary Electrical Savings (kWh)	-
Natural Gas Savings (m^3)	6,828

- On a per square footage basis, the natural gas savings = 6,828 m^3 / 13,270 ft^2 = 0.51 m^3/ft^2.

Annual Electricity Savings	– 0.0034 kWh / ft^2

- The auxiliary electrical savings represents electrical savings through the reduced use of auxiliary heating equipment such as blower motors on space heating equipment[4]. Union Gas calculator does not include this savings impact in its calculation process. Enbridge developed an equation to correlate electrical power to unit heater input size based on specifications for commercial space heating equipments.
- Since the key input assumptions used in Union Gas calculator are based on the inputs provided by

[2] Prescriptive Destratification Fan Program – Prescriptive Savings Analysis, Agviro Inc., Feb 2, 2009
[3] Cold Weather Destratification, Hunter Douglas Monitoring Results, Final Report, May 2008
[4] Prescriptive Destratification Fan Program – Prescriptive Savings Analysis, Agviro Inc., Feb 2, 2009

Agviro report and the calculated electrical savings are within 10% of the reported Enbridge gas savings. Navigant Consulting assumes same amount of auxiliary electrical savings can be achieved by destratification fans in Union Gas service territories.

- Therefore, net electricity consumption (kWh) = electricity consumptions in electric motor (kWh) – auxiliary electrical saving (kWh) = 812 kWh – 767 kWh = 45 kWh
- On a per square footage basis, the electricity savings = – 45 kWh / 13,270 ft^2 = – 0.0034 kWh/ft^2.

Annual Water Savings	0 L

N/A

Other Input Assumptions

Effective Useful Life (EUL)	15 Years

The estimated equipment life for de-stratification fans is 15 years[5]. This value is also supported by ASHRAE[6], which lists the service life for propeller fans as 15 years.

Base & Incremental Conservation Measure Equipment and O&M Costs	$7,021

The weighted average costs are based on market shares described above and cost data[7].

	Fan Sizes	
Results	24' diameter	20' diameter
Incremental Cost for 1 Fan	$7,088	$6,885
Market Share	55%	27%
Weighted Average Cost	$7,021	

According to Envira-North (a local Canadian manufacturer of destratification fans), the suggested retail price for a de-stratification fan with a 2' drop from the ceiling, 2 HP and stealth blade is $6,000. For the 20' fan with 1' drop, 1 HP and a stellar blade, the price is $5,200.

Customer Payback Period (Natural Gas Only)[8]	2.1 Years

Using a 5-year average commodity cost (avoided cost)[9] of $0.38 / m^3 and an average commercial distribution cost[10] of $0.12 / m^3, the payback period for natural gas savings is determined to be 2.1 years, based on the following:

Payback Period = Incremental cost / (natural gas savings x natural gas cost)
= $7,021 / (6,828 m^3/year * $0.5 / m^3)
= 2.1 years

Market Penetration[11]	Low

Based on conversations with suppliers of destratification fans, Navigant Consulting estimates that fewer than 5% of buildings in Ontario capable of installing the technology currently have them installed. Although this is considered to be low market penetration, this technology is relatively new and the penetration is steadily growing.

[5] SEED Program Guideline, J-20, December 2004, http://www.oregon.gov/ENERGY/CONS/SEED/docs/AppendixJ.pdf
[6] ASHRAE Handbook, HVAC Applications SI Edition. Chapter 36 – Table 4. Pg.36.3, 2007.
[7] Targeted Market Study. HVLS Fans on Wisconsin Dairy Farms. State of Wisconsin Department of Administration Division of Energy. June 12, 2006., RSMeans. Mechanical Cost Data – 29th Annual Edition. 2006, and communications with Manufactures.
[8] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.
[9] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.
[10] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).
[11] Navigant Consulting is defining "Low" as below 5%, "Medium" as between 5-50%, and "High" as above 50%,

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
N/A	N/A	N/A	N/A	N/A
Comments N/A				

Energy Recovery Ventilator (ERV) – New Commercial, EGD & UG

Revision #	Description/Comment	Date Revised
		September 16, 2010

Efficient Equipment and Technologies Description
Ventilation with ERV
Base Equipment and Technologies Description
Ventilation without ERV

Decision Type	Target Market(s)	End Use
New	New Commercial	Space Heating

Codes, Standards, and Regulations

1) Restriction for new building construction: This measure is not applicable to system ≥5,000 CFM with ≥70% OA ratio because energy recovery is required by Ontario Building Code 2006.
2) Restriction for new building construction: This measure is not applicable to systems serving health care spaces indicated in **Table 1** because heat recovery is required by CSA Z317.2-01

Table 1 - Health Care Spaces Not Eligible		
Anaesthetic gas scavenging	Cart and can washers	Areas using hazardous gases
Animal facilities	Chemical storage	Isolation rooms
Autopsy suite	Cooking facilities	Perchloric hoods
Biohazard and fume hoods	Ethylene oxide	Radioisotope hoods

Resource Savings Table

Year (EUL=)	Electricity and Other Resource Savings: Natural Gas (m^3/CFM)	Electricity (kWh)	Water (L)	Equipment & O&M Costs of Conservation Measure ($/CFM)	Equipment & O&M Costs of Base Measure ($)
1	2.05 – 5.77	0	0	3.18	0
2	2.05 – 5.77	0	0	0	0
3	2.05 – 5.77	0	0	0	0
4	2.05 – 5.77	0	0	0	0
5	2.05 – 5.77	0	0	0	0
6	2.05 – 5.77	0	0	0	0
7	2.05 – 5.77	0	0	0	0
8	2.05 – 5.77	0	0	0	0
9	2.05 – 5.77	0	0	0	0
10	2.05 – 5.77	0	0	0	0
11	2.05 – 5.77	0	0	0	0
12	2.05 – 5.77	0	0	0	0
13	2.05 – 5.77	0	0	0	0
14	2.05 – 5.77	0	0	0	0
TOTALS	**28.7 – 80.8**	**0**	**0**	**3.18**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	2.05 – 5.77 m^3/CFM

- ERV gas savings in new buildings is determined in the same way as in the ERV gas savings in existing buildings except the balance point temperature of a building. The balance point temperature of a building is selected based on building's thermal characteristics (internal & solar heat gains, infiltration rates and indoor temperature settings). Generally, older buildings (pre-1970's) or buildings with low internal heat gains (residences, motels, supermarkets, warehouses) should consider using a base HDD65°F or HDD60°F value. New buildings built to current OBC standards or buildings with high internal heat gains (retail, restaurants, offices) should consider using base HDD55°F, HDD50°F or even lower balance point temperature.
- Natural gas savings are determined from engineering calculations utilizing inputs such as air flow, indoor/outdoor temperatures, indoor/outdoor and relative humidity.

Symbols	Variable Names	Values	Source
A	Supply air flow (cfm)	ERV Capacity	UG
B	Exhaust air flow (cfm)	ERV Capacity	UG
C	Average Indoor Air Temperature (°F)	70	UG
D	Average Indoor Relative Humidity (%)	30	UG
E	Average Outside Air Temperature (°F)	Adjust Based On District	N
F	Average Outdoor Relative Humidity (%)	75	N
G	Atmospheric Pressure (psia)	14.25	UG
H	No. Of Hours in Heating Season (hrs)	Adjust Based On District	N
I2	No. Of Hours Of Operation Per Week	See Table Below	N
K	Effectiveness Of Heat Recovery Equipment (%)	67	N
L	Sensible Heat Recovery Only	no	UG
M	Enthalpy (Btu/lba) & Humidity Ratio (lbw/lba) Of INLET Exhaust Air	Calculated	UG
N	Enthalpy (Btu/lba) & Humidity Ratio (lbw/lba) Of INLET Supply Air	Calculated	UG
O	Enthalpy (Btu/lba) & Humidity Ratio (lbw/lba) Of OUTLET supply Air	Calculated	UG
P	Average Temperature of OUTLET Supply Air (°F)	Calculated	UG
Q	Average Hourly Moisture Addition (lb/hr)	Calculated	UG
R	Defrost Control Derating Factor (%)	5	UG
S	Average Hourly Heat Recovery (MBH)	Calculated	UG
T	Season Efficiency of Gas-Fired Equipment (%)	82	UG
U	Average Annual Gas Reduction (m^3)	Calculated	UG
V	Incremental Natural Gas Reduction (\$/m^3)	0.3	UG
W	Average Annual Gas Savings ($)	Calculated	UG

UG - Union Gas

N - Nexant, Evaluation of Natural Gas DSM Measures: ERVs & HRVs, March 12 2010

NG Savings = # of Hours in Heating Season x (operating hours/168) x Average Hourly Heat Recovery / (35.3 m^3/MJ) / (Seasonal Efficiency / 100%) **(A)**

- 168 hour = 7 days/week x 24hours/day

Average Hourly Heat Recovery = Supply air flow x 60 x (Supply air flow – Inlet supply air)/Specific Supply Air Conditions Volume x (1 – Defrost Control De-rating Factor[1] %) **(B)**

[1] From Union Gas, all air-to-air heat recovery equipment requires frost control in colder climates to prevent freeze-up of exhaust air condensate on heat exchange components. Depending on the defrost control system, annual heat recovery estimates should be reduced by 5 to 15 %. Equipment manufacturers and suppliers can provide an estimated defrost derating factor given the operating conditions of the equipment.

- Operating hours for each sectors being considered are as the following

Segment	Hours of Operation per Week
Multi-Family	168
Health Care	168
Nursing Home	168
Hotel	120
Restaurant	87
Retail	73
Office	64
Warehouse	61
School	54

- New buildings and existing buildings mainly differ in the enthalpy (BTU/LBa) that is used to calculate the Specific Supply Air Conditions Volume in formula **(B).**
- Based on the NG Savings formula (A) and input assumptions above, the natural gas savings for each of the commercial sectors are calculated. Gas savings for each district were combined using a 70/30 South/North split. Markets with similar gas savings were combined to reduce administration costs and to simplify the program.

			New Buildings	
Grouping	**Segment**	**ERV Capacity (CFM)**	**Gas Savings (m^3)**	**Gas Savings per CFM (m^3/CFM)**
High Use	Multi-Family Health Care Nursing Home	500	2885	5.77
Medium Use	Hotel Restaurant Retail	500	1603	3.21
Low Use	Office Warehouse School	500	1025	2.05

Annual Electricity Savings — 0 kWh

N/A

Annual Water Savings — 0 L

N/A

Other Input Assumptions

Effective Useful Life (EUL)	14 Years
The 14 year life recommended by DEER is based on KEMA-XENERGY's *Retention Study of PG&Es 1996-1997 Energy Incentive Program* (50). This study tracked installed equipment over 6 years and used statistical analysis to calculate EUL.[2]	
Incremental Costs	**$3.18 / CFM**
The incremental costs are based on relative scaling of incremental costs $2,500 / 1000 CFM[3]. Based on communication with local contractors, the incremental costs are $3/CFM. Nexant recommends increasing the incremental cost by inflation, to $3.18/CFM.[4]	

[2] Nexant, Evaluation of Natural Gas DSM Measures: ERVs & HRVs, March 12 2010, page 6-32
[3] "Prescriptive Incentives for Selected Natural Gas Technologies", Prepared for Enbridge Consumers Gas and Union Gas Ltd., by Jacques Whitford Environment Limited, Agviro Inc., and Engineering Interface Ltd., September 27, 2000.
[4] Nexant, Evaluation of Natural Gas DSM Measures: ERVs & HRVs, March 12 2010, page 6-34

Energy Recovery Ventilator (ERV) – Existing Commercial, EGD & UG

Revision #	Description/Comment	Date Revised
		September 16, 2010

Efficient Equipment and Technologies Description
Ventilation with an Energy Recovery Ventilator (ERV)
Base Equipment and Technologies Description
Ventilation without an Energy Recovery Ventilator (ERV)

Decision Type	Target Market(s)	End Use
Replacement	Existing Commercial	Space Heating

Codes, Standards, and Regulations

N/A

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/CFM)	Electricity (kWh)	Water (L)	($/CFM)	($)
1	2.17 – 6.12	0	0	3.18	0
2	2.17 – 6.12	0	0	0	0
3	2.17 – 6.12	0	0	0	0
4	2.17 – 6.12	0	0	0	0
5	2.17 – 6.12	0	0	0	0
6	2.17 – 6.12	0	0	0	0
7	2.17 – 6.12	0	0	0	0
8	2.17 – 6.12	0	0	0	0
9	2.17 – 6.12	0	0	0	0
10	2.17 – 6.12	0	0	0	0
11	2.17 – 6.12	0	0	0	0
12	2.17 – 6.12	0	0	0	0
13	2.17 – 6.12	0	0	0	0
14	2.17 – 6.12	0	0	0	0
TOTALS	**30.4 – 85.7**	**0**	**0**	**3.18**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	$2.17 – 6.12\ m^3/CFM$

- Natural gas savings are determined from engineering calculations utilizing inputs such as air flow, indoor/outdoor temperatures, indoor/outdoor and relative humidity.

Symbols	Variable Names	Values	Source
A	Supply air flow (cfm)	ERV Capacity	UG
B	Exhaust air flow (cfm)	ERV Capacity	UG
C	Average Indoor Air Temperature (°F)	70	UG
D	Average Indoor Relative Humidity (%)	30	UG
E	Average Outside Air Temperature (°F)	Adjust Based On District	N
F	Average Outdoor Relative Humidity (%)	75	N
G	Atmospheric Pressure (psia)	14.25	UG
H	No. Of Hours in Heating Season (hrs)	Adjust Based On District	N
I2	No. Of Hours Of Operation Per Week	See Table Below	N
K	Effectiveness Of Heat Recovery Equipment (%)	67	N
L	Sensible Heat Recovery Only	no	UG
M	Enthalpy (Btu/lba) & Humidity Ratio (lbw/lba) Of INLET Exhaust Air	Calculated	UG
N	Enthalpy (Btu/lba) & Humidity Ratio (lbw/lba) Of INLET Supply Air	Calculated	UG
O	Enthalpy (Btu/lba) & Humidity Ratio (lbw/lba) Of OUTLET supply Air	Calculated	UG
P	Average Temperature of OUTLET Supply Air (°F)	Calculated	UG
Q	Average Hourly Moisture Addition (lb/hr)	Calculated	UG
R	Defrost Control Derating Factor (%)	5	UG
S	Average Hourly Heat Recovery (MBH)	Calculated	UG
T	Season Efficiency of Gas-Fired Equipment (%)	82	UG
U	Average Annual Gas Reduction (m^3)	Calculated	UG
V	Incremental Natural Gas Reduction ($\$/m^3$)	0.3	UG
W	Average Annual Gas Savings ($)	Calculated	UG

UG - Union Gas

N - Nexant, Evaluation of Natural Gas DSM Measures: ERVs & HRVs, March 12 2010

- **NG Savings** = # of Hours in Heating Season x (operating hours/168) x Average Hourly Heat Recovery / (35.3 m^3/MJ) / (Seasonal Efficiency / 100%) **(A)**
  - 168 hour = 7 days/week x 24hours/day
  - Average Hourly Heat Recovery = Supply air flow x 60 x (Supply air flow – Inlet supply air)/Specific Supply Air Conditions Volume x (1 – Defrost Control De-rating Factor[1] %) **(B)**

[1] From Union Gas, all air-to-air heat recovery equipment requires frost control in colder climates to prevent freeze-up of exhaust air condensate on heat exchange components. Depending on the defrost control system, annual heat recovery estimates should be reduced by 5 to 15 %. Equipment manufacturers and suppliers can provide an estimated defrost derating factor given the operating conditions of the equipment.

- Operating hours for each sectors being considered are as the following

Segment	Hours of Operation per Week
Multi-Family	168
Health Care	168
Nursing Home	168
Hotel	120
Restaurant	87
Retail	73
Office	64
Warehouse	61
School	54

- Based on the NG Savings formula (A) and input assumptions above, the natural gas savings for each of the commercial sectors are calculated. Gas savings for each district were combined using a 70/30 South/North split. Markets with similar gas savings were combined to reduce administration costs and to simplify the program.

Example below:

			Existing Buildings	
Grouping	Segment	ERV Capacity (CFM)	Gas Savings (m^3)	Gas Savings per CFM (m^3/CFM)
High Use	Multi-Family Health Care Nursing Home	500	3058	6.12
Medium Use	Hotel Restaurant Retail	500	1699	3.40
Low Use	Office Warehouse School	500	1086	2.17

Annual Electricity Savings	0 kWh

N/A

Annual Water Savings	0 L/CFM

N/A

Other Input Assumptions

Effective Useful Life (EUL)	14 Years
The 14 year life recommended by DEER is based on KEMA-XENERGY's *Retention Study of PG&Es 1996-1997 Energy Incentive Program* (50). This study tracked installed equipment over 6 years and used statistical analysis to calculate EUL.[2]	
Incremental Costs	**$3.18/CFM**
The incremental costs are based on relative scaling of incremental costs $2,500 / 1000 CFM[3]. Based on communication with local contractors, the incremental costs are $3/CFM. Nexant recommends increasing the incremental cost by inflation, to $3.18/CFM.[4]	

[2] Nexant, Evaluation of Natural Gas DSM Measures: ERVs & HRVs, March 12 2010, page 6-32

[3] "Prescriptive Incentives for Selected Natural Gas Technologies", Prepared for Enbridge Consumers Gas and Union Gas Ltd., by Jacques Whitford Environment Limited, Agviro Inc., and Engineering Interface Ltd., September 27, 2000.

[4] Nexant, Evaluation of Natural Gas DSM Measures: ERVs & HRVs, March 12 2010, page 6-34

Heat Recovery Ventilator (HRV) – New Commercial, EGD & UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
Ventilation with HRV
Base Equipment and Technologies Description
Ventilation without HRV

Decision Type	Target Market(s)	End Use
New	Commercial	Space Heating

Codes, Standards, and Regulations

- Restriction for New Building Construction: This measure is not applicable to system ≥5,000 CFM in an application requiring ≥70% OA ratio according to Ontario Building Code 2006, because energy recovery is required.
- Restriction for New Building Construction: This measure is not applicable to systems serving health care spaces indicated in **Table 1** because heat recovery is required by CSA Z317.2-01

Table 1 - Health Care Spaces Not Eligible		
Anaesthetic gas scavenging	Cart and can washers	Areas using hazardous gases
Animal facilities	Chemical storage	Isolation rooms
Autopsy suite	Cooking facilities	Perchloric hoods
Biohazard and fume hoods	Ethylene oxide	Radioisotope hoods

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/CFM)	Electricity (kWh)	Water (L)	($/CFM)	($)
1	1.52 – 4.28	0	0	3.61	0
2	1.52 – 4.28	0	0	0	0
3	1.52 – 4.28	0	0	0	0
4	1.52 – 4.28	0	0	0	0
5	1.52 – 4.28	0	0	0	0
6	1.52 – 4.28	0	0	0	0
7	1.52 – 4.28	0	0	0	0
8	1.52 – 4.28	0	0	0	0
9	1.52 – 4.28	0	0	0	0
10	1.52 – 4.28	0	0	0	0
11	1.52 – 4.28	0	0	0	0
12	1.52 – 4.28	0	0	0	0
13	1.52 – 4.28	0	0	0	0
14	1.52 – 4.28	0	0	0	0
TOTALS	**21.3 – 59.9**	**0**	**0**	**3.61**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	1.52 – 4.28 m^3/CFM

- HRV gas savings in new buildings is determined in the same way as in the HRV gas savings in existing buildings except the balance point temperature of a building. The balance point temperature of a building is selected based on building's thermal characteristics (internal & solar heat gains, infiltration rates and indoor temperature settings). Generally, older buildings (pre-1970's) or buildings with low internal heat gains (residences, motels, supermarkets, warehouses) should consider using a base HDD65oF or HDD60oF value. New buildings built to current OBC standards or buildings with high internal heat gains (retail, restraurants, offices) should consider using base HDD55oF, HDD50oF or even lower balance point temperature. The balance point values listed represent climate data for the London area.
- Natural gas savings are determined from engineering calculations utilizing inputs such as air flow, indoor/outdoor temperatures, indoor/outdoor and relative humidity.

Symbols	Variable Names	Values	Source
A	Supply air flow (cfm)	HRV Capacity	UG
B	Exhaust air flow (cfm)	HRV Capacity	UG
C	Average Indoor Air Temperature (°F)	70	UG
D	Average Indoor Relative Humidity (%)	30	UG
E	Average Outside Air Temperature (°F)	Adjust Based On District	N
F	Average Outdoor Relative Humidity (%)	75	N
G	Atmospheric Pressure (psia)	14.25	UG
H	No. Of Hours in Heating Season (hrs)	Adjust Based On District	N
I2	No. Of Hours Of Operation Per Week	See Table Below	N
K	Effectiveness Of Heat Recovery Equipment (%)	61	N
L	Sensible Heat Recovery Only	no	UG
M	Enthalpy (Btu/lba) & Humidity Ratio (lbw/lba) Of INLET Exhaust Air	Calculated	UG
N	Enthalpy (Btu/lba) & Humidity Ratio (lbw/lba) Of INLET Supply Air	Calculated	UG
O	Enthalpy (Btu/lba) & Humidity Ratio (lbw/lba) Of OUTLET supply Air	Calculated	UG
P	Average Temperature of OUTLET Supply Air (°F)	Calculated	UG
Q	Average Hourly Moisture Addition (lb/hr)	Calculated	UG
R	Defrost Control Derating Factor (%)	5	UG
S	Average Hourly Heat Recovery (MBH)	Calculated	UG
T	Season Efficiency of Gas-Fired Equipment (%)	82	UG
U	Average Annual Gas Reduction (m^3)	Calculated	UG
V	Incremental Natural Gas Reduction ($/$m^3$)	0.3	UG
W	Average Annual Gas Savings ($)	Calculated	UG

UG - Union Gas

N - Nexant, Evaluation of Natural Gas DSM Measures: ERVs & HRVs, March 12 2010

- **NG Savings** = # of Hours in Heating Season x (operating hours/168) x Average Hourly Heat Recovery / (35.3 m^3/MJ) / (Seasonal Efficiency / 100%) **(A)**
  - 168 hour = 7 days/week x 24hours/day
  - Average Hourly Heat Recovery = Supply air flow x 60 x (Supply air flow – Inlet supply air)/Specific Supply Air Conditions Volume x (1 – Defrost Control De-rating Factor[13] %) **(B)**
- Operating hours for each sectors being considered are as the following

Segment	Hours of Operation per Week
Multi-Family	168
Health Care	168
Nursing Home	168
Hotel	120
Restaurant	87
Retail	73
Office	64
Warehouse	61
School	54

- New buildings and existing buildings mainly differ in enthalpy (BTU/LBa) that is used to calculate the Specific Supply Air Conditions Volume in formula **(B).**
- Based on the NG Savings formula (A) and input assumptions above, the natural gas savings for each of the commercial sectors are calculated. Gas savings for each district were combined using a 70/30 South/North split. Markets with similar gas savings were combined to reduce administration costs and to simplify the program.

			New Buildings	
Grouping	Segment	ERV Capacity (CFM)	Gas Savings (m^3)	Gas Savings per CFM (m^3/CFM)
High Use	Multi-Family Health Care Nursing Home	500	2142	4.28
Medium Use	Hotel Restaurant Retail	500	1190	2.38
Low Use	Office Warehouse School	500	761	1.52

Annual Electricity Savings — 0 kWh

N/A

Annual Water Savings — 0 L/CFM

N/A

[13] From Union Gas, all air-to-air heat recovery equipment requires frost control in colder climates to prevent freeze-up of exhaust air condensate on heat exchange components. Depending on the defrost control system, annual heat recovery estimates should be reduced by 5 to 15 %. Equipment manufacturers and suppliers can provide an estimated defrost derating factor given the operating conditions of the equipment.

Other Input Assumptions

Effective Useful Life (EUL)	14 Years
The 14 year life recommended by DEER is based on KEMA-XENERGY's *Retention Study of PG&Es 1996-1997 Energy Incentive Program* (50). This study tracked installed equipment over 6 years and used statistical analysis to calculate EUL.[14]	
Incremental Costs	**$3.61 / CFM**
The incremental costs are based on relative scaling of incremental costs $1,700 / 500 CFM[15]. Nexant recommends increasing the incremental cost by inflation, to $3.61/CFM.[16]	

[14] Nexant, Evaluation of Natural Gas DSM Measures: ERVs & HRVs, March 12 2010, page 6-32

[15] "Prescriptive Incentives for Selected Natural Gas Technologies", Prepared for Enbridge Consumers Gas and Union Gas Ltd., by Jacques Whitford Environment Limited, Agviro Inc., and Engineering Interface Ltd., September 27, 2000.

[16] Nexant, Evaluation of Natural Gas DSM Measures: ERVs & HRVs, March 12 2010, page 6-34

Heat Recovery Ventilator (HRV) – Existing Commercial, EGD & UG

Revision #	Description/Comment	Date Revised
		September 16, 2010

Efficient Equipment and Technologies Description
Ventilation with HRV
Base Equipment and Technologies Description
Ventilation without HRV

Decision Type	Target Market(s)	End Use
Retrofit	Existing Commercial	Space Heating

Codes, Standards, and Regulations

N/A

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/CFM)	Electricity (kWh)	Water (L)	($/CFM)	($)
1	1.67 – 4.70	0	0	3.61	0
2	1.67 – 4.70	0	0	0	0
3	1.67 – 4.70	0	0	0	0
4	1.67 – 4.70	0	0	0	0
5	1.67 – 4.70	0	0	0	0
6	1.67 – 4.70	0	0	0	0
7	1.67 – 4.70	0	0	0	0
8	1.67 – 4.70	0	0	0	0
9	1.67 – 4.70	0	0	0	0
10	1.67 – 4.70	0	0	0	0
11	1.67 – 4.70	0	0	0	0
12	1.67 – 4.70	0	0	0	0
13	1.67 – 4.70	0	0	0	0
14	1.67 – 4.70	0	0	0	0
TOTALS	**23.4 – 65.8**	**0**	**0**	**3.61**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	1.67 – 4.70 m^3 / CFM

- Natural gas savings are determined from engineering calculations utilizing inputs such as air flow, indoor/outdoor temperatures, indoor/outdoor and relative humidity.

Symbols	Variable Names	Values	Source
A	Supply air flow (cfm)	HRV Capacity	UG
B	Exhaust air flow (cfm)	HRV Capacity	UG
C	Average Indoor Air Temperature (°F)	70	UG
D	Average Indoor Relative Humidity (%)	30	UG
E	Average Outside Air Temperature (°F)	Adjust Based On District	N
F	Average Outdoor Relative Humidity (%)	75	N
G	Atmospheric Pressure (psia)	14.25	UG
H	No. Of Hours in Heating Season (hrs)	Adjust Based On District	N
I2	No. Of Hours Of Operation Per Week	See Table Below	N
K	Effectiveness Of Heat Recovery Equipment (%)	61	N
L	Sensible Heat Recovery Only	no	UG
M	Enthalpy (Btu/lba) & Humidity Ratio (lbw/lba) Of INLET Exhaust Air	Calculated	UG
N	Enthalpy (Btu/lba) & Humidity Ratio (lbw/lba) Of INLET Supply Air	Calculated	UG
O	Enthalpy (Btu/lba) & Humidity Ratio (lbw/lba) Of OUTLET supply Air	Calculated	UG
P	Average Temperature of OUTLET Supply Air (°F)	Calculated	UG
Q	Average Hourly Moisture Addition (lb/hr)	Calculated	UG
R	Defrost Control Derating Factor (%)	5	UG
S	Average Hourly Heat Recovery (MBH)	Calculated	UG
T	Season Efficiency of Gas-Fired Equipment (%)	82	UG
U	Average Annual Gas Reduction (m^3)	Calculated	UG
V	Incremental Natural Gas Reduction ($/$m^3$)	0.3	UG
W	Average Annual Gas Savings ($)	Calculated	UG

UG - Union Gas

N - Nexant, Evaluation of Natural Gas DSM Measures: ERVs & HRVs, March 12 2010

- **NG Savings** = # of Hours in Heating Season x (operating hours/168) x Average Hourly Heat Recovery / (35.3 m^3/MJ) / (Seasonal Efficiency / 100%) **(A)**
  - 168 hour = 7 days/week x 24hours/day
  - Average Hourly Heat Recovery = Supply air flow x 60 x (Supply air flow – Inlet supply air)/Specific Supply Air Conditions Volume x (1 – Defrost Control De-rating Factor[5] %) **(B)**

[5] From Union Gas, all air-to-air heat recovery equipment requires frost control in colder climates to prevent freeze-up of exhaust air condensate on heat exchange components. Depending on the defrost control system, annual heat recovery estimates should be reduced by 5 to 15 %. Equipment manufacturers and suppliers can provide an estimated defrost derating factor given the operating conditions of the equipment.

- Operating hours for each sectors being considered are as the following

Segment	Hours of Operation per Week
Multi-Family	168
Health Care	168
Nursing Home	168
Hotel	120
Restaurant	87
Retail	73
Office	64
Warehouse	61
School	54

- New buildings and existing buildings mainly differ in enthalpy (BTU/LBa) that is used to calculate the Specific Supply Air Conditions Volume in formula **(B).**
- Based on the NG Savings formula (A) and input assumptions above, the natural gas savings for each of the commercial sectors are calculated. Gas savings for each district were combined using a 70/30 South/North split. Markets with similar gas savings were combined to reduce administration costs and to simplify the program.

Example below:

			Existing Buildings	
Grouping	Segment	ERV Capacity (CFM)	Gas Savings (m^3)	Gas Savings per CFM (m^3/CFM)
High Use	Multi-Family Health Care Nursing Home	500	2352	4.70
Medium Use	Hotel Restaurant Retail	500	1307	2.61
Low Use	Office Warehouse School	500	835	1.67

Annual Electricity Savings	0 kWh

N/A

Annual Water Savings	0 L / CFM

N/A

Other Input Assumptions

Effective Useful Life (EUL)	14 Years
The 14 year life recommended by DEER is based on KEMA-XENERGY's *Retention Study of PG&Es 1996-1997 Energy Incentive Program* (50). This study tracked installed equipment over 6 years and used statistical analysis to calculate EUL.[6]	
Incremental Costs	**$3.61 / CFM**
The incremental costs are based on relative scaling of incremental costs $1,700 / 500 CFM[7]. Nexant recommends increasing the incremental cost by inflation, to $3.61/CFM.[8]	

[6] Nexant, Evaluation of Natural Gas DSM Measures: ERVs & HRVs, March 12 2010, page 6-32)

[7] "Prescriptive Incentives for Selected Natural Gas Technologies", Prepared for Enbridge Consumers Gas and Union Gas Ltd., by Jacques Whitford Environment Limited, Agviro Inc., and Engineering Interface Ltd., September 27, 2000.

[8] Nexant, Evaluation of Natural Gas DSM Measures: ERVs & HRVs, March 12 2010, page 6-34

HIGH EFFICIENCY BOILERS UNDER 300 MBH

Small Commercial – New/Existing, EGD & UG

Efficient Technology & Equipment Description
High Efficiency non-condensing boilers having annual fuel utilization efficiency (AFUE) of 85% or greater. Boiler input size is under 300,000 Btu/hr. Application is for seasonal or non-seasonal use. MBH is defined throughout this document as 1,000 Btu/hr.
Base Technology & Equipment Description
Non-condensing boiler having an AFUE of 80% for either seasonal or non-seasonal use. Boiler input size is under 300,000 Btu/hr.

Resource Savings Assumptions

Natural Gas	**<u>Seasonal</u>** **0.00665 m^3 /(Btu/hr Boiler Input)** **<u>Non-Seasonal</u>** **Boiler Input Under 100 MBH = 0.02430 m^3 /(Btu/hr Boiler Input)** **Boiler Input 100 To Under 200 MBH = 0.01491 m^3 /(Btu/hr)** **Boiler Input 200 To Under 300 MBH = 0.01115 m^3 /(Btu/hr)**

<u>Estimation Based on Agviro Study for Enbridge</u>

- Based on Agviro's report[1], the energy analysis compares use of a high efficiency non-condensing boiler having an AFUE of 87.5% versus a base case non-condensing boiler having an AFUE of 80%.
- The normalized gas use for a seasonal base case boiler is determined by the relationship:

$$Normalized\,Gas\,Use = 77.575 \times BoilerIP$$

where:

BoilerIP = seasonal boiler input size (MBH)

Normalized Gas Use = normalized annual seasonal gas use (m3/yr)

- The gas savings for a non-seasonal base case boiler is determined by the relationship:

$$NonSeasonal\,Gas\,Use = 36.282 \times BoilerIP + 9256.9$$

where:

BoilerIP = seasonal boiler input size (MBH)

Non Seasonal Gas Use = annual non-seasonal gas use (m3/yr)

- The gas savings of the condensing versus the base case boiler is determined by the relationship:

[1] Prescriptive Savings Analysis – Condensing Boilers Under 300MBH, Agviro Inc., Jan 17, 2011

$$GasSavings = GasUse \times (1 - \frac{\%Eff_{BC}}{\%Eff_{CE}})$$

where:

GasUse = seasonal or non-seasonal gas use (m3)
$\%Eff_{BC}$ = Efficiency of the Base Case boiler
[seasonal = 80%; non-seasonal=66.2%]
$\%Eff_{CE}$ = Efficiency of the Condensing boiler
[seasonal = 87.5%; non-seasonal=78.08%]
GasSavings = annual gas savings (m3/yr)

- On a per Btu/hr boiler input basis, the natural gas savings is:
  - seasonal boiler = 0.00665 m^3 / (Btu/hr)
  - non-seasonal boiler =
    - Boiler Input Under 100 MBH = 0.02430 m^3 /(Btu/hr Boiler Input)
    - Boiler Input 100 To Under 200 MBH = 0.01491 m^3 /(Btu/hr)
    - Boiler Input 200 To Under 300 MBH = 0.01115 m^3 /(Btu/hr)

Electricity	**0 kWh**
Water	**0 L**

Other Input Assumptions

Equipment Life	**25 yrs**

-

Incremental Cost

Existing Construction

Boiler Input (MBH)	**Incremental Cost ($)**
Under 100	**$1,808**
100 To Under 200	**$2,114**
200 To Under 300	**$1,958**

New Construction

Boiler Input (MBH)	**Incremental Cost ($)**
Under 100	**$1,238**
100 To Under 200	**$1,544**
200 To Under 300	**$1,388**

Incremental costs account for differences in venting, controls and labour.

Incremental Cost – Existing Construction

- Boiler Input Under 100 MBH = $1,808
- Boiler Input 100 To Under 200 MBH = $2,114
- Boiler Input 200 To Under 300 MBH = $1,958

Incremental Cost – New Construction

- Boiler Input Under 100 MBH = $1,238
- Boiler Input 100 To Under 200 MBH = $1,544
- Boiler Input 200 To Under 300 MBH = $1,388

High Efficiency (Condensing) Furnace – Commercial, UG & EGD

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
High-efficiency condensing furnace with regular PSC motor – AFUE 96.
Base Equipment and Technologies Description
Mid-efficiency furnace AFUE 90.

Decision Type	Target Market(s)	End Use
New, Retrofit	Commercial office buildings	Space Heating

Codes, Standards, and Regulations

- Under Ontario's building code, all gas furnaces installed in new residential construction must meet a minimum condensing efficiency level effective January 1, 2007[1].
- However, effective December 31, 2009, NRCan requires the minimum performance level, or the Annual Fuel Utilization Efficiency (AFUE), for residential gas-fired furnaces with an input rate not exceeding 65.92 kW (225 000 Btu/h) to be 90%[2].

Resource Savings Table

AFUE 96

[1] Ministry of Energy, "Heating and Cooling your Home: A Conservation Guide." Reproduced with the permission of Natural Resource Canada, 2004. http://www.energy.gov.on.ca/english/pdf/conservation/heating_and_cooling_your_home.pdf

[2] Office of Energy Efficiency, Canada's Energy Efficiency Regulations, Final Bulletin, December 2008. http://oee.nrcan.gc.ca/regulations/bulletin/gas-furnaces-dec08.cfm?attr=0

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/kBtu/h)	Electricity (kWh)	Water (L)	($/kBtu/hr)	($/kBtu/hr)
1	1.7	0	0	30.6	22.2
2	1.7	0	0	0	0
3	1.7	0	0	0	0
4	1.7	0	0	0	0
5	1.7	0	0	0	0
6	1.7	0	0	0	0
7	1.7	0	0	0	0
8	1.7	0	0	0	0
9	1.7	0	0	0	0
10	1.7	0	0	0	0
11	1.7	0	0	0	0
12	1.7	0	0	0	0
13	1.7	0	0	0	0
14	1.7	0	0	0	0
15	1.7	0	0	0	0
16	1.7	0	0	0	0
17	1.7	0	0	0	0
18	1.7	0	0	0	0
TOTALS	**30.6**	**0**	**0**	**30.6**	**22.2**

Resource Savings Assumptions

Annual Natural Gas Savings	1.7m³ / kBtu / h

- Gas savings associated with upgrading from a mid-efficiency furnace to a high efficiency furnace are based on the following formula:
- Annual Savings = 1 – Base Technology AFUE / Efficient Equipment AFUE
  = 1 – 90/96
  = 6.3%
- The US DOE reports a 4.91% gas savings for an AFUE 96 furnace (based on an AFUE90 baseline).[3]
- Natural gas savings are based on Enbridge research[4] indicates the average consumption for a high-efficiency furnace[5] is 2,045m³.
- Using the calculated percent savings (6.3%) multiplied by the base energy consumption (2,045 m³) the annual gas savings are estimated to be 129 m³.
- Assuming a typical commercial furnace input of 75,000 BTU/h, natural gas savings on a per thousand BTU/h basis are 129 m³ / 75 kBtu/h = 1.7 kBtu/h

Annual Electricity Savings	0 kWh

Electricity savings resulting from high efficiency furnaces are negligible.

Annual Water Savings	0 L

N/A

Other Input Assumptions

Effective Useful Life (EUL)	18 Years

ACEEE[6] and State of Iowa[7] both estimate an effective useful life of 18 years. Puget Sound Energy[8] and New England State Program Working Group (SPWG)[9] also suggest 18 years for high efficiency furnaces.

Base & Incremental Conservation Measure Equipment and O&M Costs	$8.4/ kBtu / h

Average incremental cost is based on communication with local HVAC contractors. Navigant Consulting is assuming that the ratio of the incremental cost between a commercial AFUE 90 furnace and a commercial AFUE 96 furnace is the same as for residential market (38%). Therefore, using a baseline commercial AFUE 90 furnace of $3,000, the incremental cost i is estimated to be $1,135 for a 135,000 Btu/hr furnace, or $8.4.5/kBtu/hr.

Customer Payback Period (Natural Gas Only)[10]	9.6 Years

Using an 5-year average commodity cost (avoided cost)[11] of $0.36/ m³ and an average commercial distribution cost[12] of $0.14 / m³, the payback period for natural gas savings is determined to be 9.6

[3] US DOE Residential Furnaces and Boilers Technical Support Document Analytical Tools. Life Cycle Cost Results for Non-Weatherized Gas Furnaces. http://www1.eere.energy.gov/buildings/appliance_standards/residential/docs/lcc_nwgf_gt6000hdd.xls
[4] Based on information provided by Enbridge Gas, based on Decision for the Enbridge 2006 DSM Plan (EB2005-0001).
[5] Average commercial baseline consumption for a mid-efficiency furnace was not available from either of the Ontario gas utilities, therefore, residential baseline furnace consumption will be used and computed on a per thousand Btu/h basis.
[6] Powerful Priorities: Updating Energy Efficiency Standards for Residential Furnaces, Commercial Air Conditioners, and Distribution Transformers. ACEEE, September 2004.
[7] Joint Assessment Study, MidAmerican Energy Company, Appendix C. State of Iowa Utilities Board Docket No. EEP-08-2, 2008, C-131
[8] Quantec, Comprehensive Demand-Side Management Resource Assessment, Prepared for Puget Sound Energy, May 2007
[9] GDS Associates, Inc., Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, Prepared for The New England State Program Working Group (SPWG), For use as an Energy Efficiency Measures/Programs Reference Document for the ISO Forward Capacity Market (FCM), June 2007
[10] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.

years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = $8.4/kBtu/hr / (1.7m^3/kBtu/hr/year* $0.50 / m^3) = 9.6 Years

Market Share[13]	**Medium**
Based on market share information for residential furnaces[14], Navigant Consulting is assuming a similar trend for the commercial sector. Therefore, Navigant Consulting estimates the market share in Ontario to be medium.	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Questar Gas, 2006[15]	841.5	20	487.5	N/A
Comments Questar Gas reported 30.6 DTH annual natural gas savings, which translates to 841.5 m^3.				
Puget Sound Energy[16]	0.0396 m^3/sq.ft.	20	$0.1/sq.ft.	N/A
Comments Puget Sound reports 12% savings based on a baseline gas furnace of AFUE 75 and energy efficient furnace of AFUE 85. Baseline usage is 0.12 therms/sq.ft., therefore savings is 12% x 0.12 therms/sq.ft. x 2.75 m^3/therm = 0.0396 m^3 /sq.ft.				

[11] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.
[12] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).
[13] Navigant Consulting is defining “Low” as below 5%, “Medium” as between 5-50%, and “High” as above 50%,
[14] NRCan, Office of Energy Efficiency, Comprehensive Energy Use Database: Table 22: Single detached heating system stock by heating system type, http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/trends_res_on.cfm, updated September 2008.
[15] Nexant, Questar Gas DSM Market Characterization Report, 2006
[16] Quantec, Comprehensive Demand-Side Management Resource Assessment, Prepared for Puget Sound Energy, May 2007

Infrared Heaters, UG & EGD

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
Infrared heater (up to 255,000 Btu/hour)
Base Equipment and Technologies Description
Regular unit heater

Decision Type	Target Market(s)	End Use
New/Retrofit	New/Existing Commercial buildings	Space Heating

Codes, Standards, and Regulations

The old code CAN 1-2.16-M81 (R1996) has been withdrawn.

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/Btu/hour)	Electricity (kWh)	Water (L)	($/Btu/hour)	($)
1	0.0159	16 - 873	0	0.0122	0
2	0.0159	16 - 873	0	0	0
3	0.0159	16 - 873	0	0	0
4	0.0159	16 - 873	0	0	0
5	0.0159	16 - 873	0	0	0
6	0.0159	16 - 873	0	0	0
7	0.0159	16 - 873	0	0	0
8	0.0159	16 - 873	0	0	0
9	0.0159	16 - 873	0	0	0
10	0.0159	16 - 873	0	0	0
11	0.0159	16 - 873	0	0	0
12	0.0159	16 - 873	0	0	0
13	0.0159	16 - 873	0	0	0
14	0.0159	16 - 873	0	0	0
15	0.0159	16 - 873	0	0	0
16	0.0159	16 - 873	0	0	0
17	0.0159	16 - 873	0	0	0
18	0.0159	16 - 873	0	0	0
19	0.0159	16 - 873	0	0	0
20	0.0159	16 - 873	0	0	0
TOTALS	**0.32**	**326 – 17,469**	**0**	**0.0122**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	**0.0159 m^3 / Btu/ h**

The infrared heater gas savings were based on the analysis procedures previously created by Agviro Inc. for Union Gas[1].

Savings in the Agviro report are provided in three bins, corresponding to the input rating (Btu/hour) of the 0% over-sized conventional draft hood unit heater to be replaced. Agviro explicitly notes that over-sizing was not taken into account in the calculation of savings.

Agviro also notes that the efficient technology, the infrared heater "has been downsized by the infrared adjustment factor" and that "[when/if] the conventional system is 75,000 btu/h input... the infrared heater is [approximately] 64,000 Btu/h input...."

Put another way, an IR heater replacing a 0% over-sized conventional draft hood heater will have an input in btu/h that is 85% (the IR adjustment factor) that of the conventional unit.

Rather than using input range bins for the conventional draft hood heater, Navigant recommends using the corresponding input range bins for the efficient technology. This is for two reasons:

1. It will likely be much simpler to determine the input (btu/h) of the replacement/efficient technology than of the old conventional heater to be replaced.
2. The savings will not be overstated regardless of whether or not the conventional unit is over-sized, so long as the IR heater is appropriately sized for the heating load to be served. If in fact the conventional unit is over-sized the savings estimated will likely be understated given that an oversized draft hood heater operating at partial capacity is likely to consume more gas for a given heating load than a 0% oversized draft hood heater operating at optimal capacity.

In summary: the input heater range bins (and the attendant savings) shown below correspond to the input of *the efficient measure*.

Location	Heater Range (Btu/h)	Annual Gas Savings (m^3/year)		
		Single Stage	2-Stage	High Intensity
London	0 – 63,750	898	1,508	898
	64,600 – 127,500	1,786	3,017	1,786
	128,350 - 255,000	3,591	6,033	3,591
Sudbury	0 – 63,750	971	1,631	971
	64,600 – 127,500	1,942	3,262	1,942
	128,350 - 255,000	3,883	6,524	3,883

Annual gas savings were determined by taking the difference in the annual natural gas consumption of a conventional system and the annual natural gas consumption of the efficient technology as in equation (1) below.

$$\Delta GasUse = \left(\frac{AnnualHeatLoss_{Conv}}{Eff_{Conv}} - \frac{AnnuaHeatLoss_{EE}}{Eff_{EE}} \right) \times \frac{1}{35,300} \qquad (1)$$

Where:

$AnnualHeatLoss$ = Annual heat loss of conventional heater and EE infrared heater (as

[1] Assessment of Average Infrared Heater Savings, Agviro, December 1, 2004

	defined by subscript).
Eff =	The combustion efficiency of the heater (%).
35,300 =	The energy value of natural gas (Btu/m^3)

The annual heat loss is calculated by Agviro as the sum of unit heat losses in a variety of outdoor temperature bins each of which is multiplied by the number of hours in which the temperature, on average falls into a given bin[2].

An average rate of savings of 0.0159 m^3/Btu/hour was determined by taking a weighted average of the savings from both locations: 70% of Union Gas South (London) and 30% of Union Gas North (Sudbury) based on customer population distribution in Union Gas service territories. Navigant, in determining the average rate of savings from the information in the Agviro report has conservatively assumed that the Btu/h is the highest possible for a given range. For example, a single-stage infrared heater saves on average 920 m^3 of natural gas per year (see table directly below) for Infrared heaters in the 0 – 63,750 Btu/h range – the weighted average between Union's two territories. Assuming that the average Btu/h within this range is in fact the highest possible value in this range (in this case 63,750 Btu/h) this results in savings of 0.0144 m^3/Btu/hr/year as shown in the table below.

The savings associated with the different types of IR heaters were then averaged using market share weightings, resulting in 0.0159 m^3/Btu/hr/year.[3]

Capacity (Btu/h)	Single stage	2 Stage	High Intensity	Average
63,750	920	1,545	920	1,128
127,500	1,833	3,091	1,833	2,252
250,000	3,679	6,180	3,679	4,513
Infrared Tier	Revised Calculation			Average
63,750	0.0144	0.0242	0.0144	0.0177
127,500	0.0144	0.0242	0.0144	0.0177
255,000	0.0144	0.0242	0.0144	0.0177
Weighted by Navigant market estimate				
Capacity (Btu/h)	79%	15%	6%	**Average**
63,750	0.0114	0.0036	0.0009	**0.0159**
127,500	0.0114	0.0036	0.0009	**0.0159**
255,000	0.0114	0.0036	0.0009	**0.0159**

Annual Electricity Savings — 16 - 873 kWh

Both infrared heaters and conventional draft-hood unit heaters require an electrically powered circulating fan. Infrared heaters typically use a fan of a much lower horse-power than those used by a conventional draft-hood heater.

Navigant has estimated the base measure's fan load by converting the average fan horse-power of a representative sample of conventional draft-hood heaters[4] into kilowatts. Fan loads for infrared heaters

[2] Ibid.

[3] As agreed to in the 2010 audit. Data from The Cadmus Group, Inc., "Independent Audit of 2010 DSM Program Results – Report", July 2011, pg 13.

[4] Horse-powers are drawn from Trane's specifications sheet for that company's line of conventional draft-hood heaters: http://www.trane.com/Commercial/Uploads/Pdf/1024/uh-ts-1.pdf

were obtained by Navigant by contacting several manufacturers by and requesting the horse-power of the fan/blower on the most popular units in a given btu/hr input range[5].

As with the natural gas savings shown above, the electricity savings correspond to the input range bin in which the input (btu/h) of the efficient technology falls, not the base technology.

	Fan load (kW)		Operating Hours per Year		
Heater Range (Btu/h)	Conventional draft-hood heater	Infrared Heater	Conventional draft-hood heater	Infrared Heater	**Electricity Savings**
< 50,000	0.02	0.02	2509	2133	**16**
50,000 - 165,000	0.19	0.04	2509	2133	**409**
> 165,000	0.43	0.09	2509	2133	**873**

Annual Water Savings	0 L
N/A	

Other Input Assumptions

Effective Useful Life (EUL)	20 Years
Infrared heaters have an estimated service life of 20 years[6].	
Base & Incremental Conservation Measure Equipment and O&M Costs	**$ 0.0122 / Btu / h**
An incremental cost of $350 was used based on past input assumptions filed by Union[7]. Local retailers reported an average of $0.009 / Btu/hr incremental cost. Navigant Consulting therefore is estimating an average of $0.0122 / Btu/hour.	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Questar Gas[8]	32.64	17	1,391	N/A
Comments Specifications for infrared heaters are not provided in the report or the baseline assumptions.				

[5] Navigant contacted Spaceray (www.spaceray.com) , Schwank (www.schwankgroup.com) and Calcana (www.Calcana.com) and also consulted the online specifications published by Solaronics (http://solaronics.thomasnet.com/Asset/SSTG-SSTU-GB_200010_Spec_Sheet.pdf). The infrared heaters produced by Solaronics, Schwank and Spaceray all use the same horse-power fan, regardless of btu/hr input, whereas the Calcana heater fan horse-power varies by input range. Navigant has conservatively assumed that the fan load of the 0 – 75,000 btu/hr range will be the average of all those reported to Navigant, whereas the fan-load for the other two buckets will be those reported by Calcana.

[6] "Prescriptive Incentives for Selected Natural Gas Technologies", Prepared for Enbridge Consumers Gas and Union Gas Ltd., Prepared by: Jacques Whitford Environment Limited, Agviro Inc., and Engineering Interface Ltd., September 27, 2000.

[7] EB-2005-0211, Union Gas Settlement Agreement, April 7, 2005

[8] Questar Gas, DSM Market Characterization Report, by Nexant, August 9, 2006

HIGHER EFFICIENCY BOILERS –SPACE HEATING

Existing and New Commercial and Multi- Residential, UG & EGD

Efficient Technology & Equipment Description
Hydronic Boilers for space (Seasonal)
Base Technology & Equipment Description
80% Combustion Efficiency Space Heating Boiler

Resource Savings Assumptions

Natural Gas (Updated)

Boiler Size	**Space Heating (Seasonal) M3 Savings by Combustion Efficiency 83-84%**	**85-88%**
300 MBH	**2,105**	**3,125**
600 MBH	**3,994**	**5,930**
1,000 MBH	**7,310**	**10,856**
1,500 MBH	**11,554**	**17,157**
2,000 MBH	**16,452**	**24,431**

Source: Prescriptive Commercial Boiler Program – Prescriptive Savings Analysis – Agviro Report Sept 10, 2008.

An iterative approach was used to determine the annual savings in the commercial sector. The following steps were taken:

a. The Rate 6 accounts were subdivided into bins of annual gas use. This provided the annual average gas use, number of accounts, seasonal, non-seasonal and total gas use.

b. The seasonal portion of the annual gas use was normalized to 30 year weather data. This normalized gas use was correlated to a seasonal boiler size required for gas consumption.

c. Categories of boiler sizes were selected to provide a suitable range of boilers available within the sector.

d. The Rate 6 accounts were subdivided using the normalized average seasonal gas use for the respective categories of boilers selected. This provided the annual average gas use, number of accounts, and total gas use per seasonal boiler size category.

e. Seasonal annual gas use normalization of the boiler size category accounts was completed.

f. Annual seasonal efficiency of the boiler size categories for each of the combustion efficiency ranges was determined.

g. Boiler costs for the boiler size categories was compiled.

h. A TRC analysis was completed for each of the boiler size categories.

i. A similar approached was used for the non-seasonal gas use with the exception of normalizing the data.

Electricity (Updated)	**kWh**
Water	**L**

Other Input Assumptions

Equipment Life	**25 years**
As per EB 2008-0384 & 0385	
Incremental Cost (Contr. Install)	**Space Heating (Seasonal) Incremental Cost by Combustion Efficiency**

Boiler Size	83-84%	85-88%
300 MBH	$3,900	$ 4,500
600 MBH	$5,800	$ 6,000
1,000 MBH	$7,400	$10,300
1,500 MBH	$5,900	$ 7,400
2,000 MBH	$4,950	$ 7,050

Source: Prescriptive Commercial Boiler Program – Prescriptive Savings Analysis – Agviro Report Sept 10, 2008.

Free Ridership

	Enbridge
Small Commercial	10%
Large Commercial	12%
Multi-Family	20%

As per EB 2008-0384 - 0385

PRESCRIPTIVE SCHOOL BOILERS - ELEMENTARY

Commercial Existing Buildings, EGD/UG

Efficient Technology & Equipment Description
Space Heating, Hydronic Boiler with Combustion Efficiency of 83% or higher
Base Technology & Equipment Description
Space Heating, Hydronic Boiler with Combustion Efficiency of 80% to 82%.

Resource Savings Assumptions

Natural Gas	**10,830 m^3**
As recommended by Navigant and approved in EB-2008-0384 / 0385.	
Electricity	**N/A kWh**
Water	**N/A L**

Other Input Assumptions

Equipment Life	**25 years**
As recommended by Navigant and approved in EB-2008-0384 / 0385.	
Incremental Cost (Contractor Install)	**$8,646**
Source: Elementary Schools Prescriptive Savings Analysis Report, Agviro Inc., November 23, 2007. Incremental costs are based on the weighted average of boiler types as noted above. As approved in EB-2008-0384 & 0385.	
Free Ridership (EGD/UG)	**12% / 27%**
As recommended in Summit Blue and approved in EB 2008-0384 & 0385.	

PRESCRIPTIVE SCHOOL BOILERS - SECONDARY

Commercial Existing Buildings, EGD/UG

Efficient Technology & Equipment Description -
Space Heating, Hydronic Boiler with Combustion Efficiency of 83% or higher
Base Technology & Equipment Description
Space Heating, Hydronic Boiler with Combustion Efficiency of 80% to 82%.

Resource Savings Assumptions

Natural Gas	**43,859 m^3**
As recommended by Navigant and approved in EB-2008-0384 / 0385.	
Electricity	**N/A kWh**
Water	**N/A L**

Other Input Assumptions

Equipment Life	**25 years**
As recommended by Navigant and approved in EB-2008-0384 / 0385.	
Incremental Cost (Contractor Install)	**$14,470**
Source: Secondary Schools Prescriptive Savings Analysis Report, Agviro Inc., November 23, 2007. Incremental costs are based on the weighted average of boiler types as noted above. As approved in EB-2008-0384 & 0385	
Free Ridership (EGD)	**12% / 27%**
As recommended in Summit Blue and approved in EB 2008-0384 & 0385.	

Programmable Thermostat – Commercial, UG

Revision #	Description/Comment	Date Revised
		Aug 16, 2011

Efficient Equipment and Technologies Description

Programmable thermostat assuming full set-back.

Base Equipment and Technologies Description

Standard non-programmable thermostat.

Decision Type	Target Market(s)	End Use
Existing	Commercial	Space heating

Codes, Standards, and Regulations

- To be an Energy Star®-qualified programmable thermostat, the device must have at least two different programming periods, four possible temperature settings and allow for temporary user-override.
- CSA C828-99- CAN/CSA Performance Requirements for Thermostats

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	13 - 108	15 - 77			
2	13 - 108	15 - 77			
3	13 - 108	15 - 77			
4	13 - 108	15 - 77			
5	13 - 108	15 - 77			
6	13 - 108	15 - 77			
7	13 - 108	15 - 77			
8	13 - 108	15 - 77			
9	13 - 108	15 - 77			
10	13 - 108	15 - 77			
11	13 - 108	15 - 77			
12	13 - 108	15 - 77			
13	13 - 108	15 - 77			
14	13 - 108	15 - 77			
15	13 - 108	15 - 77			
TOTALS	**195 – 1,620**	**225 – 1,155**	**0**	**$110**	

Resource Savings Assumptions

Annual Natural Gas Savings	13 – 108 m^3

The online Energy Star® spreadsheet calculator for programmable thermostats suggests that for every degree Fahrenheit in temperature reduction there is a 3% reduction in space-heating natural gas consumption.

Union Gas estimates that, corrected for the average outdoor heating season temperature, for every degree Fahrenheit in temperature reduction there is a 2.4% reduction in natural gas consumption in southern and central Ontario and a 2.05% reduction in natural gas consumption in northern Ontario[1]. The weighted average percentage savings, based on Enbridge's overall distribution of customers (80% Central, 20% Eastern) is 2.33%.

Given the climatic similarity between Union's northern Ontario (North Bay) territory and Enbridge's eastern territory (Ottawa) and the climatic similarity between Union's south/central territory (London) and Enbridge's central territory (Toronto), Navigant has assumed that gas savings would not substantially differ between Union's northern and Enbridge's eastern territories or between Union's south/central and Enbridge's central territories.

Under the assumption that full thermostat setback is 8 degrees Fahrenheit[2] this implies that for every hour in which the thermostat is fully set back, there is an 18.64% reduction in space-heating natural gas consumption.

It is likely that not all commercial customers will practice full set-back, and it is also likely that some percentage of commercial customers already practice manual set-back with a non-programmable thermostat. No robust data-set exists for Ontario that tracks this behaviour for commercial natural gas customers.

As a proxy, Navigant has used the results of a survey conducted as part of Navigant's evaluation of the Ontario Power Authority's (OPA) Hot and Cool Savings program, which asked participants about how they habitually set their thermostat both before and after obtaining a programmable thermostat. Residential customers that set back their thermostats an additional three or more degrees Celsius are assumed to be a proxy for the percentage of commercial customers that practiced full set-back as outlined by the Energy Star calculator (i.e., 8 degrees Fahrenheit). Residential customers that set back their thermostats an additional 1 – 3 degrees Celsius only are assumed to be a proxy for the percentage of commercial customers that practiced half of the full set-back as outlined by the Energy Star calculator (i.e., 4 degrees Fahrenheit).

Table 1 – Space-Heating Behaviour Change

Behaviour		Sub-Behaviour, With Programmable T-Stat	
Practiced Manual Set-Back	40%	No additional set-back	73%
		Additional full set-back	9%
		Additional partial set-back	19%
Did Not Practice Manual Set-Back	50%	No additional set-back	44%
		Additional full set-back	20%
		Additional partial set-back	35%
Data Not Available (Refused to Answer)	10%	N/A	N/A
		N/A	N/A
		N/A	N/A

Note that in some cases values may add to more or less than 100% due to rounding error

Navigant notes that the above distribution is very conservative. It is highly unlikely that those responding to

[1] Based on average temperatures in London, Ontario and North Bay, respectively. Estimated by Union Gas based on the 3% savings for the Energy Star calculator, adjusted by temperature norms in Union Gas territories. Drawn from Union Gas' March 13, 2009 response to Navigant's initial draft of *Measures and Assumptions For Demand Side Management* prepared for the Ontario Energy Board.

[2] Energy Star Calculator assumption. U.S. DOE, *Programmable Thermostat Tool*, http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=TH

the survey that practice manual thermostat set-back do so punctually every single evening of the year during the heating season. There are almost certainly incremental savings not captured in this sheet due to the automation of thermostat set-back amongst those that practice manual set-back. Lacking firm empirical data, however, these savings cannot accurately be estimated and are thus not included.

The Hot and Cool Savings findings in the table above (excluding those that did not answer the survey questions) imply:

Table 2 – Aggregated Behaviour and Savings

Implied Overall Behaviour (Excluding Those That Refused to Answer)	Distribution of Households	Natural Gas Savings
No additional set-back	57%	0%
Additional full set-back	15%	18.64%
Additional partial set-back	28%	9.32%

The average natural gas savings per business on any given hour when the temperature is set back may therefore be calculated as: 57% x 0% + 15% x 18.64% + 28% x 9.32% = 5.41%

This percentage saving may then be applied to

a. All hours in which it is expected that the thermostat could be set back for a given market segment
b. The space-heating energy intensity of that market segment
c. The area of a building in that market segment which may reasonably be supposed to be controlled by an individual programmable thermostat.

The setback duration (a., above) has been estimated by Navigant and is shown in Table 3, below.
The energy intensity of each market segment, except Small Fitness/Spa[3], (b., above) has been drawn from a Marbek report recently completed for Enbridge Gas[4] and is shown in Table 3, below. The energy intensities used in Table 3 below are a weighted average based on the distribution of Enbridge customers between the Central and Eastern zones (80% Central, 20% Eastern).

The thermostat control area (c., above) has been provided by Union Gas based on internal research done by Union Gas staff and provided to Navigant and is shown in

Table 4, below.

The segments identified by Marbek and those identified by Union Gas were mapped to each other as shown in

Table 4, below.

Not all segments identified by Marbek are included. Some segments (e.g., Large Offices) identified by Marbek generally have large-scale central controls for temperature settings and do not make use of individual thermostats, programmable or otherwise.

[3] This intensity was drawn from table C24 of the 2003 CBECS tables published the U.S. DOE and calibrated to Ontario's climate through a comparison with other CBECs intensities and those found in the Marbek report.

[4] Marbek Resource Consultants, *Natural Gas Energy Efficiency Potential: Update 2008 Commercial Sector*, May 2009

Table 3 – Annual Gas Savings per ft^2

Marbek Segment	Times in which thermostat set-back is possible	% of Time Set-Back Possible	% Savings	Energy Intensity (m^3/ft^2)	Gas Savings (m^3/ft^2)
Warehouse / Wholesale	12 hours/weekday & Sat, 24 hours Sunday	57%	3.1%	1.43	0.04
Small Office	12 hours/weekday, 24 hours weekends	64%	3.5%	1.72	0.06
Strip Mall	7 hours/night	29%	1.6%	1.18	0.02
Non-food retail (Mall)	7 hours/night	29%	1.6%	1.46	0.02
Food Retail	7 hours/night	29%	1.6%	2.30	0.04
Restaurant/Tavern	7 hours/night	29%	1.6%	3.74	0.06
Large Hotel	7 hours/night	29%	1.6%	1.43	0.02
Motel/Hotel	7 hours/night	29%	1.6%	1.32	0.02
School	12 hours/weekday, 24 hours weekends	64%	3.5%	1.91	0.07
University/College	12 hours/weekday, 24 hours weekends	64%	3.5%	1.71	0.06
Small Fitness/Spa	5 hours/night	21%	1.1%	1.24	0.01

Table 4 - Annual Gas Savings per Thermostat, by Segment

Union Gas Market Segment	Marbek Segment	Area of Thermostat Control Zone (ft^2)	Gas Savings (m^3/ft^2)	Annual Gas Savings (m^3/per thermostat)
Warehouse	Warehouse / Wholesale	3000	0.04	132
Office	Small Office	650	0.06	39
Retail	Strip Mall	600	0.02	11
Retail	Non-food retail (Mall)	600	0.02	14
Retail	Food Retail	600	0.04	22
Food Service	Restaurant/Tavern	1175	0.06	69
Hotels/Motels	Large Hotel	461	0.02	10
Hotels/Motels	Motel/Hotel	461	0.02	10
Educational Services	School	986	0.07	65
Educational Services	University/College	986	0.06	58
Recreation	Small Fitness/Spa	2500	0.01	35

The savings values above were consolidated into the following segments to match UG's market segmentation.

Union Gas Market Segments	m3	Avg m3
Warehouse	132	**108**
Industrial *	132	
Agriculture *	132	
Recreation	35	
Food Service	69	**69**
Office	39	**50**
Institute **	61.5	
Retail ***	15.7	**13**
Hotel	10	

* uses the same savings as warehouse
** average of Educational services - schools & university/college
***average of Retail - Strip mall, Non-food retail(mall) & Food retail

Annual Electricity Savings	15 – 77 kWh

The online Energy Star® spreadsheet calculator for programmable thermostats suggests that for every degree Fahrenheit in temperature increase there is a 6% reduction in space cooling electricity consumption.

Under the assumption that full thermostat setup is 4 degrees Fahrenheit (from 74^{o} to 78^{o}F), this implies that for every hour in which the thermostat is set back, there is an 24% reduction in space-cooling electricity consumption.

It is likely that not all commercial customers will practice full set-back, and it is also likely that some percentage of commercial customers already practice manual set-back with a non-programmable thermostat. No robust data-set exists for Ontario that tracks this behaviour for commercial natural gas customers.

As a proxy, Navigant has used the results of a survey conducted as part of Navigant's evaluation of the Ontario Power Authority's (OPA) Hot and Cool Savings program, which asked participants about how they habitually set their thermostat after receiving a programmable one. Unfortunately participants (unlike for heating) were not asked to what temperature they set their thermostat to prior to having the programmable thermostat. Residential customers that set up their thermostats an additional three or more degrees Celsius are assumed to be a proxy for the percentage of commercial customers that practiced full set-up as outlined by the Energy Star calculator (i.e., 4 degrees Fahrenheit). Residential customers that set up their thermostats an additional 1 – 3 degrees Celsius only are assumed to be a proxy for the percentage of commercial customers that practiced half of the full set-up as outlined by the Energy Star calculator (i.e., 2 degrees Fahrenheit).

Table 5 - Space Cooling Behaviour Change

Thermostat set-back	Distribution of Households	Electricity Savings
No additional thermostat set-back	64%	0%
3 or more additional degrees set-back	13%	24%
1 - 3 additional degrees set-back	22%	12%

The average electricity savings per business on any given hour when the temperature is set up may therefore be calculated as: 64% x 0% + 13% x 24% + 22% x 12% = 5.87%

This percentage saving may then be applied to

a. All hours in which it is expected that the thermostat could be set up for a given market segment
b. The space-cooling energy intensity of that market segment
c. The area of a building in that market segment which may reasonably be supposed to be controlled by an individual programmable thermostat.
d. The market saturation (incidence of A/C) of central air-conditioning for a given market segment[5].

The setback duration (a., above) has been estimated by Navigant and is shown in

Table 6, below.

The energy intensity of each market segment, except Small Fitness/Spa[6], segment (b., above) has been drawn from a Marbek report recently completed for Enbridge Gas[7] and is shown in

Table 6, below. The energy intensities used in

Table 6below are a weighted average based on the distribution of Enbridge customers between the Central and Eastern zones (80% Central, 20% Eastern).

The thermostat control area (c., above) has been provided by Union Gas based on internal research done by Union Gas staff and provided to Navigant and is shown in

Table 7, below.

The segments identified by Marbek and those identified by Union Gas were mapped to each other as shown in

[5] While there will of course be no electricity savings when this device is installed in a building without central air-conditioning, it is assumed that these devices will be installed in a representative sample of the population for that segment, thus making the average electricity savings per thermostat a function of the percent of the population in question that has central air-conditioning.

[6] Since the Marbek report does not include a space cooling energy intensity or A/C saturation for this segment, Navigant has assumed that both of these will be approximately the average of the space cooling intensity and A/C saturation of the Non-food Retail and Restaurant/Tavern segments.

[7] Marbek Resource Consultants, *Natural Gas Energy Efficiency Potential: Update 2008 Commercial Sector*, May 2009.

Table 7, below.

The market saturation of central air-conditioning of each market segment, except Small Fitness/Spa (d., above) has been drawn from a Marbek report recently completed for Enbridge Gas[8] and is shown in

Table 6, below. The saturations used are the weighted average of the Central and Eastern zone saturations, based on the distribution of Enbridge customers by zone (80% Central, 20% Eastern).

Not all segments identified by Marbek are included. Some segments (e.g., Large Offices) identified by Marbek generally have large-scale central controls for temperature settings and do not make use of individual thermostats, programmable or otherwise.

Table 6 – Annual Electricity Savings per ft^2

Marbek Segment	Times in which thermostat set-back is possible	% of Time Set-Back Possible	Space Cooling Market Saturation	% Savings	Energy Intensity (kWh/ft^2)	Electricity Savings (kWh/ft^2)
Warehouse / Wholesale	12 hours/weekday & Sat, 24 hours Sunday	57%	10%	0.3%	0.90	0.003
Small Office	12 hours/weekday, 24 hours weekends	64%	86%	3.2%	2.06	0.07
Strip Mall	7 hours/night	29%	85%	1.5%	2.18	0.03
Non-food retail (Mall)	7 hours/night	29%	85%	1.5%	2.18	0.03
Food Retail	7 hours/night	29%	80%	1.4%	1.98	0.03
Restaurant/Tavern	7 hours/night	29%	85%	1.5%	4.50	0.07
Large Hotel	7 hours/night	29%	85%	1.5%	2.12	0.03
Motel/Hotel	7 hours/night	29%	85%	1.5%	1.68	0.02
School	12 hours/weekday, 24 hours weekends	64%	15%	0.6%	1.52	0.01
University/College	12 hours/weekday, 24 hours weekends	64%	75%	2.8%	2.04	0.06
Small Fitness/Spa	5 hours/night	21%	85%	1.0%	3.34	0.03

[8] Marbek Resource Consultants, *Natural Gas Energy Efficiency Potential: Update 2008 Commercial Sector*, May 2009.

Table 7 - Annual Electricity Savings per Thermostat, by Segment

Union Gas Market Segment	Marbek Segment	Area of Thermostat Control Zone (ft^2)	Electricity Savings (kWh/ft^2)	Annual Electricity Savings (kWh/ per thermostat)
Warehouse	Warehouse / Wholesale	3000	0.003	9
Office	Small Office	650	0.07	43
Retail	Strip Mall	600	0.03	19
Retail	Non-food retail (Mall)	600	0.03	19
Retail	Food Retail	600	0.03	16
Food Service	Restaurant/Tavern	1175	0.07	77
Hotels/Motels	Large Hotel	461	0.03	14
Hotels/Motels	Motel/Hotel	461	0.02	11
Educational Services	School	986	0.01	8
Educational Services	University/College	986	0.06	57
Recreation	Small Fitness/Spa	2500	0.03	87

The savings values above were consolidated into the following segments to match UG's market segmentation.

Union Gas Market Segments	kWh	Avg kWh
Warehouse	9	**29**
Industrial *	9	
Agriculture *	9	
Recreation	87	

Food Service	77	**77**
Office	43	**38**
Institute **	32.5	
Retail ***	18	**15**
Hotel	12.5	

* uses the same savings as warehouse
** average of Educational services - schools & university/college
***average of Retail - Strip mall, Non-food retail(mall) & Food retail

Annual Water Savings	0 L
N/A	

Other Input Assumptions

Effective Useful Life (EUL)	15 Years
Navigant has assumed the effective useful life of this measure to be fifteen years, in accordance with that given on the Energy Star® web-site.	
Incremental Costs	**$110**
Navigant has assumed that the average incremental cost of a commercial-grade programmable thermostat is $110 based on the on-line price for the Honeywell MULTIPRO Commercial Thermostat.	

Programmable Thermostat – Commercial, EGD

Revision #	Description/Comment	Date Revised
		September 29, 2010

Efficient Equipment and Technologies Description
Programmable thermostat assuming full set-back.

Base Equipment and Technologies Description
Standard non-programmable thermostat.

Decision Type	Target Market(s)	End Use
Existing	Commercial	Space heating

Codes, Standards, and Regulations

- To be an Energy Star®-qualified programmable thermostat, the device must have at least two different programming periods, four possible temperature settings and allow for temporary user-override.
- CSA C828-99- CAN/CSA Performance Requirements for Thermostats

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	10 - 132	8 – 87			
2	10 - 132	8 – 87			
3	10 - 132	8 – 87			
4	10 - 132	8 – 87			
5	10 - 132	8 – 87			
6	10 - 132	8 – 87			
7	10 - 132	8 – 87			
8	10 - 132	8 – 87			
9	10 - 132	8 – 87			
10	10 - 132	8 – 87			
11	10 - 132	8 – 87			
12	10 - 132	8 – 87			
13	10 - 132	8 – 87			
14	10 - 132	8 – 87			
15	10 - 132	8 – 87			
TOTALS	**144 – 1,984**	**127 – 1,301**	**0**	**$110**	

Resource Savings Assumptions

Annual Natural Gas Savings	10 – 132 m^3

The online Energy Star® spreadsheet calculator for programmable thermostats suggests that for every degree Fahrenheit in temperature reduction there is a 3% reduction in space-heating natural gas consumption.

Union Gas estimates that, corrected for the average outdoor heating season temperature, for every degree Fahrenheit in temperature reduction there is a 2.4% reduction in natural gas consumption in southern and central Ontario and a 2.05% reduction in natural gas consumption in northern Ontario[1]. The weighted average percentage savings, based on Enbridge's overall distribution of customers (80% Central, 20% Eastern) is 2.33%.

Given the climatic similarity between Union's northern Ontario (North Bay) territory and Enbridge's eastern territory (Ottawa) and the climatic similarity between Union's south/central territory (London) and Enbridge's central territory (Toronto), Navigant has assumed that gas savings would not substantially differ between Union's northern and Enbridge's eastern territories or between Union's south/central and Enbridge's central territories.

Under the assumption that full thermostat setback is 8 degrees Fahrenheit[2] this implies that for every hour in which the thermostat is fully set back, there is an 18.64% reduction in space-heating natural gas consumption.

It is likely that not all commercial customers will practice full set-back, and it is also likely that some percentage of commercial customers already practice manual set-back with a non-programmable thermostat. No robust data-set exists for Ontario that tracks this behaviour for commercial natural gas customers.

As a proxy, Navigant has used the results of a survey conducted as part of Navigant's evaluation of the Ontario Power Authority's (OPA) Hot and Cool Savings program, which asked participants about how they habitually set their thermostat both before and after obtaining a programmable thermostat. Residential customers that set back their thermostats an additional three or more degrees Celsius are assumed to be a proxy for the percentage of commercial customers that practiced full set-back as outlined by the Energy Star calculator (i.e., 8 degrees Fahrenheit). Residential customers that set back their thermostats an additional 1 – 3 degrees Celsius only are assumed to be a proxy for the percentage of commercial customers that practiced half of the full set-back as outlined by the Energy Star calculator (i.e., 4 degrees Fahrenheit).

Table 1 – Space-Heating Behaviour Change

Behaviour		Sub-Behaviour, With Programmable T-Stat	
Practiced Manual Set-Back	40%	No additional set-back	73%
		Additional full set-back	9%
		Additional partial set-back	19%
Did Not Practice Manual Set-Back	50%	No additional set-back	44%
		Additional full set-back	20%
		Additional partial set-back	35%
Data Not Available (Refused to Answer)	10%	N/A	N/A
		N/A	N/A
		N/A	N/A

Note that in some cases values may add to more or less than 100% due to rounding error

Navigant notes that the above distribution is very conservative. It is highly unlikely that those responding to

1 Based on average temperatures in London, Ontario and North Bay, respectively. Estimated by Union Gas based on the 3% savings for the Energy Star calculator, adjusted by temperature norms in Union Gas territories. Drawn from Union Gas' March 13, 2009 response to Navigant's initial draft of *Measures and Assumptions For Demand Side Management* prepared for the Ontario Energy Board.

2 Energy Star Calculator assumption. U.S. DOE, *Programmable Thermostat Tool*, http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=TH

the survey that practice manual thermostat set-back do so punctually every single evening of the year during the heating season. There are almost certainly incremental savings not captured in this sheet due to the automation of thermostat set-back amongst those that practice manual set-back. Lacking firm empirical data, however, these savings cannot accurately be estimated and are thus not included.

The Hot and Cool Savings findings in the table above (excluding those that did not answer the survey questions) imply:

Table 2 – Aggregated Behaviour and Savings

Implied Overall Behaviour (Excluding Those That Refused to Answer)	Distribution of Households	Natural Gas Savings
No additional set-back	57%	0%
Additional full set-back	15%	18.64%
Additional partial set-back	28%	9.32%

The average natural gas savings per business on any given hour when the temperature is set back may therefore be calculated as: 57% x 0% + 15% x 18.64% + 28% x 9.32% = 5.41%

This percentage saving may then be applied to

a. All hours in which it is expected that the thermostat could be set back for a given market segment
b. The space-heating energy intensity of that market segment
c. The area of a building in that market segment which may reasonably be supposed to be controlled by an individual programmable thermostat.

The setback duration (a., above) has been estimated by Navigant and is shown in Table 3, below. The energy intensity of each market segment, except Small Fitness/Spa[3], (b., above) has been drawn from a Marbek report recently completed for Enbridge Gas[4] and is shown in Table 3, below. The energy intensities used in Table 3 below are a weighted average based on the distribution of Enbridge customers between the Central and Eastern zones (80% Central, 20% Eastern).

The thermostat control area (c., above) has been provided by Union Gas based on internal research done by Union Gas staff and provided to Navigant and is shown in

Table 4, below.

The segments identified by Marbek and those identified by Union Gas were mapped to each other as shown in

Table 4, below.

Not all segments identified by Marbek are included. Some segments (e.g., Large Offices) identified by Marbek generally have large-scale central controls for temperature settings and do not make use of individual thermostats, programmable or otherwise.

[3] This intensity was drawn from table C24 of the 2003 CBECS tables published the U.S. DOE and calibrated to Ontario's climate through a comparison with other CBECs intensities and those found in the Marbek report.

[4] Marbek Resource Consultants, *Natural Gas Energy Efficiency Potential: Update 2008 Commercial Sector*, May 2009

Table 3 – Annual Gas Savings per ft²

Marbek Segment	Times in which thermostat set-back is possible	% of Time Set-Back Possible	% Savings	Energy Intensity (m^3/ft^2)	Gas Savings (m^3/ft^2)
Warehouse / Wholesale	12 hours/weekday & Sat, 24 hours Sunday	57%	3.1%	1.43	0.04
Small Office	12 hours/weekday, 24 hours weekends	64%	3.5%	1.72	0.06
Strip Mall	7 hours/night	29%	1.6%	1.18	0.02
Non-food retail (Mall)	7 hours/night	29%	1.6%	1.46	0.02
Food Retail	7 hours/night	29%	1.6%	2.30	0.04
Restaurant/Tavern	7 hours/night	29%	1.6%	3.74	0.06
Large Hotel	7 hours/night	29%	1.6%	1.43	0.02
Motel/Hotel	7 hours/night	29%	1.6%	1.32	0.02
School	12 hours/weekday, 24 hours weekends	64%	3.5%	1.91	0.07
University/College	12 hours/weekday, 24 hours weekends	64%	3.5%	1.71	0.06
Small Fitness/Spa	5 hours/night	21%	1.1%	1.24	0.01

Table 4 - Annual Gas Savings per Thermostat, by Segment

Union Gas Market Segment	Marbek Segment	Area of Thermostat Control Zone (ft^2)	Gas Savings (m^3/ft^2)	Annual Gas Savings (m^3/per thermostat)
Warehouse	Warehouse / Wholesale	3000	0.04	132
Office	Small Office	650	0.06	39
Retail	Strip Mall	600	0.02	11
Retail	Non-food retail (Mall)	600	0.02	14
Retail	Food Retail	600	0.04	22
Food Service	Restaurant/Tavern	1175	0.06	69
Hotels/Motels	Large Hotel	461	0.02	10
Hotels/Motels	Motel/Hotel	461	0.02	10
Educational Services	School	986	0.07	65
Educational Services	University/College	986	0.06	58
Recreation	Small Fitness/Spa	2500	0.01	35

Annual Electricity Savings	8 – 87 kWh

The online Energy Star® spreadsheet calculator for programmable thermostats suggests that for every degree Fahrenheit in temperature increase there is a 6% reduction in space cooling electricity consumption.

Under the assumption that full thermostat setup is 4 degrees Fahrenheit (from 74° to 78°F), this implies that for every hour in which the thermostat is set back, there is an 24% reduction in space-cooling electricity consumption.

It is likely that not all commercial customers will practice full set-back, and it is also likely that some percentage of commercial customers already practice manual set-back with a non-programmable thermostat. No robust data-set exists for Ontario that tracks this behaviour for commercial natural gas customers.

As a proxy, Navigant has used the results of a survey conducted as part of Navigant's evaluation of the Ontario Power Authority's (OPA) Hot and Cool Savings program, which asked participants about how they habitually set their thermostat after receiving a programmable one. Unfortunately participants (unlike for heating) were not asked to what temperature they set their thermostat to prior to having the programmable thermostat. Residential customers that set up their thermostats an additional three or more degrees Celsius are assumed to be a proxy for the percentage of commercial customers that practiced full set-up as outlined by the Energy Star calculator (i.e., 4 degrees Fahrenheit). Residential customers that set up their thermostats an additional 1 – 3 degrees Celsius only are assumed to be a proxy for the percentage of commercial customers that practiced half of the full set-up as outlined by the Energy Star calculator (i.e., 2 degrees Fahrenheit).

Table 5 - Space Cooling Behaviour Change

Thermostat set-back	Distribution of Households	Electricity Savings
No additional thermostat set-back	64%	0%
3 or more additional degrees set-back	13%	24%
1 - 3 additional degrees set-back	22%	12%

The average electricity savings per business on any given hour when the temperature is set up may therefore be calculated as: 64% x 0% + 13% x 24% + 22% x 12% = 5.87%

This percentage saving may then be applied to

a. All hours in which it is expected that the thermostat could be set up for a given market segment
b. The space-cooling energy intensity of that market segment
c. The area of a building in that market segment which may reasonably be supposed to be controlled by an individual programmable thermostat.
d. The market saturation (incidence of A/C) of central air-conditioning for a given market segment[5].

The setback duration (a., above) has been estimated by Navigant and is shown in

Table 6, below.

The energy intensity of each market segment, except Small Fitness/Spa[6], segment (b., above) has been drawn from a Marbek report recently completed for Enbridge Gas[7] and is shown in

Table 6, below. The energy intensities used in

Table 6below are a weighted average based on the distribution of Enbridge customers between the

[5] While there will of course be no electricity savings when this device is installed in a building without central air-conditioning, it is assumed that these devices will be installed in a representative sample of the population for that segment, thus making the average electricity savings per thermostat a function of the percent of the population in question that has central air-conditioning.

[6] Since the Marbek report does not include a space cooling energy intensity or A/C saturation for this segment, Navigant has assumed that both of these will be approximately the average of the space cooling intensity and A/C saturation of the Non-food Retail and Restaurant/Tavern segments.

[7] Marbek Resource Consultants, *Natural Gas Energy Efficiency Potential: Update 2008 Commercial Sector*, May 2009.

Central and Eastern zones (80% Central, 20% Eastern).

The thermostat control area (c., above) has been provided by Union Gas based on internal research done by Union Gas staff and provided to Navigant and is shown in

Table 7, below.

The segments identified by Marbek and those identified by Union Gas were mapped to each other as shown in

Table 7, below.

The market saturation of central air-conditioning of each market segment, except Small Fitness/Spa (d., above) has been drawn from a Marbek report recently completed for Enbridge Gas[8] and is shown in

Table 6, below. The saturations used are the weighted average of the Central and Eastern zone saturations, based on the distribution of Enbridge customers by zone (80% Central, 20% Eastern).

Not all segments identified by Marbek are included. Some segments (e.g., Large Offices) identified by Marbek generally have large-scale central controls for temperature settings and do not make use of individual thermostats, programmable or otherwise.

Table 6 – Annual Electricity Savings per ft^2

[8] Marbek Resource Consultants, *Natural Gas Energy Efficiency Potential: Update 2008 Commercial Sector*, May 2009.

Marbek Segment	Times in which thermostat set-back is possible	% of Time Set-Back Possible	Space Cooling Market Saturation	% Savings	Energy Intensity (kWh/ft^2)	Electricity Savings (kWh/ft^2)
Warehouse / Wholesale	12 hours/weekday & Sat, 24 hours Sunday	57%	10%	0.3%	0.90	0.003
Small Office	12 hours/weekday, 24 hours weekends	64%	86%	3.2%	2.06	0.07
Strip Mall	7 hours/night	29%	85%	1.5%	2.18	0.03
Non-food retail (Mall)	7 hours/night	29%	85%	1.5%	2.18	0.03
Food Retail	7 hours/night	29%	80%	1.4%	1.98	0.03
Restaurant/Tavern	7 hours/night	29%	85%	1.5%	4.50	0.07
Large Hotel	7 hours/night	29%	85%	1.5%	2.12	0.03
Motel/Hotel	7 hours/night	29%	85%	1.5%	1.68	0.02
School	12 hours/weekday, 24 hours weekends	64%	15%	0.6%	1.52	0.01
University/College	12 hours/weekday, 24 hours weekends	64%	75%	2.8%	2.04	0.06
Small Fitness/Spa	5 hours/night	21%	85%	1.0%	3.34	0.03

Table 7 - Annual Electricity Savings per Thermostat, by Segment

Union Gas Market Segment	Marbek Segment	Area of Thermostat Control Zone (ft^2)	Electricity Savings (kWh/ft^2)	Annual Electricity Savings (kWh/ per thermostat)
Warehouse	Warehouse / Wholesale	3000	0.003	9
Office	Small Office	650	0.07	43
Retail	Strip Mall	600	0.03	19
Retail	Non-food retail (Mall)	600	0.03	19
Retail	Food Retail	600	0.03	16
Food Service	Restaurant/Tavern	1175	0.07	77
Hotels/Motels	Large Hotel	461	0.03	14
Hotels/Motels	Motel/Hotel	461	0.02	11
Educational Services	School	986	0.01	8
Educational Services	University/College	986	0.06	57
Recreation	Small Fitness/Spa	2500	0.03	87

Annual Water Savings	0 L
N/A	

Other Input Assumptions

Effective Useful Life (EUL)	15 Years
Navigant has assumed the effective useful life of this measure to be fifteen years, in accordance with that given on the Energy Star® web-site.	
Incremental Costs	**$110**
Navigant has assumed that the average incremental cost of a commercial-grade programmable thermostat is $110 based on the on-line price for the Honeywell MULTIPRO Commercial Thermostat.	

Programmable Thermostat – Multi-Residential, EGD & UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
Programmable thermostat.
Base Equipment and Technologies Description
Standard thermostat.

Decision Type	Target Market(s)	End Use
Existing	Existing Multi-Residential	Space Heating

Codes, Standards, and Regulations

- For a programmable thermostat to receive Energy Star® qualification, it must meet specific criteria such as having at least two different programming periods (for weekday and weekend programming), at least four possible temperature settings and allow for temporary overriding by the user.
- In Canada, applicable CSA standards can be found in CSA C828-99- CAN/CSA Performance Requirements for Thermostats used with Individual Room Electric Space Heating Devices.

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	15	13	0	80	0
2	15	13	0	0	0
3	15	13	0	0	0
4	15	13	0	0	0
5	15	13	0	0	0
6	15	13	0	0	0
7	15	13	0	0	0
8	15	13	0	0	0
9	15	13	0	0	0
10	15	13	0	0	0
11	15	13	0	0	0
12	15	13	0	0	0
13	15	13	0	0	0
14	15	13	0	0	0
15	15	13	0	0	0
TOTALS	**225**	**195**	**0**	**80**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	15 m^3

- The savings calculated below for a household living in a multi-residential dwelling (i.e., an apartment) are predicated on the assumption that the occupants of the dwelling are responsible for paying for the natural gas they use and thus subject to the economic incentive to actually program the thermostat.
- Two utility studies[1] are used to determine savings resulting from residential programmable thermostats on natural gas consumptions.

  - In the ***GasNetworks*** study[2], 4,061 mail-in surveys and bills were analyzed. Results were normalized for temperature and the energy impacts were determined through a multivariate regression analysis. The study found that programmable thermostat saved 6 % of total household annual natural gas use. GasNetworks is proposing 75 ccf (212 m^3) natural gas savings based on a Non-Programmable Thermostat annual consumption of 1,253 ccf (3,548 m^3) natural gas.
  - In the ***Enbridge Billing Analysis***[3], 911 customers' natural gas consumption was analyzed in 2005. Enbridge determined an average savings of 159 m^3 for a house using 2,878 m^3 of natural gas.

- Canadian Centre for Housing Technology (CCHT) also conducted a study in 2005 on programmable thermostat natural gas savings[4]. The study was done in two identical research homes located in Ottawa to allow direct comparison of changes in operating conditions in a home. It reports a 6.5% predicted savings for 18°C night setback.
- Based on these three studies, Navigant is assuming an average saving at 6% for natural gas consumptions for full temperature set back in single-family homes.

Table 1 - Gas Savings From Previous Studies

Studies	Baseline Gas Consumption (m^3)	Gas Savings (m^3)	Gas Savings%
GasNetworks (2007)	3,548	212	6.0%
Enbridge (2005)	2,878	159	5.5%
CCHT (2005)	-	-	6.5%
NCI Average			6.0%

- Applying the 6% savings estimated above for single-family homes to multi-family homes would require that multi-family household space-heating natural gas use is the same proportion of total multi-family household natural gas use as single-family household space-heating natural gas use is of total single family household natural gas use. An examination of NRCan data[5] implies that this is not, in fact, the case.

[1] "Resource Savings Values in Selected Residential DSM Prescriptive Programs", Summit Blue Consulting, June 2008.
[2] RLW Analytics, Validating the impact of programmable thermostats: final report. Prepared for GasNetworks by RLW Analytics. Middletown, CT, January 2007.
[3] "Resource Savings Values in Selected Residential DSM Prescriptive Programs", Summit Blue Consulting, June 2008.
[4] The Effects of Thermostat Setting on Seasonal Energy Consumption at the CCHT Research Facility, Manning, Swinton, Szadkowski, Gusdorf, Ruest, February 14, 2005, http://irc.nrc-cnrc.gc.ca/pubs/rr/rr191/rr191.pdf
[5] Comprehensive Energy Use Database Tables, Residential Sector – Ontario, http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/trends_res_on.cfm?attr=0

Table 2 - Estimate of Proportion of NG Use for Space-Heating

Structural Type of Dwelling	Total Natural Gas Use (PJ)	Total Space-Heating Energy Use (PJ)	% of Space-Heating Energy Use That is NG*	Implied Space-Heating Natural Gas Use (PJ)	% of NG Use That is Space-Heating
Apartment	56	42	72%	30	53%
Single-Family Detached	252	272		196	78%

** Estimates are available only for all of Ontario and are not split by dwelling type.*

- The above table implies that a 6% reduction in total natural gas use in single-family homes is equivalent to a (6%/78%) = 7.74% reduction in space-heating natural gas use.
- Applying these savings to the multi-family sector (i.e., apartments), implies that for full set-back multi-family homes save (7.74%*53%) = 4.13% of total annual natural gas use.

Taking into account behavioural changes:

- Based on a recent Statistics Canada report[6], approximately 41% of Ontario households with non-programmable or non-programmed thermostats manually set back their thermostat at night (19% lowered by 3 or more degrees, 21% lowered by 1 or 2 degrees) in the winter season, whereas 59% did not lower their thermostat before going to sleep.
- Similar values were found based on an evaluation Ontario Power Authority's 2007 Hot and Cool Savings Program conservation program, a summary of which are presented in the table below.

Table 3 - Distribution of Behaviour 1

Behaviour		Sub-Behaviour, With Programmable T-Stat	
Practiced Manual Set-Back	40%	No additional set-back	73%
		3 or more degrees additional set-back	9%
		1 - 3 more degrees additional set-back	19%
Did Not Practice Manual Set-Back	50%	No additional set-back	44%
		3 or more degrees additional set-back	20%
		1 - 3 more degrees additional set-back	35%
Data Not Available (Refused to Answer)	10%	N/A	N/A
		N/A	N/A
		N/A	N/A

Note that in some cases values may add to more or less than 100% due to rounding error

- Navigant notes that the above distribution is very conservative. It is highly unlikely that those responding to the survey (either Navigant's or StatCan's) that practice manual thermostat set-back do so punctually every single evening of the year during the heating season. There are almost certainly incremental savings not captured in this sheet due to the automation of thermostat set-back amongst those that practice manual set-back. Lacking firm empirical data, however, these savings cannot accurately be estimated and are thus not included.
- The Hot and Cool Savings findings in the table above (excluding those that did not answer the survey questions) imply[7]:

[6] Statistics Canada, Household and Environment Survey, 2006

[7] For example: (40% Practiced Manual Set-Back*73% No Additional Set-Back + 50% Did Not Practice Manual Set-Back * 44% No Additional Set-Back)/(40% Practiced Manual Set-Back+50% Did Not Practice Manual Set-Back) = 57%

Table 4 - Distribution of Behaviour 2

Implied Overall Behaviour (Excluding Those That Refused to Answer)	Distribution of Households	Natural Gas Savings
No additional set-back	57%	0%
3 or more degrees additional set-back	15%	4.13%
1 - 3 more degrees additional set-back	28%	2.07%

- Average Ontario annual natural gas consumption by structural dwelling type may be estimated from NRCan data[8]:

Table 5 - Provincial Average NG Consumption

Structural Type of Dwelling	Total Housing Stock (thousands)	Total Natural Gas Use (PJ)	Natural Gas Use Per Household (m^3)*
Apartment	1400	56	1,046
Single-Family Detached	2774	252	2,379

** 1 GJ = 26.137 m^3 of NG*

- The average furnace natural gas consumption of a single family home in Enbridge's service territory is 2,291 m^3 and that of a water heater[9] is 550 m^3 for a total of 2,841 of m^3. This is somewhat higher than the average number reported by NRCan due to the fact that the NRCan number is an Ontario average and thus will include homes that use electricity for space and water heat. Scaling up the NRCan average annual natural gas consumption of apartments by the Enbridge single-family home/NRCan single-family home ratio (2,841/2,379 = 119%) implies that the average natural gas consumption for apartments in Enbridge's service territory is 1,249 m^3.
- Using the annual consumption derived above and the distribution derived in Table 4, above, Navigant estimates the following natural gas savings from the installation of programmable thermostats are:

  1,249 m^3 x [15%x4.13% + 28% x 2.07%)] = 15 m^3
- This represents an overall savings of 1.2% of total annual natural gas use (15 m^3 / 1,249 m^3 = 1.2%)

Annual Electricity Savings	13 kWh

Heating Season Savings (Furnace fan)

- The following is based on the CCHT study analysing furnace fan consumption in relation to set back temperatures from programmable thermostats[10], adjusted by the ratio of apartment space-heating natural gas use to single-family space-heating natural gas use (30%).

Temperature Set Back	Total Winter Furnace Electricity Consumption (kWh)	Seasonal Savings (%)
None (22C)	700	0%
18 C night time set back	694	0.8%
18 C daytime and night time set back	687	1.9%

8 Comprehensive Energy Use Database Tables, Residential Sector – Ontario, http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/trends_res_on.cfm?attr=0

9 The average gas water heater consumption in Enbridge's service territory is 625 m^3 per year. According to EGD Load Research, 88% of EGD customers have a natural gas water heater, therefore the average annual consumption of gas for heating water in an EGD customer's home is 88%*625 m^3 = 550 m^3

Annual savings for full set-back night-time setback during the heating season are therefore 6 kWh.

- Applying the same behaviour changes as presented above in Table 4,furnace fan savings during the heating season are estimated to be as follows:

  6 kWh x (15% + 28%) = 2.58 kWh

Cooling Season Savings

- A side-by-side housing study conducted by the CCHT[10]. determined seasonal energy savings for a residential unit from a programmable thermostat as follows (the values below have been adjusted by the ratio of apartment space-heating natural gas use to single-family space-heating natural gas use, as above):

Temp Set Back	Total Summer Furnace and CAC Electricity Consumption (kWh)	Seasonal Savings (%)
None (22C)	938	0%
24 C daytime set back	837	11%
25 C daytime set back	719	23%

- A BC Hydro study[11] reports savings between 10% and 15% for 4°C set back during night and unoccupied periods, Energy Star Calculator[12] reports 6% saving per degree (Fahrenheit) for *cooling season*.
- Full-load cooling hours were estimated for Enbridge's service territory based on the findings of the Energy Center of Wisconsin[13]. The full-load cooling hours for Eau Claire and La Crosse were reported to be 293 and 361, respectively. These correspond to the average annual cooling degree days (CDD) in each location of 556 and 840, respectively. The average annual CDD for Ottawa and Toronto between 2000 and September 2010 were 570 and 718, respectively[14]. Using the relative CDD of Ottawa/Eau Claire and Toronto/La Crosse to factor the full-load cooling hours, the implied full-load cooling hours for Ottawa are 293 x (570/556) = 300 and for Toronto are 361 x (718/840) = 309. The average (304) of both cities' full-load cooling hours may be used as a reasonable proxy for the full-load cooling hours of Enbridge's service territory.
- Assuming that baseline multi-residential dwelling is equipped with a SEER 11[15], 1 ton[16] A/C unit and is used 304 hours per year[17], this implies that

  Base A/C electricity use = 304 (cooling hours)*[12,000 (Btu/hr)/(11 (SEER)* 1,000)] = 332 kWh

Taking into Account Changes in Behaviour (Cooling Season)

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[10] The Effects of Thermostat Setting on Seasonal Energy Consumption at the CCHT Research Facility, Manning, Swinton, Szadkowski, Gusdorf, Ruest, February 14, 2005, http://irc.nrc-cnrc.gc.ca/pubs/rr/rr191/rr191.pdf

[11] Marbek Resource Consultants, TheSheltair Group Inc, BC Hydro BC Hydro Conservation Potential Review 2002, Residential Sector Support (Base Year: Fiscal 2000/01) (Revision 1) Submitted to: BC Hydro, June 2003

[12] US EPA (EPA Energy Star® Simple Savings Calculator – Programmable Thermostat), http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorProgrammableThermostat.xls

[13] Energy Center of Wisconsin, *Central Air Conditioning in Wisconsin: A Compilation of Recent Field Research*, May 2008

[14] Although typically in Canada CDD are calculated based on Celsius, for comparative purposes in this case CDD were calculated based on Fahrenheit, with 65° F used as the threshold temperature.

[15] NRCan's Comprehensive Energy Use Data-Base for Ontario (Residential, Table 27) indicates that the average stock SEER of an Ontario CAC unit is 10.7 for 2008 – no data exist for 2009 or 2010. Projecting historical SEER for stock out to 2010 using a linear trend estimated on the historical data beginning in 2001, Navigant estimates that current (2010) stock SEER is approximately 11 (11.05).

[16] Ontario Power Authority, 2009 OPA Measures and Assumptions Lists (Mass Market), November 2008, referenced from: Heating, Refrigeration and Air Conditioning Institute of Canada (HRAI), 2006 Cool Savings Rebate Program, Prepared for the Ontario Power Authority, April 2007, adjusted to reflect the fact that, on average multi-residential dwellings are 46% the size of single-family dwellings upon which the OPA Measures and Assumptions are based.

[17] Number of full-load cooling hours provided by http://energyexperts.org/ac%5Fcalc/ and based on the assumption that Ontario's climate is sufficiently similar to that of the north-eastern U.S.

- Based on the same program evaluation survey for the OPA[18], found that following the installation of a programmable thermostat, respondents:

Thermostat set-back	Distribution
No thermostat set-back	64%
3 or more degrees set-back	13%
1 - 3 more degrees set-back	22%

- The OPA Hot and Cool Savings survey did not ask about customer behaviour previous to the installation of the programmable thermostat and thus the percent of customers that practiced manual set-back in the summer cannot be estimated from these survey results.
- Statistics Canada's report, *Households and the Environment* does not report the percent of the population that manually adjusts the thermostat when they are away from home during the summer. Navigant Consulting has therefore assumed that the distribution of behaviour changes (shown above) is identical for both the population which practice manual temperature changes and that which did not. This implies :

Thermostat set-back	Distribution of Households	Electricity Savings
No additional thermostat set-back	64%	0%
3 or more additional degrees set-back	13%	23%
1 - 3 additional degrees set-back	22%	11%

- NCI estimates the following cooling season electricity savings for each programmable thermostat installed in households with central air conditioning:

  332 kWh x (64% x 0% + 13% x23% +22% x 11%) = 18 kWh

- However, assuming a penetration rate of central air conditioners in Ontario = 57%[19], NCI estimates that the average home in Ontario will save the following in electricity during the cooling savings:

  57% x 18 kWh = 10 kWh

- Total electricity savings for both heating (furnace fan) and cooling savings for an average Ontario home are estimated to be kWh (3 kWh + 10 kWh = 13 kWh).

Annual Water Savings	0 L
N/A	

Other Input Assumptions

Effective Useful Life (EUL)	15 Years
Navigant Consulting is estimating 15 years as the effective useful life based on the average lifetime of programmable thermostat from Energy Star ® website.	
Base & Incremental Conservation Measure Equipment and O&M Costs	**$80**
Enbridge, in consultation with trade allies has estimated the installation cost of this retrofit measure to be $40 (to be paid by Enbridge mail-in rebate) and estimated the equipment cost to be $40 following a review of retail outlets such as Home Depot by Enbridge Program Manager.	

[18] Navigant Consulting, Evaluation Report: 2007 Hot and Cool Savings Programs, prepared for the Ontario Power Authority (OPA), July 2008.
[19] Natural Resource Canada, Survey of Household Energy Use (SHEU), December 2005

Gas-fired Rooftop Unit, EGD & UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description
Two-stage rooftop units (5 ton per unit)
Base Equipment and Technologies Description
Single-stage rooftop units (5 ton per unit)

Decision Type	Target Market(s)	End Use
New/Replacement	Commercial buildings (New/Existing)	Space Heating

Codes, Standards, and Regulations

- Residential gas furnaces are prescribed as regulated products under Canada's Energy Efficiency Regulations[1]
- NRCan proposes to increase the minimum performance level, Annual Fuel Utilization Efficiency (AFUE), for gas-fired furnaces with an input rate not exceeding 65.92 kW (225 000 Btu/h) to 90%. The amendment is intended to introduce new MEPS and associated reporting and compliance requirements for Commercial and industrial gas unit heaters.
- DOE currently has no regulation on AFUE level for commercial gas-fired rooftop units[2].

Resource Savings Table

Year (EUL=)	Electricity and Other Resource Savings: Natural Gas (m^3)	Electricity (kWh)	Water (L)	Equipment & O&M Costs of Conservation Measure ($)	Equipment & O&M Costs of Base Measure ($)
1	255	0	0	375	0
2	255	0	0	0	0
3	255	0	0	0	0
4	255	0	0	0	0
5	255	0	0	0	0
6	255	0	0	0	0
7	255	0	0	0	0
8	255	0	0	0	0
9	255	0	0	0	0
10	255	0	0	0	0
11	255	0	0	0	0
12	255	0	0	0	0
13	255	0	0	0	0
14	255	0	0	0	0
15	255	0	0	0	0
TOTALS	**3,825**	**0**	**0**	**375**	**0**

[1] Canada's Energy Efficiency Regulations (OEE), http://oee.nrcan.gc.ca/regulations/bulletin/gas-furnace-jan2008.cfm?attr=0
[2] U.S. Department of Energy, http://www1.eere.energy.gov/buildings/appliance_standards/commercial/ac_hp.html

Resource Savings Assumptions

Annual Natural Gas Savings	255 m^3

- Baseline reference case is for a typical new 10,000 sq ft office building, occupant density of 200 sq ft per person. Ventilation is through the five 5 ton rooftop HVAC units using the unit fans[3].
- Energy efficiency option is five 5 ton units with 2 stage burners in the heating section.
- Baseline estimates of natural gas consumption = 25,500 m^3.
- Natural Gas Savings % = 1,275 m^3 / 25,500 m^3 = 5%
- OBC 2006 does not have more stringent efficiency requirements than OBC 1997 for the furnace section of rooftop units, so the energy savings from the Jacques Whitford study[4] were not modified.

Equipment Description	Incremental Cost Estimate	Efficiency	Gas Consumption (m^3/year)
Single stage units	$0	80%	25,500
2-stage heating (5)	$1,250	85%	24,225
Savings			**1,275**

- Therefore, one 5 ton unit with 2 stage burners is estimated to save 1,275 m^3 / 5 units = 255 m^3.

Annual Electricity Savings	0 kWh

N/A

Annual Water Savings	0 L

N/A

Other Input Assumptions

Effective Useful Life (EUL)	15 Years

Estimated equipment life is 15 years[5].

Base & Incremental Conservation Measure Equipment and O&M Costs	$ 375

The incremental cost of two-stage rooftop units compared single-stage units is $1,250 for five units, which equates to $250 per 5 ton unit[6]. Local Canadian manufacturer disclosed incremental cost of $500 for 2-stage rooftop units comparing with single stage rooftop units. Therefore, an average cost of $375 is assumed.

Customer Payback Period (Natural Gas Only)[7]	2.9 Years

Using an 5-year average commodity cost (avoided cost)[8] of $0.38 / m^3 and an average commercial distribution cost[9] of $0.12 / m^3, the payback period for natural gas savings is determined to be 2.9 years, based on the following:

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[3] "Prescriptive Incentives for Selected Natural Gas Technologies", Prepared for Enbridge Consumers Gas and Union Gas Ltd., Prepared by: Jacques Whitford Environment Limited, Agviro Inc., and Engineering Interface Ltd., September 27, 2000. A survey of manufacturers and distributors was conducted to solicit updated information as per Union Gas' Heating Product Database. Detailed lists were developed for each technology and integrated with the Heating Products Database.

[4] Ibid.

[5] ASHRAE Handbook, 2008

[6] "Prescriptive Incentives for Selected Natural Gas Technologies", Prepared for Enbridge Consumers Gas and Union Gas Ltd., Prepared by: Jacques Whitford Environment Limited, Agviro Inc., and Engineering Interface Ltd., September 27, 2000. A survey of manufacturers and distributors was conducted to solicit updated information as per Union Gas' Heating Product Database. Detailed lists were developed for each technology and integrated with the Heating Products Database.

[7] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.

[8] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.

[9] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).

Payback Period = Incremental cost / (natural gas savings x natural gas cost)
= $375 / (255 m^3/year * $0.5 / m^3)
= 2.9 years

Market Penetration[10]	Medium
Based on communication with local contractors and manufacturers, 2-stage rooftop units are popular and more efficient technology for space heating. Therefore, Navigant Consulting is estimating a medium market penetration in Ontario.	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Emerging Technologies & Practice, ACEEE[11]	770	15	1,000	N/A

Comments

28 MMBtu/year is approximately equal to 770 m^3 natural gas.

Equipment Description	Incremental Cost Estimate	Efficiency	Gas Consumption (MMBtu/year)
10 ton gas-fired rooftop unit	$0	0.80	178.5
10 ton gas-fired condensing rooftop unit	$1,000	0.95	150.3

[10] Navigant Consulting is defining “Low” as below 5%, “Medium” as between 5-50%, and “High” as above 50%,
[11] ACEEE, High Efficiency Gas-fired Rooftop Units, www.aceee.org/pubs/a042_h16.pdf

Commercial Water Heating

OZONE LAUNDRY

Commercial – New/Existing, UG & EGD

Efficient Technology & Equipment Description
Commercial Laundry Washing Equipment with Ozone In the commercial laundry industry, ozone is generated via corona discharge or ultraviolet light. It dissolves in cold to ambient temperature water (light and medium soil laundry) and activates the detergents, improving their activity and leading to a stronger cleaning action. However, since the solubility of ozone is low and its decomposition is faster at higher temperatures (38degC, (100degF)), the use of ozone is not recommended for heavy soils, which require warmer water. Generally, heavy soil laundry is treated with traditional laundry techniques.
Qualifier/Restriction
- No residential style clothes washers - Minimum required annual laundry load for each washer using ozone is: Washer Type — Minimum Laundry Load (Lbs/yr) Washer extractor – 60 lbs — 100,000 lbs/yr Washer extractor – 500 lbs — 260,000 lbs/yr Tunnel Washer – 120 lbs — 600,000 lbs/yr Tunnel Washer – 500 lbs — 1,900,000 lbs/yr
Base Technology & Equipment Description
Commercial Laundry Washing Equipment without Ozone

Resource Savings Assumptions

Natural Gas		**See below**
Washer Type	Gas Savings per Pounds washed per year (Lbs/yr)	
Washer extractor – 60 lbs	**0.0328**	**m3/(lbs/yr)**
Washer extractor – 500 lbs	**0.0328**	**m3/(lbs/yr)**
Tunnel Washer – 120 lbs	**0.0240**	**m3/(lbs/yr)**
Tunnel Washer – 500 lbs	**0.0240**	**m3/(lbs/yr)**
Operating conditions used to calculate the energy consumptions per pound of laundry evaluated using input data from the “Ozone Company” and from a linen service: “La Buanderie Centrale de Montréal”. These operating conditions are typical of what may be found in high production industrial laundries[1]. Assumptions: supply water temperature of 9 degC and natural gas water heater efficiency of 78%. Note that 120 lbs is a typical tunnel washer capacity. Larger tunnel washers (up to 500 lbs) do exist but are less frequent. The savings was normalized by dividing the estimated savings by the annual laundry load (lbs/yr) of laundry found in the report.		
Electricity		**See below**

[1] Riesenberg, James, “PBMP- Commercial Laundry Facilities”, Koeller and Company, November 4th, 2005

Electrical savings were based on the same conditions as described above.

Washer Type	Electricity savings per Pounds washed per year (Lbs/yr)	
Washer extractor – 60 lbs	**0.00219**	**kWh/(lbs/yr)**
Washer extractor – 500 lbs	**0.00219**	**kWh/(lbs/yr)**
Tunnel Washer – 120 lbs	**0.00152**	**kWh/(lbs/yr)**
Tunnel Washer – 500 lbs	**0.00152**	**kWh/(lbs/yr)**

Water — **See below**

Electrical savings were based on the same conditions as described above.

Washer Type	Water savings	
Washer extractor – 60 lbs	**2.01**	**L/(lbs/yr)**
Washer extractor – 500 lbs	**2.01**	**L/(lbs/yr)**
Tunnel Washer – 120 lbs	**1.22**	**L/(lbs/yr)**
Tunnel Washer – 500 lbs	**1.22**	**L/(lbs/yr)**

Other Input Assumptions

Equipment Life — **15 yrs**

Savings attributed to the measures are expected to last the life expectancy of the equipment. This data was obtained from suppliers.[2]

Incremental Cost — **See below**

Washer Type	Incremental Costs
Washer extractor – 60 lbs	**$10,970**
Washer extractor – 500 lbs	**$30,270**
Tunnel Washer – 120 lbs	**$49,667**
Tunnel Washer – 500 lbs	**$160,065**

Capital and installation costs were obtained in US dollars from The Ozone Company and converted to Canadian dollars.[3],[4]

Free Ridership — **8 %**

Free Ridership was estimated using market penetration in UG territory, according to the results of a survey conducted by TNS Canadian Facts. Further penetration of ozone systems for laundry is presently limited by the type of washing machines used (ozone cannot be used with residential type commercial machines)[5].

[2] NGTC, DSM OZONE LAUNDRY TREATMENT Final Report_v02 (#134809) November 25, 2009, Pgs iv-vi
[3] NGTC, DSM OZONE LAUNDRY TREATMENT Final Report_v02 (#134809) November 25, 2009, Pg 6
[4] NGTC, DSM OZONE LAUNDRY TREATMENT Final Report_v02 (#134809) November 25, 2009, Pgs iv-vi
[5] NGTC, DSM OZONE LAUNDRY TREATMENT Final Report_v02 (#134809) November 25, 2009, Pgs 19

CONDENSING BOILERS UNDER 300 MBTUH, DOMESTIC HOT WATER (DHW)

Commercial – New/Existing, UG & EGD

Please see the Condensing Boiler under 300 MBTUH substantiation documents in the Commercial Space Heating section.

Condensing Gas Water Heater - Commercial, UG & EGD

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description

Condensing Gas Water Heater[1] (95% thermal efficiency), 50 gallons.

Due to the variability in energy savings for commercial buildings resulting from the quantity of daily water use, resource savings were calculated for three scenarios of daily hot water use[2]:

Scenario **A**: 100 gallons (378 litres)
Scenario **B**: 500 gallons (1,893 litres)
Scenario **C**: 1,000 gallons (3,786 litres)

Base Equipment and Technologies Description

Conventional storage tank gas water heater[3] (thermal efficiency[4]=80%), 91 gallons.

Decision Type	Target Market(s)	End Use
New/Retrofit	Commercial (New/Existing)	Water heating

Codes, Standards, and Regulations

Ontario's Energy Efficiency Act[5] applies only to water heaters with an input rating of less than 75,000 Btu/hr.

[1] Locally available commercial condensing gas water heater, trade name: Polaris, model #: PC 199-50 http://www.johnwoodwaterheaters.com/pdfs/GSW_PolarisSpecSheet.pdf

[2] One of the input assumptions required for calculating resource savings for this measure is the stand-by heat loss of storage tank water heaters. Hourly stand-by losses are treated as constant using values drawn from GAMA's *Consumer Directory* (see citation below). This means that marginal percentage gas savings will fall as hot water use rises.

[3] Locally available commercial conventional (non-condensing) gas water heater with the same input rating as the Polaris. Manufacturer: Rheem, model #: G91-200.

[4] Although the required minimum thermal efficiency to be in compliance with ASHRAE 90.1 is 78%, http://www.energycodes.gov/comcheck/pdfs/404text.pdf, only an very small percentage of commercial gas water heaters listed in the GAMA *Consumer's Directory of Certified Efficiency Ratings* had a thermal efficiency of less than 80%. http://www.neo.ne.gov/neq_online/july2006/commgaswtrhtr.pdf

[5] http://www.energy.gov.on.ca/english/pdf/conservation/2006%20-%20EEA%20Guide%20C%20-%20Water%20Heaters.pdf

Resource Savings Table

Year (EUL=)	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	**A**: 332 **B**: 873 **C**: 1,551	0	0	5,880	3,650
2	**A**: 332 **B**: 873 **C**: 1,551	0	0	0	0
3	**A**: 332 **B**: 873 **C**: 1,551	0	0	0	0
4	**A**: 332 **B**: 873 **C**: 1,551	0	0	0	0
5	**A**: 332 **B**: 873 **C**: 1,551	0	0	0	0
6	**A**: 332 **B**: 873 **C**: 1,551	0	0	0	0
7	**A**: 332 **B**: 873 **C**: 1,551	0	0	0	0
8	**A**: 332 **B**: 873 **C**: 1,551	0	0	0	0
9	**A**: 332 **B**: 873 **C**: 1,551	0	0	0	0
10	**A**: 332 **B**: 873 **C**: 1,551	0	0	0	0
11	**A**: 332 **B**: 873 **C**: 1,551	0	0	0	0
12	**A**: 332 **B**: 873 **C**: 1,551	0	0	0	0
13	**A**: 332 **B**: 873 **C**: 1,551	0	0	0	0
TOTALS	**A**: 4,316 **B**: 11,349 **C**: 20,163	**0**	**0**	**5,880**	**3,650**

Resource Savings Assumptions

Annual Natural Gas Savings	**A: 332 m^3** **B: 873 m^3** **C: 1,551 m^3**

Assumptions and inputs:

- Daily hot water draw:
  - Scenario A: 100 gallons (378 litres)
  - Scenario B: 500 gallons (1,893 litres)
  - Scenario C: 1,000 gallons (3,786 litres)
- Input rating for efficient and base equipment: 199,000 Btu.

- Average water inlet temperature: 9.33 °C (48.8 °F)[6]
- Average water heater set point temperature: 54 °C (130 °F)[7]
- Stand-by loss of (condensing) Polaris PC 199-50 3NV: 244 Btu/hr[8].
- Stand-by loss of (non-condensing) Rheem G91-200: 1,050 Btu/hr[9].

Annual gas savings calculated as follows:

$$Savings = \left[W * 8.33 * (T_{out} - T_{in}) * \left(\frac{1}{Eff_{base}} - \frac{1}{Eff_{eff}} \right) + \left(Stby_{base} - Stby_{eff} \right) * 24 * 365 \right] * 10^{-6} * 27.8$$

Where:

W = Annual hot water use (gallons)
8.33 = Energy content of water (Btu/gallon/°F)
T_{out} = Water heater set point temperature (°F)
T_{in} = Water inlet temperature (°F)
Eff_{base} = Thermal efficiency of base equipment
Eff_{eff} = Thermal efficiency of efficient equipment
10^{-6} = Factor to convert Btu to MMBtu
$Stby_{base}$ = Stand-by loss per hour for base equipment (Btu)
$Stby_{eff}$ = Stand-by loss per hour for efficient equipment (Btu)
24 = Hours per day
365 = Days per year
27.8 = Factor to convert MMBtu to m^3

Scenario A: Gas savings were determined to be 29% over base measure
Scenario B: Gas savings were determined to be 19% over base measure
Scenario C: Gas savings were determined to be 17% over base measure

$$PercentSavings = \frac{\left(G_{base} - G_{eff} \right)}{G_{base}}$$

G_{eff} = Annual natural gas use with efficient equipment,
Scenario **A:** 782 m^3
Scenario **B:** 3,672 m^3
Scenario **C:** 7,284 m^3
G_{base} = Annual natural gas use with base equipment,
Scenario **A:** 1,114 m^3
Scenario **B:** 4,545 m^3
Scenario **C:** 8,835 m^3

Annual Electricity Savings	0 kWh
N/A	

[6] Chinnery, Glen. *Policy Recommendations for the HERS Community to Consider regarding HERS point credit for Waste Water Heat Recovery Devices,*EPA, Energy Star for homes, March 2004 http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/Waste_Water_Heat_Recovery_Guidelines.pdf
[7] As suggested by NRCan: http://oee.nrcan.gc.ca/residential/personal/new-homes/water-conservation.cfm?attr=4
[8] *Consumer's Directory of Certified Efficiency Ratings* http://www.neo.ne.gov/neq_online/july2006/commgaswtrhtr.pdf In this case stand-by losses are constant. Recalculating gas savings using the WHAM algorithm, in which stand-by losses are a function of water draw, results in less than 3% variation over the figures presented above. Lutz, J.D., C.D. Whitehead, A.B. Lekov, G.J. Rosenquist., and D.W. Winiarski. 1999. *WHAM: Simplified tool for calculating water heater energy use*. ASHRAE Transactions 105 (1): 1005-1015.
[9] *Consumer's Directory of Certified Efficiency Ratings*http://www.neo.ne.gov/neq_online/july2006/commgaswtrhtr.pdf.

Annual Water Savings	0 L
Navigant has assumed that adopting the measure would not affect the quantity of water consumed.	

Other Input Assumptions

Effective Useful Life (EUL)	13 Years
Studies conducted in two different jurisdictions (Iowa[10] and Washington State[11]) use an EUL of 13 years, whereas one conducted for Enbridge and Union in 2000[12] uses an EUL of 15 years. Given that the two most recent studies both use 13 years, Navigant Consulting also recommends adopting 13 years.	
Base & Incremental Conservation Measure Equipment and O&M Costs	**2,230 $**
Incremental cost determined from communication with local distributor[13]	
Customer Payback Period (Natural Gas Only)[14]	**A: 13 Years B: 5 Years C: 2.8 Years**
Using a 5-year average commodity cost (avoided cost)[15] of \$0.38 / m^3 and an average commercial distribution cost[16] of \$0.12 / m^3, the payback period for natural gas savings is determined to be 13 years for Scenario A, 5 years for Scenario B and 2.8 years for Scenario C, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) Scenario A = \$2,230/ (332 m^3/year * \$0.5 / m^3) = 13 years Scenario B = \$2,230/ (873 m^3/year * \$0.5 / m^3) = 5 years Scenario C = \$2,230/ (1,614 m^3/year * \$0.5 / m^3) = 2.8 years	
Market Penetration[17]	**Low**
Based on the observation of low penetration in another jurisdiction (Washington State[18] – 5%), the paucity of distributors in Ontario and of the relatively high incremental cost, Navigant Consulting estimates the penetration in Ontario to be low.	

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[10] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2

[11] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy

[12] Jacques Whitford Environment Ltd, *Prescriptive Incentives for Select Natural Gas Technologies*, Sept 2000

[13] Rheem G91-200: \$3,650
Polaris PC 199-50: \$5,880

[14] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.

[15] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.

[16] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).

[17] Navigant Consulting is defining “Low” as below 5%, “Medium” as between 5-50%, and “High” as above 50%,

[18] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Pacific Gas & Electric, April 2007[19]	2,107	N/A	N/A	N/A
Comments Average daily hot water use 2,083 gallons per day, thermal efficiency of new technology (60 gallon tank), 95%, thermal efficiency of base measure (standard efficiency tankless water heater), 82%. Measure provides savings of 28% over 7,496 m^3 required for heating water used with base equipment.				

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Puget Sound Energy, 2007[20]	0.78 per ft^2.	13	N/A	5%
Comments Savings calculated for an existing restaurant. Measure saves 34% of 2.28 m^3 per square foot required for water heating.				

[19] Karras, A. and D. Fisher, *Energy Efficiency Potential of Gas-Fired Water Heating Systems in a Quick Service Restaurant.* Pacific Gas & Electric, April 2007
http://www.fishnick.com/publications/appliancereports/special/Commercial_Water_Heating_Systems.pdf

[20] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy

Drain Water Heat Recovery (DWHR) Units – Laundromat

New Construction, UG & EGD

Description/Comment
Laundry - with storage tank and pumping equipment. Savings and Costs are Shown per Laundromat.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. A storage tank and pumping equipment is needed for batch-style (i.e., front load or top load) Laundry equipment to ensure cold water flows into the DWHR system and warm drain water flows out concurrently.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
New Construction.	Laundromats. Laundry Equipment.	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (KWh)	Water (L)	($)	($)
1	49,735	0	0	$31,820.00	$0.00
2	49,735	0	0	$545.45	$0.00
3	49,735	0	0	$495.87	$0.00
4	49,735	0	0	$450.79	$0.00
5	49,735	0	0	$409.81	$0.00
6	49,735	0	0	$372.55	$0.00
7	49,735	0	0	$338.68	$0.00
8	49,735	0	0	$307.89	$0.00
9	49,735	0	0	$279.90	$0.00
10	49,735	0	0	$254.46	$0.00
11	49,735	0	0	$231.33	$0.00
12	49,735	0	0	$210.30	$0.00
13	49,735	0	0	$191.18	$0.00
14	49,735	0	0	$173.80	$0.00

15	49,735	0	0	$158.00	$0.00
16	49,735	0	0	$143.64	$0.00
17	49,735	0	0	$130.58	$0.00
18	49,735	0	0	$118.71	$0.00
19	49,735	0	0	$107.92	$0.00
20	49,735	0	0	$98.10	$0.00
21	49,735	0	0	$89.19	$0.00
22	49,735	0	0	$81.08	$0.00
23	49,735	0	0	$73.71	$0.00
24	49,735	0	0	$67.01	$0.00
25	49,735	0	0	$60.92	$0.00
Total	**1,243,364**	**0**	**0**	**$37,211**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**49,735**	m^3

One manifolded DWHR assembly (made of (4) units or pipes) is connected, with storage and pumping equipment to the laundry equipment.

The following are the characteristics used to estimate the drain water from the laundry equipment:
Laundry Rate: 0.37 Loads/person/day [1]
Water Usage Rate: 60 L/load[2]
Consumer base for Laundromat: 1303 [3][4][5] Based on the number of Laundromats in the service area and the number of persons who use Laundromats.

$$Yearly\ Concurrent\ Drainwater\ Flow = 0.37\ (Loads/person/day) \times 60\ (L/load) \times 1303\ (persons) \times 365\ (days) = 10{,}536{,}258\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for laundry equipment: 70°C [6]
Domestic Cold Water Temperature: 9.33 °C [7]
DWHR unit effectiveness for noted piping configuration: 60% [8]
Storage losses derating factor: 90% [9]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3) = \frac{10{,}536{,}258\ \left(\frac{L}{year}\right) \times\ 4.184\ \left(\frac{KJ}{Kg\ °C}\right) \times\ [70\ (°C) - 9.33\ (°C)] \times\ 60\ (\%) \times\ 90\ (\%)}{78\ (\%) \times\ 37230\ \left(\frac{KJ}{m^3}\right)}$$

$$= 49{,}735\ (m^3/year)$$

Annual Electricity Savings	**0**	KWh

N/A

Annual Water Savings	**0**	L

N/A

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [8]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**37,211**	$
DWHR assembly cost: $12,920.[10] One assembly made up of (4) units (pipes) is required in this case.. Accessories cost: $13,500. Includes costs for pumps, storage tank, controls and other necessary equipment for non-concurrent flow applications. Installation: $4,800. This is calculated based on the materials, equipment and labour needed to install a unit, as estimated from RS Means. Maintenance: $600. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to. However, the storage tank and pump will require yearly maintenance and the pump requires some energy to operate.[11] A discount rate of 10%, consistent with the TRC calculation, is applied to the yearly O&M cost, to calculate the NPV ($5991). $37,211 = $12,920 + $13,500 + $4,800 + $5991		
Number of DWHR Units for Reported Savings	**4**	Units
One manifolded DWHR assembly is required to handle the high flow rates for the laundry equipment. There are 4 DWHR units per assembly. The savings and payback are based on this configuration, which is representative of an average laundromat.		
Customer Payback Period (Natural Gas Only)	**2.2**	Years
Simple payback period, based on a natural gas price of $0.30/m^3.		

$$Simple\ Payback\ Period = \frac{Incremental\ Cost}{Natural\ Gas\ Savings \times Natural\ Gas\ Cost - Yearly\ Cost}$$

$$= \frac{31{,}220(\$)}{49{,}735(m^3) \times 0.3\ (\$/m^3) - 600\ (\$)} = 2.2\ (years)$$

References

[1] Gleick, P.H., et al. Waste Not, Want Not: The Potential for Urban Water Conservation in California. Pacific Institute: Oakland, California, 2003.

[2] Speed Queen, Front Load Washer Horizon Line Product Brochure, 2010. Available at www.speedqueen.com

[3] Buertime, Industry Overview- Coin Operated Laundry, 2010. Available at http://buyertime.com/Laundry.html

[4] Coin Laundry Association, Industry Overview, 2006. Available at http://coinlaundry.org/resources/industryoverview.cfm

[5] Statistics Canada, Study: Changes and Challenges for Canada's Residential Real Estate Landlords, The Daily, May 25 2007. Available at http://www.statcan.gc.ca/daily-quotidien/070525/dq070525b-eng.htm

[6] ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating

[7] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[8] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[9] Value is from common industry practice, communication with Enermodal Engineering, November 2010.

[10] RenewABILITY Energy Inc.

[11] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – Arena, Showering

New Construction, UG & EGD

Description/Comment
Showering. Savings and Costs are shown per Showerhead.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
New Construction.	Recreation Facility/ Arena. Showering.	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3 /showerhead)	Electricity (KWh /showerhead)	Water (L /showerhead)	($/showerhead)	($/showerhead)
1	394	0	0	$776	$0.00
2	394	0	0	$0.00	$0.00
3	394	0	0	$0.00	$0.00
4	394	0	0	$0.00	$0.00
5	394	0	0	$0.00	$0.00
6	394	0	0	$0.00	$0.00
7	394	0	0	$0.00	$0.00
8	394	0	0	$0.00	$0.00
9	394	0	0	$0.00	$0.00
10	394	0	0	$0.00	$0.00
11	394	0	0	$0.00	$0.00
12	394	0	0	$0.00	$0.00
13	394	0	0	$0.00	$0.00
14	394	0	0	$0.00	$0.00

15	394	0	0	$0.00	$0.00
16	394	0	0	$0.00	$0.00
17	394	0	0	$0.00	$0.00
18	394	0	0	$0.00	$0.00
19	394	0	0	$0.00	$0.00
20	394	0	0	$0.00	$0.00
21	394	0	0	$0.00	$0.00
22	394	0	0	$0.00	$0.00
23	394	0	0	$0.00	$0.00
24	394	0	0	$0.00	$0.00
25	394	0	0	$0.00	$0.00
Total	**9,855**	**0**	**0**	**$776**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**394**	m^3/showerhead

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of showerheads, resulting in savings per showerhead. This will allow for different system sizes. See below for details.

One DWHR assembly (with 2 pipes) is connected to the showers in the change rooms of the facility.

The following are the characteristics used to estimate the drain water from showers :
Showerhead flow rate: 4.7 L/min (1.25 GPM) [1]
Shower Usage Rate: 10% [2] Amount of time shower is in use.
Facility Hours of Operation: 16 hours per day [3]
Showers per Facility: 12 showers/facility [4]

$$Yearly\ Concurrent\ Drainwater\ Flow$$

$$= 4.7\ (L/min) \times 16\ (hours/day) \times 60\ (min/hour) \times 365\ (days/year) \times 10\% \times 12\ (showers/facility)$$

$$= 1{,}976{,}256\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for showers: 37°C [5]
Domestic Cold Water Temperature: 9.33 °C [6]
DWHR unit effectiveness for noted piping configuration: 60% [7]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3) = \frac{1{,}976{,}256\ (L/year/facility) \times 4.187\ (KJ/(Kg\ °C)) \times [37\ (^\circ\ C) - 9.33\ (^\circ\ C)] \times 60\ (\%)}{78\ (\%) \times 37230\ (KJ/m^3)}$$

$$= 4{,}731 (m^3/year)$$

394 m3/yr per showerhead = 4731 m3/yr / 12 showers per facility

Annual Electricity Savings	**0**	KWh/showerhead
N/A		
Annual Water Savings	**0**	L/showerhead
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [7]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**776**	$/showerhead

The cost associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of showerheads, resulting in costs per showerhead.

DWHR assembly cost: $5,510. One assembly with 2 DWHR units (pipes) is required in this case.[8][9][10]
Installation: $3,800 (total). This is calculated based on the materials, equipment and labour needed to install a unit, as estimated from RS Means
$9,310 = $3,800 + $5,510
$776 per showerhead = $9,310/12 showerheads per facility.

Maintenance: $0. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.

Customer Payback Period (Natural Gas Only)	**6.6**	Years

Simple payback period, based on a natural gas price of $0.30/m^3$.

$$Simple\ Payback\ Period\ = \frac{Incremental\ Cost}{Natural\ Gas\ Savings\ \times\ Natural\ Gas\ Cost}$$

$$= \frac{776(\$)}{394\ (m^3) \times 0.3\ (\$/m^3)} = 6.6\ (years)$$

References

[1] 1.25 GPM showerheads were used based on the likelihood of the facility participating in the low-flow showerhead program. This was agreed to by UG and their Evaluation and Audit Committee in November-December 2010.

[2] Ontario Recreation Facility Association (ORFA) indicated half of the showers are “on” 10-15 minutes/hr on average. This value will be higher for weekends and primetime periods.   10% = 12.5 minutes “on” / 60 minutes * 50% of showers

[3] Based on survey of typical rinks by Enermodal, corroborated with a web search of five rinks by UG.

[4] The typical maximum number of showers that can be ganged is 12.   This is based on Enermodal’s discussions with DWHR suppliers.

[5] ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating

[6] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[7] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[8] The number of assemblies required is based on the supplier RenewABILITY Energy Inc. and modified to account for the installation of low flow showerheads (1.25 GPM) instead of typical showerheads in agreement with the research contractor, Enermodal. Low flow showerheads are expected to be half the flow rate of typical showerheads.

[9] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

[10] The original report from Enermodal required two assemblies to service 12 typical flow showerheads. However, after the report, the showerhead flow rates were reduced by 50% (to 1.25 GPM). DWHR systems are sized according to flow rate, so if the flow rate is half of the original, the number of DWHR assemblies required will be half as well. Enermodal agreed to reduce the number of DWHR assemblies from two to one, which reduces the cost of the equipment by 50%.

Drain Water Heat Recovery (DWHR) Units – University/College Cafeterias, Dishwashing

New Construction, UG & EGD

Description/Comment
Continuous Flow Dishwasher. Savings and Costs are shown per Meal Served per Day.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. This measure applies only to DWHR systems installed with Continuous Flow Dishwashers where there is concurrent hot water flow in and drain water flow out of the DWHR system.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
New Construction.	University/College Cafeterias. Kitchen Dishwashing. Continuous Flow Dishwashers	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/Meal per Day)	Electricity (KWh/Meal per Day)	Water (L/Meal per Day)	($/Meal per Day)	($/Meal per Day)
1	4.6	0	0	$3.41	$0.00
2	4.6	0	0	$0.00	$0.00
3	4.6	0	0	$0.00	$0.00
4	4.6	0	0	$0.00	$0.00
5	4.6	0	0	$0.00	$0.00
6	4.6	0	0	$0.00	$0.00
7	4.6	0	0	$0.00	$0.00
8	4.6	0	0	$0.00	$0.00
9	4.6	0	0	$0.00	$0.00
10	4.6	0	0	$0.00	$0.00
11	4.6	0	0	$0.00	$0.00

12	4.6	0	0	$0.00	$0.00
13	4.6	0	0	$0.00	$0.00
14	4.6	0	0	$0.00	$0.00
15	4.6	0	0	$0.00	$0.00
16	4.6	0	0	$0.00	$0.00
17	4.6	0	0	$0.00	$0.00
18	4.6	0	0	$0.00	$0.00
19	4.6	0	0	$0.00	$0.00
20	4.6	0	0	$0.00	$0.00
21	4.6	0	0	$0.00	$0.00
22	4.6	0	0	$0.00	$0.00
23	4.6	0	0	$0.00	$0.00
24	4.6	0	0	$0.00	$0.00
25	4.6	0	0	$0.00	$0.00
Total	**115**	**0**	**0**	**$3.41**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**4.6**	m^3/Meal per Day

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of meals served per day, resulting in savings per meals served per day. See below for details.

One DWHR unit is connected to the dishwasher drain and used to preheat the water before the dishwasher water heater. A continuous flow dishwasher is used for the calculations.

The following are the characteristics used to estimate the drain water from the dishwashers:
Water Use per Meal:
= 9.1 (L/meal) 0* (1-70%) [1]
= 2.7 (L/meal)

Average restaurant size: 519 meals/day [2][3] Calculate based on the number of establishments in the area, market share and number of meals eaten out per day.
Percentage of water use per meal for dishwashers: 80% [4]

$$Yearly\ Concurrent\ Drainwater\ Flow$$
$$= 2.7\ (L/meal) \times 519\ (meals/day) \times 365\ (days/year) \times 80\%$$
$$= 408{,}893\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for dishwasher: 77°C [1]
Domestic Cold Water Temperature: 9.33 °C [5]
DWHR unit effectiveness for noted piping configuration: 60% [6]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3)$$
$$= \frac{408{,}893\ (L/year) \times 4.184\ (KJ/(Kg\ °C)) \times [77\ (°C) - 9.33\ (°C)] \times 60\ (\%)}{78\ (\%) \times 37230\ (KJ/m^3)}$$

$= 2{,}392(m^3/year)$ 4.6 m^3/meal served per day = 2,392 m^3/year / 519 meals served per day per facility		
Annual Electricity Savings	**0**	KWh/Meal per Day
N/A		
Annual Water Savings	**0**	L/Meal per Day
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [6]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**3.41**	$/Meal per Day
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average cost per meals served per day, resulting in a cost per meals served per day. DWHR unit cost: $1,030 [7] Installation: $740. This is calculated based on the materials, equipment and labour needed to install a unit, as estimated from RS Means. Maintenance: $0. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to. [8] $3.41 per meal served per day = ($1,030 + $740) / 519 meals served per day per facility		
Customer Payback Period (Natural Gas Only)	**2.5**	Years
Simple payback period, based on a natural gas price of $0.30/m^3$.		

$$Simple\ Payback\ Period = \frac{Incremental\ Cost}{Natural\ Gas\ Savings \times Natural\ Gas\ Cost}$$

$$= \frac{3.41(\$)}{4.6\ (m^3) \times 0.3\ (\$/m^3)} = 2.5\ (years)$$

References

[1] The 9.1 (L/meal) value originates from ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating and is associated with a study from the 70's. This value was updated by multiplying it by one minus the % reduction in water use by Conveyor and Flight-Type machines since then, gathered from a manufacturer (Suzanne Supplee - Champion Industries/BiLine) and Genevieve Bussieres from Natural Gas Technology Centre (NGTC) quoting an NSF study and conversations with Hobart (another manufacturer). The 70% reduction in water use value was chosen for this calculation based on the above sources (68% from Champion and 70-72% from NGTC's findings).[2]

Natural Gas Technologies Centre, DSM Opportunities associated with Commercial Dishwashers, April 27 2009.

[3] Ebbin, J, Americans' Dining-Out Habits, Restaurant USA, November 2000. Available at http://www.restaurant.org/tools/magazines/rusa/magArchive/year/article/?ArticleID=138

[4] Wexiodisk, Rack Conveyor Dishwasher, 2006. Available at www.wexiodisk.com

[5] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[6] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[7] RenewABILITY Energy Inc.

[8] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – Hospital, Dishwashing

New Construction, UG & EGD

Description/Comment
Continuous Flow Dishwasher. Savings and Costs are shown per Bed.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. This measure applies only to DWHR systems installed with Continuous Flow Dishwashers where there is concurrent hot water flow in and drain water flow out of the DWHR system.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
New Construction.	Hospital. Kitchen Dishwashing. Continuous Flow Dishwasher.	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3 / Bed)	Electricity (KWh / Bed)	Water (L / Bed)	($ / Bed)	($ / Bed)
1	12	0	0	$11.88	$0.00
2	12	0	0	$0.00	$0.00
3	12	0	0	$0.00	$0.00
4	12	0	0	$0.00	$0.00
5	12	0	0	$0.00	$0.00
6	12	0	0	$0.00	$0.00
7	12	0	0	$0.00	$0.00
8	12	0	0	$0.00	$0.00
9	12	0	0	$0.00	$0.00
10	12	0	0	$0.00	$0.00
11	12	0	0	$0.00	$0.00
12	12	0	0	$0.00	$0.00
13	12	0	0	$0.00	$0.00

14	12	0	0	$0.00	$0.00
15	12	0	0	$0.00	$0.00
16	12	0	0	$0.00	$0.00
17	12	0	0	$0.00	$0.00
18	12	0	0	$0.00	$0.00
19	12	0	0	$0.00	$0.00
20	12	0	0	$0.00	$0.00
21	12	0	0	$0.00	$0.00
22	12	0	0	$0.00	$0.00
23	12	0	0	$0.00	$0.00
24	12	0	0	$0.00	$0.00
25	12	0	0	$0.00	$0.00
Total	**311**	**0**	**0**	**$11.88**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**12**	m^3/Bed

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds in a hospital, resulting in savings per bed. See below for details.

One DWHR unit is connected to the dishwasher drain and used to preheat the water before the dishwasher water heater. A continuous flow dishwasher is used for the calculations.

The following are the characteristics used to estimate the drain water from the dishwashers:
Water Use per Meal:
=9.1 (L/meal) * (1-70%)) [1]
= 2.7 (L/meal)
Average hospital size: 149 beds [2]
Percentage of beds requiring meals: 75% [3]
Additional meals for staff: 20% [3]
Percentage of water use per meal for dishwashers: 80% [4]

$Yearly\ Concurrent\ Drainwater\ Flow$

$$= 2.7\ (L/meal) \times 3\ (meals/day) \times 365\ (days/year) \times 149\ (beds/hospital) \times 75\%\ (beds\ requiring\ meals) \times 120\%\ (staff\ meals) \times 80\%$$

$$= 317{,}173\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for dishwasher: 77°C [1]
Domestic Cold Water Temperature: 9.33 °C [5]
DWHR unit effectiveness for noted piping configuration: 60% [6]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3) = \frac{317{,}173\ (L/year)\ \times\ 4.184\ (KJ/(Kg\ ^\circ C))\ \times\ [77\ (^\circ C) - 9.33\ (^\circ C)]\ \times\ 60\ (\%)}{78\ (\%)\ \times\ 37230\ (KJ/m^3)}$$

$$= 1{,}856\ (m^3/year)$$

12 m3/yr per bed = 1,856m3/yr / 149 beds

Annual Electricity Savings	**0**	KWh/Bed
N/A		
Annual Water Savings	**0**	L/Bed
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [6]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**11.88**	$/Bed

The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds per facility, resulting in a cost per bed.

DWHR unit cost: $1,030 [7]
Installation: $740. This is calculated based on the materials, equipment and labour needed to install a unit, as estimated from RS Means.
$11.88 = ($1,030 + $740)/149 beds/facility

Maintenance: $0. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.[8]

Customer Payback Period (Natural Gas Only)	**3.3**	Years

Simple payback period, based on a natural gas price of $0.30/m^3.

$$Simple\ Payback\ Period\ = \frac{Incremental\ Cost}{Natural\ Gas\ Savings\ \times\ Natural\ Gas\ Cost}$$

$$= \frac{11.88(\$)}{12\ (m^3) \times 0.3\ (\$/m^3)} = 3.3\ (years)$$

References

[1] The 9.1 (L/meal) value originates from ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating and is associated with a study from the 70’s. This value was updated by multiplying it by one minus the % reduction in water use by Conveyor and Flight-Type machines since then, gathered from a manufacturer (Suzanne Supplee - Champion Industries/BiLine) and Genevieve Bussieres from Natural Gas Technology Centre (NGTC) quoting an NSF study and conversations with Hobart (another manufacturer). The 70% reduction in water use value was chosen for this calculation based on the above sources (68% from Champion and 70-72% from NGTC’s findings).

[2] Ontario Hospital Association, Health System Facts and Figures- Beds Staffed and in Operation, Ontario, 2009. Available at http://www.healthsystemfacts.com

[3] Grand River Hospital - Diet Office of the Nutrition/Food Service Department

[4] Wexiodisk, Rack Conveyor Dishwasher, 2006. Available at www.wexiodisk.com

[5] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[6] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[7] RenewABILITY Energy Inc.

[8] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – Hospital, Laundry

New Construction, UG & EGD

Description/Comment
Laundry - with storage tank and pumping equipment. Savings and Costs are shown per Bed.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. A storage tank and pumping equipment is needed for batch-style (ie. front load or top load) Laundry equipment to ensure cold water flows into the DWHR system and warm drain water flows out concurrently.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
New Construction	Hospital. On-premise Laundry. Laundry Equipment	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/Bed)	Electricity (KWh/Bed)	Water (L/Bed)	($/Bed)	($/Bed)
1	295	0	0	$213.56	$0.00
2	295	0	0	$3.66	$0.00
3	295	0	0	$3.33	$0.00
4	295	0	0	$3.03	$0.00
5	295	0	0	$2.75	$0.00
6	295	0	0	$2.50	$0.00
7	295	0	0	$2.27	$0.00
8	295	0	0	$2.07	$0.00
9	295	0	0	$1.88	$0.00
10	295	0	0	$1.71	$0.00
11	295	0	0	$1.55	$0.00
12	295	0	0	$1.41	$0.00
13	295	0	0	$1.28	$0.00

14	295	0	0	\$1.17	\$0.00
15	295	0	0	\$1.06	\$0.00
16	295	0	0	\$0.96	\$0.00
17	295	0	0	\$0.88	\$0.00
18	295	0	0	\$0.80	\$0.00
19	295	0	0	\$0.72	\$0.00
20	295	0	0	\$0.66	\$0.00
21	295	0	0	\$0.60	\$0.00
22	295	0	0	\$0.54	\$0.00
23	295	0	0	\$0.49	\$0.00
24	295	0	0	\$0.45	\$0.00
25	295	0	0	\$0.41	\$0.00
Total	**7,365**	**0**	**0**	**\$250**	**\$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**295**	m^3/Bed

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds in a hospital, resulting in savings per bed. See below for details.

One manifolded DWHR assembly (made of (4) units or pipes) is connected, with storage and pumping equipment to the on-premise laundry equipment in the hospital.

The following are the characteristics used to estimate the drain water from the laundry equipment:
Water Usage Rate: 9.5 L/lb [1]
Average hospital size: 149 beds [2]
Quantity of Laundry: 18 Lbs/Room/day [3]

$$Yearly\ Concurrent\ Drainwater\ Flow$$
$$= 9.5\ (L/lb)\ \times\ 18\ (lbs/room/day)\ \times 149\ (beds)\ \times\ 365\ (days)$$
$$= 9{,}299{,}835\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for laundry equipment: 70°C [4]
Domestic Cold Water Temperature: 9.33 °C [5]
DWHR unit effectiveness for noted piping configuration: 60% [6]
Storage losses derating factor: 90% [7]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3)$$
$$= \frac{9{,}299{,}835\ \left(\frac{L}{year}\right) \times\ 4.184\ \left(\frac{KJ}{Kg\ °C}\right) \times\ [70\ (°C) - 9.33\ (°C)] \times\ 60\ (\%) \times\ 90\ (\%)}{78\ (\%) \times\ 37230\ \left(\frac{KJ}{m^3}\right)}$$

$= 43{,}898\ (m^3/year)$ 295 m^3 per Bed = 43,898 m^3 / 149 Beds per facility		
Annual Electricity Savings	**0**	KWh/Bed
N/A		
Annual Water Savings	**0**	L/Bed
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [6]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**250**	$/Bed
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds per facility, resulting in a cost per bed. DWHR assembly cost: $12,920.[8] One assembly made up of (4) units (pipes) is required. Accessories cost: $13,500. Includes costs for pumps, storage tank, controls and other necessary equipment for non-concurrent flow applications. Installation: $4,800. This is calculated based on the materials, equipment and labour needed to install a unit, as estimated from RS Means. Maintenance: $600. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.[9] However, the storage tank and pump will require yearly maintenance and the pump requires some energy to operate. A discount rate of 10%, consistent with the TRC calculation, is applied to the yearly O&M cost, to calculate the NPV ($5991). $250 per Bed = ($12,920 + $13,500 + $4,800 + $5,991)/ 149 Beds		
Customer Payback Period (Natural Gas Only)	**2.5**	Years
Simple payback period, based on a natural gas price of $0.30/$m^3$. $Simple\ Payback\ Period = \frac{Incremental\ Cost}{Natural\ Gas\ Savings \times Natural\ Gas\ Cost - Yearly\ Cost}$ $= \frac{(\frac{31{,}220}{149\ Beds})(\$)}{295\ (m^3) \times 0.3\ \left(\frac{\$}{m^3}\right) - (\frac{600}{149\ Beds})\ (\$)} = 2.5\ (years)$		

References

[1] Alliance for Water Efficiency, Commercial Laundry Facilities Introduction, 2009. Available at http://www.allianceforwaterefficiency.org/commercial_laundry.aspx

[2] Ontario Hospital Association, Health System Facts and Figures- Beds Staffed and in Operation, Ontario, 2009.

Available at http://www.healthsystemfacts.com

[3] Department of Veteran Affairs, Veterans Health Administration: Environmental Management Service Laundry and Linen Operations, March 2008. Available at http://www.wbdg.org/ccb/VA/VASPACE/7610-408.pdf

[4] ASHRAE Handbook 2007, HVAC Applications, Section 49- Service Water Heating

[5] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[6] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[7] Value is from common industry practice, communication with Enermodal Engineering, November 2010.

[8] RenewABILITY Energy Inc.

[9] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – Nursing Home, Dishwashing

New Construction, UG & EGD

Description/Comment
Continuous Flow Dishwasher. Saving and Costs are shown per Bed.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. This measure applies only to DWHR systems installed with Continuous Flow Dishwashers where there is concurrent hot water flow in and drain water flow out of the DWHR system.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
New Construction.	Nursing Home. Kitchen Dishwashing. Continuous Flow Dishwasher.	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/Bed)	Electricity (KWh/Bed)	Water (L/Bed)	($/Bed)	($/Bed)
1	12	0	0	$16.54	$0.00
2	12	0	0	$0.00	$0.00
3	12	0	0	$0.00	$0.00
4	12	0	0	$0.00	$0.00
5	12	0	0	$0.00	$0.00
6	12	0	0	$0.00	$0.00
7	12	0	0	$0.00	$0.00
8	12	0	0	$0.00	$0.00
9	12	0	0	$0.00	$0.00
10	12	0	0	$0.00	$0.00
11	12	0	0	$0.00	$0.00
12	12	0	0	$0.00	$0.00
13	12	0	0	$0.00	$0.00

14	12	0	0	$0.00	$0.00
15	12	0	0	$0.00	$0.00
16	12	0	0	$0.00	$0.00
17	12	0	0	$0.00	$0.00
18	12	0	0	$0.00	$0.00
19	12	0	0	$0.00	$0.00
20	12	0	0	$0.00	$0.00
21	12	0	0	$0.00	$0.00
22	12	0	0	$0.00	$0.00
23	12	0	0	$0.00	$0.00
24	12	0	0	$0.00	$0.00
25	12	0	0	$0.00	$0.00
Total	**311**	**0**	**0**	**$16.54**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**12**	m^3/Bed

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds in a Nursing Home, resulting in savings per bed. See below for details.

One DWHR unit is connected to the dishwasher drain and used to preheat the water before the dishwasher water heater. A continuous flow dishwasher is used for the calculations.

The following are the characteristics used to estimate the drain water from the dishwashers:
Water Use per Meal:
= 9.1 (L/meal) * (1-70%) [1]
= 2.7 (L/meal)Average Nursing Home size: 107 beds [2]
Percentage of beds requiring meals: 75% [3]
Additional meals for staff: 20% [3]
Percentage of water use per meal for dishwashers: 80% [4]

$$Yearly\ Concurrent\ Drainwater\ Flow$$
$$= 2.7\ (L/meal)\ \times\ 3\ (meals/day)\ \times\ 365\ (days/year)\ \times 107\ \left(\frac{beds}{Nursing\ Home}\right) \times\ 75\%\ \ (beds\ requiring\ meals) \times 120\%\ (staff\ meals)\ \times 80\%$$
$$= 227{,}769 (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for dishwasher: 77°C [1]
Domestic Cold Water Temperature: 9.33 °C [5]
DWHR unit effectiveness for noted piping configuration: 60% [6]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3) = \frac{227{,}769\ (L/year)\ \times\ 4.184\ (KJ/(Kg\ °C))\ \times\ [77\ (°C) - 9.33\ (°C)]\ \times\ 60\ (\%)}{78\ (\%)\ \times\ 37230\ (KJ/m^3)}$$
$$= 1{,}332 (m^3/year)$$

12 m3/yr = 1,332 m3 / 107 Beds per facility

Annual Electricity Savings	**0**	KWh/Bed
N/A		
Annual Water Savings	**0**	L/Bed
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [6]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**16.54**	$/Bed
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds per facility, resulting in a cost per bed. DWHR unit cost: $1,030 [7] Installation: $740. This is calculated based on the materials, equipment and labour needed to install a unit, as estimated from RS Means. Maintenance: $0. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.[8] $16.54 / Bed = $1,030 + $740)/107 Beds per facility		
Customer Payback Period (Natural Gas Only)	**4.6**	Years
Simple payback period, based on a natural gas price of $0.30/m^3.		

$$Simple\ Payback\ Period = \frac{Incremental\ Cost}{Natural\ Gas\ Savings \times Natural\ Gas\ Cost}$$

$$= \frac{16.54(\$)}{12\ (m^3) \times 0.3\ (\$/m^3)} = 4.6\ (years)$$

References

[1] The 9.1 (L/meal) value originates from ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating and is associated with a study from the 70's. This value was updated by multiplying it by one minus the % reduction in water use by Conveyor and Flight-Type machines since then, gathered from a manufacturer (Suzanne Supplee - Champion Industries/BiLine) and Genevieve Bussieres from Natural Gas Technology Centre (NGTC) quoting an NSF study and conversations with Hobart (another manufacturer). The 70% reduction in water use value was chosen for this calculation based on the above sources (68% from Champion and 70-72% from NGTC's findings).

[2] American Health Care Association, Trends in Nursing Facility Characteristics, December 2009. Available at http://www.ahcancal.org/Pages/Default.aspx

[3] Grand River Hospital - Diet Office of the Nutrition/Food Service Department.

[4] Wexiodisk, Rack Conveyor Dishwasher, 2006. Available at www.wexiodisk.com

[5] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[6] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[7] RenewABILITY Energy Inc.

[8] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – Laundromat

Retrofit, UG & EGD

Description/Comment
Laundry – with storage tank and pumping equipment. Savings and Costs are Shown per Laundromat.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. A storage tank and pumping equipment is needed for batch-style (i.e., front load or top load) Laundry equipment to ensure cold water flows into the DWHR system and warm drain water flows out concurrently.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
Retrofit	Laundromat. Laundry Equipment	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (KWh)	Water (L)	($)	($)
1	49,735	0	0	$35,420.00	$0.00
2	49,735	0	0	$545.45	$0.00
3	49,735	0	0	$495.87	$0.00
4	49,735	0	0	$450.79	$0.00
5	49,735	0	0	$409.81	$0.00
6	49,735	0	0	$372.55	$0.00
7	49,735	0	0	$338.68	$0.00
8	49,735	0	0	$307.89	$0.00
9	49,735	0	0	$279.90	$0.00
10	49,735	0	0	$254.46	$0.00
11	49,735	0	0	$231.33	$0.00
12	49,735	0	0	$210.30	$0.00
13	49,735	0	0	$191.18	$0.00
14	49,735	0	0	$173.80	$0.00

15	49,735	0	0	$158.00	$0.00
16	49,735	0	0	$143.64	$0.00
17	49,735	0	0	$130.58	$0.00
18	49,735	0	0	$118.71	$0.00
19	49,735	0	0	$107.92	$0.00
20	49,735	0	0	$98.10	$0.00
21	49,735	0	0	$89.19	$0.00
22	49,735	0	0	$81.08	$0.00
23	49,735	0	0	$73.71	$0.00
24	49,735	0	0	$67.01	$0.00
25	49,735	0	0	$60.92	$0.00
Total	**1,243,364**	**0**	**0**	**$40,811**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**49,735**	m^3

One manifolded DWHR assembly (made of (4) units or pipes) is connected, with storage and pumping equipment to the laundry equipment.

The following are the characteristics used to estimate the drain water from the laundry equipment:
Laundry Rate: 0.37 Loads/person/day [1]
Water Usage Rate: 60 L/load[2]
Consumer base for Laundromat: 1303 [3][4][5] Based on the number of Laundromats in the service area and the number of persons who use Laundromats.

$$Yearly\ Concurrent\ Drainwater\ Flow = 0.37\ (Loads/person/day) \times 60\ (L/load) \times 1303\ (persons) \times 365\ (days) = 10{,}536{,}258\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for laundry equipment: 70°C [6]
Domestic Cold Water Temperature: 9.33 °C [7]
DWHR unit effectiveness for noted piping configuration: 60% [8]
Storage losses derating factor: 90% [9]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3) = \frac{10{,}536{,}258\ \left(\frac{L}{year}\right) \times\ 4.184\ \left(\frac{KJ}{Kg\ °C}\right) \times\ [70\ (°C) - 9.33\ (°C)] \times\ 60\ (\%) \times\ 90\ (\%)}{78\ (\%) \times\ 37230\ \left(\frac{KJ}{m^3}\right)} = 49{,}735\ (m^3/year)$$

Annual Electricity Savings	**0**	KWh
N/A		

Annual Water Savings	**0**	L
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [8]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**40,811**	$
DWHR assembly cost: $12,920.[10] One assembly made up of (4) units (pipes) is required in this case. Accessories cost: $13,500. Includes costs for pumps, storage tank, controls and other necessary equipment for non-concurrent flow applications. Installation: $8,400. This is calculated based on the materials, equipment and labour needed to install a unit, in an existing building, as estimated from RS Means. Maintenance: $600. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.[8] However, the storage tank and pump will require yearly maintenance and the pump requires some energy to operate.[11] A discount rate of 10%, consistent with the TRC calculation, is applied to the yearly O&M cost, to calculate the NPV ($5991). $40,811 = $12,920 + $13,500 + $8,400 + $5991.		
Number of DWHR Units for Reported Savings	**4**	Units
One manifolded DWHR assembly is required to handle the high flow rates for the laundry equipment. There are 4 DWHR units per assembly. The savings and payback are based on this configuration, which is representative of an average laundromat..		
Customer Payback Period (Natural Gas Only)	**2.4**	Years

Simple payback period, based on a natural gas price of $\$0.30/m^3$.

$$Simple\ Payback\ Period = \frac{Incremental\ Cost}{Natural\ Gas\ Savings \times Natural\ Gas\ Cost - Yearly\ Cost}$$

$$= \frac{34{,}820(\$)}{49{,}735\ (m^3) \times 0.3\ (\$/m^3) - 600\ (\$)} = 2.4\ (years)$$

References

[1] Gleick, P.H., et al. Waste Not, Want Not: The Potential for Urban Water Conservation in California. Pacific Institute: Oakland, California, 2003.

[2] Speed Queen, Front Load Washer Horizon Line Product Brochure, 2010. Available at www.speedqueen.com

[3] Buertime, Industry Overview- Coin Operated Laundry, 2010. Available at http://buyertime.com/Laundry.html

[4] Coin Laundry Association, Industry Overview, 2006. Available at http://coinlaundry.org/resources/industryoverview.cfm

[5] Statistics Canada, Study: Changes and Challenges for Canada's Residential Real Estate Landlords, The Daily, May 25 2007. Available at http://www.statcan.gc.ca/daily-quotidien/070525/dq070525b-eng.htm

[6] ASHRAE Handbook 2007, HVAC Applications, Section 49- Service Water Heating

[7] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[8] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[9] Value is from common industry practice, communication with Enermodal Engineering, November 2010.

[10] RenewABILITY Energy Inc.

[11] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – Arena, Showering

Retrofit, UG & EGD

Description/Comment
Showering. Savings and Costs are shown per Showerhead.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
Retrofit	Existing Recreation Facility/ Arena. Showering.	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/ showerhead)	Electricity (KWh/ showerhead)	Water (L/ showerhead)	($/showerhead)	($/showerhead)
1	394	0	0	$1,209	$0.00
2	394	0	0	$0.00	$0.00
3	394	0	0	$0.00	$0.00
4	394	0	0	$0.00	$0.00
5	394	0	0	$0.00	$0.00
6	394	0	0	$0.00	$0.00
7	394	0	0	$0.00	$0.00
8	394	0	0	$0.00	$0.00
9	394	0	0	$0.00	$0.00
10	394	0	0	$0.00	$0.00
11	394	0	0	$0.00	$0.00
12	394	0	0	$0.00	$0.00
13	394	0	0	$0.00	$0.00
14	394	0	0	$0.00	$0.00

15	394	0	0	$0.00	$0.00
16	394	0	0	$0.00	$0.00
17	394	0	0	$0.00	$0.00
18	394	0	0	$0.00	$0.00
19	394	0	0	$0.00	$0.00
20	394	0	0	$0.00	$0.00
21	394	0	0	$0.00	$0.00
22	394	0	0	$0.00	$0.00
23	394	0	0	$0.00	$0.00
24	394	0	0	$0.00	$0.00
25	394	0	0	$0.00	$0.00
Total	**9,848**	**0**	**0**	**$1,209**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**394**	m^3/showerhead

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of showerheads, resulting in savings per showerhead. This will allow for different system sizes. See below for details.

One DWHR assembly (with 2 pipes) is connected to the showers in the change rooms of the facility.

The following are the characteristics used to estimate the drain water from showers :
Showerhead flow rate: 4.7 L/min (1.25 GPM)[1]
Shower Usage Rate: 10% [2] Amount of time shower is in use.
Facility Hours of Operation: 16 hours per day [3]
Showers per Facility: 12 showers/facility [4]

$$Yearly\ Concurrent\ Drainwater\ Flow = 4.7\ (L/min) \times 16\ (hours/day) \times 60\ (min/hour) \times 365\ (days/year) \times 10\% \times 12\ (showers/facility) = 1{,}976{,}256\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for showers: 37°C [5]
Domestic Cold Water Temperature: 9.33 °C [6]
DWHR unit effectiveness for noted piping configuration: 60% [7]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3) = \frac{1{,}976{,}256\ (L/year/facility) \times 4.184\ (KJ/(Kg\ °C)) \times [37\ (°C) - 9.33\ (°C)] \times 60\ (\%)}{78\ (\%) \times 37230\ (KJ/m^3)}$$

$$= 4{,}727\ (m^3/year)$$

394 m3/yr per showerhead = 4,727 m3 / 12 showers/facility

Annual Electricity Savings	**0**	KWh/showerhead

N/A

Annual Water Savings	**0**	L/showerhead

N/A

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [7]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**1,209**	$/showerhead
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of showerheads, resulting in costs per showerhead. DWHR assembly cost: $5,510. One assembly with 2 DWHR units (pipes) is required in this case.[8][9][10] Installation: $9,000 (total). This is calculated based on the materials, equipment and labour needed to install a unit, in an existing building, as estimated from RS Means. $1,209 per showerhead = ($5,510 + $9,000)/12 showers/facility Maintenance: $0. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.		
Customer Payback Period (Natural Gas Only)	**10.2**	Years
Simple payback period, based on a natural gas price of $0.30/m^3.		

$$Simple\ Payback\ Period\ = \frac{Incremental\ Cost}{Natural\ Gas\ Savings\ \times\ Natural\ Gas\ Cost}$$

$$= \frac{1{,}209(\$)}{394\ (m^3) \times 0.3\ (\$/m^3)} = 10.2\ (years)$$

References

[1] 1.25 GPM showerheads were used based on the likelihood of the facility participating in the low-flow showerhead program. This was agreed to by UG and their Evaluation and Audit Committee in November-December 2010.

[2] Ontario Recreation Facility Association (ORFA) indicated half of the showers are “on” 10-15 minutes/hr on average. This value will be higher for weekends and primetime periods. 10% = 12.5 minutes “on” / 60 minutes * 50% of showers

[3] Based on survey of typical rinks by Enermodal, corroborated with a web search of five rinks by UG.

[4] The typical maximum number of showers that can be ganged is 12. This is based on Enermodal’s discussions with DWHR suppliers.

[5] ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating

[6] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant’s Draft

Gas Measure Characterizations, March 2009.

[7] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[8] The number of assemblies required is based on the DWHR supplier RenewABILITY Energy Inc. and modified to account for the installation of low flow showerheads (1.25 GPM) instead of typical showerheads in agreement with the research contractor, Enermodal. Low flow showerheads are expected to be half the flow rate of typical showerheads.

[9] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

[10] The original report from Enermodal required two assemblies to service 12 typical flow showerheads. However, after the report, the showerhead flow rates were reduced by 50% (to 1.25 GPM). DWHR systems are sized according to flow rate, so if the flow rate is half of the original, the number of DWHR assemblies required will be half as well. Enermodal agreed to reduce the number of DWHR assemblies from two to one, which reduces the cost of the equipment by 50%.

Drain Water Heat Recovery (DWHR) Units – University/College Cafeterias, Dishwashing

Retrofit, UG & EGD

Description/Comment
Continuous Flow Dishwasher. Savings and Costs are shown per Meal Served per Day.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. This measure applies only to DWHR systems installed with Continuous Flow Dishwashers where there is concurrent hot water flow in and drain water flow out of the DWHR system.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
Retrofit	University/College Cafeterias. Kitchen Dishwashing. Continuous Flow Dishwashers	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/Meal per Day)	Electricity (KWh/Meal per Day)	Water (L/Meal per Day)	($/Meal per Day)	($/Meal per Day)
1	11.6	0	0	$6.26	$0.00
2	11.6	0	0	$0.00	$0.00
3	11.6	0	0	$0.00	$0.00
4	11.6	0	0	$0.00	$0.00
5	11.6	0	0	$0.00	$0.00
6	11.6	0	0	$0.00	$0.00
7	11.6	0	0	$0.00	$0.00
8	11.6	0	0	$0.00	$0.00
9	11.6	0	0	$0.00	$0.00
10	11.6	0	0	$0.00	$0.00
11	11.6	0	0	$0.00	$0.00

12	11.6	0	0	$0.00	$0.00
13	11.6	0	0	$0.00	$0.00
14	11.6	0	0	$0.00	$0.00
15	11.6	0	0	$0.00	$0.00
16	11.6	0	0	$0.00	$0.00
17	11.6	0	0	$0.00	$0.00
18	11.6	0	0	$0.00	$0.00
19	11.6	0	0	$0.00	$0.00
20	11.6	0	0	$0.00	$0.00
21	11.6	0	0	$0.00	$0.00
22	11.6	0	0	$0.00	$0.00
23	11.6	0	0	$0.00	$0.00
24	11.6	0	0	$0.00	$0.00
25	11.6	0	0	$0.00	$0.00
Total	**290**	**0**	**0**	**$6.26**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**11.6**	m^3/Meal per Day

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of meals served per day, resulting in savings per meals served per day. See below for details.

One DWHR unit is connected to the dishwasher drain and used to preheat the water before the dishwasher water heater. A continuous flow dishwasher is used for the calculations. The following are the characteristics used to estimate the drain water from the dishwashers:
Water Use per Meal:
= 9.1 (L/meal) * (1-70%)/(1-60%) [1]
= 6.8 (L/meal)
Average restaurant size: 519 meals/day [2][3] Calculate based on the number of establishments in the area, market share and number of meals eaten out per day.
Percentage of water use per meal for dishwashers: 80% [4]

$$Yearly\ Concurrent\ Drainwater\ Flow = 6.8\ (L/meal) \times 519\ (meals/day) \times 365\ (days/year) \times 80\% = 1{,}029{,}805\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for dishwasher: 77°C [1]
Domestic Cold Water Temperature: 9.33 °C [5]
DWHR unit effectiveness for noted piping configuration: 60% [6]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3) = \frac{1{,}029{,}805\ (L/year) \times 4.184\ (KJ/(Kg\ °C)) \times [77\ (°C) - 9.33\ (°C)] \times 60\ (\%)}{78\ (\%) \times 37230\ (KJ/m^3)}$$

$$= 6{,}024 (m^3/year)$$

11.6 m3/meal served per day = 6,024m3/year / 519 meals served per day per facility		
Annual Electricity Savings	**0**	KWh/Meal per Day
N/A		
Annual Water Savings	**0**	L/Meal per Day
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [6]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**6.26**	$/Meal per Day
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average cost per meals served per day, resulting in a cost per meals served per day. DWHR unit cost: $1,030 [7] Installation: $2,220. This is calculated based on the materials, equipment and labour needed to install a unit, in an existing building, as estimated from RS Means. Maintenance: $0. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.[8] $6.26 per meal served per day = ($1,030 + $2,220)/519 meals served per day per facility		
Customer Payback Period (Natural Gas Only)	**1.8**	Years
Simple payback period, based on a natural gas price of $0.30/m^3.		

$$Simple\ Payback\ Period\ = \frac{Incremental\ Cost}{Natural\ Gas\ Savings\ \times\ Natural\ Gas\ Cost}$$

$$= \frac{6.26(\$)}{11.6\ (m^3) \times 0.3\ (\$/m^3)} = 1.8\ (years)$$

References

[1] The 9.1 (L/meal) value originates from the ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating and is associated with a study from the 70's. This value was updated to reflect water use from middle-aged equipment as expected in existing buildings. Machines in existing buildings are expected to be typically 10 years old based on the equipment life of 20 years, which in-turn came from the Food Service Technology Center (FSTC) as cited in NGTC, DSM OPPORTUNITIES ASSOCIATED WITH COMMERCIAL DISHWASHERS, Final Report, April 27, 2009, pg 17.).

In order to take this into account, the 9.1 value was multiplied by one minus the 70% reduction in water use by Conveyor and Flight-Type machines since the 70's, then divided by one minus the 60% reduction in water-use of new machines vs. machines built 10 years ago. This data was gathered from a manufacturer (Suzanne Supplee - Champion Industries/BiLine) and Genevieve Bussieres from the Natural Gas Technology Centre (NGTC) quoting an NSF study and conversations with Hobart (another manufacturer). The 70% reduction in water use value was chosen for this calculation based on the above sources (68% from Champion and 70-72% from NGTC's findings). The 60% reduction value was chosen based on the same sources (61% from Champion and 58% from NGTC's findings).

[2] Natural Gas Technologies Centre, DSM Opportunities associated with Commercial Dishwashers, April 27 2009.

[3] Ebbin, J, Americans' Dining-Out Habits, Restaurant USA, November 2000. Available at http://www.restaurant.org/tools/magazines/rusa/magArchive/year/article/?ArticleID=138

[4] Wexiodisk, Rack Conveyor Dishwasher, 2006. Available at www.wexiodisk.com

[5] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[6] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[7] RenewABILITY Energy Inc.

[8] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – Hospital, Dishwashing

Retrofit, UG & EGD

Description/Comment
Continuous Flow Dishwasher. Savings and Costs are shown per Bed.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. This measure applies only to DWHR systems installed with Continuous Flow Dishwashers where there is concurrent hot water flow in and drain water flow out of the DWHR system.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
Retrofit	Existing Hospital. Kitchen Dishwashing. Continuous Flow Dishwashers.	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3 / Bed)	Electricity (KWh / Bed)	Water (L / Bed)	($ / Bed)	($ / Bed)
1	31	0	0	$18.19	$0.00
2	31	0	0	$0.00	$0.00
3	31	0	0	$0.00	$0.00
4	31	0	0	$0.00	$0.00
5	31	0	0	$0.00	$0.00
6	31	0	0	$0.00	$0.00
7	31	0	0	$0.00	$0.00
8	31	0	0	$0.00	$0.00
9	31	0	0	$0.00	$0.00
10	31	0	0	$0.00	$0.00
11	31	0	0	$0.00	$0.00
12	31	0	0	$0.00	$0.00
13	31	0	0	$0.00	$0.00

14	31	0	0	$0.00	$0.00
15	31	0	0	$0.00	$0.00
16	31	0	0	$0.00	$0.00
17	31	0	0	$0.00	$0.00
18	31	0	0	$0.00	$0.00
19	31	0	0	$0.00	$0.00
20	31	0	0	$0.00	$0.00
21	31	0	0	$0.00	$0.00
22	31	0	0	$0.00	$0.00
23	31	0	0	$0.00	$0.00
24	31	0	0	$0.00	$0.00
25	31	0	0	$0.00	$0.00
Total	**775**	**0**	**0**	**$18.19**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**31**	m^3/Bed

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds in a hospital, resulting in savings per bed. See below for details.

One DWHR unit is connected to the dishwasher drain and used to preheat the water before the dishwasher water heater. A continuous flow dishwasher is used for the calculations.

The following are the characteristics used to estimate the drain water from the dishwashers:
Water Use per Meal
= 9.1 (L/meal) * (1-70%)/(1-60%) [1]
= 6.8 (L/meal)
Average hospital size: 149 beds [2]
Percentage of beds requiring meals: 75% [3]
Additional meals for staff: 20% [3]
Percentage of water use per meal for dishwashers: 80% [4]

$$\begin{aligned}&Yearly\ Concurrent\ Drainwater\ Flow\\&= 6.8\ (L/meal)\ \times\ 3\ (meals/day)\ \times\ 365\ (days/year)\ \times 149\ (beds/hospital)\\&\qquad \times\ 75\%\ \ (beds\ requiring\ meals) \times 120\%\ (staff\ meals)\ \times 80\%\\&= 798{,}807\ (L/year)\end{aligned}$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for dishwasher: 77°C [1]
Domestic Cold Water Temperature: 9.33 °C [5]
DWHR unit effectiveness for noted piping configuration: 60% [6]
Standard Natural gas water heater efficiency: 78%

$$\begin{aligned}&Natural\ Gas\ Saving\ (m^3)\\&= \frac{798{,}807\ (L/year)\ \times\ 4.184\ (KJ/(Kg\ ^\circ\ C))\ \times\ [77\ (^\circ\ C) - 9.33\ (^\circ\ C)]\ \times\ 60\ (\%)}{78\ (\%)\ \times\ 37230\ (KJ/m^3)}\\&= 4{,}673\ (m^3/year)\end{aligned}$$

$31m^3$ per bed = 4,673 m^3 / 149 beds per facility		
Annual Electricity Savings	**0**	KWh/Bed
N/A		
Annual Water Savings	**0**	L/Bed
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [6]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**18.19**	$/Bed
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds per facility, resulting in a cost per bed. DWHR unit cost: $1,030 [7] Installation: $1,680. This is calculated based on the materials, equipment and labour needed to install a unit, in an existing building, as estimated from RS Means. Maintenance: $0. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.[8] $18.19 per bed = ($1,030 + $1,680) / 149 beds per facility		
Customer Payback Period (Natural Gas Only)	**1.9**	Years
Simple payback period, based on a natural gas price of $0.30/m^3$.		

$$Simple\ Payback\ Period\ =\frac{Incremental\ Cost}{Natural\ Gas\ Savings\ \times\ Natural\ Gas\ Cost}$$

$$=\frac{18.19(\$)}{31\ (m^3)\times 0.3\ (\$/m^3)}=1.9\ (years)$$

References

[1] The 9.1 (L/meal) value originates from the ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating and is associated with a study from the 70's. This value was updated to reflect water use from middle-aged equipment as expected in existing buildings. Machines in existing buildings are expected to be typically 10 years old based on the equipment life of 20 years, which in-turn came from the Food Service Technology Center (FSTC) as cited in NGTC, DSM OPPORTUNITIES ASSOCIATED WITH COMMERCIAL DISHWASHERS, Final Report, April 27, 2009, pg 17.).

In order to take this into account, the 9.1 value was multiplied by one minus the 70% reduction in water use by Conveyor and Flight-Type machines since the 70's, then divided by one minus the 60% reduction in water-use of new machines vs. machines built 10 years ago. This data was gathered from a manufacturer (Suzanne Supplee - Champion

Industries/BiLine) and Genevieve Bussieres from the Natural Gas Technology Centre (NGTC) quoting an NSF study and conversations with Hobart (another manufacturer). The 70% reduction in water use value was chosen for this calculation based on the above sources (68% from Champion and 70-72% from NGTC's findings). The 60% reduction value was chosen based on the same sources (61% from Champion and 58% from NGTC's findings).[2] Ontario Hospital Association, Health System Facts and Figures- Beds Staffed and in Operation, Ontario, 2009. Available at http://www.healthsystemfacts.com

[3] Grand River Hospital - Diet Office of the Nutrition/Food Service Department

[4] Wexiodisk, Rack Conveyor Dishwasher, 2006. Available at www.wexiodisk.com

[5] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[6] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[7] RenewABILITY Energy Inc.

[8] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – Hospital, Laundry

Retrofit, UG & EGD

Description/Comment
Laundry - with storage tank and pumping equipment. Savings and Costs are shown per Bed.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. A storage tank and pumping equipment is needed for batch-style (ie. front load or top load) Laundry equipment to ensure cold water flows into the DWHR system and warm drain water flows out concurrently.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
Retrofit	Existing Hospital. On-premise Laundry. Laundry Equipment.	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/Bed)	Electricity (KWh/Bed)	Water (L/Bed)	($/Bed)	($/Bed)
1	295	0	0	$237.72	$0.00
2	295	0	0	$3.66	$0.00
3	295	0	0	$3.33	$0.00
4	295	0	0	$3.03	$0.00
5	295	0	0	$2.75	$0.00
6	295	0	0	$2.50	$0.00
7	295	0	0	$2.27	$0.00
8	295	0	0	$2.07	$0.00
9	295	0	0	$1.88	$0.00
10	295	0	0	$1.71	$0.00
11	295	0	0	$1.55	$0.00
12	295	0	0	$1.41	$0.00
13	295	0	0	$1.28	$0.00

14	295	0	0	$1.17	$0.00
15	295	0	0	$1.06	$0.00
16	295	0	0	$0.96	$0.00
17	295	0	0	$0.88	$0.00
18	295	0	0	$0.80	$0.00
19	295	0	0	$0.72	$0.00
20	295	0	0	$0.66	$0.00
21	295	0	0	$0.60	$0.00
22	295	0	0	$0.54	$0.00
23	295	0	0	$0.49	$0.00
24	295	0	0	$0.45	$0.00
25	295	0	0	$0.41	$0.00
Total	**7,365**	**0**	**0**	**$274**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**295**	m^3/Bed

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds in a hospital, resulting in savings per bed. See below for details.

One manifolded DWHR assembly (made of (4) units or pipes) is connected with storage and pumping equipment to the on-premise laundry equipment in the hospital.

The following are the characteristics used to estimate the drain water from the laundry equipment:
Water Usage Rate: 9.5 L/lb [1]
Average hospital size: 149 beds [2]
Quantity of Laundry: 18 Lbs/Room/day [3]

$$Yearly\ Concurrent\ Drainwater\ Flow$$
$$= 9.5\ (L/lb) \times 18\ (lbs/room/day) \times 149\ (beds) \times 365\ (days)$$
$$= 9{,}299{,}835\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for laundry equipment: 70°C [4]
Domestic Cold Water Temperature: 9.33 °C [5]
DWHR unit effectiveness for noted piping configuration: 60% [6]
Storage losses derating factor: 90% [7]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3)$$
$$= \frac{9{,}299{,}835\ \left(\frac{L}{year}\right) \times 4.184\ \left(\frac{KJ}{Kg\ °C}\right) \times [70\ (°C) - 9.33\ (°C)] \times 60\ (\%) \times 90\ (\%)}{78\ (\%) \times 37230\ \left(\frac{KJ}{m^3}\right)}$$
$$= 43{,}898\ (m^3/year)$$

295 m3 per Bed = 43,898 m3 / 149 Beds per facility

Annual Electricity Savings	**0**	KWh/Bed

N/A

Annual Water Savings	**0**	L/Bed
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [6]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**274**	$/Bed
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds per facility, resulting in a cost per bed. DWHR assembly cost: $12,920.[8] One assembly made up of (4) units (pipes) is required. Accessories cost: $13,500. Includes costs for pumps, storage tank, controls and other necessary equipment for non-concurrent flow applications. Installation: $8,400. This is calculated based on the materials, equipment and labour needed to install a unit, in an existing building, as estimated from RS Means. Maintenance: $600. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to. [9] However, the storage tank and pump will require yearly maintenance and the pump requires some energy to operate. A discount rate of 10%, consistent with the TRC calculation, is applied to the yearly O&M cost, to calculate the NPV ($5991). $274 per Bed = ($12,920 + $13,500 + $8,400 + $5,991)/ 149 Beds per Facility		
Customer Payback Period (Natural Gas Only)	**2.8**	Years
Simple payback period, based on a natural gas price of $0.30/m^3.		

$$Simple\ Payback\ Period\ = \frac{Incremental\ Cost}{Natural\ Gas\ Savings\ \times\ Natural\ Gas\ Cost - Yearly\ Cost}$$

$$= \frac{(\frac{34{,}820}{149\ Beds})(\$)}{295\ (m^3) \times 0.3\ \left(\frac{\$}{m^3}\right) - (\frac{600}{149\ Beds})\ (\$)} = 2.8\ (years)$$

References

[1] Alliance for Water Efficiency, Commercial Laundry Facilities Introduction, 2009. Available at http://www.allianceforwaterefficiency.org/commercial_laundry.aspx

[2] Ontario Hospital Association, Health System Facts and Figures- Beds Staffed and in Operation, Ontario, 2009. Available at http://www.healthsystemfacts.com

[3] Department of Veteran Affairs, Veterans Health Administration: Environmental Management Service Laundry and Linen Operations, March 2008. Available at http://www.wbdg.org/ccb/VA/VASPACE/7610-408.pdf

[4] ASHRAE Handbook 2007, HVAC Applications, Section 49- Service Water Heating

[5] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.[6] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[7] Value is from common industry practice, communication with Enermodal Engineering, November 2010.

[8] RenewABILITY Energy Inc.

[9] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

Drain Water Heat Recovery (DWHR) Units – Nursing Home, Dishwashing

Retrofit, UG & EGD

Description/Comment
Continuous Flow Dishwasher. Savings and Costs are shown per Bed.

Efficient Equipment and Technologies Description
Drain Water Heat Recovery (DWHR) pre-heats incoming domestic cold water with the available drain water heat that would otherwise be lost. This measure applies only to DWHR systems installed with Continuous Flow Dishwashers where there is concurrent hot water flow in and drain water flow out of the DWHR system.
Base Equipment and Technologies Description
None

Decision Type	Target Market	End Use
Retrofit	Existing Nursing Home. Kitchen Dishwashing. Continuous Flow Dishwasher.	Water Heating

Codes, Standards and Regulations

None.

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3/Bed)	Electricity (KWh/Bed)	Water (L)	($/Bed)	($/Bed)
1	31	0	0	$25.33	$0.00
2	31	0	0	$0.00	$0.00
3	31	0	0	$0.00	$0.00
4	31	0	0	$0.00	$0.00
5	31	0	0	$0.00	$0.00
6	31	0	0	$0.00	$0.00
7	31	0	0	$0.00	$0.00
8	31	0	0	$0.00	$0.00
9	31	0	0	$0.00	$0.00
10	31	0	0	$0.00	$0.00
11	31	0	0	$0.00	$0.00
12	31	0	0	$0.00	$0.00
13	31	0	0	$0.00	$0.00
14	31	0	0	$0.00	$0.00

15	31	0	0	$0.00	$0.00
16	31	0	0	$0.00	$0.00
17	31	0	0	$0.00	$0.00
18	31	0	0	$0.00	$0.00
19	31	0	0	$0.00	$0.00
20	31	0	0	$0.00	$0.00
21	31	0	0	$0.00	$0.00
22	31	0	0	$0.00	$0.00
23	31	0	0	$0.00	$0.00
24	31	0	0	$0.00	$0.00
25	31	0	0	$0.00	$0.00
Total	**775**	**0**	**0**	**$25.33**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**31**	m^3/Bed

The savings associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds in a Nursing Home, resulting in savings per bed. See below for details.

One DWHR unit is connected to the dishwasher drain and used to preheat the water before the dishwasher water heater. A continuous flow dishwasher is used for the calculations.

The following are the characteristics used to estimate the drain water from the dishwashers:
Water Use per Meal:
= 9.1 (L/meal) * (1-70%) / (1-60%) [1]
= 6.8 (L/meal)
Average Nursing Home size: 107 beds [2]
Percentage of beds requiring meals: 75% [3]
Additional meals for staff: 20% [3]
Percentage of water use per meal for dishwashers: 80% [4]

$$Yearly\ Concurrent\ Drainwater\ Flow$$
$$= 6.8\ (L/meal) \times 3\ (meals/day) \times 365\ (days/year) \times 107\ (\frac{beds}{Nursing\ Home}) \times 75\%\ (beds\ requiring\ meals) \times 120\%\ (staff\ meals) \times 80\%$$
$$= 573{,}640\ (L/year)$$

The energy that can be recovered and therefore natural gas saved is calculated based on the following factors:
Yearly concurrent drain water flow: see above calculation
Drain water temperature for dishwasher: 77°C [1]
Domestic Cold Water Temperature: 9.33 °C [5]
DWHR unit effectiveness for noted piping configuration: 60% [6]
Standard Natural gas water heater efficiency: 78%

$$Natural\ Gas\ Saving\ (m^3) = \frac{573{,}640\ (L/year) \times 4.184\ (KJ/(Kg\ °C)) \times [77\ (°C) - 9.33\ (°C)] \times 60\ (\%)}{78\ (\%) \times 37230\ (KJ/m^3)}$$
$$= 3{,}356 (m^3/year)$$

31 m^3/yr = 3,356 m^3 / 107 Beds per facility

Annual Electricity Savings	**0**	KWh/Bed
N/A		
Annual Water Savings	**0**	L/Bed
N/A		

Other Input Assumptions

Effective Useful Life (EUL)	**25**	Years
The DWHR units have a useful life in excess of 25 years. [6]		
Base & Incremental Conservation Measure Equipment and O&M Cost	**25.33**	$/Bed
The costs associated with installing a DWHR system is calculated below. The value was calculated for an average facility and then divided by the average number of beds per facility, resulting in a cost per bed. DWHR unit cost: $1,030 [7] Installation: $1,680. This is calculated based on the materials, equipment and labour needed to install a unit, in an existing building, as estimated from RS Means. Maintenance: $0. DWHR is a passive technology and requires no maintenance similar to the piping systems that it is connected to.[8] $25.33 per Bed = ($1,030 + $1,680)/107 Beds per facility		
Customer Payback Period (Natural Gas Only)	**2.7**	Years
Simple payback period, based on a natural gas price of $0.30/m^3.		

$$Simple\ Payback\ Period\ = \frac{Incremental\ Cost}{Natural\ Gas\ Savings\ \times\ Natural\ Gas\ Cost}$$

$$= \frac{25.33(\$)}{31\ (m^3) \times 0.3\ (\$/m^3)} = 2.7\ (years)$$

References

[1] The 9.1 (L/meal) value originates from the ASHRAE Handbook 2007, HVAC Applications, Section 49 - Service Water Heating and is associated with a study from the 70's. This value was updated to reflect water use from middle-aged equipment as expected in existing buildings. Machines in existing buildings are expected to be typically 10 years old based on the equipment life of 20 years, which in-turn came from the Food Service Technology Center (FSTC) as cited in NGTC, DSM OPPORTUNITIES ASSOCIATED WITH COMMERCIAL DISHWASHERS, Final Report, April 27, 2009, pg 17.).

In order to take this into account, the 9.1 value was multiplied by one minus the 70% reduction in water use by Conveyor and Flight-Type machines since the 70's, then divided by one minus the 60% reduction in water-use of new machines vs. machines built 10 years ago. This data was gathered from a manufacturer (Suzanne Supplee - Champion Industries/BiLine) and Genevieve Bussieres from the Natural Gas Technology Centre (NGTC) quoting an NSF study

and conversations with Hobart (another manufacturer). The 70% reduction in water use value was chosen for this calculation based on the above sources (68% from Champion and 70-72% from NGTC's findings). The 60% reduction value was chosen based on the same sources (61% from Champion and 58% from NGTC's findings).

[2] American Health Care Association, Trends in Nursing Facility Characteristics, December 2009. Available at http://www.ahcancal.org/Pages/Default.aspx

[3] Grand River Hospital - Diet Office of the Nutrition/Food Service Department.

[4] Wexiodisk, Rack Conveyor Dishwasher, 2006. Available at www.wexiodisk.com

[5] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.

[6] RenewABILITY Energy Inc., RenewABILITY Inc. Product Presentation, Delivered at Enermodal Engineering on November 2, 2009

[7] RenewABILITY Energy Inc.

[8] Enermodal Engineering, Development of DSM Measures and Market Information on Commercial Drain Water Heat Recovery, Rev 1., March 31, 2010

ENERGY STAR DISHWASHERS

Commercial – New/Existing, UG & EGD

Efficient Technology & Equipment Description
Energy Star versions of (6) different types of Commercial Dishwashers: Undercounter Type – High Temperature (HT) Undercounter Type – Low Temperature (LT) Stationary Rack, (Door type, or Single rack) - HT Stationary Rack, (Door type, or Single rack) - LT Rack Conveyor, Single (Tank) – HT Rack Conveyor, Multi (Tank) - HT
Base Technology & Equipment Description
Non-Energy Star Dishwashers

Resource Savings Assumptions

Natural Gas	**See below**
Energy Savings were based on the results of NGTC study and savings calculator. NGTC racks or loads/day data for stationary Rack dishwashers was updated using UG territory data. The remaining load data came from FSTC & Energy Star. NGTC booster heater fuel type was updated to electric, due to popularity in Ontario. The idle energy rate & water use per rack values were adjusted by NGTC to represent an Energy Star dishwasher model that is not of average E-Star efficiency and not that just meets the minimum, but halfway in-between (25th percentile E-Star model, based on efficiency). **Assumptions[1]:** DW supply water temperature: 140°F (60°C) Temperature increase for building water heating: 90°F (50°C)[2] Natural gas water heater annual efficiency (recovery rate): 78%[3] Electric booster water heater efficiency: 96%[4] Wash water circulation temperature differential: 20°F (11°C)[5]. The 25th percentile E-Star models (in terms of efficiency) are sold more often than the average E-Star model.[6] Undercounter - HT **801 m3/yr** Undercounter - LT **326 m3/yr** Stationary Rack - HT **619 m3/yr** Stationary Rack - LT **841 m3/yr**	

[1] NGTC, DSM Opportunities Associated with Commercial Dishwashers, Final Report, April 27, 2009, Pg 13 and calculator, 100201_DSM_analysis_final - PK.xlsx.

[2] DHW DW supply – Water city average = 140°F-50°F = 90°F (60°C-10°C = 50°C).

[3] GAMA

[4] Minimum EF for a 5 gallon booster; 98% of boosters are electric (source: Steve Garvin, UG)

[5] Phone conversation with Joel Dipp from Hobart, worst case.

[6] As discussed with the EAC & UG during conversation, estimated, no data, April 2010.

Rack Conveyor Single – HT	**2,203 m3/yr**
Rack Conveyor Multi - HT	**3,708 m3/yr**

Electricity	**See below**

Electrical savings based on idle energy, pump energy, conveyor energy (where applicable), electric booster heater energy (for HT models). The assumptions above also apply.[7]

Undercounter - HT	**3,754 kWh/yr**
Undercounter - LT	**559 kWh/yr**
Stationary Rack - HT	**3,553 kWh/yr**
Stationary Rack - LT	**855 kWh/yr**
Rack Conveyor Single – HT	**9,811 kWh/yr**
Rack Conveyor Multi - HT	**15,822 kWh/yr**

Water	**See below**

Water savings is based on Energy Star Criteria, LBNL data, manufacturer wash tank capacity data, and associated differences in water use in wash & rinse cycles.[8]

Undercounter - HT	**112,795 L/yr**
Undercounter - LT	**45,891 L/yr**
Stationary Rack - HT	**87,119 L/yr**
Stationary Rack - LT	**118,369 L/yr**
Rack Conveyor Single – HT	**310,271 L/yr**
Rack Conveyor Multi - HT	**522,192 L/yr**

Other Input Assumptions

Equipment Life	**See below**

The equipment lifetime came from FSTC (Food Service Technology Centre) who contributed to the development of the Energy Star US calculator.[9],[10] No lifetime distinction was identified relative to the sanitation method (high or low temperature) or to the efficiency (Energy Star qualified or not) of the dishwashers.

Undercounter - HT	**10 yrs**
Undercounter - LT	**10 yrs**
Stationary Rack - HT	**15 yrs**
Stationary Rack - LT	**15 yrs**

[7] NGTC, DSM Opportunities Associated with Commercial Dishwashers, Final Report, April 27, 2009, Pg 13 and calculator, 100201_DSM_analysis_final - PK.xlsx.
[8] NGTC, DSM Opportunities Associated with Commercial Dishwashers, Final Report, April 27, 2009, Pg 14 and calculator, 100201_DSM_analysis_final - PK.xlsx.
[9] NGTC, DSM Opportunities Associated with Commercial Dishwashers, Final Report, April 27, 2009, Pg 17
[10] US Energy Star. Energy Star Program Requirements for Commercial Dishwashers. [On line]. September 2008. http://www.energystar.gov/ia/partners/product_specs/eligibility/comm_dishwashers_elig.pdf.

Rack Conveyor Single – HT **20 yrs** Rack Conveyor Multi - HT **20 yrs**	
Incremental Cost	**See below**
According to DW manufacturers and their sales representatives there is no distinguishable difference in installation costs between the base case & upgrade cases, therefore they were left out. NGTC updated their pricing to reflect the 25th percentile (in terms of efficiency) E-Star models because it was presumed to be sold more often than the average E-Star model.[11] List pricing was used because this analysis couldn't be done using the report's original pricing source because not enough information (pricing according to exact efficiency wasn't available). List prices for Energy Star (ES) and Non-ES models were obtained from manufacturers' lists when available and from online commercial dishwasher vendors such as dishwasherworld.com, greatdishwashers.com, restaurantequipment.net, foodservicewarehouse.com and retrevo.com. Undercounter - HT (-) **$13** Undercounter - LT (-) **$13** Stationary Rack - HT (-) **$350** Stationary Rack - LT (-) **$350** Rack Conveyor Single – HT **$2,375** Rack Conveyor Multi - HT **$288**	
Free Ridership	**See below**
Free Ridership is estimated using market share for Energy Star Dishwashers in UG territory.[12] Undercounter - HT **40%** Undercounter - LT **40%** Stationary Rack - HT **20%** Stationary Rack - LT **20%** Rack Conveyor Single – HT **27%** Rack Conveyor Multi - HT **27%**	

[11] As agreed upon with the EAC & UG, estimated, no data, April 9, 2010.
[12] NGTC, DSM Opportunities Associated with Commercial Dishwashers, Final Report, April 27, 2009, Pg 11

HIGH EFFICIENCY BOILERS – UNDER 300 MBTUH – DOMESTIC HOT WATER (DWH)

Commercial New & Existing Buildings, UG & EGD

Please see the High Efficiency Boiler under 300 MBtuH in the Commercial Space Heating section.

Pre-Rinse Spray Nozzle (1.24 GPM), UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description

Low-flow pre-rinse spray nozzle/valve (1.24 GPM)

Due to the variability in energy savings resulting from variability in daily water use, resource savings were calculated for three types of commercial enterprise using this technology[1]:

Scenario **A**: Full service restaurant

Scenario **B:** Limited service (fast food) restaurant

Scenario **C:** Other

Base Equipment and Technologies Description

Standard pre-rinse spray nozzle/valve (3.0 GPM)

Decision Type	Target Market(s)	End Use
Retrofit	Commercial (existing)	Water heating

Codes, Standards, and Regulations

N/A

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	**A:** 886 **B:** 190 **C:** 200	0	**A:** 170,326 **B:** 36,484 **C:** 38,383	60	0
2	**A:** 886 **B:** 190 **C:** 200	0	**A:** 170,326 **B:** 36,484 **C:** 38,383	0	0
3	**A:** 886 **B:** 190 **C:** 200	0	**A:** 170,326 **B:** 36,484 **C:** 38,383	0	0
4	**A:** 886 **B:** 190 **C:** 200	0	**A:** 170,326 **B:** 36,484 **C:** 38,383	0	0
5	**A:** 886 **B:** 190 **C:** 200	0	**A:** 170,326 **B:** 36,484 **C:** 38,383	0	0
TOTALS	**A:** 4,430 **B:** 950 **C:** 1,000	0	**A:** 851,630 **B:** 182,420 **C:** 191,915	**60**	**0**

[1] These bins are chosen based on empirical research conducted by Energy Profiles Ltd on behalf of Union Gas
Energy Profiles Ltd, *Deemed Savings for (Low Flow) Pre-Rinse Spray Nozzles*, January 2009

Resource Savings Assumptions

Annual Natural Gas Savings	**A:** 886 m^3 **B:** 190 m^3 **C:** 200 m^3

Assumptions and inputs:

- Average water inlet temperature: 9.33 ^oC (48.8 ^oF)[2]
- Average water heater set point temperature: 63 ^oC (145 ^oF)[3]
- Water heater thermal efficiency: 0.78[4]
- Percentage of water used that is hot: 69%[5]

Annual gas savings calculated as follows:

$$Savings = Ws * Phot * 8.33 * (T_{out} - T_{in}) * \frac{1}{Eff} * 10^{-6} * 27.8$$

Where:

Ws = Water savings (gallons)
Phot = Percentage of water used that is hot
T_{out} = Water heater set point temperature (^oF)
T_{in} = Water inlet temperature (^oF)
Eff = Water heater thermal efficiency
8.33 = Energy content of water (Btu/gallon/^oF)
10^{-6} = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to m^3

Gas savings were determined to be 59% over base equipment:

$$PercentSavings = \frac{(G_{base} - G_{eff})}{G_{base}}$$

Where:

Full service restaurant:
G_{eff} = Annual natural gas use with efficient equipment, 624 m^3
G_{base} = Annual natural gas use with base equipment, 1510 m^3

Limited service restaurant:
G_{eff} = Annual natural gas use with efficient equipment, 134 m^3
G_{base} = Annual natural gas use with base equipment, 323 m^3

Other:
G_{eff} = Annual natural gas use with efficient equipment, 141 m^3
G_{base} = Annual natural gas use with base equipment, 340 m^3

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[2] Cited in the following as personal communication with City of Toronto Works Dept.
VEIC, *Comments on Navigant's Draft Gas Measure Characterizations*, March 2009
[3] Average of temperatures found in a survey of restaurants in four Ontario municipalities.
Energy Profiles Ltd, *Deemed Savings for (Low Flow) Pre-Rinse Spray Nozzles*, January 2009
[4] Minimum thermal efficiency for compliance with ASHRAE 90.1 standard.
[5] Average of ratio found in a survey of restaurants in four Ontario municipalities.
Energy Profiles Ltd, *Deemed Savings for (Low Flow) Pre-Rinse Spray Nozzles*, January 2009

Annual Electricity Savings	0 kWh
N/A	
Annual Water Savings	**A:** 170,326 m^3 **B:** 36,484 m^3 **C:** 38,383 m^3

Assumptions and inputs:

- Veritec's 2008 Calgary Study found a 6% increase in average daily use after the introduction of a low-flow valve, but did not test the significance of this change. Navigant Consulting is therefore assuming that daily water use remains the same after the introduction of the efficient equipment.

Annual water savings calculated as follows:

$$Savings = (Fl_{base} - Fl_{eff}) * 60 * Hr * 365$$

Where:

Fl_{base} = Flow rate of base equipment (GPM)
Fl_{eff} = Flow rate of efficient equipment (GPM)
60 = Minutes per hour
Hr = Hours used per day
365 = Days per year

Water savings were determined to be 59% over base equipment:

$$PercentSavings = \frac{(W_{base} - W_{eff})}{W_{base}}$$

Where:

Full service restaurant:
W_{eff} = Annual water consumed with efficient equipment, 120,002 litres (31,694 gallons)
W_{base} = Annual water consumed by showers with base equipment: 290,329 litres (76,680 gallons)

Limited service restaurant:
W_{eff} = Annual water consumed with efficient equipment, 25,705 litres (6,789 gallons)
W_{base} = Annual water consumed by showers with base equipment: 62,189 litres (16,425 gallons)

Other:
W_{eff} = Annual water consumed with efficient equipment, 27,043 litres (7,142 gallons)
W_{base} = Annual water consumed by showers with base equipment: 65,426 litres (17,280 gallons)

Other Input Assumptions

Effective Useful Life (EUL)	**5 Years**
Studies conducted for the City of Calgary[6], the U.S. DOE's FEMP[7] and by Puget Sound Energy[8] all give EUL for this measure as five years.	
Base & Incremental Conservation Measure Equipment and O&M Costs	**60 $**
Incremental cost based on a survey of online retailers[9].	
Customer Payback Period (Natural Gas Only)[10]	**0.1-0.6 Years**
Using a 5-year average commodity cost (avoided cost)[11] of \$0.38 / m^3 and an average commercial distribution cost[12] of \$0.12 / m^3, the payback period for natural gas savings is determined to be between 0.1 and 0.6 years, based on the following: Scenario A Payback Period = Incremental cost / (natural gas savings x natural gas cost) = \$60/ (886 m^3/year * \$0.50 / m^3) = 0.1 years Scenario B Payback Period = Incremental cost / (natural gas savings x natural gas cost) = \$60/ (190 m^3/year * \$0.50 / m^3) = 0.6 years Scenario C Payback Period = Incremental cost / (natural gas savings x natural gas cost) = \$60/ (200 m^3/year * \$0.50 / m^3) = 0.6 years	
Market Penetration[13]	**Low**
Although 1.6 GPM spray nozzles have a high penetration in one jurisdiction (Washington State[14] – 70%) and a medium penetration in another (Iowa[15] – 45%), no figures were uncovered for 1.24 GPM spray nozzles. Given the relative novelty of this newer, lower flow rate spray nozzle, Navigant Consulting estimates the penetration in Ontario to be low.	

[6] Ibid.
[7] U.S. DOE, Federal Energy Management Program, *How to Buy a Low-Flow Pre-Rinse Spray Valve* http://www1.eere.energy.gov/femp/pdfs/prerinsenozzle.pdf
[8] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy
[9] T & S Brass (B-0107-C35) - JetSpray 1.24 GPM low flow spray valve http://www.foodservicewarehouse.com/t-s-brass/b-0107-c35/p345921.aspx?source=googleps
[10] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.
[11] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.
[12] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).
[13] Navigant Consulting is defining "Low" as below 5%, "Medium" as between 5-50%, and "High" as above 50%,
[14] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy
[15] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
City of Calgary, 2008[16]	469	5	0 (City installed)	N/A
Comments Daily mean use estimated to be 47 minutes before measure installed and 50 minutes with the efficient measure installed. On-site water use data reveal an even mix of hot and cold water used. Average flow rate of base equipment was found to be 3 GPM, while the average flow rate after efficient equipment installed was found to be 1.1 GPM. No indication given of percentage savings or base natural gas consumption for water heating.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/Market Share**
U.S. Department of Energy, Federal Energy Management Program[17]	2,021	5	N/A	N/A
Comments Assumptions: four hours of use per day, switch from a 3.0 GPM pre-rinse spray valve to a 1.6 GPM pre-rinse spray valve. Measure provides savings of 47% over 4,340 m3 required for heating water used with base equipment.				

[16] Veritec Consulting (2008) http://www.calgary.ca/docgallery/bu/water_services/conservation/indoor/calgary_pre_rinse_report.pdf

[17] U.S. DOE, Federal Energy Management Program, *How to Buy a Low-Flow Pre-Rinse Spray Valve* http://www1.eere.energy.gov/femp/pdfs/prerinsenozzle.pdf

PRE-RINSE SPRAY NOZZLE (0.64 GPM)

Commercial New, EGD

Efficient Technology & Equipment Description
Low-flow pre-rinse spray nozzle/valve (0.64 GPM)
Base Technology & Equipment Description
Standard pre-rinse spray nozzle/valve (3.0 GPM)

Resource Savings Assumptions

Natural Gas	**See below m^3**

Market Segment	**Natural Gas** (m^3/yr
Full Dining Establishments	1,286
Limited Service Establishments	339
Other Establishments	318

A field study was undertaken at 37 sites across 4 regions in Union Gas territory. Measurements of water pressure, incoming and leaving (at both burner On and Off setpoints) water temperature at the water heater and supplied to the pre-rinse spray valve, details of the make, model and type of water heater, and type of food service establishment, were collected at each site.

Flow rate vs. pressure curves for high-flow and nominal 0.64 USgpm pre-rinse spray valves (PRSV) were developed from the Veritec studies in Waterloo[1] and Calgary[2]. An average flow rate vs pressure curve for high-flow PRSVs was developed from the Veritec Waterloo study.

Water savings were evaluated for each region based on the difference between the flow rates of the high-flow and low-flow PRSV at the average measured water pressure, and the average usage of the PRSV for each of 3 food service establishmentc types from the Veritec studies in Waterloo and Calgary.

Natural gas savings were determined using the US-DOE WHAM[3] model to establish water heater efficiency. Inputs to the model from site measurements included the average cold water and hot water setpoint temperatures for each region. Additional inputs to the model included water heater energy factor and rated water heater input (both average for the region), ambient air temperature (assumed at 70°F), and average daily volume of hot water. This last item was determined from a combination of research undertaken by FSTC[4], and ASHRAE[5] recommendations, for each food service establishment type. The proportion of hot water delivered to the PRSV was determined from the average measured mixed water temperature for each region. Operating times are not
expected to be different between 1.24 & 0.64 (Bricor model B064) USgpm models based on cleanability times of 20-21 seconds according to the FTSC[6].
Resource Savings are not dependent on Decision Type, i.e., New or Existing facilities

[1] "Region of Waterloo – Pre-Rinse Spray Valve Pilot Study – Final Report", Veritec Consulting Inc., January 2005
[2] "City of Calgary" – Pre-Rinse Spray Valve Pilot Study – Final Report", Veritec Consulting Inc., December 2005.
[3] Appendix D-2. Water Heater Analysis Model. Water Heater Rulemaking Technical Support Documents. http://www1.eere.energy.gov/buildings/appliance_standards/residential/waterheat_0300_r.html
[4] Charles Wallace and Don Fisher Energy Efficiency Potential of Gas-Fired Commercial Hot Water Heating Systems in Restaurants. FSTC April 2007
[5] ASHRAE Handbook 2007HVAC Applications. Chapter 49
[6] pg 32 & 37 "Deemed Savings for (Low Flow) Pre-Rinse Spray Nozzles" by Energy Profiles, January 30, 2009.

Electricity	0 kWh

Water	See below L

Market Segment	Water (L)[6]
Full Dining Establishments	252,000
Limited Service Establishments	66,400
Other Establishments	62,200

Assumptions and inputs:

- Water savings were evaluated for 3 food service establishment types: Full Service Restaurants, Limited Service Restaurants, and Other
- The PRSV water usage was based on the 2 Veritec studies, and incorporated the measured differences in usage time for the high-flow and low-flow PRSVs.

Resource Savings are not dependent on Decision Type, i.e., New or Existing facilities

Other Input Assumptions

Equipment Life	5 years
As per EB 2008-0346 Decision Commercial Existing facilities.	

Incremental Cost (Cust. / Contr. Install)	$150

$88 = ($50/pc* + $1/pc* shipping USD) x 1.28901** exchange rate + $22 installation***

*estimated by Bricor, March 2, 2009

**Exchange rate from March 2, 2009 - http://www.xe.com/ucc/convert.cgi

***estimated installation from Seattle Utilities ($21-23/pc), based on conversation with Bricor, March 2, 2009

Free Ridership	0 %
Basis: Relatively new product probably only aware of one manufacturer (Bricor).	

PRE-RINSE SPRAY NOZZLE (0.64 GPM)

Commercial, Existing, UG & EGD

Efficient Technology & Equipment Description
Low-flow pre-rinse spray nozzle/valve (0.64 GPM)
Base Technology & Equipment Description
Standard pre-rinse spray nozzle/valve (3.0 GPM)

Resource Savings Assumptions

Natural Gas	**See below m^3**

Market Segment	**Natural Gas** (m^3/yr
Full Dining Establishments	1,286
Limited Service Establishments	339
Other Establishments	318

A field study was undertaken at 37 sites across 4 regions in Union Gas territory. Measurements of water pressure, incoming and leaving (at both burner On and Off setpoints) water temperature at the water heater and supplied to the pre-rinse spray valve, details of the make, model and type of water heater, and type of food service establishment, were collected at each site.

Flow rate vs. pressure curves for high-flow and nominal 0.64 USgpm pre-rinse spray valves (PRSV) were developed from the Veritec studies in Waterloo[3] and Calgary[4]. An average flow rate vs pressure curve for high-flow PRSVs was developed from the Veritec Waterloo study.

Water savings were evaluated for each region based on the difference between the flow rates of the high-flow and low-flow PRSV at the average measured water pressure, and the average usage of the PRSV for each of 3 food service establishment types from the Veritec studies in Waterloo and Calgary.

Natural gas savings were determined using the US-DOE WHAM[5] model to establish water heater efficiency. Inputs to the model from site measurements included the average cold water and hot water setpoint temperatures for each region. Additional inputs to the model included water heater energy factor and rated water heater input (both average for the region), ambient air temperature (assumed at 70°F), and average daily volume of hot water. This last item was determined from a combination of research undertaken by FSTC[6], and ASHRAE[7] recommendations, for each food service establishment type. The proportion of hot water delivered to the PRSV was determined from the average measured mixed water temperature for each region. Operating times are not
expected to be different between 1.24 & 0.64 (Bricor model B064) USgpm models based on cleanability times of 20-21 seconds according to the FTSC[8].

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3 "Region of Waterloo – Pre-Rinse Spray Valve Pilot Study – Final Report", Veritec Consulting Inc., January 2005

4 "City of Calgary" – Pre-Rinse Spray Valve Pilot Study – Final Report", Veritec Consulting Inc., December 2005.

5 Appendix D-2. Water Heater Analysis Model. Water Heater Rulemaking Technical Support Documents. http://www1.eere.energy.gov/buildings/appliance_standards/residential/waterheat_0300_r.html

6 Charles Wallace and Don Fisher Energy Efficiency Potential of Gas-Fired Commercial Hot Water Heating Systems in Restaurants. FSTC April 2007

7 ASHRAE Handbook 2007HVAC Applications. Chapter 49

8 pg 32 & 37 "Deemed Savings for (Low Flow) Pre-Rinse Spray Nozzles" by Energy Profiles, January 30, 2009.

Electricity	**0 kWh**

Water	**See below L**

Market Segment	Water (L)[8]
Full Dining Establishments	252,000
Limited Service Establishments	66,400
Other Establishments	62,200

Assumptions and inputs:

- Water savings were evaluated for 3 food service establishment types: Full Service Restaurants, Limited Service Restaurants, and Other
- The PRSV water usage was based on the 2 Veritec studies, and incorporated the measured differences in usage time for the high-flow and low-flow PRSVs.

Other Input Assumptions

Equipment Life	**5 years**

This is consistent with other studies[9,10]

Incremental Cost (Cust. / Contr. Install)	**$150**

Equipment cost: $100 (utility bulk price).

Installation cost: $50 (Contracted price with third-party installer).

Free Ridership	**0 %**

Relatively new product; currently only aware one manufacturer. Propose 0% free ridership.

[9] CEE Commercial Kitchens Initiative - Program Guidance on Pre-Rinse Spray Valves

[10] Enbridge market survey of average usage

Pre-Rinse Spray Nozzle (0.64 GPM)

Commercial – Existing Market,UG & EGD

Efficient Equipment and Technologies Description
Low-flow pre-rinse spray nozzle/valve (0.64 GPM) Due to the variability in energy savings resulting from variability in daily water use, resource savings were calculated for three types of commercial enterprise using this technology[25]: Scenario **A**: Full service restaurant Scenario **B:** Limited service (fast food) restaurant Scenario **C:** Other

Base Equipment and Technologies Description
Less efficient pre-rinse spray nozzle/valve (1.6 GPM)

Decision Type	Target Market(s)	End Use
Retrofit	Commercial (existing)	Water heating

Codes, Standards, and Regulations

N/A

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	**A:** 457 **B:** 90 **C:** 109	0	**A:** 97,292 **B:** 19,197 **C:** 23,166	150	0
2	**A:** 457 **B:** 90 **C:** 109	0	**A:** 97,292 **B:** 19,197 **C:** 23,166	0	0
3	**A:** 457 **B:** 90 **C:** 109	0	**A:** 97,292 **B:** 19,197 **C:** 23,166	0	0
4	**A:** 457 **B:** 90 **C:** 109	0	**A:** 97,292 **B:** 19,197 **C:** 23,166	0	0
5	**A:** 457 **B:** 90 **C:** 109	0	**A:** 97,292 **B:** 19,197 **C:** 23,166	0	0
TOTALS	**A:** 2,284 **B:** 451 **C:** 544	**0**	**A:** 486,462 **B:** 95,987 **C:** 115,829	**150**	**0**

[25] These bins are chosen based on empirical research conducted by Energy Profiles Ltd on behalf of Union Gas Energy Profiles Ltd, *Deemed Savings for (Low Flow) Pre-Rinse Spray Nozzles*, January 2009

Resource Savings Assumptions

Annual Natural Gas Savings	**A:** 457 m^3 **B:** 90 m^3 **C:** 109 m^3

Assumptions and inputs:

- Average water inlet temperature: 14.5 ^oC (58 ^oF)[26]
- Average food service water heater set point temperature: 63 ^oC (145 ^oF)[27]
- Water heater thermal efficiency: 0.78[28]
- Percentage of water used that is hot: 69%[29]

Annual gas savings calculated as follows:

$$Savings = Ws * Phot * 8.33 * (T_{out} - T_{in}) * \frac{1}{Eff} * 10^{-6} * 27.8$$

Where:

Ws = Water savings (gallons)
Phot = Percentage of water used that is hot
T_{out} = Water heater set point temperature (^oF)
T_{in} = Water inlet temperature (^oF)
Eff = Water heater thermal efficiency
8.33 = Energy content of water (Btu/gallon/^oF)
10^{-6} = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to m^3

Gas savings were determined to be 60% over base equipment:

$$Percent\,Savings = \frac{(G_{base} - G_{eff})}{G_{base}}$$

Where:

Full service restaurant:
G_{eff} = Annual natural gas use with efficient equipment, 305 m^3
G_{base} = Annual natural gas use with base equipment, 761 m^3

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[26] A simple average of Toronto inlet temperature, cited in the following as personal communication with City of Toronto Works Dept.
VEIC, *Comments on Navigant's Draft Gas Measure Characterizations*, March 2009, and the average inlet water temperatures found in four jurisdictions examined as part of the following study: Energy Profiles Ltd, *Deemed Savings for (Low Flow) Pre-Rinse Spray Nozzles*, January 2009

[27] Average of temperatures found in a survey of restaurants in four Ontario municipalities.
Energy Profiles Ltd, *Deemed Savings for (Low Flow) Pre-Rinse Spray Nozzles*, January 2009
[28] Minimum thermal efficiency for compliance with ASHRAE 90.1 standard.
[29] Average of ratio found in a survey of restaurants in four Ontario municipalities.
Energy Profiles Ltd, *Deemed Savings for (Low Flow) Pre-Rinse Spray Nozzles*, January 2009

Limited service restaurant:
G_{eff} = Annual natural gas use with efficient equipment, 60 m^3
G_{base} = Annual natural gas use with base equipment, 150 m^3

Other:
G_{eff} = Annual natural gas use with efficient equipment, 73 m^3
G_{base} = Annual natural gas use with base equipment, 181 m^3

Annual Electricity Savings	0 kWh
N/A	
Annual Water Savings	**A:** 97,292 L **B:** 19,197 L **C:** 23,166 L

Assumptions and inputs:

- The study by Energy Profiles Ltd cited above measured average daily use for each facility examined before and after a 3.0 GPM nozzle was replaced with a 1.24 GPM nozzle. The difference in average usage time by facility, before and after replacement was tested by Navigant Consulting and found to be not statistically significant. Additionally, the same study reports that its findings suggest no difference in the duration of use between a 0.64 GPM nozzle and a 3.0 GPM nozzle. Given these results, Navigant Consulting has assumed that duration of use will be identical before and after replacement.
- From the Energy Profiles Ltd. study cited above, the following average durations of use were calculated:

  Full-service restaurant: 1.26 hours per day.
  Limited-service restaurant: 0.24 hours per day
  Other: 0.33 hours per day
- The average numbers of days of operation per year for each restaurant type were drawn from the Energy Profiles Ltd. report. They are:

  Full-service restaurant: 355 days per year.
  Limited-service restaurant: 365 days per year.
  Other: 320 days per year.

Annual water savings calculated as follows:

$$Savings = (Fl_{base} - Fl_{eff}) * 60 * Hr * Days$$

Where:

Fl_{base} = Flow rate of base equipment (GPM)
Fl_{eff} = Flow rate of efficient equipment (GPM)
60 = Minutes per hour
Hr = Hours used per day
Days = Days per year

Water savings were determined to be 60% over base equipment:

$$Percent\,Savings = \frac{(W_{base} - W_{eff})}{W_{base}}$$

Where:

Full service restaurant:

W_{eff} = Annual water consumed with efficient equipment, 64,862 litres

W_{base}= Annual water consumed by showers with base equipment: 162,154 litres

Limited service restaurant:

W_{eff} = Annual water consumed with efficient equipment, 12,798 litres

W_{base}= Annual water consumed by showers with base equipment: 31,996 litres

Other:

W_{eff} = Annual water consumed with efficient equipment, 15,444 litres

W_{base}= Annual water consumed by showers with base equipment: 38,610 litres

Other Input Assumptions

Effective Useful Life (EUL)	5 Years
Studies conducted for the City of Calgary[30], the U.S. DOE's FEMP[31] and by Puget Sound Energy[32] all give EUL for this measure as five years.	
Base & Incremental Conservation Measure Equipment and O&M Costs	**$150**
Equipment cost: $100 (utility bulk price). Installation cost: $50 (Contracted price with third-party installer).	
Free Ridership	**0%**
Basis: Relatively new product probably only aware of one manufacturer (Bricor).	

[30] Ibid.

[31] U.S. DOE, Federal Energy Management Program, *How to Buy a Low-Flow Pre-Rinse Spray Valve* http://www1.eere.energy.gov/femp/pdfs/prerinsenozzle.pdf

[32] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy

HIGHER EFFICIENCY BOILERS – DOMESTIC WATER HEATING

Existing and New Commercial and Multi- Residential, UG & EGD

Efficient Technology & Equipment Description
Hydronic Boilers for water heating (Non Seasonal)
Base Technology & Equipment Description
80% Combustion Efficiency Domestic Water Heating Boiler

Resource Savings Assumptions

Natural Gas (Updated)

Boiler Size	Domestic Water Heating (Non Seasonal) M3 Savings by Combustion Efficiency 83-84%	85-88%
300 MBH	1,075	1,766
600 MBH	1,777	2,290
1,000 MBH	3,136	5,155
1,500 MBH	4,317	7,095

Source: Prescriptive Commercial Boiler Program – Prescriptive Savings Analysis – Agviro Report Sept 10, 2008.

An iterative approach was used to determine the annual savings in the commercial sector. The following steps were taken:
a. The Rate 6 accounts were subdivided into bins of annual gas use. This provided the annual average gas use, number of accounts, seasonal, non-seasonal and total gas use.
b. The seasonal portion of the annual gas use was normalized to 30 year weather data. This normalized gas use was correlated to a seasonal boiler size required for gas consumption.
c. Categories of boiler sizes were selected to provide a suitable range of boilers available within the sector.
d. The Rate 6 accounts were subdivided using the normalized average seasonal gas use for the respective categories of boilers selected. This provided the annual average gas use, number of accounts, and total gas use per seasonal boiler size category.
e. Seasonal annual gas use normalization of the boiler size category accounts was completed.
f. Annual seasonal efficiency of the boiler size categories for each of the combustion efficiency ranges was determined.
g. Boiler costs for the boiler size categories was compiled.
h. A TRC analysis was completed for each of the boiler size categories.
i. A similar approached was used for the non-seasonal gas use with the exception of normalizing the data.

Electricity (Updated)	**kWh**

Water	**L**

Other Input Assumptions

Equipment Life	**25**	**years**
As per EB 2008-0384 & 0385		
Incremental Cost (Contr. Install)	**Boiler Size** **300 MBH** **600 MBH** **1,000 MBH** **1,500 MBH**	**Domestic Water Heating (Non Seasonal) Incremental Cost by Combustion Efficiency** **83-84% 85-88%** **\$3,900 \$ 4,500** **\$5,800 \$ 6,000** **\$7,400 \$10,300** **\$5,900 \$ 7,400**
Source: Prescriptive Commercial Boiler Program – Prescriptive Savings Analysis – Agviro Report Sept 10, 2008.		
Free Ridership	**Enbridge** **Small Commercial 10%** **Large Commercial 12%** **Multi-Family 20%**	
As per EB 2008-0384 – 0385		

TANKLESS WATER HEATER

Commercial – New/Existing, UG & EGD

Efficient Technology & Equipment Description
Tankless Water Heater (84% thermal efficiency (77% adjusted thermal efficiency), where approximately 50-150 USG/day will be used.
Base Technology & Equipment Description
Conventional storage tank gas water heater (thermal efficiency[1]=80%), 91 gallons.

Resource Savings Assumptions

Natural Gas	**154 m^3**
As approved in EB-2008-0346, Tankless Water Heater – Commercial, Decision Type: New. Resource savings are not dependent on Decision Type.	
Electricity	**n/a kWh**
Water	**n/a L**

Other Input Assumptions

Equipment Life	**18 years**
As approved in EB-2008-0346, Tankless Water Heater – Commercial, Decision Type: New. Equipment life is not dependent on Decision Type	
Incremental Cost (Cust. / Contr. Install)	**$-1,102**
As approved by EB-2008-0346, Tankless Water Heater – Commercial, Decision Type: New. Incremental Cost is not dependent on Decision Type	
Free Ridership	**2 %**
Free-ridership rate as per EB-2008-0384 and 0385	

Multi-Family Water Heating

CEE Tier 2 Front-Loading Clothes Washer, UG & EGD

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description

CEE Tier 2 high efficiency front load washers for application in the Multi-Family sector (MEF[1]=2.20 , WF[2]=5.1, tub size = 2.8 ft^3)

Base Equipment and Technologies Description

Conventional top loading vertical axis washers (MEF = 1.26, WF=9.5, tub size = 2.8 ft^3)

Decision Type	Target Market(s)	End Use
New/Replacement	Multi-Family	Water heating

Codes, Standards, and Regulations

NRCan Federal Energy Efficiency Regulations require:

- Top loading washers are required to have a minimum MEF of 1.26 and a maximum tub size of 3.5 cubic feet.
- Front loading washers are required to have a minimum MEF of 1.26 and a maximum tub size of 4 cubic feet.

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	117	396	58,121	$1,450	$850
2	117	396	58,121	0	0
3	117	396	58,121	0	0
4	117	396	58,121	0	0
5	117	396	58,121	0	0
6	117	396	58,121	0	0
7	117	396	58,121	0	0
8	117	396	58,121	0	0
9	117	396	58,121	0	0
10	117	396	58,121	0	0
11	117	396	58,121	0	0
TOTALS	**1,287**	**4,356**	**639,331**	$1,450	$850

[1] Modified Energy Factor.
[2] Water Factor: the number of gallons per load cycle per cubic foot that the clothes washer uses. The lower the water factor, the more efficient the washer is.

Resource Savings Assumptions

Annual Natural Gas Savings	117 m^3

Assumptions and inputs:

- Percentage of water used by base equipment which is hot water: 17%.
- Percentage of water used by efficient equipment which is hot water: 10%[3]
- Average water inlet temperature: 9.33 ^oC (48.8 ^oF)[4]
- Average water heater set point temperature: 54 ^oC (130 ^oF)[5]
- Water heater thermal efficiency: 0.78[6]
- Gas use per cycle[7] for commercial gas dryer with base equipment: 0.138 m^3
- Gas use per cycle for commercial gas dryer with CEE Tier 2 clothes washer: 0.96 m^3
- Gas dryer penetration in Ontario Multi-Family market: 25.5%[8]
- Annual gas savings from reduced dryer use: 13 m^3
- Annual gas savings from reduced hot water use: 103 m^3

Annual gas savings calculated as follows:

$$Savings = \left[\left(W_{base} * Hot_{base} - W_{eff} * Hot_{eff}\right) * 8.33 * \frac{1}{Eff} * \left(T_{out} - T_{in}\right) + \left(Dr_{base} - Dr_{eff}\right) * Pene \right] * 10^{-6} * 27.8$$

Where:

W_{base} = Annual water use with base equipment (gallons)
W_{eff} = Annual water use with efficient equipment (gallons)
Hot_{base} = Percentage of water used that's hot with base equipment
Hot_{eff} = Percentage of water used that's hot with efficient equipment
8.33 = Energy content of water (Btu/gallon/^oF)
Eff = Eff = Water heater thermal efficiency
T_{out} = Water heater set point temperature (^oF)
T_{in} = Water inlet temperature (^oF)
Dr_{base} = Annual dryer gas use with base equipment (Btu)
Dr_{eff} = Annual dryer gas use with efficient equipment (Btu)
Pene = Penetration rate of natural gas powered clothes dryers in Ontario
10^{-6} = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to m^3

Gas savings were determined to be 66% over base equipment.

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[3] Base equipment uses 4.4 gallons of hot water per cycle, efficient equipment uses 1.4 gallons of hot water per cycle. U.S. DOE Federal Energy Management Program, Life-Cycle and Cost and Payback Period spreadsheet, http://www1.eere.energy.gov/buildings/appliance_standards/commercial/clothes_washers.html

[4] Chinnery, Glen. *Policy Recommendations for the HERS Community to Consider regarding HERS point credit for Waste Water Heat Recovery Devices,*EPA, Energy Star for homes, March 2004 http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/Waste_Water_Heat_Recovery_Guidelines.pdf

[5] As suggested by NRCan: http://oee.nrcan.gc.ca/residential/personal/new-homes/water-conservation.cfm?attr=4

[6] Minimum thermal efficiency for compliance with ASHRAE 90.1 standard.

[7] U.S. DOE Federal Energy Management Program, National Energy Savings and Shipments spreadsheet http://www1.eere.energy.gov/buildings/appliance_standards/commercial/clothes_washers.html

[8] Average residential penetration rate of gas dryers in Union and Enbridge territories. The commercial/Multi-Family clothes dryers is likely to be slightly higher. Enbridge Gas Distribution, *Enbridge Gas Distribution to the Ontario Power Authority in the matter of the province's energy supply mix,* August 26, 2005. http://www.energy.gov.on.ca/opareport/Part%205%20-%20Submissions%20and%20Presentations/5.1%20Written%20Submissions%20to%20the%20Supply%20Mix%20Project/Enbridge_Gas_Distribution_Supply_Mix_Submission_Aug_26_2005.pdf

$$PercentSavings = \frac{(G_{base} - G_{eff})}{G_{base}}$$

Where:

G_{eff} = Annual natural gas use with efficient equipment, 73 m^3
G_{base} = Annual natural gas use with base equipment, 176 m^3

Annual Electricity Savings	396 kWh

Assumptions and inputs:

- Water heated by natural gas (see above).
- Washer electricity use per cycle, base equipment: 0.13 kWh[9].
- Washer electricity use per cycle, efficient equipment: 0.11 kWh.
- Dryer electricity use per cycle, base equipment: 1.3 kWh.
- Dryer electricity use per cycle, efficient equipment: 0.9 kWh.
- Average number of cycles per year for clothes washer serving Multi-Family: 1,246 cycles[10].

Annual electricity savings calculated as follows:

$$Savings = [(Wa_{base} - Wa_{eff}) + (Dr_{base} - Dr_{eff}) * (1 - Pene)] * Cyc$$

Where:

Wa_{base} = Washer electricity use per cycle, base equipment (kWh)
Wa_{eff} = Washer electricity use per cycle, efficient equipment (kWh)
Dr_{base} = Dryer electricity use per cycle, base equipment (kWh)
Dr_{eff} = Dry electricity use per cycle, efficient equipment (kWh)
Pene = Penetration rate of natural gas powered clothes dryers in Ontario
Cyc = Average number of cycles per year machine is used

Electricity savings were determined to be 29% over base equipment:

$$Percent\ Savings = \frac{(Elec_{base} - Elec_{new})}{Elec_{base}}$$

Where:

$Elec_{eff}$ = Annual natural gas use with efficient equipment, 973 kWh
$Elec_{base}$ = Annual natural gas use with base equipment, 1,369 kWh

Annual Water Savings	58,121 L

Assumptions and inputs:

- Water use per cycle, base equipment: 101 litres (26.6 gallons).
- Water use per cycle, new technology: 54 litres (14.3 gallons).
- Average number of cycles per year for clothes washer serving Multi-Family: 1,246 cycles[11]

[9] U.S. DOE Federal Energy Management Program, Life-Cycle and Cost and Payback Period spreadsheet, http://www1.eere.energy.gov/buildings/appliance_standards/commercial/clothes_washers.html
[10] U.S. DOE Federal Energy Management Program, National Energy Savings and Shipments spreadsheet http://www1.eere.energy.gov/buildings/appliance_standards/commercial/clothes_washers.html
[11] Ibid.

Annual water savings calculated as follows:

$$Savings = \left(W_{base} - W_{eff}\right) * Cyc$$

Where:

W_{base} = Annual water use with base equipment (gallons or litres)
W_{eff} = Annual water use with efficient equipment (gallons or litres)
Cyc = Average number of cycles per year machine is used

Water savings were determined to be 46% over base measure:

$$PercentSavings = \frac{\left(W_{base} - W_{eff}\right)}{W_{base}}$$

Where:

W_{eff} = Annual water consumed with efficient equipment, 67,368 litres (17,793 gallons).
W_{base} = Annual water consumed by showers with base equipment: 125,489 litres (33,144 gallons).

Other Input Assumptions

Effective Useful Life (EUL)	11 Years
The U.S. DOE's Federal Energy Management Program has determined that commercial/Multi-Family clothes washers have an average EUL of 11.25 years[12]. Navigant Consulting recommends adopting an EUL of 11 years.	
Base & Incremental Conservation Measure Equipment and O&M Costs	**600 $**
Incremental cost based on prices offered online by a local retailer[13] and that given by Enbridge.	
Customer Payback Period (Natural Gas Only)[14]	**10 Years**
Using a 5-year average commodity cost (avoided cost)[15] of \$0.38 / m^3 and an average commercial distribution cost[16] of \$0.12 / m^3, the payback period for natural gas savings is determined to be 10 years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = \$600/ (117 m^3/year * \$0.50 / m^3) = 10 years	
Market Share[17]	**Medium/Low**
Based on the observation of high market penetration of Energy Star qualified washers in two other jurisdictions (Washington State[18] – 48%, Iowa[19] – 72%) but the paucity of washers available from online	

12 Ibid.
13 Base measure (3.5 cu/ft top loader, GE): \$850 www.homedepot.ca. Assuming the base equipment cost/ efficient equipment cost ratio of the two 3.5 cu/ft washers is equivalent to that of two 2.8 cu/ft washers.
14 Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.
15 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.
16 Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).
17 Navigant Consulting is defining "Low" as below 5%, "Medium" as between 5-50%, and "High" as above 50%,

retailers with specifications sufficient to qualify for CEE Tier 2 Navigant Consulting estimates the penetration in Ontario to be medium to low.

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Puget Sound Energy, 2007[20]	70	14	600	48%
Comments No explicit assumptions made about base and efficient equipment for commercial clothes washers. For residential clothes washers, assumptions: base equipment, MEF = 1.0, efficient equipment, Energy Star Clothes Washer, MEF = 1.8. Measure saves 13% of 539 m^3 required for water heating.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/Market Share**
Efficiency Vermont, 2005[21]	20	14	$750	N/A
Comments Cost is reported as the full cost of the energy efficient equipment rather than the incremental cost. Savings calculated are per customer basis rather than a per machine basis. No indication given of percentage savings or base natural gas consumption for water heating.				

[18] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy
[19] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2
[20] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy
[21] Efficiency Vermont, Technical Reference User Manual (TRM) No. 2005 - 37

ENERGY STAR CLOTHES WASHER

Multi-Family – New/Existing, UG

Efficient Technology & Equipment Description
Energy Star high efficiency front load washers for application in the Multi-Family sector (MEF=1.72 ,WF=8.0, tub size = 2.8 ft)[1]
Base Technology & Equipment Description
Conventional top loading vertical axis washers (MEF = 1.26, WF=9.5, tub size = 2.8 ft)[2]

Resource Savings Assumptions

Natural Gas	**76 m^3**

Assumptions and inputs:

- Percentage of water used by base equipment which is hot water: 17%.
- Percentage of water used by efficient equipment which is hot water: 10%
- Average water inlet temperature: 9.33 degC (48.8 degF)
- Average water heater set point temperature: 54 degC (130 degF)
- Water heater thermal efficiency: 0.78
- Gas use per cycle[7] for commercial gas dryer with base equipment: 0.138 m3
- Gas use per cycle for commercial gas dryer with Energy Star clothes washer: 0.117 m3
- Gas dryer penetration in Ontario Multi-Family market: 25.5%
- Annual gas savings from reduced dryer use: 7 m3
- Annual gas savings from reduced hot water use: 69[3] m3

Annual gas savings calculated as follows:

$$Savings = \left[\left(W_{base} * Hot_{base} - W_{eff} * Hot_{eff} \right) * 8.33 * \frac{1}{Eff} * \left(T_{out} - T_{in} \right) + \left(Dr_{base} - Dr_{eff} \right) * Pene \right] * 10^{-6} * 27.8$$

Where:

W_{base} = Annual water use with base equipment (gallons)
W_{eff} = Annual water use with efficient equipment (gallons)
Hot_{base} = Percentage of water used that's hot with base equipment
Hot_{eff} = Percentage of water used that's hot with efficient equipment
8.33 = Energy content of water (Btu/gallon/ degF)
Eff = Eff = Water heater thermal efficiency
T_{out} = Water heater set point temperature (degF)
T_{in} = Water inlet temperature (degF)
Dr_{base} = Annual dryer gas use with base equipment (Btu)
Dr_{eff} = Annual dryer gas use with efficient equipment (Btu)
Pene = Penetration rate of natural gas powered clothes dryers in Ontario
10^-6 = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to m3

Gas savings were determined to be 43% over base equipment.[1]

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[1] Navigant Report, pg B-233 MEASURES AND ASSUMPTIONS FOR DEMAND SIDE MANAGEMENT (DSM) PLANNING APPENDIX C: SUBSTANTIATION SHEETS – April 16, 2009

[2] Ibid.

[3] Corrected from Navigant's original value (73), based completely on Navigant's own calculation methodology & input assumptions. "E-star comml clothes washer - Navigant calculations check - April 29 2010 - 1137am.xlsx"

$$PercentSavings = \frac{(G_{base} - G_{eff})}{G_{base}}$$

Where:
G_{eff} = Annual natural gas use with efficient equipment, 104 m3[4]
G_{base} = Annual natural gas use with base equipment, 180 m3[5]

Electricity	**201 kWh**

Assumptions and inputs:

- Water heated by natural gas (see above).
- Washer electricity use per cycle, base equipment: 0.13 kWh.
- Washer electricity use per cycle, efficient equipment: 0.11 kWh.
- Dryer electricity use per cycle, base equipment: 1.3 kWh.
- Dryer electricity use per cycle, efficient equipment: 1.11 kWh.
- Average number of cycles per year for clothes washer serving Multi-Family: 1246 cycles.

Annual electricity savings calculated as follows:

$$Savings = [(Wa_{base} - Wa_{eff}) + (Dr_{base} - Dr_{eff}) * (1 - Pene)] * Cyc$$

Where:
Wa_{base} = Washer electricity use per cycle, base equipment (kWh)
Wa_{eff} = Washer electricity use per cycle, efficient equipment (kWh)
Dr_{base} = Dryer electricity use per cycle, base equipment (kWh)
Dr_{eff} = Dry electricity use per cycle, efficient equipment (kWh)
Pene = Penetration rate of natural gas powered clothes dryers in Ontario
Cyc = Average number of cycles per year machine is used

Electricity savings were determined to be 15% over base equipment[2]:

$$Percent\ Savings = \frac{(Elec_{base} - Elec_{new})}{Elec_{base}}$$

Where:
$Elec_{eff}$ = Annual natural gas use with efficient equipment, 1,167 kWh
$Elec_{base}$ = Annual natural gas use with base equipment, 1,369 kWh

Water	**19,814 L**

Assumptions and inputs:

- Water use per cycle, base equipment: 101 litres (26.6 gallons).
- Water use per cycle, new technology: 85 litres (22.4 gallons).
- Average number of cycles per year for clothes washer serving Multi-Family: 1,246 cycles

Annual water savings calculated as follows

[4] Corrected from Navigant's original value (110 m3), based completely on Navigant's own calculation methodology & input assumptions. It is now consistent with the savings value (76 m3/yr) "E-star comml clothes washer - Navigant calculations check - April 29 2010 - 1137am.xlsx"
[5] Corrected from Navigant's original value (182 m3), based completely on Navigant's own calculation methodology & input assumptions. It is now consistent with the savings value (76 m3/yr) "E-star comml clothes washer - Navigant calculations check - April 29 2010 - 1137am.xlsx"

$$Savings = (W_{base} - W_{eff}) * Cyc$$

Where:

W_{base} = Annual water use with base equipment (gallons or litres)
W_{eff} = Annual water use with efficient equipment (gallons or litres)
Cyc = Average number of cycles per year machine is used

Water savings were determined to be 16% over base measure:

$$PercentSavings = \frac{(W_{base} - W_{eff})}{W_{base}}$$

Where:

W_{eff} = Annual water consumed with efficient equipment, 105,675 litres (27,910 gallons).
W_{base}= Annual water consumed by showers with base equipment: 125,489 litres (33,144 gallons).

Other Input Assumptions

Equipment Life	**11 years**
The U.S. DOE's Federal Energy Management Program has determined that commercial/Multi-Family clothes washers have an average EUL of 11.25 years. Navigant Consulting recommends adopting an EUL of 11 years.[3]	
Incremental Cost (Cust. / Contr. Install)	**$ 150**
Incremental cost based on prices offered online by a local retailer.[4]	
Free Ridership	**48 %**
Estimated based on Puget Sound Energy's findings.[5]	

[1] Navigant Report, pg B-233 MEASURES AND ASSUMPTIONS FOR DEMAND SIDE MANAGEMENT (DSM) PLANNING APPENDIX C: SUBSTANTIATION SHEETS – April 16, 2009

[2] Navigant Report, pg B-233 MEASURES AND ASSUMPTIONS FOR DEMAND SIDE MANAGEMENT (DSM) PLANNING APPENDIX C: SUBSTANTIATION SHEETS – April 16, 2009

[3] Navigant Report, pg B-233 MEASURES AND ASSUMPTIONS FOR DEMAND SIDE MANAGEMENT (DSM) PLANNING APPENDIX C: SUBSTANTIATION SHEETS – April 16, 2009

[4] Base measure (3.5 cu/ft top loader, GE): $850
New technology (3.5 cu/ft front loader, LG): $1,000
www.homedepot.ca. Assuming the base equipment cost/ efficient equipment cost ratio of the two 3.5 cu/ft washers is equivalent to that of two 2.8 cu/ft washers.

[5] Quantec, Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027), Prepared for Puget Sound Energy

1.0 GAL/MIN FAUCET AERATOR (BATHROOM)

Commercial Building Retrofit (Installed) - Multi-Residential, EGD

Efficient Technology & Equipment Description
1.0 GPM Faucet Aerator
Base Technology & Equipment Description
Average existing stock / 2.2 GPM Faucet Aerator

Resource Savings Assumptions

Natural Gas (Updated)	**7 m^3**
As per EB 2008-0346 Decision, 1.5GPM aerator adjusted for a 1.0 GPM unit.	
Electricity	**n/a kWh**
Water (Updated)	**2,371 L**
As per EB 2008-0346 Decision, 1.5GPM aerator adjusted for a 1.0 GPM unit.	

Other Input Assumptions

Equipment Life	**10 years**
As recommended by Navigant.	
Incremental Cost (Contractor Install)	**$1.50**
As per utility program costs.	
Free Ridership (Updated)	**10 %**
Free ridership – EB 2008-0384 & 0385	

Faucet Aerator (Multi-Family Bathroom), EGD

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description

Faucet Aerator (Bathroom) (1.5 GPM)

Base Equipment and Technologies Description

Average existing stock (2.2 GPM)[1]

Decision Type	Target Market(s)	End Use
Retrofit	Multi-Family (existing)	Water heating

Codes, Standards, and Regulations

Ontario Building Code (2006)[2] requires bathroom and kitchen faucets to have a maximum flow of 2.2 GPM (8.35 L/min).

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	4	0	1,382	2	0
2	4	0	1,382	0	0
3	4	0	1,382	0	0
4	4	0	1,382	0	0
5	4	0	1,382	0	0
6	4	0	1,382	0	0
7	4	0	1,382	0	0
8	4	0	1,382	0	0
9	4	0	1,382	0	0
10	4	0	1,382	0	0
TOTALS	**40**	**0**	**13,820**	**2**	**0**

[1] From on-site audit data. Resource Management Strategies, Inc. *Regional Municipality of York Water Efficiency Master Plan Update,* 2007. Cited in: Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, June 2008.
[2] Ontario Regulations 350/06, 2006 Building Code

Resource Savings Assumptions

Annual Natural Gas Savings	4 m^3

Assumptions and inputs:

- Average faucet water temperature: 30 °C (86 °F)[3]
- Average water inlet temperature: 9.33°C (48.8 °F)[4]
- Average water heater energy factor: 0.76[5]

Annual gas savings calculated as follows:

$$Savings = W * 8.33 * (T_{out} - T_{in}) * \frac{1}{EF} * 10^{-6} * 27.8$$

Where:

W = Water savings (gallons)
8.33 = Energy content of water (Btu/gallon/°F)
T_{out} = Faucet water temperature (°F)
T_{in} = Water inlet temperature (°F)
EF = Water heater recovery efficiency
10^{-6} = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to m^3

Gas savings were determined to be 22% over base case:

$$Percent\ Savings = \frac{(G_{base} - G_{new})}{G_{base}}$$

Where:

G_{eff} = Annual natural gas use with efficient equipment, 18 m^3
G_{base} = Annual natural gas use with base equipment, 14 m^3

Annual Electricity Savings	0 kWh

N/A

Annual Water Savings	1,382 L

Assumptions and inputs:

- Average household size: 2.14 persons[6]
- Baseline faucet use (all faucets) per capita per day: 53 litres (14 gallons)[7]

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[3] Average of findings in two studies, adjusted for Toronto water inlet temperature. Mayer, P. W. et al, *Residential Indoor Water Conservation Study: Evaluation of High Efficiency Indoor Plumbing Fixture Retrofits in Single-Family Homes in East Bay Municipal Utility District Service Area,* 2003 and Skeel, T. and Hill, S. *Evaluation of Savings from Seattle's "Home Water Saver" Apartment/Condominium Program*, 1994. Both cited in: Summit Blue (2008).

[4] Cited in the following as personal communication with City of Toronto Works Dept.
VEIC, *Comments on Navigant's Draft Gas Measure Characterizations*, March 2009

[5] Assumption used by Energy Center of Wisconsin, citing GAMA, www.doa.state.wi.us/docs_view2.asp?docid=2249

[6] Summit Blue (2008) and Census 2006. To maintain consistency with Summit Blue number but to reflect the fact that apartments are generally occupied by fewer people than houses, the Summit Blue number was degraded by the ratio of the average number of inhabitants per apartment in an Ontario building over five stories (2) to the average number of inhabitants of a fully detached house in Ontario (2.9).

[7] Ibid.

- Bathroom faucet use as a percentage of total faucet use: 15%[8]
- Point estimate of quantity of water that goes straight down the drain: 70%[9]

Annual water savings calculated as follows:

$$Savings = Fu * Ppl * 365 * Ba * \left(\frac{Fl_{base} - Fl_{eff}}{Fl_{base}} \right) * Dr$$

Where:

Fu = Faucet use per capita (gallons)
Ppl = Number of people per household
365 = Days per year
Dr = Percentage of water that goes straight down the drain
Ba = Individual bathroom faucet use as a percentage of total faucet use
Fl_{base} = Flow rate of base equipment (GPM)
Fl_{eff} = Flow rate of efficient equipment (GPM)

Water savings was determined to be 22% over base case:

$$Percent\ Savings = \frac{(W_{base} - W_{eff})}{W_{base}}$$

Where:

W_{eff} = Annual water use with efficient equipment: 4,823 litres (1,274 gallons)
W_{base}= Annual water use with base equipment: 6,205 litres (1,639 gallons)

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
The U.S. DOE assumes a 10 year life for faucet aerators[10].	
Base & Incremental Conservation Measure Equipment and O&M Costs	**2 $**
Average equipment cost based on communication with local hardware stores. This does not include installation costs.	
Customer Payback Period (Natural Gas Only)[11]	**1 Year**
Using a 5-year average commodity cost (avoided cost)[12] of $0.38 / m^3 and an average residential distribution cost[13] of $0.14 / m^3, the payback period for natural gas savings is determined to be 1 year,	

[8] DeOreo, W. and P. Mayer, *The End Uses of Hot Water in Snigle Family Homes from Flow Trace Analysis*, 1999 cited in Summit Blue (2008).
[9] Summit Blue (2008).
[10] U.S. Department of Energy, Federal Energy Management Program, *FEMP Designated Product: Lavatory Faucets* http://www1.eere.energy.gov/femp/procurement/eep_faucets.html
[11] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.

based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = $2/ (4 m^3/year * $0.52 / m^3) = 1 year

Market Penetration	90%
Based on previous research conducted for the OPA, Navigant Consulting estimates penetration of faucet aerators (bathroom and kitchen) across all sectors to be 90%[14].	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/ Market Share
Puget Sound Energy[15]	5	5	N/A	50%
Comments For a switch from a 2.5 GPM to a 1.8 GPM aerator. Measure saves 1% of 539 m^3 required for water heating.Note that no distinction is made, in this study, between kitchen and bathroom faucet use.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/ Market Share**
State of Iowa Utilities Board[16]	27	9	14 US$	90%
Comments For a switch from a 3.0 GPM to a 1.5 GPM aerator. Measure saves 8.5% of 320 m^3 required for water heating. Note that no distinction is made, in this study, between kitchen and bathroom faucet use. Note also that the flow rate reduction in this jurisdiction is more than twice that of the measure addressed by this substantiation sheet.				

12 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.

13 Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).

14 Navigant Consulting, Inc. for the Ontario Power Authority, *Residential Rebate Program: Participation Forecast and Incentive Bundling Strategy – Key Findings Summary*, December 2008

15 Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy

16 Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2

1.0 GAL/MIN FAUCET AERATOR (KITCHEN)

Commercial Building Retrofit (Installed) – Multi-Residential, EGD

Efficient Technology & Equipment Description
1.0 GPM Faucet Aerator
Base Technology & Equipment Description
Average existing stock / 2.5 GPM Faucet Aerator

Resource Savings Assumptions

Natural Gas (Updated)	**24 m^3**
As per EB 2008-0346 Decision, 1.5GPM aerator adjusted for a 1.0 GPM unit.	
Electricity	**n/a kWh**
Water (Updated)	**8,072 L**
As per EB 2008-0346 Decision, 1.5GPM aerator adjusted for a 1.0 GPM unit.	

Other Input Assumptions

Equipment Life	**10 years**
As approved in EB 2008-0346.	
Incremental Cost (Contractor Install)	**$2**
As per utility program costs.	
Free Ridership	**10 %**
Free ridership – EB 2008-0384 & 0385	

1.0 GAL/MIN FAUCET AERATOR (KITCHEN)

Multi-Family - New, UG

Efficient Technology & Equip(UGment Description
Faucet Aerator (Kitchen) (1.0 GPM)
Base Technology & Equipment Description
Ontario Building Code 2006 (2.2 GPM)

Resource Savings Assumptions

Natural Gas	**22 m^3**
Savings based on the Navigant Report[1], except using 2.2 USGPM base case and 1.0 GPM efficient technology case	
Electricity	**n/a kWh**
Water	**7,337 L**
Savings based on the Navigant Report[1], except using 2.2 USGPM base case (opposed to 2.5) and 1.0 GPM efficient technology case	

Other Input Assumptions

Equipment Life	**10 Years**
Faucet aerators have an estimated service life of 10 years.[2] As approved in EB 2008-0384 & EB 2008-0385.	
Incremental Cost	**$1.59**
As per utility program costs, bulk purchase of aerators.	
Free Ridership (Updated)	**10 %**
Free ridership – EB 2008-0384 & EB 2008-0385	

[1] Final Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, Appendix C: Substantiation Sheets, pg. C248-250, April 16, 2009..

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

Faucet Aerator (Multi-Family Kitchen), EGD

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description

Faucet Aerator (kitchen) (1.5 GPM)

Base Equipment and Technologies Description

Average existing stock (2.5 GPM)[1]

Decision Type	Target Market(s)	End Use
Retrofit	Multi-Family (existing)	Water heating

Codes, Standards, and Regulations

Ontario Building Code (2006)[2] requires bathroom and kitchen faucets to have a maximum flow of 2.2 GPM (8.35 L/min).

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	16	0	5,377	2	0
2	16	0	5,377	0	0
3	16	0	5,377	0	0
4	16	0	5,377	0	0
5	16	0	5,377	0	0
6	16	0	5,377	0	0
7	16	0	5,377	0	0
8	16	0	5,377	0	0
9	16	0	5,377	0	0
10	16	0	5,377	0	0
TOTALS	**160**	**0**	**53,770**	**2**	**0**

[1] From on-site audit data. Resource Management Strategies, Inc. *Regional Municipality of York Water Efficiency Master Plan Update,* 2007. Cited in: Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, June 2008.
[2] Ontario Regulations 350/06, 2006 Building Code

Resource Savings Assumptions

Annual Natural Gas Savings	16 m³

Assumptions and inputs:

- Average faucet water temperature: 30 °C (86 F)[3]
- Average water inlet temperature: 9.33 °C (48.8 F)[4]
- Average water heater energy factor: 0.76[5]

Annual gas savings calculated as follows:

$$Savings = W * 8.33 * (T_{out} - T_{in}) * \frac{1}{EF} * 10^{-6} * 27.8$$

Where:

W = Water savings (gallons)
8.33 = Energy content of water (Btu/gallon/°F)
T_{out} = Faucet water temperature (°F)
T_{in} = Water inlet temperature (°F)
EF = Water heater recovery efficiency
10^{-6} = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to m^3

Gas savings were determined to be 20% over base case:

$$Percent\ Savings = \frac{(G_{base} - G_{new})}{G_{base}}$$

Where:

G_{eff} = Annual natural gas use with efficient equipment, 64 m^3
G_{base} = Annual natural gas use with base equipment, 80 m^3

Annual Electricity Savings	0 kWh

N/A

Annual Water Savings	5,377 L

Assumptions and inputs:

- Average household size: 2.14 persons[6]

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[3] Average of findings in two studies, adjusted for Toronto water inlet temperature. Mayer, P. W. et al, *Residential Indoor Water Conservation Study: Evaluation of High Efficiency Indoor Plumbing Fixture Retrofits in Single-Family Homes in East Bay Municipal Utility District Service Area,* 2003 and Skeel, T. and Hill, S. *Evaluation of Savings from Seattle's "Home Water Saver" Apartment/Condominium Program*, 1994. Both cited in: Summit Blue (2008).

[4] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, *Comments on Navigant's Draft Gas Measure Characterizations,* March 2009

[5] Assumption used by Energy Center of Wisconsin, citing GAMA, www.doa.state.wi.us/docs_view2.asp?docid=2249

[6] Summit Blue (2008) and Census 2006. To maintain consistency with Summit Blue number but to reflect the fact that apartments are generally occupied by fewer people than houses, the Summit Blue number was degraded by the ratio of the average number of inhabitants per apartment in an Ontario building over five stories (2) to the average number of inhabitants of a fully detached house in Ontario (2.9). Statistics Canada. No date. *Structural Type of Dwelling (10) and Household Size (9) for Occupied Private Dwellings of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2006 Census - 100% Data* (Table) *Census 2006.* Last updated Dec 6, 2008. http://www12.statcan.ca/english/census06/data/topics/RetrieveProductTable.cfm?ALEVEL=3&APATH=3&CATNO=&DETAIL=0&

- Baseline faucet use (all faucets) per capita per day: 53 litres (14 gallons)[7]
- Kitchen faucet use as a percentage of total faucet use: 65%[8]
- Point estimate of quantity of water that goes straight down the drain: 50%[9]

Annual water savings calculated as follows:

$$Savings = Fu * Ppl * 365 * Ba * \left(\frac{Fl_{base} - Fl_{eff}}{Fl_{base}} \right) * Dr$$

Where:

Fu = Faucet use per capita (gallons)
Ppl = Number of people per household
365 = Days per year
Dr = Percentage of water that goes straight down the drain
Ki = Kitchen faucet use as a percentage of total faucet use
Fl_{base} = Flow rate of base equipment (GPM)
Fl_{eff} = Flow rate of efficient equipment (GPM)

Water savings was determined to be 20% over base case:

$$Percent\ Savings = \frac{(W_{base} - W_{eff})}{W_{base}}$$

Where:

W_{eff} = Annual water use with efficient equipment: 21,509 litres (5,681gallons)
W_{base}= Annual water use with base equipment: 26,887litres (7,101 gallons)

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
The U.S. DOE assumes a 10 year life for faucet aerators[10].	
Base & Incremental Conservation Measure Equipment and O&M Costs	**2 $**
Average equipment cost based on communication with local hardware stores. This does not include installation costs.	
Customer Payback Period (Natural Gas Only)[11]	**0.2 Years**

DIM=&DS=99&FL=0&FREE=0&GAL=0&GC=99&GID=837983&GK=NA&GRP=1&IPS=&METH=0&ORDER=1&PID=89071&PTYPE=88971&RL=0&S=1&SUB=0&ShowAll=No&StartRow=1&Temporal=2006&Theme=69&VID=0&VNAMEE=&VNAMEF=

[7] Ibid.

[8] DeOreo, W. and P. Mayer, *The End Uses of Hot Water in Snigle Family Homes from Flow Trace Analysis*, 1999 cited in Summit Blue (2008).

[9] Summit Blue (2008).

[10] U.S. Department of Energy, Federal Energy Management Program, *FEMP Designated Product: Lavatory Faucets* http://www1.eere.energy.gov/femp/procurement/eep_faucets.html

Using a 5-year average commodity cost (avoided cost)[12] of \$0.38 / m^3 and an average residential distribution cost[13] of \$0.14 / m^3, the payback period for natural gas savings is determined to be 0.2 years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = \$2/ (16 m^3/year * \$0.52 / m^3) = 0.2 years

Market Penetration	**90%**
Based on previous research conducted for the OPA, Navigant Consulting estimates penetration of faucet aerators (bathroom and kitchen) across all sectors to be 90%[14].	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost (\$)	Penetration/Market Share
Puget Sound Energy[15]	5	5	N/A	50%
Comments For a switch from a 2.5 GPM to a 1.8 GPM aerator. Measure saves 1% of 539 m^3 required for water heating. Note that no distinction is made, in this study, between kitchen and bathroom faucet use.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost (\$)**	**Penetration/Market Share**
State of Iowa Utilities Board[16]	27	9	14 US\$	90%
Comments For a switch from a 3.0 GPM to a 1.5 GPM aerator. Measure saves 8.5% of 320 m^3 required for water heating. Note that no distinction is made, in this study, between kitchen and bathroom faucet use. Note also that the flow rate reduction in this jurisdiction is more than twice that of the measure addressed by this substantiation sheet.				

[11] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.

[12] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.

[13] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).

[14] Navigant Consulting, Inc. for the Ontario Power Authority, *Residential Rebate Program: Participation Forecast and Incentive Bundling Strategy – Key Findings Summary*, December 2008

[15] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy

[16] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2

1.0 GAL/MIN FAUCET AERATOR (BATHROOM)

Multi-Family – New, UG

Efficient Technology & Equipment Description
Faucet Aerator (Bathroom) (1.0 GPM)
Base Technology & Equipment Description
Ontario Building Code 2006 (2.2 GPM)

Resource Savings Assumptions

Natural Gas (Updated)	**7 m^3**
Savings recommended by Navigant Consulting[1] adjusted for 1.0 GPM	
Electricity	**n/a kWh**
Water (Updated)	**2,371 L**
Savings recommended by Navigant Consulting[1] adjusted for 1.0 GPM	

Other Input Assumptions

Equipment Life	**10 Years**
Faucet aerators have an estimated service life of 10 years.[1, 2] As approved in EB 2008-0384 & EB 2008-0385.	
Incremental Cost	**$0.59**
As per utility program costs, bulk purchase of aerators.	
Free Ridership (Updated)	**10 %**
Free ridership – EB 2008-0384 & EB 2008-0385	

[1] Final Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, April 16, 2009

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

1.0 GAL/MIN FAUCET AERATOR (BATHROOM)

Commercial Building Retrofit (Installed) - Multi-Residential, UG

Efficient Technology & Equipment Description
1.0 GPM Faucet Aerator
Base Technology & Equipment Description
Average existing stock / 2.2 GPM Faucet Aerator

3.6.1 Resource Savings Assumptions

Natural Gas (Updated)	**7 m^3**
Based on Navigant savings calculation adjusted for a 1.0 GPM unit.	
Electricity	**n/a kWh**
Water (Updated)	**2,371 L**
Based on Navigant savings calculation adjusted for a 1.0 GPM unit.	

3.6.2 Other Input Assumptions

Equipment Life	**10 years**
As recommended by Navigant.	
Incremental Cost (Contractor Install)	**$0.59**
As per utility program costs.	
Free Ridership (Updated)	**10 %**
Free ridership – EB 2008-0384 & 0385	

1.5 GAL/MIN FAUCET AERATOR (BATHROOM)

Multi-Family – New, UG

Efficient Technology & Equipment Description
Faucet Aerator (Bathroom) (1.5 GPM)
Base Technology & Equipment Description
Ontario Building Code 2006 (2.2 GPM)

Resource Savings Assumptions

Natural Gas (Updated)	**4 m^3**
Savings recommended by Navigant Consulting.[1]	
Electricity	**n/a kWh**
Water (Updated)	**1,382 L**
Savings recommended by Navigant Consulting.[1]	

Other Input Assumptions

Equipment Life	**10 Years**
Faucet aerators have an estimated service life of 10 years.[1, 2] As approved in EB 2008-0384 & EB 2008-0385.	
Incremental Cost	**$0.49**
As per utility program costs, bulk purchase of aerators.	
Free Ridership (Updated)	**10 %**
Free ridership – EB 2008-0384 & EB 2008-0385	

[1] Final Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, April 16, 2009

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

[3] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

Faucet Aerator (Multi-Family Bathroom), UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description

Faucet Aerator (Bathroom) (1.5 GPM)

Base Equipment and Technologies Description

Average existing stock (2.2 GPM)[1]

Decision Type	Target Market(s)	End Use
Retrofit	Multi-Family (existing)	Water heating

Codes, Standards, and Regulations

Ontario Building Code (2006)[2] requires bathroom and kitchen faucets to have a maximum flow of 2.2 GPM (8.35 L/min).

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	4	0	1,382	0.	
2	4	0	1,382	0	0
3	4	0	1,382	0	0
4	4	0	1,382	0	0
5	4	0	1,382	0	0
6	4	0	1,382	0	0
7	4	0	1,382	0	0
8	4	0	1,382	0	0
9	4	0	1,382	0	0
10	4	0	1,382	0	0
TOTALS	**40**	**0**	**13,820**	**0.49**	

[1] From on-site audit data. Resource Management Strategies, Inc. *Regional Municipality of York Water Efficiency Master Plan Update,* 2007. Cited in: Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, June 2008.
[2] Ontario Regulations 350/06, 2006 Building Code

Resource Savings Assumptions

Annual Natural Gas Savings	4 m³

Assumptions and inputs:

- Average faucet water temperature: 30 °C (86 °F)[3]
- Average water inlet temperature: 9.33°C (48.8 °F)[4]
- Average water heater energy factor: 0.76[5]

Annual gas savings calculated as follows:

$$Savings = W * 8.33 * (T_{out} - T_{in}) * \frac{1}{EF} * 10^{-6} * 27.8$$

Where:

W = Water savings (gallons)
8.33 = Energy content of water (Btu/gallon/°F)
T_{out} = Faucet water temperature (°F)
T_{in} = Water inlet temperature (°F)
EF = Water heater recovery efficiency
10^{-6} = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to m^3

Gas savings were determined to be 22% over base case:

$$Percent\ Savings = \frac{(G_{base} - G_{new})}{G_{base}}$$

Where:

G_{eff} = Annual natural gas use with efficient equipment, 18 m^3
G_{base} = Annual natural gas use with base equipment, 14 m^3

Annual Electricity Savings	0 kWh
N/A	

Annual Water Savings	1,382 L

Assumptions and inputs:

- Average household size: 2.14 persons[6]
- Baseline faucet use (all faucets) per capita per day: 53 litres (14 gallons)[7]
- Bathroom faucet use as a percentage of total faucet use: 15%[8]
- Point estimate of quantity of water that goes straight down the drain: 70%[9]

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[3] Average of findings in two studies, adjusted for Toronto water inlet temperature. Mayer, P. W. et al, *Residential Indoor Water Conservation Study: Evaluation of High Efficiency Indoor Plumbing Fixture Retrofits in Single-Family Homes in East Bay Municipal Utility District Service Area,* 2003 and Skeel, T. and Hill, S. *Evaluation of Savings from Seattle's "Home Water Saver" Apartment/Condominium Program*, 1994. Both cited in: Summit Blue (2008).

[4] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, *Comments on Navigant's Draft Gas Measure Characterizations*, March 2009

[5] Assumption used by Energy Center of Wisconsin, citing GAMA, www.doa.state.wi.us/docs_view2.asp?docid=2249

[6] Summit Blue (2008) and Census 2006. To maintain consistency with Summit Blue number but to reflect the fact that apartments are generally occupied by fewer people than houses, the Summit Blue number was degraded by the ratio of the average number of inhabitants per apartment in an Ontario building over five stories (2) to the average number of inhabitants of a fully detached house in Ontario (2.9).

[7] Ibid.

[8] DeOreo, W. and P. Mayer, *The End Uses of Hot Water in Snigle Family Homes from Flow Trace Analysis*, 1999 cited in Summit Blue (2008).

[9] Summit Blue (2008).

Annual water savings calculated as follows:

$$Savings = Fu * Ppl * 365 * Ba * \left(\frac{Fl_{base} - Fl_{eff}}{Fl_{base}} \right) * Dr$$

Where:

Fu = Faucet use per capita (gallons)
Ppl = Number of people per household
365 = Days per year
Dr = Percentage of water that goes straight down the drain
Ba = Individual bathroom faucet use as a percentage of total faucet use
Fl_{base} = Flow rate of base equipment (GPM)
Fl_{eff} = Flow rate of efficient equipment (GPM)

Water savings was determined to be 22% over base case:

$$PercentSavings = \frac{(W_{base} - W_{eff})}{W_{base}}$$

Where:

W_{eff} = Annual water use with efficient equipment: 4,823 litres (1,274 gallons)
W_{base} = Annual water use with base equipment: 6,205 litres (1,639 gallons)

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
The U.S. DOE assumes a 10 year life for faucet aerators[10].	

Base & Incremental Conservation Measure Equipment and O&M Costs	0.49 $
Average equipment cost based on utility bul purchase order costs. This does not include installation costs.	

Customer Payback Period (Natural Gas Only)[11]	0.24 Year

Using a 5-year average commodity cost (avoided cost)[12] of \$0.38 / m^3 and an average residential distribution cost[13] of \$0.14 / m^3, the payback period for natural gas savings is determined to be 1 year, based on the following:

Payback Period = Incremental cost / (natural gas savings x natural gas cost)
= \$0. / (4 m^3/year * \$0.52 / m^3)
= 0. year

[10] U.S. Department of Energy, Federal Energy Management Program, *FEMP Designated Product: Lavatory Faucets* http://www1.eere.energy.gov/femp/procurement/eep_faucets.html
[11] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.
[12] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.
[13] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).

Market Penetration	90%
Based on previous research conducted for the OPA, Navigant Consulting estimates penetration of faucet aerators (bathroom and kitchen) across all sectors to be 90%[14].	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/ Market Share
Puget Sound Energy[15]	5	5	N/A	50%
Comments For a switch from a 2.5 GPM to a 1.8 GPM aerator. Measure saves 1% of 539 m^3 required for water heating.Note that no distinction is made, in this study, between kitchen and bathroom faucet use.				
Source	**Annual Natural Gas Savings (m3)**	**Effective Useful Life (Years)**	**Incremental Cost ($)**	**Penetration/ Market Share**
State of Iowa Utilities Board[16]	27	9	14 US$	90%
Comments For a switch from a 3.0 GPM to a 1.5 GPM aerator. Measure saves 8.5% of 320 m^3 required for water heating. Note that no distinction is made, in this study, between kitchen and bathroom faucet use. Note also that the flow rate reduction in this jurisdiction is more than twice that of the measure addressed by this substantiation sheet.				

[14] Navigant Consulting, Inc. for the Ontario Power Authority, *Residential Rebate Program: Participation Forecast and Incentive Bundling Strategy – Key Findings Summary*, December 2008
[15] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy
[16] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2

1.5 GAL/MIN FAUCET AERATOR (KITCHEN)

Multi-Family - New, UG

Efficient Technology & Equipment Description
Faucet Aerator (Kitchen) (1.5 GPM)
Base Technology & Equipment Description
Ontario Building Code 2006 (2.2 GPM)

Resource Savings Assumptions

Natural Gas	**13 m^3**
Savings based on the Navigant Report[1], except using 2.2 USGPM base case	
Electricity	**n/a kWh**
Water	**4,280 L**
Savings based on the Navigant Report[1], except using 2.2 USGPM base case (opposed to 2.5)	

Other Input Assumptions

Equipment Life	**10 Years**
Faucet aerators have an estimated service life of 10 years.[2] As approved in EB 2008-0384 & EB 2008-0385.	
Incremental Cost	**$1.29**
As per utility program costs, bulk purchase of aerators.	
Free Ridership	**10 %**
Free ridership – EB 2008-0384 & EB 2008-0385	

[1] Final Report "Measures and Assumptions for Demand Side Management (DSM) Planning", Navigant Consulting Inc., Ontario Energy Board, Appendix C: Substantiation Sheets, pg. C248-250, April 16, 2009.

[2] U.S. DOE – FEMP, Energy Cost Calculator for Faucets and Showerheads, http://www.eere.energy.gov/femp

[3] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

1.0 GAL/MIN FAUCET AERATOR (KITCHEN)

Commercial Building Retrofit (Installed) – Multi-Residential, UG

Efficient Technology & Equipment Description
1.0 GPM Faucet Aerator
Base Technology & Equipment Description
Average existing stock / 2.5 GPM Faucet Aerator

Resource Savings Assumptions

Natural Gas (Updated)	**24 m^3**
Based on Navigant savings calculation adjusted for a 1.0 GPM unit.	
Electricity	**n/a kWh**
Water (Updated)	**8,072 L**
Based on Navigant savings calculation adjusted for a 1.0 GPM unit.	

Other Input Assumptions

Equipment Life	**10 years**
As recommended by Navigant.	
Incremental Cost (Contractor Install)	**$1.59**
As per utility program costs.	
Free Ridership (Updated)	**10 %**
Free ridership – EB 2008-0384 & 0385	

Faucet Aerator (Multi-Family Kitchen), UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description

Faucet Aerator (kitchen) (1.5 GPM)

Base Equipment and Technologies Description

Average existing stock (2.5 GPM)[1]

Decision Type	Target Market(s)	End Use
Retrofit	Multi-Family (existing)	Water heating

Codes, Standards, and Regulations

Ontario Building Code (2006)[2] requires bathroom and kitchen faucets to have a maximum flow of 2.2 GPM (8.35 L/min).

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	16	0	5,377	.	
2	16	0	5,377	0	0
3	16	0	5,377	0	0
4	16	0	5,377	0	0
5	16	0	5,377	0	0
6	16	0	5,377	0	0
7	16	0	5,377	0	0
8	16	0	5,377	0	0
9	16	0	5,377	0	0
10	16	0	5,377	0	0
TOTALS	**160**	**0**	**53,770**	**1.29**	

[1] From on-site audit data. Resource Management Strategies, Inc. *Regional Municipality of York Water Efficiency Master Plan Update,* 2007. Cited in: Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, June 2008.
[2] Ontario Regulations 350/06, 2006 Building Code

Resource Savings Assumptions

Annual Natural Gas Savings	16 m^3

Assumptions and inputs:

- Average faucet water temperature: 30 °C (86 F)[3]
- Average water inlet temperature: 9.33 °C (48.8 F)[4]
- Average water heater energy factor: 0.76[5]

Annual gas savings calculated as follows:

$$Savings = W * 8.33 * (T_{out} - T_{in}) * \frac{1}{EF} * 10^{-6} * 27.8$$

Where:

W = Water savings (gallons)
8.33 = Energy content of water (Btu/gallon/°F)
T_{out} = Faucet water temperature (°F)
T_{in} = Water inlet temperature (°F)
EF = Water heater recovery efficiency
10^{-6} = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to m^3

Gas savings were determined to be 20% over base case:

$$Percent\ Savings = \frac{(G_{base} - G_{new})}{G_{base}}$$

Where:

G_{eff} = Annual natural gas use with efficient equipment, 64 m^3
G_{base} = Annual natural gas use with base equipment, 80 m^3

Annual Electricity Savings	0 kWh

N/A

Annual Water Savings	5,377 L

Assumptions and inputs:

- Average household size: 2.14 persons[6]
- Baseline faucet use (all faucets) per capita per day: 53 litres (14 gallons)[7]

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[3] Average of findings in two studies, adjusted for Toronto water inlet temperature. Mayer, P. W. et al, *Residential Indoor Water Conservation Study: Evaluation of High Efficiency Indoor Plumbing Fixture Retrofits in Single-Family Homes in East Bay Municipal Utility District Service Area,* 2003 and Skeel, T. and Hill, S. *Evaluation of Savings from Seattle's "Home Water Saver" Apartment/Condominium Program*, 1994. Both cited in: Summit Blue (2008).

[4] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, *Comments on Navigant's Draft Gas Measure Characterizations,* March 2009

[5] Assumption used by Energy Center of Wisconsin, citing GAMA, www.doa.state.wi.us/docs_view2.asp?docid=2249

[6] Summit Blue (2008) and Census 2006. To maintain consistency with Summit Blue number but to reflect the fact that apartments are generally occupied by fewer people than houses, the Summit Blue number was degraded by the ratio of the average number of inhabitants per apartment in an Ontario building over five stories (2) to the average number of inhabitants of a fully detached house in Ontario (2.9). Statistics Canada. No date. *Structural Type of Dwelling (10) and Household Size (9) for Occupied Private Dwellings of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2006 Census - 100% Data* (Table) *Census 2006.* Last updated Dec 6, 2008. http://www12.statcan.ca/english/census06/data/topics/RetrieveProductTable.cfm?ALEVEL=3&APATH=3&CATNO=&DETAIL=0&DIM=&DS=99&FL=0&FREE=0&GAL=0&GC=99&GID=837983&GK=NA&GRP=1&IPS=&METH=0&ORDER=1&PID=89071&PTYPE=88971&RL=0&S=1&SUB=0&ShowAll=No&StartRow=1&Temporal=2006&Theme=69&VID=0&VNAMEE=&VNAMEF=

[7] Ibid.

- Kitchen faucet use as a percentage of total faucet use: 65%[8]
- Point estimate of quantity of water that goes straight down the drain: 50%[9]

Annual water savings calculated as follows:

$$Savings = Fu * Ppl * 365 * Ba * \left(\frac{Fl_{base} - Fl_{eff}}{Fl_{base}} \right) * Dr$$

Where:

Fu = Faucet use per capita (gallons)
Ppl = Number of people per household
365 = Days per year
Dr = Percentage of water that goes straight down the drain
Ki = Kitchen faucet use as a percentage of total faucet use
Fl_{base} = Flow rate of base equipment (GPM)
Fl_{eff} = Flow rate of efficient equipment (GPM)

Water savings was determined to be 20% over base case:

$$PercentSavings = \frac{(W_{base} - W_{eff})}{W_{base}}$$

Where:

W_{eff} = Annual water use with efficient equipment: 21,509 litres (5,681gallons)
W_{base}= Annual water use with base equipment: 26,887litres (7,101 gallons)

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
The U.S. DOE assumes a 10 year life for faucet aerators[10].	
Base & Incremental Conservation Measure Equipment and O&M Costs	**1.29 $**
Average equipment cost based on utility bulk purchase order costs. This does not include installation costs.	
Customer Payback Period (Natural Gas Only)[11]	**0.16 Years**
Using a 5-year average commodity cost (avoided cost)[12] of \$0.38 / m^3 and an average residential distribution cost[13] of \$0.14 / m^3, the payback period for natural gas savings is determined to be 0.2 years, based on the following:	

[8] DeOreo, W. and P. Mayer, *The End Uses of Hot Water in Snigle Family Homes from Flow Trace Analysis*, 1999 cited in Summit Blue (2008).
[9] Summit Blue (2008).
[10] U.S. Department of Energy, Federal Energy Management Program, *FEMP Designated Product: Lavatory Faucets* http://www1.eere.energy.gov/femp/procurement/eep_faucets.html
[11] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.
[12] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.

Payback Period = Incremental cost / (natural gas savings x natural gas cost) = $1.29/ (16 m^3/year * $0.52 / m^3) = 0.16 years

Market Penetration	90%
Based on previous research conducted for the OPA, Navigant Consulting estimates penetration of faucet aerators (bathroom and kitchen) across all sectors to be 90%[14].	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Puget Sound Energy[15]	5	5	N/A	50%
Comments For a switch from a 2.5 GPM to a 1.8 GPM aerator. Measure saves 1% of 539 m^3 required for water heating. Note that no distinction is made, in this study, between kitchen and bathroom faucet use.				

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
State of Iowa Utilities Board[16]	27	9	14 US$	90%
Comments For a switch from a 3.0 GPM to a 1.5 GPM aerator. Measure saves 8.5% of 320 m^3 required for water heating. Note that no distinction is made, in this study, between kitchen and bathroom faucet use. Note also that the flow rate reduction in this jurisdiction is more than twice that of the measure addressed by this substantiation sheet.				

[13] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).

[14] Navigant Consulting, Inc. for the Ontario Power Authority, *Residential Rebate Program: Participation Forecast and Incentive Bundling Strategy – Key Findings Summary*, December 2008

[15] Quantec *Comprehensive Assessment of Demand-Side Resource Potentials (2008-2027)* Prepared for Puget Sound Energy

[16] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2

Low-Flow Showerhead (1.25 GPM, Multi-Family, per Household), UG

Revision #	Description/Comment	Date Revised
		October 28, 2010

Efficient Equipment and Technologies Description

One Low-flow Showerhead (1.25 Gpm) – distributed to participants under Union Gas' HWC program.

Base Equipment and Technologies Description

2.0 GPM (Participants who previously received a 2.0gpm showerhead from Union)

Decision Type	Target Market(s)	End Use
New/Retrofit	Multi-Family	Water heating

Codes, Standards, and Regulations

Ontario Building Code (2006)[1] requires showerheads to have a maximum flow of 2.5 GPM (9.5 L/min)

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	24	0	7933	3.79	0
2	24	0	7933	0	0
3	24	0	7933	0	0
4	24	0	7933	0	0
5	24	0	7933	0	0
6	24	0	7933	0	0
7	24	0	7933	0	0
8	24	0	7933	0	0
9	24	0	7933	0	0
10	24	0	7933	0	0
TOTALS	**240**	**0**	**79,330**	**3.79**	0

Resource Savings Assumptions

Annual Natural Gas Savings	24 m^3

Enbridge Gas commissioned a study by the SAS Institute (Canada)[2] to estimate natural gas savings for low-flow showerheads in Enbridge territory. Data was collected August 31, 2007 until

[1] Ontario Regulations 350/06, 2006 Building Code

August 31, 2009 for both treatment and control groups. Low flow showerheads were installed in treatment households between August 13, 2008 and October 30, 2008. There were 54 households with low-flow showerheads and 124 households without low-flow showerheads.

To calculate the gas savings, three different models were used to analyze the gas consumption data

1) a comparison made during the same time frame (post-installation) between a control set of households[3] and households that had them installed
2) a Pre & Post installation analysis on the same households, and
3) a complex time trend model analysis that factored in many household characteristics over the whole Pre & Post time period.

All three analyses agreed well with each other.[4]

Three buckets for pre-existing showerheads were originally proposed. However, the lowest flow bucket (2.0 GPM or less) had too few observations and are rare in the population of households. The natural gas savings for the other two buckets are estimated to be as follows:

Baseline Flow rate (GPM)	Energy Efficient Flow Rate (GPM)	Change in GPM	Annual Natural Gas Savings (m^3)	Annual Natural Gas Savings (m^3 per GPM)
2.25[5]	1.25	1.0	46	46
3[6]	1.25	1.75	88	50

For base flow/efficient flow showerhead types not explicitly tested in the SAS study, gas savings have been extrapolated in the following manner:

1. The results of the SAS institute study indicate that gas savings increase at an increasing rate as the difference between efficient and base GPM increases.
2. Fitting a polynomial function with no intercept (no change in GPM = no gas savings) delivers the following function (where ΔGPM = Base GPM – Efficient GPM):

$$\text{Annual Gas Savings } (m^3) = 40.29 * \Delta GPM + 5.71 * \Delta GPM^2$$
$$= 40.29*(2.0-1.25) + 5.71*(2.0-1.25)^2$$
$$= 33$$

However, to reflect the fact that there are fewer occupants in apartments than in single family homes (average of 2.1 persons for apartments vs. 2.9 persons for fully detached homes)[7] the savings will be adjusted as follows:

[2] Rothman, Lorne, SAS® PHASE II Analysis for Enbridge Gas Distribution Inc.: Estimating the Impact of Low-Flow Showerhead Installation; April 5, 2010
[3] where no low-flow showerheads were ever installed
[4] Model 1 – a blended rate of 71.3 m3/yr (only models II and II provided bucketed savings estimates)
Model 2 – a blended rate of 67.4 m3/yr (45.4 m3/yr for 2 to 2.5 GPM bucket and 87.8 m3/yr for over 2.5 GPM), and
Model 3 – a blended rate of 77.2 m3/yr (46.4 m3/yr for 2 to 2.5 GPM bucket and 87.9 m3/yr for over 2.5 GPM).
[5] Average of 2.0 GPM and 2.5 GPM
[6] Assumed average low flow showerhead which is greater than 2.5 GPM.
[7] Statistics Canada. *Structural Type of Dwelling (10) and Household Size (9) for Occupied Private Dwellings of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2006 Census - 100% Data* (Table) *Census 2006.* Last updated Dec 6, 2008.
http://www12.statcan.ca/english/census06/data/topics/RetrieveProductTable.cfm?ALEVEL=3&APATH=3&CATNO=&DETAIL=0&DIM=&DS=99&FL=0&FREE=0&GAL=0&GC=99&GID=837983&GK=NA&GRP=1&IPS=&METH=0&ORDER=1&PID=89071&PTYPE=88971&RL=0&S=1&SUB=0&ShowAll=No&StartRow=1&Temporal=2006&Theme=69&VID=0&VNAMEE=&VNAMEF=

$33\ m^3 \times$ (2.1 persons per household/2.9 persons per household) = 33 x 72% = 24 m^3/yr These savings values assume that 100% of household showering is reduced to 1.25 gpm. A survey determining the percentage of showering affected by the program should be used to adjust the year end program results.	
Annual Electricity Savings	**0 kWh**
N/A	
Annual Water Savings	**7,933 L**

Since the SAS report did not look at water savings, Navigant Consulting proposes the following method for calculating resulting water savings:

Assumptions and inputs:

- As-used flow rate with base equipment: 1.78 GPM[8]
- Average household size: 2.14 persons[9]
- Showers per capita per day: 0.75[10]
- Average showering time per capita per day with base equipment: 7.37 minutes [12]
- Average showering time per capita per day with new technology: 7.61 minutes[11]

Annual water savings calculated as follows:

$$Savings = Ppl * Sh * 365 * (T_{base} * Fl_{base} - T_{eff} * Fl_{eff})$$

Where:

Ppl = Number of people per household.
Sh = Showers per capita per day.
365 = Days per year.
T_{base} = Showering time with base equipment (minutes)
T_{eff} = Showering time with efficient equipment (minutes).
Fl_{base} = As-used flow rate with base equipment (GPM)
Fl_{eff} = As-used flow rate with efficient equipment (GPM)

Savings = 2,096 gallons or 7933 litres

[8] As-used flow is calculated as a function of "full-on" or label flow: as-used flow = min{ 0.691+0.542*full-on flow, full-on flow}. Proctor, J. Gavelis, B. and Miller, B. *Savings and Showers: It's All in the Head*, (PGE) Home Energy Magazine, July/Aug 1994. Cited in Summit Blue (2008). Summit Blue uses the equation without assuming that it is a min function, implicitly assuming that participants will have the expertise or desire to make minor adjustments to the house water pressure to compensate for reduced shower flow.

[9] To maintain consistency with Summit Blue number but to reflect the fact that apartments are generally occupied by fewer people than houses, the Summit Blue number was degraded by the ratio of the average number of inhabitants per apartment in an Ontario building over five stories (2) to the average number of inhabitants of a fully detached house in Ontario (2.9). Statistics Canada. No date. *Structural Type of Dwelling (10) and Household Size (9) for Occupied Private Dwellings of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2006 Census - 100% Data* (Table) *Census 2006.* Last updated Dec 6, 2008. http://www12.statcan.ca/english/census06/data/topics/RetrieveProductTable.cfm?ALEVEL=3&APATH=3&CATNO=&DETAIL=0&DIM=&DS=99&FL=0&FREE=0&GAL=0&GC=99&GID=837983&GK=NA&GRP=1&IPS=&METH=0&ORDER=1&PID=89071&PTYPE=88971&RL=0&S=1&SUB=0&ShowAll=No&StartRow=1&Temporal=2006&Theme=69&VID=0&VNAMEE=&VNAMEF=

[10] Ibid, based on data from: Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007

[11] Relationship modeled as: Average shower length = 8.17 – 0.448 * as-used GPM. From Energy Center of Wisconsin Analysis of data from Resource Management Strategies, Inc., *Regional Municipality of York Water Efficiency Master Plan Update,* April 2007. Cited in Summit Blue (2008)

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
Summit Blue (2008) suggests an EUL of 10 years based on a survey of five studies of showerheads in other jurisdictions (California – two studies, New England, Vermont, Arkansas).	
Incremental Costs	**$3.79**
As per utility program costs, bulk purchase of showerheads.	
Free-Ridership	**10%**
Free Ridership rate recommended by Summit Blue Consulting.[12]	

[12] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

Low-Flow Showerhead (1.25 GPM, Multi-Family, per Household), UG

Revision #	Description/Comment	Date Revised
		October 28, 2010

Efficient Equipment and Technologies Description

One Low-flow Showerhead (1.25 Gpm) – distributed to participants under Union Gas' HWC program.

Base Equipment and Technologies Description

Average existing stock (2.21 GPM)[1].

Decision Type	Target Market(s)	End Use
New/Retrofit	Multi-Family	Water heating

Codes, Standards, and Regulations

Ontario Building Code (2006)[2] requires showerheads to have a maximum flow of 2.5 GPM (9.5 L/min)

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	32	0	9,585	3.79	0
2	32	0	9,585	0	0
3	32	0	9,585	0	0
4	32	0	9,585	0	0
5	32	0	9,585	0	0
6	32	0	9,585	0	0
7	32	0	9,585	0	0
8	32	0	9,585	0	0
9	32	0	9,585	0	0
10	32	0	9,585	0	0
TOTALS	**320**	**0**	**95,850**	**3.79**	0

[1] Shower-heads distributed under Union Gas's ESK program are installed by homeowners rather than Union contractors. No observation is made of the base equipment's GPM. It is therefore assumed to be the full-on flow rate corresponding to the as-used flow from York Region monitoring study calculated using the equation cited below. Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007. Cited by: Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, June 2008.

[2] Ontario Regulations 350/06, 2006 Building Code

Resource Savings Assumptions

Annual Natural Gas Savings	32 m³

Enbridge Gas commissioned a study by the SAS Institute (Canada)[3] to estimate natural gas savings for low-flow showerheads in Enbridge territory. Data was collected August 31, 2007 until August 31, 2009 for both treatment and control groups. Low flow showerheads were installed in treatment households between August 13, 2008 and October 30, 2008. There were 54 households with low-flow showerheads and 124 households without low-flow showerheads.

To calculate the gas savings, three different models were used to analyze the gas consumption data

1) a comparison made during the same time frame (post-installation) between a control set of households[4] and households that had them installed
2) a Pre & Post installation analysis on the same households, and
3) a complex time trend model analysis that factored in many household characteristics over the whole Pre & Post time period.

All three analyses agreed well with each other.[5]

Three buckets for pre-existing showerheads were originally proposed. However, the lowest flow bucket (2.0 GPM or less) had too few observations and are rare in the population of households. The natural gas savings for the other two buckets are estimated to be as follows:

Baseline Flow rate (GPM)	Energy Efficient Flow Rate (GPM)	Change in GPM	Annual Natural Gas Savings (m^3)	Annual Natural Gas Savings (m^3 per GPM)
2.25[6]	1.25	1.0	46	46
3[7]	1.25	1.75	88	50

For base flow/efficient flow showerhead types not explicitly tested in the SAS study, gas savings have been extrapolated in the following manner:

1. The results of the SAS institute study indicate that gas savings increase at an increasing rate as the difference between efficient and base GPM increases.
2. Fitting a polynomial function with no intercept (no change in GPM = no gas savings) delivers the following function (where ΔGPM = Base GPM – Efficient GPM):

$$\text{Annual Gas Savings } (m^3) = 40.29 * \Delta GPM + 5.71 * \Delta GPM^2$$
$$= 40.29*(2.21-1.25) + 5.71*(2.21-1.25)^2$$
$$= 44$$

[3] Rothman, Lorne, SAS® PHASE II Analysis for Enbridge Gas Distribution Inc.: Estimating the Impact of Low-Flow Showerhead Installation; April 5, 2010
[4] where no low-flow showerheads were ever installed
[5] Model 1 – a blended rate of 71.3 m3/yr (only models II and II provided bucketed savings estimates)
Model 2 – a blended rate of 67.4 m3/yr (45.4 m3/yr for 2 to 2.5 GPM bucket and 87.8 m3/yr for over 2.5 GPM), and
Model 3 – a blended rate of 77.2 m3/yr (46.4 m3/yr for 2 to 2.5 GPM bucket and 87.9 m3/yr for over 2.5 GPM).
[6] Average of 2.0 GPM and 2.5 GPM
[7] Assumed average low flow showerhead which is greater than 2.5 GPM.

However, to reflect the fact that there are fewer occupants in apartments than in single family homes (average of 2.1 persons for apartments vs. 2.9 persons for fully detached homes)[8] the savings will be adjusted as follows: 44 m^3 x (2.1 persons per household/2.9 persons per household) = 44 x 72% = 32 m^3/yr These savings values assume that 100% of household showering is reduced to 1.25 gpm. A survey determining the percentage of showering affected by the program should be used to adjust the year end program results.	
Annual Electricity Savings	**0 kWh**
N/A	
Annual Water Savings	**9,585 L**

Since the SAS report did not look at water savings, Navigant Consulting proposes the following method for calculating resulting water savings:

Assumptions and inputs:

- As-used flow rate with base equipment: 1.89 GPM[9]
- Average household size: 2.14 persons[10]
- Showers per capita per day: 0.75[11]
- Average showering time per capita per day with base equipment: 7.32 minutes
- Average showering time per capita per day with new technology: 7.61 minutes[12]

Annual water savings calculated as follows:

$$Savings = Ppl * Sh * 365 * \left(T_{base} * Fl_{base} - T_{eff} * Fl_{eff}\right)$$

Where:

Ppl = Number of people per household.
Sh = Showers per capita per day.

[8] Statistics Canada. *Structural Type of Dwelling (10) and Household Size (9) for Occupied Private Dwellings of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2006 Census - 100% Data* (Table) *Census 2006.* Last updated Dec 6, 2008. http://www12.statcan.ca/english/census06/data/topics/RetrieveProductTable.cfm?ALEVEL=3&APATH=3&CATNO=&DETAIL=0&DIM=&DS=99&FL=0&FREE=0&GAL=0&GC=99&GID=837983&GK=NA&GRP=1&IPS=&METH=0&ORDER=1&PID=89071&PTYPE=88971&RL=0&S=1&SUB=0&ShowAll=No&StartRow=1&Temporal=2006&Theme=69&VID=0&VNAMEE=&VNAMEF=

[9] As-used flow is calculated as a function of “full-on” or label flow: as-used flow = min{ 0.691+0.542*full-on flow, full-on flow}. Proctor, J. Gavelis, B. and Miller, B. *Savings and Showers: It's All in the Head*, (PGE) Home Energy Magazine, July/Aug 1994. Cited in Summit Blue (2008). Summit Blue uses the equation without assuming that it is a min function, implicitly assuming that participants will have the expertise or desire to make minor adjustments to the house water pressure to compensate for reduced shower flow.

[10] To maintain consistency with Summit Blue number but to reflect the fact that apartments are generally occupied by fewer people than houses, the Summit Blue number was degraded by the ratio of the average number of inhabitants per apartment in an Ontario building over five stories (2) to the average number of inhabitants of a fully detached house in Ontario (2.9). Statistics Canada. No date. *Structural Type of Dwelling (10) and Household Size (9) for Occupied Private Dwellings of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2006 Census - 100% Data* (Table) *Census 2006.* Last updated Dec 6, 2008. http://www12.statcan.ca/english/census06/data/topics/RetrieveProductTable.cfm?ALEVEL=3&APATH=3&CATNO=&DETAIL=0&DIM=&DS=99&FL=0&FREE=0&GAL=0&GC=99&GID=837983&GK=NA&GRP=1&IPS=&METH=0&ORDER=1&PID=89071&PTYPE=88971&RL=0&S=1&SUB=0&ShowAll=No&StartRow=1&Temporal=2006&Theme=69&VID=0&VNAMEE=&VNAMEF=

[11] Ibid, based on data from: Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007

[12] Relationship modeled as: Average shower length = 8.17 – 0.448 * as-used GPM. From Energy Center of Wisconsin Analysis of data from Resource Management Strategies, Inc., *Regional Municipality of York Water Efficiency Master Plan Update,* April 2007. Cited in Summit Blue (2008)

365 = Days per year. T_{base} = Showering time with base equipment (minutes) T_{eff} = Showering time with efficient equipment (minutes). Fl_{base} = As-used flow rate with base equipment (GPM) Fl_{eff} = As-used flow rate with efficient equipment (GPM) Savings = 2,532 gallons or 9,585 litres

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
Summit Blue (2008) suggests an EUL of 10 years based on a survey of five studies of showerheads in other jurisdictions (California – two studies, New England, Vermont, Arkansas).	
Incremental Costs	**$3.79**
As per utility program costs, bulk purchase of showerheads.	
Free-Ridership	**10%**
Free Ridership rate recommended by Summit Blue Consulting.[13]	

[13] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

LOW-FLOW SHOWERHEAD - 1.5 GAL/MIN

Multi-Family – New, UG

Efficient Technology & Equipment Description
Low-flow showerhead 1.5 gal/min.
Base Technology & Equipment Description
2.2 gpm[1] which also conforms to Ontario Building Code 2006 requirements[2]

Resource Savings Assumptions

Natural Gas	**33 m3**
Based on Navigant savings calculation[3].	
Water	**5,228 L**
Based on Navigant savings calculation[4].	
Electricity	**n/a kWh**

Other Input Assumptions

Equipment Life	**10 years**
Low flow showerheads have an estimated service life of 10 years as recommended by Navigant and approved in EB 2008-0384 & EB 2008-0385.	
Incremental Cost (Cust Install)	**$6**
Based on Navigant's values[5]. Incremental cost based on a survey of online retailers[6]. This does not include installation costs	
Free Ridership	**10 %**
As per EB 2008-0384 & EB 2008-0385	

[1] Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, June 2008.
[2] Ontario Building Code 2006 – Table 7.6.4.2
[3] Navigant Consulting, MEASURES AND ASSUMPTIONS FOR DEMAND SIDE MANAGEMENT (DSM) PLANNING - APPENDIX C: SUBSTANTIATION SHEETS, April 16, 2009, Pg. C-251-254
[4] Navigant Consulting, MEASURES AND ASSUMPTIONS FOR DEMAND SIDE MANAGEMENT (DSM) PLANNING - APPENDIX C: SUBSTANTIATION SHEETS, April 16, 2009, Pg. C-251-254
[5] Navigant Consulting, MEASURES AND ASSUMPTIONS FOR DEMAND SIDE MANAGEMENT (DSM) PLANNING - APPENDIX C: SUBSTANTIATION SHEETS, April 16, 2009, Pg. C-251-254
[6] Whedon Products 1.5 GPM Ultra Saver Showerhead. http://www.antonline.com/p_USB3C-GP_398829.htm

Low-Flow Showerhead (1.5 GPM, Multi-Family, UG ESK, per Household), UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description

Low-flow Showerhead (1.5 GPM) – distributed to participants under Union Gas' ESK program.

Base Equipment and Technologies Description

Average existing stock (2.2 GPM)[1] .

Decision Type	Target Market(s)	End Use
Retrofit	Multi-Family (Existing)	Water heating

Codes, Standards, and Regulations

Ontario Building Code (2006)[2] requires shower heads to have a maximum flow of 2.5 GPM (9.5 L/min)

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	33	0	5,228	6	0
2	33	0	5,228	0	0
3	33	0	5,228	0	0
4	33	0	5,228	0	0
5	33	0	5,228	0	0
6	33	0	5,228	0	0
7	33	0	5,228	0	0
8	33	0	5,228	0	0
9	33	0	5,228	0	0
10	33	0	5,228	0	0
TOTALS	330	0	**52,280**	**6**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings	33 m^3

Enbridge Gas commissioned a study by the SAS Institute (Canada)[3] to estimate natural gas savings for low-flow showerheads using a sample of 69 households in Enbridge territory between August 31 2007 to December 31, 2008. Replacement low-flow showerheads were installed between August 13, 2008 and October 18, 2008.

[1] Shower-heads distributed under Union Gas's ESK program are installed by homeowners rather than Union contractors. No observation is made of the base equipment's GPM. It is therefore assumed to be the full-on flow rate corresponding to the as-used flow from York Region monitoring study calculated using the equation cited below.
Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007. Cited by: Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, June 2008.

[2] Ontario Regulations 350/06, 2006 Building Code

[3] Rothman, Lorne, SAS® Analysis for Enbridge Gas Distribution Incorporated: Estimating the impact of Low Flow Showerhead Installation, March 16, 2009

The study used two classes of statistical method for estimating savings (1) Paired T-tests and (2) Longitudinal Mixed models.

1. Three iterations of the paired t-test method were estimated and of these, the report recommends the one which makes use of the entire data-set. This model yielded savings estimates of an average of 0.24 m^3/day, for an extrapolated annual savings of 89 m^3.

2. Two longitudinal mixed models were also estimated, one relatively simple linear model controlling for a variety of household factors, the other still linear, but with more parameters to be estimated (all additional parameters being the products of two previously estimated parameters) in order to study interaction effects. This model yielded savings estimates of an average of 0.18 m^3/day for pre-existing showerhead flow rates of 2.0 to 2.5 GPM and 0.32 m^3/day for pre-existing showerhead flow rates greater than 2.5 GPM. Extrapolation of these results for annual savings is approximately 66 m^3 and 116 m^3, respectively

Navigant Consulting agrees with the report which recommends the simpler of the longitudinal mixed to be used for planning purposes, since it is the more robust of the two analyses. Therefore, the natural gas savings are estimated to be as follows:

Baseline Flow rate (GPM)	Energy Efficient Flow Rate (GPM)	Change in GPM	Annual Natural Gas Savings (m3)	Annual Natural Gas Savings (m3 per GPM)
2.25[4]	1.25	1.0	66	66
3[5]	1.25	1.75	116	66

Therefore, using an average baseline flow rate of 2.2 GPM and Union Gas' low flow showerhead of 1.5 GPM, the natural gas savings are estimated to be (2.2 – 1.5 GPM) x 66 m^3/GPM = 46 m^3.

However, to reflect the fact that there are fewer occupants in apartments than in single family homes (average of 2.1persons for apartments vs 2.9 persons for fully detached homes)[6], Navigant has adjusted the savings as follows:

46 m^3 x (2.1 persons per household/2.9 persons per household) = 46 x 72% = 33 m^3

It should be noted that the period of the sample in which the effects of the new showerheads might be observed is relatively short (e.g, between 74 days and 141 days, or roughly 15%-30% of the sample period).The report acknowledge this and recommend that the analysis be repeated when one year of post-installation data is available. Navigant agrees with the recommendation that a deemed saving for this measure be re-appraised when more post-installation data becomes available.

Annual Electricity Savings	**0 kWh**
N/A	
Annual Water Savings	**5,228 L**

Since the SAS report did not look at water savings, Navigant Consulting proposes the following method for calculating resulting water savings:

[4] Average of 2.0 GPM and 2.5 GPM
[5] Assumed average low flow showerhead which is greater that 2.5 GPM.
[6] Statistics Canada. *Structural Type of Dwelling (10) and Household Size (9) for Occupied Private Dwellings of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2006 Census - 100% Data* (Table) *Census 2006.* Last updated Dec 6, 2008.
http://www12.statcan.ca/english/census06/data/topics/RetrieveProductTable.cfm?ALEVEL=3&APATH=3&CATNO=&DETAIL=0&DIM=&DS=99&FL=0&FREE=0&GAL=0&GC=99&GID=837983&GK=NA&GRP=1&IPS=&METH=0&ORDER=1&PID=89071&PTYPE=88971&RL=0&S=1&SUB=0&ShowAll=No&StartRow=1&Temporal=2006&Theme=69&VID=0&VNAMEE=&VNAMEF=

Assumptions and inputs:

- As-used flow rate with base equipment: 1.89 GPM[7]
- Average household size: 2.14 persons[8]
- Showers per capita per day: 0.75[9]
- Proportion of showering affected by measure (i.e. percentage of the time the low-flow showerhead used) : 92%[10]
- Average showering time per capita per day with base equipment: 7.32 minutes
- Average showering time per capita per day with new technology: 7.5 minutes[11]

Annual water savings calculated as follows:

$$Savings = Ppl * Sh * 365 * \left(T_{base} * Fl_{base} - T_{eff} * Fl_{eff}\right)$$

Where:

Ppl = Number of people per household
Sh = Showers per capita per day
365 = Days per year
T_{base} = Showering time with base equipment (minutes)
T_{eff} = Showering time with efficient equipment (minutes)
Fl_{base} = As-used flow rate with base equipment (GPM)
Fl_{eff} = As-used flow rate with efficient equipment (GPM)
Pr = Percentage of showers where efficient equipment used

Water savings were determined to be 17% over base technology:

$$PercentSavings = \frac{\left(W_{base} - W_{eff}\right)}{W_{base}}$$

Where:

W_{eff} = Annual water consumed by showers with efficient equipment, 25,382 litres (6,704 gallons)
W_{base}= Annual water consumed by showers with base equipment: 30,671 litres (8,101 gallons)

[7] As-used flow is calculated as a function of “full-on” or label flow: as-used flow = min{ 0.691+0.542*full-on flow, full-on flow}. Proctor, J. Gavelis, B. and Miller, B. *Savings and Showers: It's All in the Head*, (PGE) Home Energy Magazine, July/Aug 1994. Cited in Summit Blue (2008). Summit Blue uses the equation without assuming that it is a min function, implicitly assuming that participants will have the expertise or desire to make minor adjustments to the house water pressure to compensate for reduced shower flow.

[8] To maintain consistency with Summit Blue number but to reflect the fact that apartments are generally occupied by fewer people than houses, the Summit Blue number was degraded by the ratio of the average number of inhabitants per apartment in an Ontario building over five stories (2) to the average number of inhabitants of a fully detached house in Ontario (2.9). Statistics Canada. No date. *Structural Type of Dwelling (10) and Household Size (9) for Occupied Private Dwellings of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2006 Census - 100% Data* (Table) *Census 2006.* Last updated Dec 6, 2008. http://www12.statcan.ca/english/census06/data/topics/RetrieveProductTable.cfm?ALEVEL=3&APATH=3&CATNO=&DETAIL=0&DIM=&DS=99&FL=0&FREE=0&GAL=0&GC=99&GID=837983&GK=NA&GRP=1&IPS=&METH=0&ORDER=1&PID=89071&PTYPE=88971&RL=0&S=1&SUB=0&ShowAll=No&StartRow=1&Temporal=2006&Theme=69&VID=0&VNAMEE=&VNAMEF=

[9] Ibid, based on data from: Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007

[10] Survey of participants, 116 from Enbridge, 111 from Union, Summit Blue (2008)

[11] Relationship modeled as: Average shower length = 8.17 – 0.448 * as-used GPM. From Energy Center of Wisconsin Analysis of data from Resource Management Strategies, Inc., *Regional Municipality of York Water Efficiency Master Plan Update,* April 2007. Cited in Summit Blue (2008)

Other Input Assumptions

Effective Useful Life (EUL)	10 Years
Summit Blue (2008) suggests an EUL of 10 years based on a survey of five studies of showerheads in other jurisdictions (California – two studies, New England, Vermont, Arkansas).	
Base & Incremental Conservation Measure Equipment and O&M Costs	**6$**
Incremental cost based on a survey of online retailers[12]. This does not include installation costs	
Customer Payback Period (Natural Gas Only)[13]	**0.3 Years**
Using a 5-year average commodity cost (avoided cost)[14] of $0.38 / m^3 and an average residential distribution cost[15] of $0.14 / m^3, the payback period for natural gas savings is determined to be 0.3 years, based on the following: Payback Period = Incremental cost / (natural gas savings x natural gas cost) = $6/ (33 m^3/year * $0.52 / m^3) = 0.3 years	
Market Penetration	**65%**
Based on previous research conducted for the OPA, Navigant Consulting estimates penetration of low-flow showerheads of all flow rates across all sectors to be 65%[16].	

Measure Assumptions Used by Other Jurisdictions

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
Flex Your Power[17]	72	10	N/A	N/A
Comments Based on switching from a 2.2 GPM to a 1.5 GPM showerhead.				

Source	Annual Natural Gas Savings (m3)	Effective Useful Life (Years)	Incremental Cost ($)	Penetration/Market Share
State of Iowa Utilities Board[18]	48	10	US$ 36	75%
Comments Based on switching from a 4 GPM to a 2.5 GPM showerhead. Measure saves 15% of 320 m^3 required for water heating.				

[12] Whedon Products 1.5 GPM Ultra Saver Showerhead.http://www.antonline.com/p_USB3C-GP_398829.htm

[13] Customer payback period has been calculated using natural gas savings only. Where applicable, payback period is expected to decrease when electricity and/or water savings are included.

[14] 2009 Avoided gas cost provided by Union Gas. 5 year average avoided gas cost determined by taking average for baseload and weather sensitive avoided gas cost.

[15] Average distribution cost taken calculated from both Union Gas website (http://www.uniongas.com/residential/rates/) and Enbridge Gas websites (https://portal-plumprod.cgc.enbridge.com/portal/server.pt?open=512&objID=248&PageID=0&cached=true&mode=2&userID=2).

[16] Navigant Consulting, Inc. for the Ontario Power Authority, *Residential Rebate Program: Participation Forecast and Incentive Bundling Strategy – Key Findings Summary*, December 2008

[17] http://www.fypower.org/res/tools/products_results.html?id=100160

[18] Iowa Utilities Board. Docket No. EEP-08-02 MidAmerican Energy Company. Volume IV, Appendix D, Part 1 of 2

Low Flow Showerheads, 1.25 & 1.5 GPM

MultiFamily, EGD

Please see the low flow showerhead substantiation document in the Residential Water Heating section.

AVOIDED COSTS (NG, kWk, Water)

Appendix H - Avoided Costs (NG, kWh, water)

Inflation Factor	1.9%
Discount Rate	7.9%

Gas Avoided Costs

	Residential/Commercial				Industrial	
	Baseload (m3)		Weather-Sensitive (m3)		Baseload (m3)	
	Rate	NPV	Rate	NPV	Rate	NPV
1	0.26116	0.26116	0.26671	0.26671	0.26132	0.26132
2	0.26316	0.50505	0.27392	0.52057	0.25936	0.50169
3	0.27487	0.74115	0.27452	0.75637	0.28238	0.74423
4	0.28577	0.96863	0.28793	0.98557	0.28596	0.97187
5	0.29120	1.18347	0.29340	1.20203	0.29139	1.18685
6	0.29673	1.38635	0.29898	1.40645	0.29693	1.38987
7	0.30237	1.57796	0.30466	1.59951	0.30257	1.58161
8	0.30812	1.75891	0.31044	1.78183	0.30832	1.76268
9	0.31397	1.92980	0.31634	1.95401	0.31418	1.93368
10	0.31993	2.09119	0.32235	2.11662	0.32015	2.09518
11	0.32601	2.24360	0.32848	2.27018	0.32623	2.24769
12	0.33221	2.38754	0.33472	2.41521	0.33243	2.39172
13	0.33852	2.52347	0.34108	2.55217	0.33875	2.52775
14	0.34495	2.65185	0.34756	2.68151	0.34518	2.65621
15	0.35151	2.77309	0.35416	2.80367	0.35174	2.77752
16	0.35818	2.88758	0.36089	2.91903	0.35842	2.89210
17	0.36499	2.99571	0.36775	3.02797	0.36523	3.00030
18	0.37192	3.09782	0.37474	3.13086	0.37217	3.10248
19	0.37899	3.19426	0.38186	3.22802	0.37924	3.19898
20	0.38619	3.28533	0.38911	3.31979	0.38645	3.29011
21	0.39353	3.37134	0.39650	3.40645	0.39379	3.37618
22	0.40101	3.45257	0.40404	3.48829	0.40127	3.45746
23	0.40863	3.52928	0.41171	3.56558	0.40890	3.53422
24	0.41639	3.60173	0.41954	3.63857	0.41667	3.60672
25	0.42430	3.67014	0.42751	3.70750	0.42458	3.67518
26	0.43236	3.73475	0.43563	3.77260	0.43265	3.73983
27	0.44058	3.79577	0.44391	3.83408	0.44087	3.80089
28	0.44895	3.85340	0.45234	3.89215	0.44925	3.85856
29	0.45748	3.90782	0.46094	3.94698	0.45778	3.91302
30	0.46617	3.95922	0.46969	3.99876	0.46648	3.96445

Water and Electricity Avoided Costs

	Residential/Commercial/Industrial			
	Water (m3)		Electricity (kWh)	
	Rate	NPV	Rate	NPV
1	1.82908	1.82908	0.08712	0.08712
2	1.86383	3.55645	0.08878	0.16940
3	1.89924	5.18776	0.09047	0.24711
4	1.93533	6.72836	0.09219	0.32049
5	1.97210	8.18330	0.09394	0.38980
6	2.00957	9.55733	0.09572	0.45524
7	2.04775	10.85495	0.09754	0.51705
8	2.08666	12.08042	0.09939	0.57543
9	2.12631	13.23774	0.10128	0.63055
10	2.16671	14.33071	0.10321	0.68261
11	2.20787	15.36290	0.10517	0.73178
12	2.24982	16.33769	0.10717	0.77821
13	2.29257	17.25828	0.10920	0.82206
14	2.33613	18.12768	0.11128	0.86348
15	2.38051	18.94873	0.11339	0.90258
16	2.42574	19.72412	0.11555	0.93952
17	2.47183	20.45640	0.11774	0.97440
18	2.51880	21.14796	0.11998	1.00734
19	2.56666	21.80106	0.12226	1.03845
20	2.61542	22.41785	0.12458	1.06783
21	2.66512	23.00034	0.12695	1.09558
22	2.71575	23.55043	0.12936	1.12178
23	2.76735	24.06994	0.13182	1.14652
24	2.81993	24.56056	0.13432	1.16989
25	2.87351	25.02390	0.13687	1.19196
26	2.92811	25.46147	0.13947	1.21281
27	2.98374	25.87472	0.14212	1.23249
28	3.04043	26.26498	0.14482	1.25108
29	3.09820	26.63354	0.14758	1.26864
30	3.15707	26.98161	0.15038	1.28521

EVALUATION PLANS

Residential Program Evaluation Plan 2012-2014
Summary Version

Program Overview

Market Opportunity

The following discussion presents the target market size, the barriers and hurdles that Union Gas Limited (UGL) intends to address through the Residential Demand-side Management (DSM) program.

- **Market Size**

The Residential sector includes single-family detached homes, semi-detached homes, duplexes, individually metered row dwellings as well as a small number of other dwellings. Residential end use categories include: space heating, domestic hot water, fireplace, cooking, dryers, pool heaters, and other.

- **Savings Potential:**

The most significant opportunities for natural gas savings are technologies that:

1. Reduce space heating, such as high-efficient furnaces, programmable thermostats, and insulation and air sealing in older homes.
2. Reduce water heating, such as high-efficiency water heaters and low-flow showerheads and aerators.

For the Union Gas Residential Program, the current savings potential[1] for each measure is as follows:

Measure	Annual Savings		
	Natural Gas (m^3)	Electricity (kWh)	Water (L)
1.25 gpm Showehead	44	0	13,885
1.5 gpm Kitchen Aerator	23	0	7,797
1.0 gpm Bathroom Aerator	10	0	3,435
Pipe Wrap	18	0	0
Programmable Thermostat	53	54	0
Draft Proofing Kit (incld. caulking, spray foam, foam tape, Energy Saver Gasket)	236	27	0
Ceiling insulation	105	105	0
Foundation insulation	261	145	0

- **Barriers and Hurdles Addressed**

The barriers and/or hurdles to be addressed by the program are summarized in the following table.

[1] The potential savings values as found in the program substantiation documents.

Segment	Market Obstacle		Description	Opportunity
Residential Customers	☐ Market Hurdle	☒ Market Barrier	Awareness barrier: Lack of education on energy conservation	Education activities including providing information through marketing activities
Residential Customers	☐ Market Hurdle	☒ Market Barrier	Behaviour barrier: Customers make choices based on factors other than efficiency (e.g., aesthetic, comfort, cost) for ESK and draft proofing measures	Provide free kits directly to the customers to encourage behavioural change
Residential Customers	☐ Market Hurdle	☒ Market Barrier	Operational barrier: Lack of understanding on how to achieve the benefits of the available measures, e.g. PSTAT, draft-proofing etc	Education activities (e.g., provide detailed programming and installation instructions)
Residential Customers	☒ Market Hurdle	☐ Market Barrier	Financial hurdle: Customers find the costs of the PSTAT and insulation prohibitive	Provide incentive directly to the customer to cover a portion of the cost

Program Description

The Residential Program consists of two components:

- Energy Saving Kit (ESK) – which consists of:
  - Water saving measures – showerheads & aerators
  - Draft Proofing
  - Programmable Thermostat (PSTAT) coupon
- Basement Wall and Attic Insulation

The ESK component focuses on simple, easy to install measures. The kits are provided for free to eligible Union Gas customers. The ESK consists of: 1.25gpm showerhead; 1.5gpm kitchen aerator; 1.0gpm bathroom aerator; 2m of foam pipe wrap; Teflon tape; and a PSTAT coupon.

The Draft Proofing kit (which is included within the ESK) includes: caulking; spray foam; foam tape; foam cover for electric outlets; and Energy Saver Gasket with a child safety insert.

The Programmable Thermostat coupon (which is also included within the ESK) encourages the replacement of manual thermostats with programmable ones. Customers either receive a bill rebate for purchasing and installing their own PSTAT or contractors are provided the incentive for replacing a manual thermostat with a programmable model.

Depending on the channel of distribution, the ESK is typically installed by the customer, but certain components of the kit can be installed directly by a contractor.

The Basement Wall and Attic Insulation component offering will include prescriptive incentives for the installation of attic insulation (also known as ceiling insulation) and

	basement wall insulation (also known as foundation insulation). The offering will take a two-pronged approach to the market; through channel partners/contractors and directly to customers, with incentives provided to the customer. • **Goals and Objectives:** The overall goals of the residential program include educating customers on the benefits and savings associated with energy conservation and providing them with tools and techniques for managing their energy use. The objectives are to maximize cumulative natural gas savings and customer satisfaction. • **Target Market:** The target market for the ESK offering is residential, single family customers who have a natural gas water heater. For the rest of the offerings in the residential program, the target market is single family customers who have natural gas space heating. • **Eligibility Criteria:** To obtain the ESK (Draft Proofing and Water Saving measures), the participant must be a Union Gas residential customer that has a natural gas water heater and a natural gas space heater. For the PSTAT offering, Union Gas residential customers are eligible for the rebate if they do not have a programmable thermostat already installed. Only one rebate is allowed per household. Internal tracking is used to identify which customers have received a rebate in the past. The insulation offering specifically targets houses built in 1979 or earlier. The house must have an unfinished basement and/or attic and be able to insulate the total square footage. The basement must have insulation of R-1 or less (essentially a bare wall) and be upgraded to R-12 or above. The attic must be R-10 or less and be upgraded to R-40 or above. • **Key Program Elements:** As noted, the residential program consists of two offerings: ESK (Water Saving Measures + Draft Proofing + PSTAT coupon), and Basement Wall & Attic Insulation. For the ESK, UGL implements a wide marketing campaign through multiple channels – push, pull, and install, all aimed to encourage customers to order or pick up the free kits and install the measures themselves. The pull channel includes direct marketing to eligible customers, partnering with large organizations, and partnering with large retailers. The push channel includes Residential Account Manager (RAM) initiated events and engaging with contractors whereby eligible customers receive a free kit (to install the measures themselves) without taking their own initiative (i.e., to order or pick up the kit), the kits are simply “pushed” out to the customers. Finally, the install channel consists of engaging with contractors who install the components of the kits while on site. The PSTAT offering has similar pull and install delivery channels. Pull channel includes direct marketing to customers to encourage the customers to purchase and install a programmable thermostat. Through the install channel, contractors engage the customer and install the programmable thermostat for the customer. In the

	former case, the eligible customer applies for the bill rebate. In the latter case, the contractor receives the rebate for installation of the PSTAT. The Insulation offering will be directed to the customers and to the contractors. Eligible customers will receive an incentive for installing qualifying insulation. • **Program Timing:** The ESK offering is an ongoing component of the residential program. The addition of the Draft Proofing components to the ESK and the Insulation Offering will start in 2012. All elements of the residential program are currently planned for 2012 to 2014. • **Estimated Participation:** The Residential program targets for 2012 are as follows: ESK + Draft Proofing – 56,000 kits distributed; PSTAT – 6,000 installed; and Insulation – 175 installations of either attic or basement wall insulation. • **Budget:** The total budget for the residential program for 2012 is $4.103 million. **Program Theory / Program Logic Model** In summary, the program theory as described by short term, medium term, long term: • In the short-term: the main program elements presented above will increase the level of awareness of energy conservation amongst residential customers and will lead to the distribution of free kits and purchase of programmable thermostats. • In the medium-term: the program will lead to either the direct installation of measures by contractors (kits, thermostats, insulation) or to customers installing their own measures (free kits or programmable thermostats). • In the long-term: the program will generate energy savings for residential customers and produce customer satisfaction.
Evaluation Goals and Objectives	The focal point of the evaluation activities derive from four key pillars: base-lining & market characterization, process evaluation, causality & attribution evaluation, and impact & verification. The following highlights the goals and objectives of the evaluation efforts proposed for consideration for this program. Evaluation activities will be used in support of Union's Incentive and LRAM claims. **Key Evaluation Elements** Evaluation studies will be used to: • demonstrate the impact/effectiveness of the ESK program through verification of the installation, persistence, and usage rates of the water saving devices. Evaluation studies may be used to: • demonstrate the impact/effectiveness of the ESK + Draft Proofing measures, programmable thermostats, and insulation offering and increase the precision of Project Input Assumptions (PIAs) to improve savings projections • ascertain the level of free ridership for the ESK + Draft Proofing measures, PSTAT, and Insulation offerings.

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validate or modify the current program theory/logic model
reinforce accountability of program administrator staff
provide feedback to the program manager such that improvements can be made that increase the program uptake
gauge customer satisfaction and understanding and provide feedback to the program manager such that improvements can be made to the various delivery mechanisms that result in greater participant satisfaction
inform decisions regarding whether to increase the educational information associated with each program based on the effectiveness to date
inform long-term DSM program planning whether to continue the program, evolve the program or apply an exit strategy

Research Questions
Research questions include:

What is the direct impact of the program in terms of participation rates for water saving ESK elements? (Impact evaluation)

Research questions may include:

What is the direct impact of individual program elements [ESK (water saving measures+ Draft Proofing + PSTAT) and Insulation] on energy consumption? (Impact evaluation)
What proportion of the energy savings for each measure ([ESK (water saving measures+ Draft Proofing + PSTAT) and Insulation] can be attributed to the program? (Impact Evaluation – Causality and Attribution)
How can the set of program objectives and goals be improved? Are program goals set too high? Too low? (Process Evaluation)
How effective is the marketing campaign? (Process Evaluation)
How effective are the delivery/implementation mechanisms? (Process Evaluation)
Are program designs and supporting organizational controls adequate? (Process Evaluation)
How might the program be improved? (Process Evaluation)
How effective has the program been in reducing barriers, including awareness, behaviour, and operation? (Market Effects Evaluation)

</td></tr>
<tr><td>Evaluation Elements</td><td>
UGL will continue to undertake verification of the water savings measures included I the ESK and will establish any additional evaluation activities in consultation with the Technical Evaluation Committee as outlined in the Stakeholder Engagement Terms of Reference (Appendix E).

Evaluation to be Conducted

☒ Impact Evaluation
The program will be subject to verification impact evaluation in 2012, 2013, and 2014 during which:

the install and persistence rates of the ESK water conservation offerings will be validated through a verification telephone survey of a statistically representative sample, which will also capture the usage rates of the ESK showerheads.

Evaluation to be Considered
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</table>

☐ **Impact Evaluation (Additional)**

Depending on the evaluation priority discussions, the program may be subject to additional impact evaluation activities. This evaluation could consider the following activities:

- validate the install rates of the Draft Proofing and PSTAT offerings through a verification telephone survey of a statistically representative sample
- conduct site visits for a small sub-set of ESK + Draft Proofing, and PSTAT participants
- a free-ridership survey administered to a statistically representative sample of ESK + Draft Proofing and PSTAT program participants and non-participants to determine the program's net-to-gross ratio
- review and validation of the PIAs for the ESK + Draft Proofing measures, along with PSTAT
- Review PIAs for the Insulation offering,
- pre and post site visits conducted for the Insulation program by a third party to: 1) validate assumptions; 2) determine a baseline
- conduct a billing analysis to determine the impact of the Insulation program on energy consumption
- administer a survey will be to a statistically representative sample of Insulation participants to determine the program's net-to-gross ratio

☐ **Process Evaluation**

Depending on the evaluation priority discussions, the program may be subject to a comprehensive process evaluation. This evaluation should consider the following activities:

- review logic model and assumptions to validate and improve the program theory
- phone surveys of participants and non-participants to improve the marketing campaign
- surveys of participants and non-participants and interviews with channel partners and UGL staff to improve the delivery mechanisms,
- consultations with UGL staff to re-assess program objectives and targets
- surveys of participants to test satisfaction

☐ **Market Effects Evaluation**

Depending on the evaluation priority discussions, the program may be subject to a market effects evaluation. This evaluation should consider the following activities:

- phone surveys with participants and non-participants to determine rate of recall of key messages and understanding of individual measures
- phone surveys with participants and non-participants to understand decision making processes, and
- consultations with UGL staff to improve the educational component of the program

The program administrator will be responsible collecting the data required to be used by external consultants in undertaking any evaluation work. The following table outlines the evaluation work to be considered for this program.

	To be conducted: ☒ ESK water measure installation verification ☐ Quasi-Prescriptive Input Assumption Review ☐ Energy Savings ☐ New Prescriptive Input Assumption ☐ New Quasi-Prescriptive Input Assumption	To be considered: ☒ Market Research/Participant Research ☒ Prescriptive Input Assumption Review ☒ Project-level M&V ☒ Net-to-Gross Ratio
Evaluation Approach	• **Verification Impact Evaluation** The evaluators will conduct an impact evaluation for the ESK water savings measures to verify savings of a statistically representative sample of program participants. This evaluation will be used to adjust the savings values claimed by the program. Sampling is an important factor of M&V activities. Sampling should be designed to obtain key responses with statistically representative population. The impact analysis will result in a verified savings for a sample of participants and the ESK water savings measures. A realization ratio (verified savings/claimed savings) for each measure will be determined and applied to the remaining population in order to estimate gross program savings.	
Special Provisions	No special provisions	
Data Collection Responsibilities	**External Data** An independent EM&V contractor will be responsible for all external market data collection activities (e.g., participant surveys). **Internal Tracking of Program Results** Union will be responsible for internal tracking of program data such as customer information, installation information, participant incentive, etc. All tracking data will be provided to the EM&V contractor during the verification of the HHC program. Using the tracking system along with additional information tracked by the program, Union aggregates the annual program results into an internal tracking report at the end of each year. This report will outline: • # of participants and contact information for each participant • # of channel partners and contact information • incentives paid – to contractors; to customers • associated prescriptive m^3 savings by measure by project • associated kit costs • other program costs including: marketing and delivery expenses, salaries, verification, etc.	

	Organization	Name	Title / Accountability
Procurement Process	UGL	Internal Evaluator with input from the Technical Evaluation Committee	Selection of the independent EM&V contractors
	UGL	Internal Evaluator and Program Manager	Coordination with the independent EM&V contractors
	Independent EM&V Contractor selected to conduct the EM&V Studies	To Be Determined	Finalize the EM&V Plan Collect "External Data" Perform Analysis Deliver the EM&V Studies

Commercial/Industrial Custom & Prescriptive Offering Evaluation Plan 2012-2014
Summary Version

Given the different natures of the CI Custom and Prescriptive offerings, evaluation activities specific to each program area have been presented separately. This Evaluation Plan provides a Program Overview of the market and budget, which, aside from the Market Barriers and Hurdles, is the same for both custom and prescriptive. After the Program Overview, the evaluation plan components are presented for CI Custom in their entirety, followed by CI Prescriptive.

Custom & Prescriptive Program Overview

Market Opportunity

The following discussion presents the target market size, the barriers and hurdles that Union Gas Limited (UGL) intends to address through the Commercial/Industrial (CI) Custom & Prescriptive Demand-side Management (DSM) program.

- **Market Characteristics**

<u>Commercial</u>
UGL's commercial sector is divided into 13 main customer segments including Office, Retail, Multifamily, Foodservice, Hotel/Motel, Agriculture, Entertainment/Recreation, Education, Healthcare, Religious, Service, Warehouse, and Other.
Key market actors in the commercial sector include: Service Providers, Suppliers, Associations, Manufacturers, and Distributors.

<u>Industrial</u>
UGL's industrial sector is divided into nine main customer segments including Primary Metal Manufacturing, Chemical Manufacturing, Paper Manufacturing, Transportation & Machinery Manufacturing, Petroleum Refineries, Mining, Food and Beverage Manufacturing, Non-Metallic Mineral Product Manufacturing, and Miscellaneous.

The categorization of market actors for the industrial sector is similar to the commercial sector: Service Providers, Suppliers, Associations, Manufacturers, and Distributors. Some specific examples of associations include: Canadian Manufacturers and Exporters (CME), Consortium for Energy Efficiency (CEE), Energy Solutions Center (ESC).

- **Budget:**

The 2012 budget for the Commercial/Industrial Program is $9.181M, which includes both custom and prescriptive offerings.

- **Custom Program Barriers and Hurdles Addressed**

The barriers and/or hurdles to be addressed by the Custom program are summarized in the following table.

Segment	Market Obstacle	Description	Opportunity

Commercial/ Industrial Customers	☒ Market Hurdle	☐ Market Barrier	Financial hurdle: Customers find the cost of pre-feasibility, process and steam trap studies prohibitive	Provide incentives directly to the customer to cover a portion of the study costs
Commercial/ Industrial Customers	☒ Market Hurdle	☐ Market Barrier	Financial hurdle: Customers find the cost of project implementation prohibitive	Provide incentives directly to the customer based on estimated energy savings in order to offset the cost of implementation.
Industrial Customers	☐ Market Hurdle	☒ Market Barrier	Capacity barrier (customers): Small-medium size industry customers don't have the staff availability/technical knowledge to prioritize opportunities identified in pre-feasibility studies	Providing support through the UGL 'Energy Team' to help these customers define project scope
Commercial/ Industrial Customers	☐ Market Hurdle	☒ Market Barrier	Information barrier: Lack of education on energy conservation	Education activities through seminars, newsletters, events to inform customers about the potential financial implication, alternative costs and risks associated with not installing EE equipment
Service Providers	☐ Market Hurdle	☒ Market Barrier	Capacity barrier (market actor): Service providers not always considering DSM and aren't producing pre-feasibility, process or steam studies in accordance with best practice	Provide guidelines for pre-feasibility, process and steam trap studies

- **Prescriptive Program Barriers and Hurdles Addressed**

The barriers and/or hurdles to be addressed by the Prescriptive program are summarized in the following table.

Segment	Market Obstacle		Description	Opportunity
C&I	☒ Market Hurdle	☐ Market Barrier	Sensitive to cost; demand low payback periods (< 2 years)	Incentives can lower hurdle and drive adoption
C&I	☐ Market Hurdle	☒ Market Barrier	Certain technologies may be entrenched in the market and more efficient equipment is hard to find	Incent new equipment to build mindshare for more efficient products
C&I	☐ Market Hurdle	☒ Market Barrier	Customers are unaware of more efficient practices (e.g. DCKV)	Educate: Introduce technology, its benefits, and potential savings

Custom Evaluation Plan

Custom Program Description

Custom Offering Description

Union provides a mix of energy efficiency initiatives that can be customized to meet the distinct needs of different customers. These initiatives are categorized as follows:

- Communication and Education
- Industrial Process Studies
- Energy Efficiency Feasibility Studies
- Equipment Incentives
- Demonstration of New Technology

- Building Optimization

- **Goals and Objectives:**

The overall objectives for the CI Custom program are:

- maximization of cost effective cumulative natural gas savings,
- pursuit of cumulative deep energy savings, and
- customer Satisfaction

- **Target Market:**

The CI Custom Offering targets commercial and industrial customers within the following rate classes: M1, M2, 01, 10, M4, M5, M7, 20

- **Eligibility Criteria:**

Eligible participants must be located in UGL's franchise area and must be a customer within one of the targeted rate classes.

- **Key Program Elements:**

The following activities will be undertaken:

- Channel Partner Engagement – These activities include:
  - Establishing relationships with key industry partners including: Canadian Manufacturers and Exporters (CME), Ontario Ministry of Small Business and Consumer Services, Consortium for Energy Efficiency (CEE), Energy Solutions Centre (ESC) and Natural Resources Canada (NRCan)
  - Establishing relationships with key commercial partners including: service providers, suppliers, associations, manufacturers and distributors

- Marketing – These activities include:
  - Targeted Marketing (Industrial & Commercial) – Direct sales calls are made to industrial and large commercial customers by UGL account managers.
  - Mass Marketing (Commercial) – Program brochures are sent by mail to eligible commercial customer base (small to medium size).
  - National Account Marketing (Commercial) – National account managers communicate directly with national organization contacts (i.e. hotel chains, grocery store chains, etc.) to promote the program.

- Education - These activities are aimed primarily at the industry sector and include holding training seminars, sending out newsletters, and attending channel partner events.

- Study Support – Incentives are provided for pre-feasibility, process improvement and steam trap studies. Guideline material is provided for service providers that are planning on submitting pre-feasibility, process and steam trap studies on behalf of customers seeking a study incentive.

- Support via Energy Team – Support is provided to industry customers through the UGL 'Energy Team' to help them prioritize opportunities

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identified in studies, and to help them define an appropriate project scope.

• Project Incentives – Incentives are provided based on estimated energy savings in order to offset the cost of implementation.

• Program Timing:

The CI Custom Offering has been in the market since 2007 and all main program elements have been rolled out at least once. The program will be offered in 2012 and in the subsequent two years. UGL seeks to have the relevance of the program assessed periodically by third-party evaluators.

Program Theory / Program Logic Model

In summary, the program theory is as follows:
• In the short-term: the main program elements presented above will increase the level of customer awareness about the CI Custom Offering and their awareness in general about energy efficiency. This will in turn lead to the completion of energy efficiency studies and the implementation of energy efficiency projects.
• In the medium-term: customers will be able to identify opportunities without support from UGL. This will lead to further project implementation.
In the long-term: the program will generate natural gas savings (including deep savings) and customer satisfaction.
</td></tr>
<tr><td>Custom Evaluation Goals and Objectives</td><td>
The focal point of the evaluation activities derive from four key pillars: base-lining & market characterization, process evaluation, causality & attribution evaluation, and impact & verification. The following highlights the goals and objectives of the evaluation efforts proposed for consideration for this program. Evaluation activities will be used in support of Union’s Incentive and LRAM claims.

Key Evaluation Elements

Evaluation studies will be used to:
• verify natural gas savings directly resulting from program activities

Evaluation studies may be used to:
• validate or modify the current program theory/logic model
• provide feedback to the program manager such that improvement can be made to the program implementation process
• provide feedback to the program manager such that improvements can be made that increase the program uptake
• provide feedback to the program manager such that improvements can be made to the various delivery mechanisms that result in greater participant satisfaction
• inform long-term DSM program planning whether to continue the program, evolve the program or apply an exit strategy
• inform decisions regarding whether to increase and improve the education activities, decrease them or maintain the status quo based on the effectiveness to date
• provide feedback to the program manager such that improvement can be made to the operation of the energy team and the structure of the study guidelines

Research Questions
</td></tr>
</table>

	Research questions include: • What is the direct impact of individual program elements on energy consumption? (Impact evaluation) Research questions to be considered: • What proportion of the energy savings can be attributed to the program? (Impact Evaluation – Causality and Attribution) • Are the program design and its operational systems adequate? (Process Evaluation) • Are program staff implementing the program effectively in regards to liaising with customers, tracking program data, following guidelines and adhering to timelines? (Process Evaluation) • How can the program better appeal to the targeted population? (Process Evaluation) • How can the program set of objectives and targets be improved? Are program goals set too high? Too low? (Process Evaluation) • Are participants satisfied with the program? (Process) • How effective has the program been in reducing lack-of-education barriers? (Market Effect Evaluation) • How effective has the program been at increasing service providers' capacity to produce best practice studies and increasing customers' capacity to scope energy efficiency projects? (Market Effects Evaluation)
Custom Evaluation Elements	UGL will continue to undertake current evaluation activities specific to verifying a sample of custom project savings and establish any additional evaluation activities in consultation with the Technical Evaluation Committee as outlined in the Stakeholder Engagement Terms of Reference (Appendix E). **Evaluation to be Conducted** ☒ **Impact Evaluation (Verification)** The program will be subject to an impact evaluation in 2012, 2013, and 2014 during which: • Equipment replacement and steam trap project savings claims will be validated through desktop reviews for a statistically representative sample, • Process improvement project savings claims will be validated through desktop reviews and/or site visits for a statistically representative sample. **Evaluation to be Considered** ☐ **Impact Evaluation (Additional)** Depending on the evaluation priority discussions, the offering may be subject to additional impact evaluation activities: • Savings directly resulting from studies (no or low cost measures) can be validated through phone surveys for a statistically representative sample of the applicable population of studies (studies that have identified no or low cost measures), • Site visits can be conducted for a small percentage of the equipment replacement and steam trap project sample to test the assumption that projects were implemented as claimed, and • A free-ridership survey can be administered to a statistically

representative sample of program participants to determine the program's net-to-gross ratio.

☐ **Process Evaluation**
Depending on the evaluation priority discussions, the program may be subject to a comprehensive process evaluation. This evaluation could consider the following activities:

- Review logic model and assumptions to validate and improve the program theory,
- Phone surveys of a sample of participants and non-participants, and interviews with UGL staff to improve the delivery mechanisms,
- Phone surveys of a sample of participants and non-participants to improve the marketing campaign,
- Consultations with UGL staff to re-assess program objectives and targets, and
- Phone surveys participants to test satisfaction.

☐ **Market Effects Evaluation.**
Depending on the evaluation priority discussions, the program can be subjected to a market effects evaluation. This evaluation could consider the following activities:

- Phone surveys of a sample of participants and non-participants to improve education activities,
- Interviews with UGL staff to understand the level effort and subsequent impact of the UGL 'Energy Team' activities, and
- Reviews by an expert panel to assess the quality of studies that are being funded by the program.

The program administrator will be responsible collecting the data required to be used by external consultants in undertaking any evaluation work. The following table outlines the evaluation work to be considered for this program.

To be conducted:	To be considered:
☐ Prescriptive Input Assumption Review	☒ Market Research/Participant Research
☐ Quasi-Prescriptive Input Assumption Review	☐ New Prescriptive Input Assumption
☒ Project-level M&V	☐ New Quasi-Prescriptive Input Assumption
☐ Energy Savings & Demand/Peak Reduction	☒ Net-to-Gross Ratio

Custom Evaluation Approach

- **Verification Impact Evaluation**

The evaluators will conduct an impact evaluation to verify gross savings of a statistically representative sample of program participants. This evaluation will be used to estimate the gross impact of individual program elements on energy consumption.

The impact analysis will determine verified savings for a statistically representative sample of the following two project population subsets:

<table>
<tr><td></td><td>
Equipment replacement and steam trap projects
Process improvement projects
The weighted realization rate (verified savings/claimed savings) for each of these subsets will be applied the remaining populations in order to estimate gross program savings.</td></tr>
<tr><td>Special Provisions</td><td>No special provisions.</td></tr>
<tr><td>Custom Data Collection Responsibilities</td><td>External Tracking
An independent EM&V contractor will be responsible to conduct of the evaluation.

Tracking for Program Results
Union will be responsible for internal tracking of program data such as customer information, installation information, participant incentive, etc. All tracking data will be provided to the EM&V contractor during the verification of the HHC program. Using the tracking system in conjunction with information tracked by the program, Union aggregates the annual program results into an internal tracking report at the end of each year. This report will outline:

participant contact and address information
service provider contact and address information
non-participant contact and address information
and type of studies conducted
study costs
service provider that prepared study
incentives paid by study
and type of project implemented
project costs
service provider and contractor involved with project
estimated m^3 savings by measure by project
incentives paid by measure by project
other program costs including: marketing and delivery expenses, salaries, verification, etc.
</td></tr>
<tr><td>Custom EM&V Procurement Process</td><td>
<table>
<tr><th>Organization</th><th>Name</th><th>Title / Accountability</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>UGL</td><td>Internal Evaluator with input from the Technical Evaluation Committee</td><td>Selection of the independent EM&V contractors</td></tr>
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<tr><td>Independent EM&V Contractor selected to conduct the EM&V Studies</td><td>To Be Determined</td><td>Finalize the EM&V Plan
Collect “External Data”
Perform Analysis
Deliver the EM&V Studies</td></tr>
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<table>
<tr><th colspan="2">Prescriptive Evaluation Plan</th></tr>
<tr><td>Prescriptive Program Description</td><td>
Prescriptive Offering Description
The prescriptive offering consists of several energy efficient measures that target significant m³ savings:

Condensing Boilers
Infrared Heating
Energy Recovery Ventilators
Heat Recovery Ventilators
Condensing Rooftop Units
Drain Water Heat Recovery Systems
Laundry Washing Equipment with Ozone
Condensing Unit Heaters
Condensing Gas Water Heaters
Demand Control Kitchen Ventilation
CEE Tier 2 Front-Loading Clothes Washers
Energy Star Dishwashers
Hot Water Conservation (Showerheads and Faucet Aerators)
Energy Star Convection Ovens
Energy Star Steam Cookers
Energy Star Fryers
High-Efficiency Under-Fired Broilers

Union will explore additional measures to include in the prescriptive offering over the course of the plan. The CI Prescriptive Offering has been designed to address the hurdles and barriers identified in the commercial and industrial sectors.
Goals and Objectives
The goal of the prescriptive suite of programs is to increase energy savings and promote a culture of continuous energy management among Union Gas’s customers. Specifically, the program goals are to:

Maximize the cost effectiveness of natural gas savings;
Pursue deep measures; and,
Ensure customer satisfaction.

Target Market
The target market for this suite of offerings is broad, and includes the segments as identified above under Market Characteristics.

These market segments fall within the following rate classes: M1, M2, 01, 10, M4, M5, M7, 20.
Eligibility Criteria
The main eligibility criterion is that the participant be a Union Gas customer with an account of the appropriate commercial or industrial rate class. Several of the market segments have further eligibility criteria; for example, Pre-Rinse Spray Nozzles are only available to customers who have a Food Service component to
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</table>

their business, such as hotel/motel, health care, and restaurants.

- **Key Program Elements**

The following activities will be undertaken within the program:

- Opportunity Identification - Potential program participants are identified through market research and a targeted marketing approach is directed to encourage customer applicants. In the case of some programs, the supply and delivery of equipment may be accomplished by a third party delivery firm (e.g. Eco-fitt).
- Marketing:
    - Mass Marketing (Commercial) – Program brochures are sent by mail to eligible commercial and industrial customer base.
    - Service Provider - Service providers are a key player within the prescriptive programs and are directly marketed to. Providers include “design decision makers” such as engineers, architects, contractors, and HVAC installers.
- Project Incentives - are provided based on a per item prescriptive value. Additional incentives are sometimes offered to encourage the installation of some measures.

- **Program Timing**

This offering is ongoing through the duration of the three year DSM Plan. It may be refined each year in the event new equipment are added to the offering.

- **Estimated Participation**

The C/I program is expected to generate 533 million m^3 of cumulative natural gas savings annually for the duration of the 2012-2014 framework. Union will focus on maximizing cost effectiveness, prevention of lost opportunities, and pursue the uptake of deep measures. Deep measures for 2012 include: Condensing Boilers, Energy Recovery Ventilators, Infrared Heaters, Destratification Fans, Condensing Make Up Air Units, and Drain Water Heat Recovery Systems; each has a measure life greater than (or equal to) 14 years.

Program Theory / Program Logic Model

In summary, the program theory as described by short term, medium term, long term objectives:

- In the short-term: lower the hurdles and barriers that hinder the adoption of energy-efficient equipment (primarily the higher incremental cost of energy-efficient equipment).
- In the medium-term: encourage customers to seek out further incentives and savings
- In the long-term: deliver energy savings, leading to increased customer satisfaction.

Prescriptive Evaluation Goals and Objectives	The focal point of the evaluation activities derive from four key pillars: base-lining & market characterization, process evaluation, causality & attribution evaluation, and impact & verification. The following highlights the goals and objectives of the evaluation efforts proposed for consideration for this program. Evaluation activities will be used in support of Union's Incentive and LRAM claims. **Key Evaluation Elements** Evaluation studies will be used to: • assess the gross impact of the program Evaluation studies may be used to: • further characterize market segments that participate in the program • test the validity and increase the precision of certain key prescriptive inputs assumptions (PIAs) • determine the net-to-gross ratio of the program **Research Questions** Research questions include: • Does program tracking accurately reflect installation rates? (Impact Evaluation) Research questions that may be considered include: • What proportion of those effects can be attributed to the program? (Impact Evaluation – Causality and attribution) • What is the direct impact of individual program elements on energy consumption? (Impact Evaluation) • Are the prescriptive impact assumptions for key measures (e.g. fans, boilers) accurate and reflective of real-world installed conditions (Impact Evaluation) • How accurately have markets and barriers been characterized prior to launching a new program segment? (Market Characterization)
Prescriptive Evaluation Elements	UGL will continue to verify Hot Water Conservation and establish any additional evaluation activities in consultation with the Technical Evaluation Committee as outlined in the Stakeholder Engagement Terms of Reference (Appendix E). **Evaluation to be Considered** ☐ **Impact Evaluation** Depending on evaluation priorities established through the stakeholder engagement process, the program may be subject to verification impact evaluation in 2012, 2013, and 2014 to: • validate installation rates for a select number of program measures for a statistically representative sample. ☐ **Additional Impact Evaluation** Further impact evaluation activities could be used to verify the impacts of some of the larger prescriptive programs: • for some of the larger program measures (e.g. boilers), a project-level M&V could be used in conjunction with a PIA assessment. In

many facilities, the effects of changing a boiler will be apparent in the natural gas readings. An M&V plan that conforms to IPMVP Option C will allow the attribution of the savings to the new boiler and verify the prescriptive savings claimed for each measure.

- a free-ridership survey may be administered to a statistically representative sample program participants and non-participants to determine the program's net-to-gross ratio

☐ **Market Characterization**

Determining the market size and technology penetration rates could be used to improve the program offerings. Additionally, understanding key market stakeholders will improve the ability of program staff to reach their desired audience.

- survey non-participants to determine the penetration of incented technologies (e.g. pre-rinse spray nozzles, condensing boilers, ERVs, etc.)
- determine the reasons that non-participants have for not installing incented equipment – confirm and/or determine the hurdles and/or barriers for each incented equipment category.

☐ **Process Evaluation**

Due to budget constrains the C/I Prescriptive program will not be subject to a process evaluation at this time. It is believed that since this program primarily exists to lower the well-established cost barriers of more-efficient equipment, the process evaluation budget is better spent on programs with more complex market hurdles and barriers.

The program administrator will be responsible collecting the data required to be used by external consultants in undertaking any evaluation work. The following table outlines the evaluation work to be considered for this program.

To be considered:	To be considered:
☒ Prescriptive Input Assumption Review	☒ Market Research/Participant Research
☒ Quasi-Prescriptive Input Assumption Review	☐ New Prescriptive Input Assumption
☒ Net-to-Gross Ratio	☐ New Quasi-Prescriptive Input Assumption
☐ Energy Savings & Demand/Peak Reduction	☒ Project-level M&V

Prescriptive Evaluation Approach

- **Verification Impact Evaluation**

The evaluators may conduct a verification study. This evaluation will be used to confirm the installation of individual program elements for Hot Water Conservation. The program administrator will need to collect a certain amount of data for use in the evaluation through their routine tracking activities, and through careful indexing and storage of all program documentation.

The impact analysis will determine verified savings for a statistically representative

<table>
<tr><td></td><td>sample of several of the key prescriptive programs. This is expected to be determined through the stakeholder consultation process.

The weighted realization rate (verified savings/claimed savings) for each of these subsets will be applied the remaining populations in order to estimate gross program savings.</td></tr>
<tr><td>Special Provisions</td><td>There are no special provisions.</td></tr>
<tr><td>Prescriptive Data Collection Responsibilities</td><td>External Data

An independent EM&V contractor will be responsible for all external market data collection activities.

Internal Data Tracking for Program Results
Union will be responsible for internal tracking of program data such as customer information, installation information, participant incentive, etc. All tracking data will be provided to the EM&V contractor during the verification of the HHC program. Using the tracking system along with additional information tracked by the program, Union aggregates the annual program results into an internal tracking report at the end of each year. This report will outline:
participant contact and address information
service provider contact and address information
and type of installed prescriptive measures
prescriptive m^3 savings values by measure by project
incentives paid by measure by project
other program costs including: marketing and delivery expenses, salaries, verification, etc.</td></tr>
<tr><td>Prescriptive Procurement Process</td><td><table><tr><th>Organization</th><th>Name</th><th>Title / Accountability</th></tr><tr><td></td><td></td><td></td></tr><tr><td>UGL</td><td>Internal Evaluator with input from the Technical Evaluation Committee</td><td>Selection of the independent EM&V contractors</td></tr><tr><td>UGL</td><td>Internal Evaluator and Program Manager</td><td>Coordination with the independent EM&V contractors</td></tr><tr><td>Independent EM&V Contractor selected to conduct the EM&V Studies</td><td>To Be Determined</td><td>Finalize the EM&V Plan
Collect “External Data”
Perform Analysis
Deliver the EM&V Studies</td></tr></table></td></tr>
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Rate T1 and Rate 100 Evaluation Plan 2012-2014
Summary Version

Program Overview

Market Opportunity

The following discussion presents the target market size, the barriers and hurdles that Union Gas Limited (UGL) intends to address through the Rate T1 and Rate 100 Demand-side Management (DSM) program.

- **Market Characteristics**

A variety of industry sectors are represented within the Rate T1 and Rate 100 rate classes, including steel mills, chemical refineries, food processing plants, commercial alcohol producers, pulp and paper plants, power plants, health complexes, and greenhouses.

Historically, these customers provide the vast majority of the gas savings and cost benefits from DSM programs.

While past programs have included some education and promotion efforts, as well as process and feasibility studies, the focus has traditionally been on equipment installation. However, opportunities currently exist to influence discretionary spending on operations and maintenance and overcome barriers/hurdles preventing the implementation of cost-effective savings measures.

- **Barriers and Hurdles Addressed**

The barriers and/or hurdles to be addressed by the program are summarized in the following table.

Segment	Market Obstacle		Description	Opportunity
Large Industrial	☐ Market Hurdle	☒ Market Barrier	Lack of awareness and understanding of energy savings by maintenance, operations and purchasing staff	Develop capacity through targeted training
Large Industrial	☐ Market Hurdle	☒ Market Barrier	Lack of dedicated support for energy management and staff turnover	Help create and support Energy Teams
Large Industrial	☐ Market Hurdle	☒ Market Barrier	Lack of incentive for management attention	Provide valuable recognition of top performers
Large Industrial	☒ Market Hurdle	☐ Market Barrier	Lack of in-house expertise in performance of thermal systems.	Provide direct technical assistance to identify and assess energy saving opportunities
Large Industrial	☒ Market Hurdle	☐ Market Barrier	Cost to fund in-depth studies of energy opportunities can be difficult to justify	Provide financial incentive towards the cost - generating "call to action"
Large Industrial	☒ Market Hurdle	☐ Market Barrier	Budgets for O&M are constrained and there is internal competition for available dollars	Provide performance incentive to improve business case for O&M investments

Program Description

The Rate T1 and Rate 100 program is an integrated customer engagement and opportunity development offering. Four components are included:

- Customer engagement, featuring targeted technical training, support for the creation and operation of Energy Teams, and corporate recognition
- Site energy assessments of thermal systems conducted by Union Gas staff to identify energy savings opportunities
- Incentives for in-depth process improvement studies
- Performance based incentives for O&M improvements in steam/thermal, combustion, HVAC, process heating and other natural gas equipment, systems and processes.

- **Goals and Objectives:**

The overall goals for the Rate T1 and Rate 100 program are to:

- provide Rate T1 and Rate 100 customers with the tools and support to assess their energy usage as compared to industry best practices,
- demonstrate the long term value of process and equipment improvements through sustainable reductions in energy consumption,
- encourage the adoption of behavioural and process changes that supports a continual focus on energy management, and
- provide valued tools and services that leverage Union's expertise in the area of energy efficiency in a cost effective manner.

The overall objectives for the Rate T1 AND Rate 100 program are to:

- Increase customer capacity to manage energy
- Produce energy savings
- Increase customer satisfaction

Through participation in the program, customers will have increased awareness of and capability of managing energy opportunities and will have direct and financial assistance in identifying, assessing and implementing performance improvement measures.

- **Target Market:**

Rate T1 and Rate 100:

- **Eligibility Criteria:**

Members of the Rate T1 and Rate 100 rate classes are eligible. O&M investments are eligible for the performance improvement incentive.

- **Key Program Elements:**

- Customer Engagement Site Energy Assessments
- Process Improvement Studies
- Performance Improvement Incentives

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- **Program Timing:**

As noted, the focus of the program is now shifting to education and promotion efforts, process and feasibility studies, in support of O&M improvements for 2012-2014.

- **Estimated Participation:**

Using data from participation in previous program offerings, program staff characterized O&M process improvement opportunities by type, average size, and total annual savings expected, per the rolling three year average.

- **Budget:**

The proposed budget is $2.2 million per year. This includes $360,000 for program costs and $1.84 million for performance incentives. This is broken down as follows:

Program Theory / Program Logic Model

In summary, the program theory is as follows:

- In the short-term: the main program elements presented above will increase the level of awareness, motivation and the capability of customer staff and Energy Teams, while generating actual process, system performance improvement proposals that are implemented.
- In the medium-term: the awareness, motivation and capability, combined with the practical experience of implementing improvements will give customers greater overall capacity to manage energy.

In the long-term: the program will generate direct energy savings from the O&M improvements implemented under the program. Additionally, the greater capacity to manage energy will generate other improvements implemented outside the program or following the end of the program. Both will lead to enhanced customer satisfaction.
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</tr>
<tr>
<td>**Evaluation Goals and Objectives**</td>
<td>

The focal point of the evaluation activities derive from four key pillars: base-lining & market characterization, process evaluation, causality & attribution evaluation, and impact & verification. The following highlights the goals and objectives of the evaluation efforts proposed for consideration for this program. Evaluation activities will be used in support of Union's Incentive and LRAM claims.

Key Evaluation Elements

Evaluation studies will be used to:

- determine natural gas savings directly resulting from program activities

Evaluation studies may be used to:

- validate or modify the current program theory/logic model
- provide feedback to the program manager such that improvement can be made to the program implementation process
- provide feedback to the program manager such that improvements can be made that increase the program uptake
- provide feedback to the program manager such that improvements can be made to the various delivery mechanisms that result in greater participant satisfaction
- inform long-term DSM program planning whether to continue the program,
</td>
</tr>
</table>

	evolve the program or apply an exit strategy • inform decisions regarding whether to increase and improve the engagement activities, decrease them or maintain the status quo based on the effectiveness to date • provide feedback to the program manager such that improvement can be made to the operation of the energy team and the structure of the energy assessment and process improvement studies **Research Questions** Research questions include: • What is the direct impact of the program on energy consumption? (Impact evaluation) Research questions to be considered: • What proportion of the energy savings can be attributed to the program? (Impact Evaluation – Causality and Attribution) • Are the program design and its operational systems adequate? (Process Evaluation) • Are the program staff implementing the program effectively with regards to liaising with customers, tracking program data, following guidelines and adhering to timelines? (Process Evaluation) • How can the program better appeal to the targeted population? (Process Evaluation) • How can the program set of objectives and targets be improved? Are program goals set too high? Too low? (Process Evaluation) • Are participants satisfied with the program? (Process Evaluation) • How effective has the program been in reducing lack-of-capacity barriers? (Market Effect Evaluation)
Evaluation Elements	UGL will establish evaluation activities in consultation with the Technical Evaluation Committee as outlined in the Stakeholder Engagement Terms of Reference (Appendix E). **Evaluation to be Conducted** ☒ **Impact Evaluation** The program will be subject to verification impact evaluation in 2012, 2013, and 2014 during which: • performance Improvement savings claims will be validated through third party on-site engineering assessment for a sample of projects involving claimed savings. A sampling methodology will need to be established to support this effort. **Evaluation to be Considered** ☐ **Impact Evaluation (Additional)** Depending on the evaluation priority discussions, the program may be subject to additional impact evaluation activities: • attribution will be assessed through in-person interviews and project analyses for projects involving large claimed savings proportionate to the population of program participants. Findings will be extrapolated to the full population • savings resulting from assessments and studies (no or low cost

<table>
<tr><td rowspan="1"></td><td colspan="2">
measures or measures not submitted for incentives) will be validated through phone surveys for a statistically representative sample of the applicable population of studies (studies that have identified no or low cost measures)

☐ Process Evaluation
Depending on the evaluation priority discussions, the program may be subject to a comprehensive process evaluation:
• to validate and improve the program theory,
• to improve the delivery mechanisms,
• to improve the engagement strategy,
• to re-assess program objectives and targets, and
• to test participant satisfaction
Process evaluations are performed through a set of surveys, consultations and field activities with the most important stakeholders: participants, non-participants, channel partners, program managers, account managers, energy team staff and administrative staff.

☐ Market Effects Evaluation
Depending on the evaluation priority discussions, the program may be subject to a market effects evaluation:
• to assess the effectiveness of capacity development activities
Market effects evaluations are performed to test whether program activities are effectively addressing market barriers. This is done through a set of surveys and consultations with participants, non-participants, program staff and subject experts.

The program administrator will be responsible collecting the data required to be used by external consultants in undertaking any evaluation work. The following table outlines the evaluation work to be considered for this program.
</td></tr>
<tr><td></td><td>To be conducted:

☒ Project-level M&V

☒ Energy Savings

☐ Prescriptive Input Assumption Review

☐ Quasi-Prescriptive Input Assumption Review</td><td>To be considered:

☒ Market Research/Participant Research

☒ Net-to-Gross Ratio

☐ New Prescriptive Input Assumption

☐ New Quasi-Prescriptive Input Assumption</td></tr>
<tr><td>Evaluation Approach</td><td colspan="2">
• Verification Impact Evaluation

The evaluators will conduct a project-level verification impact evaluation of a sample of projects. A sampling methodology will first need to be developed to facilitate this verification study. The verification impact evaluation will be used to (1) establish the baseline energy consumption for each site and (2) estimate and compare the gross savings impact of measures for which incentives have been claimed.

The program administrator will collect a certain amount of data used in evaluation through metering and routine tracking activities, and through careful indexing and storage of all program documentation.
</td></tr>
</table>

<table>
<tr><td></td><td>The specific savings estimation approach will depend on the nature of the O&M process improvement. It may include statistical analysis of meter readings, validation of input assumptions, additional metering/continuous measurements, and modeling of savings using observed parameters (e.g. temperatures, plume analysis, etc.).</td></tr>
<tr><td>Special Provisions</td><td>No special provisions.</td></tr>
<tr><td>Data Collection Responsibilities</td><td>External Tracking

An independent EM&V contractor will be responsible for conduct of the evaluation.

Internal Tracking of Program Results

Union will be responsible for internal tracking of program data such as customer information, installation information, participant incentive, etc. All tracking data will be provided to the EM&V contractor during the verification of the HHC program. Using the tracking system along with additional information tracked by the program, Union aggregates the annual program results into an internal tracking report at the end of each year. This report will outline:
participant contact and address information
and type of studies conducted
results of Process Improvement Studies
study costs
service provider that prepared study
incentives paid by study
and type of project implemented
project costs
estimated m3 savings by measure by project
incentives paid by measure by project
description of available meter data</td></tr>
<tr><td>Procurement Process</td><td><table>
<tr><th>Organization</th><th>Name</th><th>Title / Accountability</th></tr>
<tr><td>UGL</td><td>Internal Evaluator with input from the Technical Evaluation Committee</td><td>Selection of the independent EM&V contractors</td></tr>
<tr><td>UGL</td><td>Internal Evaluator and Program Manager</td><td>Coordination with the independent EM&V contractors</td></tr>
<tr><td>Independent EM&V Contractor selected to conduct the EM&V Studies</td><td>To Be Determined</td><td>Finalize the EM&V Plan
Collect “External Data”
Perform Analysis
Deliver the EM&V Studies</td></tr>
</table></td></tr>
</table>

Low Income Evaluation Plan 2012-2014
Summary Version

Program Overview

Market Opportunity

The following discussion presents the target market size, the barriers and hurdles that Union Gas Limited (UGL) intends to address through the Low-income Demand-side Management (DSM) program.

- **Market Characteristics**

Approximately 20% of all Union Gas Residential customers are considered to be 'Low Income,' which represents an estimated 240,000[1] customers. Customers are identified as low-income if they have a household income which is at 135% or below Statistic Canada's pre-tax, post transfer low-income cut-off (LICO). Additional qualification criteria further reduces the number of eligible participants.

Key market actors in the low-income market segment include: social service agencies, social housing providers, municipalities, property managers and other associations such as the Social Housing Services Corporation (SHSC) and the Ontario Non-Profit Housing Association (ONPHA).

- **Barriers and Hurdles Addressed**

The barriers and/or hurdles to be addressed by the program are summarized in the following table.

Segment	Market Obstacle		Description	Opportunity
Low-income household	☒ Market Hurdle	☐ Market Barrier	Low-income customers are difficult to reach	Multiple outreach channels involving strategic partners, direct mail, e-mail blast, website, etc.
Low-income household	☒ Market Hurdle	☐ Market Barrier	Low-income customers are difficult to identify	Extensive screening activities. Data mining and advance visualization and mapping technology to identify clusters of low-income customers.
Low-income household	☒ Market Hurdle	☐ Market Barrier	Financial hurdle: Low-income customers cannot afford energy efficient technologies	Providing equipment free of charge
Low-income household	☒ Market Hurdle	☐ Market Barrier	Cultural/Institutional hurdle (transaction cost): Low-income customers will not spend time investigating and installing energy conservation measures	Direct-install
Low-income household	☒ Market Hurdle	☐ Market Barrier	Informational hurdle: Low-income customers don't know the response to the following question: "How much money will they save?"	Information brochures, direct install, pre- and post-audit.
Low-income household	☐ Market Hurdle	☒ Market Barrier	Cultural/Institutional barrier (double-agent): Low-income customers don't pay the energy bill directly.	Providing equipment free of charge / Invest on their behalf

[1] This number has not been confirmed.

Low-income household	☐ Market Hurdle	☒ Market Barrier	Informational barrier: Lack of education on energy conservation	Education activities including education guide, clinics, direct mail, email-blast, etc.
Property owners	☐ Market Hurdle	☒ Market Barrier	Cultural/Institutional barrier: Authority-Renters unable to authorize work on building structure	Seek partnership, and direct communication activities toward property owners.

Program Description

The UGL low-income program is a direct-install program that includes three major components: Helping Homes Conserve (HHC) which focuses on simple easy to install measures, the Home Retrofit component which includes deeper measures providing greater energy savings and the Social and Assisted Housing Multi-Family Offering which provides deep measures to multi-family buildings.

The HHC offering provides low-income customers the free installation of up to two energy efficient showerheads, two metres of foam pipe insulation and a programmable thermostat. Additionally, bathroom and kitchen aerators are also provided to the customer for self-installation.

The Home Retrofit offering provides low-income customers with a free home energy audit to assess the energy upgrade requirements for the home. Once the audit is completed, customers may be eligible for upgrades including; attic insulation, basement insulation, wall insulation, comprehensive draft proofing measures (i.e. air sealing.), high water heaters and high-efficiency furnaces.

The Social and Assisted Housing Multi-Family Offering supports Social and Assisted Housing Providers to address energy efficient upgrades in their buildings. Eligible upgrades may include prescriptive measure upgrades, such as Condensing Boilers and Condensing Gas Water Heaters, and custom measure upgrades including building envelope upgrades and Building Optimization.

- **Goals and Objectives:**

The UGL Low-income program will help lower the natural gas cost burden and help reduce the impact of future natural gas price increases on the most vulnerable Ontarians. In addition, the low-income program will help increase the level of comfort of low-income customer dwellings.

- **Target Market:**

The UGL Low-income program targets UGL low-income customers who have a household income equal to or below 135% of Statistic Canada's Pre-Tax LICO levels.

UGL will also target Social and Assisted Housing Providers that operate part 3 and part 9 buildings.

- **Eligibility Criteria:**

The eligibility criteria to UGL Low-income program follow the Ontario Energy Board's

(OEB's) criteria outlined on page 8 of Demand Side Management Guidelines for Natural Gas Utilities, EB-2008-0346, June 30 2011.

- **Key Program Elements:**

UGL fosters relationships with strategic partners including; social service agencies, social housing providers, municipalities, property managers and other associations such as the Social Housing Services Corporation (SHSC) and the Ontario Non-Profit Housing Association (ONPHA).

UGL implements a targeted marketing campaign to pre-identified customers residing in postal codes with high-propensities of low income customers including direct mail, and notification flyers. A toll-free number and website information is provided on these marketing pieces for customers to seek further information and support.

UGL also hosts energy conservation clinics in partnership with their strategic partners. These clinics provide customers with low cost and no cost conservation tips and informs them of the low income offerings in their communities.

UGL contracts delivery agents to deliver the installations for all of the low income program offerings.

When an eligible customer agrees to receive the HHC measures, the delivery agent will install up to two low flow showerheads, two metres of foam pipe insulation and a programmable thermostat. Additionally, the delivery agent will leave behind bathroom and kitchen aerators for self-installation and the new thermostat instructions guide in case the customer has any issues with the thermostat at a later date. The offering is provided at no cost to the customer.

When an eligible customer agrees to participate in the weatherization program, he/she will receive a free home energy audit. Once the audit is completed, the participant may be eligible for upgrades including; attic insulation, basement insulation, wall insulation, comprehensive draft proofing measures (i.e. air sealing, high-efficiency water heaters and high-efficiency furnaces. A post-energy audit will be performed to measure the effectiveness of the upgrades once installed. The offering is provided at no cost to the customer.

Union will work directly with Social and Assisted Housing Providers to assess the needs of their buildings. Union will reach out to providers through multiple channels including:

  - Municipalities
  - Organizations and Associations (i.e. Ontario Not-For- Profit Association)
  - Direct Marketing mediums

- **Program Timing:**

The HHC offering has been in market since 2007. The Home Retrofit offering has been in market since 2008. The Social and Assisted Housing offering will be a new offering for 2012. The program will be offered in 2012 and in subsequent years subject to approval by the OEB.UGL seeks to have the relevance of the program assessed periodically by third-party evaluators.

- **Estimated Participation:**

	The participation in the HHC offering is estimated to reach 10,000 participants for showerhead, aerators and pipe wrap (6,000 for programmable thermostats), and the participation in the Home Retrofit program is estimated to reach 550 participants. • **Budget:** In 2012, the forecasted budget for the program (including all program costs and incentive costs) is $6.8 Million. **Program Theory / Program Logic Model** In summary, the program theory is as follows: • In the short-term, the main program elements presented above will increase the level of awareness of UGL low-income customers, will convince qualified customers to participate, and will lead to the site visit and the free installation of the measures • In the long-term, the program will generate energy savings and non-energy benefits for the low-income customer, such as reduced energy bills, increased energy security and better comfort in the dwellings. Also, the program will yield acceptable customer satisfaction and will generate positive word-of-mouth that will in turn foster further program participation
Evaluation Goals and Objectives	The focal point of the evaluation activities derive from four key pillars: base-lining & market characterization, process evaluation, causality & attribution evaluation, and impact & verification. The following highlights the goals and objectives of the evaluation efforts proposed for consideration for this program. Evaluation activities will be used in support of Union's Incentive and LRAM claims. **Key Evaluation Elements** Evaluation studies may be used to: • validate or modify the current program theory/logic model • reinforce accountability of delivery agent staff and program administrator staff • provide feedback to the program manager such that improvements can be made that increase the program uptake • provide feedback to the program manager such that improvements can be made to the various delivery mechanisms that result in greater participant satisfaction • inform decisions regarding whether to increase and improve the education activities, decrease them or maintain the status quo based on the effectiveness to date • demonstrate the effectiveness of measure and increase the precision of Project Input and Assumption (PIA) to improve savings projections and integrated resource planning • inform long-term DSM program planning whether to continue the program, evolve the program or apply an exit strategy **Research Questions** Research questions may include: • How can the program set of objectives and goals be improved? Are program goals set too high? Too low? (Process Evaluation)

<table>
<tr><td></td><td>

- What is the direct impact of individual program elements on energy consumption? (Impact evaluation)
- What proportion of those effects can be attributed to the program? (Impact Evaluation – Causality and attribution)
- How can the program better appeal to the targeted population? (Process Evaluation)
- Are program designs and supporting organizational controls adequate? (Process Evaluation)
- Are the tools used properly by program delivery agents? (Process Evaluation)
- How might the program be improved? (Process Evaluation)
- How effective has the program been in reducing lack-of-education barriers? (Market Effect Evaluation)

</td></tr>
<tr><td>Evaluation Elements</td><td>

UGL will continue to undertake verification evaluation for the HHC program. Any additional evaluation will be determined in consultation with the Technical Evaluation Committee as outlined in the Stakeholder Engagement Terms of Reference (Appendix E).

Evaluation to be Conducted

☒ **Impact Evaluation**

The program will be subject to verification impact evaluation in 2012, 2013, and 2014 during which:

- the HHC savings claims will be validated through a verification telephone survey of a statistically representative sample
- uninstall and non-install rates will be measured

Evaluation to be Considered

☐ **Process Evaluation**

Depending on the evaluation priority discussions, the program may be subject to a comprehensive process evaluation:

- to validate and improve the program theory,
- to improve the marketing campaign, and the delivery mechanisms.

Process evaluations are performed through a set of surveys, consultations and field activities with the most important stakeholders: HHC participants, Weatherization participants, non-participants, strategic partners, and the delivery agents.

While any formal process evaluation study will be determined when setting evaluation priorities, Union will continue internal activities that would fall within the scope of process evaluation. These activities include:

- ongoing communication with Union sales representatives and program delivery agents
- formal statistically representative annual Market Research surveys with residential customer segments to gather insights and perspectives on Union's DSM programs and customer service in general

These two activities are further augmented by the verification studies and any information gathered through educational/awareness outreach sessions with program participants.

☐ **Market Effects Evaluation**

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<tr><td></td><td colspan="2">Some market effect research questions may be considered for evaluation as determined through the priority discussions; the program intends to generate some awareness among low income customers through energy conservation clinics and other communication activity.

The program administrator will be responsible collecting the data required to be used by external consultants in undertaking any evaluation work. The following table outlines the evaluation work to be considered for this program.</td></tr>
<tr><td></td><td>☐ Prescriptive Input Assumption Review
☐ Quasi-Prescriptive Input Assumption Review
☒ Project-level M&V for HHC
☐ Energy Savings & Demand/Peak Reduction</td><td>☒ Market Research/Participant Research
☐ New Prescriptive Input Assumption
☐ New Quasi-Prescriptive Input Assumption
☒ Net-to-Gross Ratio</td></tr>
<tr><td>Evaluation Approach</td><td colspan="2">• Verification Impact Evaluation

The evaluators will conduct a verification impact evaluation. The impact and attribution evaluation will be used to (1) estimate the net verified impact of individual program elements of HHC measures on energy consumption, (2) establish accountability of program administrator and delivery agent staffs regarding how the program actually yielded the savings that are reported to the OEB, (3) suggest improvements to the measures that are promoted through the program, and (4) calibrate future program savings projections for future DSM planning efforts.

The program administrator will collect a certain amount of data used in evaluation through its routine tracking activities, and through careful indexing and storage of all program documentation.

Sampling is going to be a key success factor of the M&V activities. Sampling should be designed to obtain key responses with statistically representative population.

The analysis, based on the verification impact evaluation, should result in a verified savings for each of the HHC measures, and ultimately a realization ratio for each of the measures.</td></tr>
<tr><td>Special Provisions</td><td colspan="2">No special provisions</td></tr>
<tr><td>Data Collection Responsibilities</td><td colspan="2">External Tracking

An independent EM&V contractor will be responsible for all external market data collection activities.

Tracking for Program Results

Union will be responsible for internal tracking of program data such as customer information, installation information, participant incentive, etc. All tracking data will be provided to the EM&V contractor during the verification of the HHC program. Using</td></tr>
</table>

<table>
<tr><td></td><td>the tracking system along with additional information tracked by the program, Union aggregates the annual program results into an internal tracking report at the end of each year. This report will outline:

# of HHC participants
associated prescriptive m³ savings of HHC participants (adjusted for installation and persistence verification)
associated prescriptive equipment costs
associated program and incentive costs
# of LIWP participants
associated custom m³ savings delta between pre and post home audits to inform cumulative m³ savings
associated equipment and installation costs as established by delivery agent and are used to inform program cost per cumulative m³ savings
program-spend will be tracked separately to include: marketing and delivery expenses, salaries, verification and incentives
</td></tr>
<tr><td>Procurement Process</td><td>
<table>
<tr><th>Organization</th><th>Name</th><th>Title / Accountability</th></tr>
<tr><td>UGL</td><td>DSM Tracking Manager and Program Manager</td><td>Program Tracking and Annual Tracking Reports – Collection of “Internal Data”.</td></tr>
<tr><td>UGL</td><td>Internal Evaluator in consultation with the Technical Evaluation Committee</td><td>Selection of the independent EM&V contractors</td></tr>
<tr><td>UGL</td><td>Internal Evaluator</td><td>Coordination with the independent EM&V contractors</td></tr>
<tr><td>Independent EM&V Contractor selected to conduct the EM&V Studies</td><td>To Be Determined</td><td>Finalize the EM&V Plan
Collect “External Data”
Perform Analysis
Deliver the EM&V Studies</td></tr>
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High Efficiency Water Heater Evaluation Plan 2012-2014
Summary Version

Program Overview

Market Opportunity

The following discussion presents the target market size, the barriers and hurdles that Union Gas Limited (UGL) intends to address through the High Efficiency Water Heater (HEWH) Demand-side Management (DSM) program.

- **Market Characteristics**

The HEWH program will target builders of single family detached homes and individually metered town-homes. M1 and R01 rate classes will be targeted. The market size varies depending on economic conditions from year to year. It is estimated that 15,500 – 18,000 new single-family dwellings are constructed each year within UGL's territory. The program will target both residential home builders, as well as residential natural gas customers purchasing a new home. The program will offset the incremental cost to home builders and home buyers using a financial incentive for either purchase or rental of a High Efficiency (0.80 EF or above) water heater. Relationships with Builders and Installers (trades persons/contractors), manufacturers, and other organizations will also be developed to facilitate greater penetration of HEWH.

- **Savings Potential:**

The total market is estimated to be between 15,500 and18,000 homes annually, and the program intends to shift HEWH to an approximate market penetration rate of 25% in 6 years. Over the course of the first 3 years of the program, it is expected that the adoption / market share will be 15% in year one, 2012 results plus 2% points increase in year 2, and 2013 results plus an additional 2% points increase in year 3. Minimum efficiency water heaters currently dominate the market. Moving the market from 0.57 EF to 0.80 EF represents a significant shift.

- **Barriers and Hurdles Addressed**

The barriers and/or hurdles to be addressed by the program are summarized in the following table.

Segment	Market Obstacle		Description	Opportunity
Builders / Installers	☐ Market Hurdle	☒ Market Barrier	Previous bad experience with old HEWH technology	Educate Builders about new HEWH technology benefits
Builders / Installers	☐ Market Hurdle	☒ Market Barrier	Negative customer perceptions of HEWH technology	Educate Builders about new HEWH technology benefits and how to allay customer concerns
Customers	☒ Market Hurdle	☐ Market Barrier	Higher rental / purchase costs	Reduced cost HEWH
Customers	☐ Market Hurdle	☒ Market Barrier	HEWH maintenance requirements	Educate consumers about proper maintenance
Customers	☐ Market Hurdle	☒ Market Barrier		

			Lack of familiarity / interest from customers	Increased customer awareness of HEWH through education/marketing initiatives
Builders / Installers	☐ Market Hurdle	☒ Market Barrier	Technical education required for installers of HEWH	Provide technical instruction/education to ensure that more installers are comfortable with, and qualified to, install HEWH

Program Description

- **Goals and Objectives:**

The main goals of the HEWH Program are to remove market barriers currently preventing adoption of HEWH (0.80 EF and above) and to build a competitive market for these measures. The program will focus on achieving a market penetration of 25% by 2018 and retain this market share beyond the conclusion of the program. Another important goal is to support the development of the market conditions necessary for future building Code and federal regulations regarding water efficiency.

- **Target Market:**

The HEWH program will target natural gas customers purchasing newly-constructed single family detached homes and individually metered town-homes. There are an estimated 15,500 to 18,000 single family dwellings constructed each year in UGL territory. The supply chain of HEWH will also be targeted from manufacturers, installers (trades people), builders of new homes, and rental companies. These organizations are targeted to increase the capacity to sell and install HEWH.

- **Eligibility Criteria:**

Only M1 and R01 rate classes qualify. Customers must be purchasing a new home (i.e. no retrofits). Verification for this criterion will occur as part of the program delivery strategy in partnership with builders, and installers.

- **Key Program Elements:**

The HEWH program includes the following elements: Establish strategic partners in the market to help deliver and promote the program. Work cooperatively with residential home builders and their sales agents to effectively promote the benefits of HEWH to homebuyers with the goal of reducing/eliminating home-buyer call backs and related “unsatisfied” complaints. Facilitate training for installers of HEWH, thereby increasing installation capability within the market and reducing installation quality issues. Offset the incremental cost borne by homebuyers and builders with an incentive per HEWH installed.

- **Program Timing:**

HEWH Program will launch in 2012 and is expected to continue to 2018. UGL expects to exit the market by 2018 and achieve 25% market penetration rate of HEWH.

<table>
<tr><td></td><td>Program Theory / Program Logic Model
In summary, the program theory as described by short term, medium term, long term:
In the short-term:
strategic partners are engaged and active in the market
qualified customers agree to have HEWH installed in their new home
In the medium-term:
strategic partners in market promoting incentive program to customers
generating increased customer awareness of HEWH
HEWH equipment is installed onsite
In the long-term:
increased sales capacity in supply chain
increased installation capacity within the market
increased market adoption to a level that is sustained naturally in the market
energy savings versus Base Code established</td></tr>
<tr><td>Evaluation Goals and Objectives</td><td>The focal point of the evaluation activities derive from four key pillars: base-lining & market characterization, process evaluation, causality & attribution evaluation, and impact & verification. The following highlights the goals and objectives of the evaluation efforts proposed for consideration for this program. Evaluation activities will be used in support of Union's Incentive and LRAM claims.

Key Evaluation Elements

Evaluation studies may be used to:
develop market characterization and profile to establish external baseline
establish effectiveness of program through process evaluation
establish causality & attribution to assess the program's causal effects on the market
determine energy savings and verify program components by project (verified program related natural gas savings will be used for the purpose of supporting Incentive claims and LRAM adjustments) through impact and verification evaluation
Research Questions

Research questions include:
What is the Market Baseline? (Impact & Market Effect Evaluation)
Was UGL's Marketing and Communication Strategy Effective? (Process Evaluation)
Are Program Design and Organization Adequate? (Process Evaluation)
What are the Positive Outcomes Attributable to the Program? (Impact Evaluation – Causality & Attribution)
Have Target Market(s) Been Transformed? (Market Effect Evaluation)
Was the program cost effective? (Impact Evaluation)</td></tr>
<tr><td>Evaluation Elements</td><td>UGL will establish evaluation activities in consultation with the Technical Evaluation Committee as outlined in the Stakeholder Engagement Terms of Reference (Appendix E).</td></tr>
</table>

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Evaluation to be Considered

☐ **Initial Base-lining and Market Characterization**
An external baseline to measure program market effects study can determine:

- Market penetration rates,
- A characterization of the market's players and their relationships.

☐ **Process Evaluation**
Depending on the evaluation priority discussions, the program may be subject to a comprehensive process evaluation:

- to validate and improve the program theory,
- to improve the marketing campaign, and the delivery mechanisms.

☐ **Causality& Attribution Evaluation**
An evaluation of the causal effects the program is having in the market could be conducted. This evaluation considers the changes to the market in relation to the initial baseline established prior to program launch.

☐ **Impact & Verification**
Impact & verification evaluation assesses the likely impact of the program in the market in addition to verifying key program elements, such as installation of equipment.

☐ **Ongoing Market Characterization & Monitoring**
As the program develops, the market can be monitored and characterized in relation to the external baselines established prior to the program to understand the ongoing impact the program is having in the market and to re-adjust program elements as required.

☐ **Persistence of HEWH After Program Participation**
To understand the long-term persistence of HEWH in the market.

The program administrator will be responsible collecting the data required to be used by external consultants in undertaking any evaluation work. The following table outlines the evaluation work to be considered for this program.

</td></tr>
<tr><td>☐ Prescriptive Input Assumption Review
☐ Quasi-Prescriptive Input Assumption Review
☒ Project-level M&V
☒ Energy Savings</td><td>☒ Market Research/Participant Research
☐ New Prescriptive Input Assumption
☐ New Quasi-Prescriptive Input Assumption
☒ Net-to-Gross Ratio</td></tr>
<tr><td>Evaluation Approach</td><td colspan="2">To be determined in consultation with the Technical Evaluation Committee.</td></tr>
</table>

<table>
<tr><td>Special Provisions</td><td>No special provisions.</td></tr>
<tr><td>Data Collection Responsibilities</td><td>External Data

Independent EM&V contractor(s) will be responsible for all external market data collection activities.

Tracking for Program Results

Union will be responsible for internal tracking of program data such as customer information, installation information, participant incentive, etc. All tracking data will be provided to the EM&V contractor during the verification of the HHC program. Using the tracking system along with additional information tracked by the program, Union aggregates the annual program results into an internal tracking report at the end of each year. This report will outline:
• # of participants rebated (Customers)
• # of builders engaged
• # of installers / trades persons / contractors
• # of education seminars & outreach events
• rebate amounts paid
• program costs
• m^3 savings</td></tr>
<tr><td>Procurement Process</td><td>
<table>
<tr><th>Organization</th><th>Name</th><th>Title / Accountability</th></tr>
<tr><td>UGL</td><td>Internal Evaluator in consultation with the Technical Evaluation Committee</td><td>Selection of the independent EM&V contractors</td></tr>
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New Home Efficiency Program Evaluation Plan 2012-2014
Summary Version

Program Overview

Market Opportunity

The following discussion presents the target market size, the barriers and hurdles that Union Gas Limited (UGL) intends to address through the New Home Efficiency Program (NHEP) Demand-side Management (DSM) Market Transformation program. Note that for the purposes of this program, an Energy Efficient home is understood to equate to Ontario Building Code (OBC) +15%.

- **Market Characteristics**

The NHEP will target the residential home-builder market. The program is focused on production builders in the UGL franchise area who produce about 50 houses per year or more. This includes builders of single family detached homes and individually metered town-homes. The market size varies depending on economic conditions from year to year. It is estimated that 15,000 – 18,000 new single-family dwellings are constructed each year within UGL's territory. The program will provide consulting, training and education to increase the builder's capacity to supply Energy Efficient houses. Relationships with Builders and Installers (trades persons), manufacturers, and other organizations will also be developed to facilitate greater penetration of Energy Efficient housing. Given the new building Code coming into effect in 2012, it is expected that the number of builders exceeding Code will be negligible in 2012.

- **Savings Potential:**

Union is targeting 8 builders to participate in 2012, with 30% of these participating builders completing a prototype home 15% above OBC in the same year.

- **Barriers and Hurdles Addressed**

The barriers and/or hurdles to be addressed by the program are summarized in the following table.

Segment	Market Obstacle		Description	Opportunity
Builders	☒ Market Hurdle	☐ Market Barrier	Sensitive to Incremental Costs of Delivering EE Housing Upgrades	Reduce Incremental Cost to Builders
Builders	☐ Market Hurdle	☒ Market Barrier	Unfamiliar With Newer EE Technologies	Educate Builders on New EE Technologies
Builders / Consumer	☐ Market Hurdle	☒ Market Barrier	Difficulty Selling EE Housing to Home-Buyers	Increase Sales Capacity of Builders
Consumers	☐ Market Hurdle	☒ Market Barrier	Not Informed / Aware of Benefits of EE Housing	Educate Consumers of Benefits to EE Housing

	Program Description • **Goals and Objectives:** The goals of the New Home Efficiency Program are to have 'production' residential home builders: • Review their key business functions and building practices for the purpose of identifying areas where efficiencies can be gained. • Integrate the identified new best practices into their daily business functions and new housing starts. • Incorporate high efficiency measures into their new home designs to improve overall house efficiency to 15% above OBC 2012. • Utilize the savings identified through the NHEP to reduce the incremental costs associated with the energy efficient upgrades. • Educate builders on how to sell energy efficient homes to ensure there is customer demand for their product. • By 2016, those builders that were introduced to the program in year one (2012) will have the majority of their housing starts at 15% above OBC 2012 and those introduced in year two will have half of their housing starts at 15% above OBC 2012. • **Target Market:** The target market is builders of residential new homes in the UGL franchise area. The primary target market is production builders constructing 50 or more housing starts per year. Another secondary focus is on builders who produce below this threshold, yet may increase their production above 50 by participating in the program. • **Eligibility Criteria:** New home builder constructing new homes in UGL franchise area. • **Key Program Elements:** Union will enroll builders over the duration of the three-year plan and provide support and incentives. Some program activities will run for five years to recognize builders that enroll in years two and three require support through the "sunset period". • **Program Milestones and Metrics:** The New Home Efficiency program is a three-year commitment with a specified metric at the end of each phase: • Phase 1 – one "Discovery Home™" built and certified • Phase 2 – 10% of housing starts that year will be 15% above Code • Phase 3 – 25% of housing starts that year will be 15% above Code • **Program Timing:**

	The program is expected to start in 2012 and continue through 2019. • **Estimated Participation:** • **2012** – 8 New Builders • **2013** – 4 New Builders • **2014 –** 2 New builders **Program Theory / Program Logic Model** In summary, the program theory as described by short term, medium term, long term: • In the short-term: ▪ engage builders & conduct info seminars ▪ builders agree to participate in program ▪ builders conduct internal audit & benchmarking ▪ builders construct model home • In the medium-term: ▪ builders establish process map, long term tasks, and undertake process alignment to produce more EE Housing ▪ builders accomplish long-term tasks and benchmark performance • In the long-term: ▪ increased capacity of home builders to build EE homes ▪ increased market adoption of EE homes ▪ increase saturation of EE homes, including communities ▪ energy savings incremental to base code requirements
Evaluation Goals and Objectives	The focal point of the evaluation activities derive from four key pillars: base-lining & market characterization, process evaluation, causality & attribution evaluation, and impact & verification. The following highlights the goals and objectives of the evaluation efforts proposed for consideration for this program. Evaluation activities will be used in support of Union's Incentive and LRAM claims. **Key Evaluation Elements** Evaluation studies may be used to: • develop market characterization and profile to establish external baseline • establish effectiveness of program through process evaluation • establish causality & attribution to assess the program's causal effects on the market • determine energy savings and verify program components by project (verified program related natural gas savings will be used for the purpose of LRAM adjustments) through impact and verification evaluation **Research Questions** Research questions include: • What is the market baseline? (Impact and Market Effect Evaluation) • Was UGL's marketing and communication strategy effective? (Process Evaluation) • Are program design and organization adequate? (Process Evaluation) • What are the positive outcomes attributable to the program? (Impact Evaluation – Causality and Attribution)

<table>
<tr><td></td><td>

- Have target market(s) been transformed? (Market Effect Evaluation)
- Was the program cost effective? (Process Evaluation)

</td></tr>
<tr><td>Evaluation Elements</td><td>

UGL will establish evaluation activities in consultation with the Technical Evaluation Committee as outlined in the Stakeholder Engagement Terms of Reference (Appendix E).

Evaluation to be Considered

☐ **Initial Base-lining and Market Characterization**
An external baseline to measure program market effects study can determine:

- Market penetration rates,
- A characterization of the market's players and their relationships.

☐ **Process Evaluation**
Depending on the evaluation priority discussions, the program may be subject to a comprehensive process evaluation:

- to validate and improve the program theory,
- to improve the marketing campaign, and the delivery mechanisms.

☐ **Causality & Attribution Evaluation**
An evaluation of the causal effects the program is having in the market can be conducted. This evaluation considers the changes to the market in relation to the initial baseline established prior to program launch.

☐ **Impact & Verification**
Impact & verification evaluation assesses the likely impact of the program in the market in addition to verifying key program elements.

☐ **Ongoing Market Characterization & Monitoring**
As the program develops, the market can be monitored and characterized in relation to the external baselines established prior to the program to understand the ongoing impact the program is having in the market and to re-adjust program elements as required.

☐ **Persistence of Energy Efficient Housing Construction After Program Participation**
To understand the long-term persistence of NHEP in the market.

The program administrator will be responsible for collecting the data required to be used by external consultants in undertaking any evaluation work. The following table outlines the evaluation work to be considered for this program.

<table>
<tr><td>☒ Energy Savings</td><td>☐ New Quasi-Prescriptive Input Assumption</td></tr>
<tr><td>☒ Market Research/Participant Research</td><td>☐ New Prescriptive Input Assumption</td></tr>
<tr><td>☒ Net-to-Gross Ratio</td><td>☐ Quasi-Prescriptive Input Assumption Review</td></tr>
<tr><td>☒ Project-level M&V</td><td></td></tr>
</table>

</td></tr>
</table>

<table>
<tr><td>Evaluation Approach</td><td>To be determined in consultation with the Technical Evaluation Committee.</td></tr>
<tr><td>Special Provisions</td><td>No special provisions.</td></tr>
<tr><td>Data Collection Responsibilities</td><td>External Tracking

An independent EM&V contractor will be responsible for all external market data collection activities.

Tracking for Program Results

Union will be responsible for internal tracking of program data such as customer information, installation information, participant incentive, etc. All tracking data will be provided to the EM&V contractor during the verification of the HHC program. Using the tracking system in conjunction with information tracked by the program, Union aggregates the annual program results into an internal tracking report at the end of each year. This report will outline:
# of participants rebated
# of builders engaged
# of contractors (installers / trades persons)
# of education seminars & outreach events
rebate amounts paid
program costs
market penetration rates</td></tr>
<tr><td>Procurement Process</td><td><table>
<tr><th>Organization</th><th>Name</th><th>Title / Accountability</th></tr>
<tr><td>UGL</td><td>Internal Evaluator in consultation with the Technical Evaluation Committee</td><td>Selection of the independent EM&V contractors</td></tr>
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Integrated Energy Management System Evaluation Plan 2012-2014

Summary Version

Program Overview

Market Opportunity

The following discussion presents the target market size, the barriers and hurdles that Union Gas Limited (UGL) intends to address through the Integrated Energy Management System (IEMS) Demand-side Management (DSM) program.

- **Market Characteristics**

This program focuses on UGL's Industrial Manufacturing Customers. To qualify for the program, customers must consume in excess of 1,000,000 m³ per annum. This target group will include natural gas customers who have process and/or heating loads.

- **Savings Potential:**

The program is expected to produce a 2-5% annual consumption decrease per participant. These savings are expected to be continuous, and persistent. The total avoided energy consumption from the year 1 pilot program is expected to be 0 m³ as all the activities occurring in Year 1 are associated with providing the groundwork for future savings.

- **Barriers and Hurdles Addressed**

The barriers and/or hurdles to be addressed by the program are summarized in the following table.

Segment	Market Obstacle		Description	Opportunity
Industrial Manufacturer	☐ Market Hurdle	☒ Market Barrier	Linkages between energy use and production processes are not measured	Monitor & Track (M&T) energy use and production processes
Industrial Manufacturers	☐ Market Hurdle	☒ Market Barrier	Large manufacturers not fully aware of benefits of Integrated Energy Management	Increased awareness, stimulate demand for IEMS approach
Industrial Manufacturers	☐ Market Hurdle	☒ Market Barrier	Efficiencies for process improvements under recognized	M&T allows customer to identify opportunities for improvement
Industrial Manufacturers	☒ Market Hurdle	☐ Market Barrier	Business case for M&T is difficult to make due to perceived risk & costs	Incentives reduce risk and costs

Program Description

- **Goals and Objectives:**

The goal of the program is to encourage customers to take a 'systems' approach to sub-metering, integrate energy conservation with existing management and production practices. The focus is to capture the effects that operational and behavioural activities have on energy consumption, and re-align those activities/ processes towards higher efficiency outcomes. Program participants are expected to demonstrate buy-in from senior management. Participants will commit to an integrated approach to energy management through ongoing monitoring and tracking and relate energy efficiency opportunity realization.

- **Target Market:**

Large industrial manufacturers will be targeted. Two participants will be targeted for the first year pilot. In total, the three year program will target seven participants for program implementation. Rate classes targeted include M2, 10, M4, M5, M7, and 20 which represent Commercial / Industrial General Service and Commercial / Industrial Contract customers.

- **Eligibility Criteria:**

Program applicants will be pre-screened via UGL's internal natural gas consumption data.

- **Key Program Elements:**

The program will focus on integrating energy conservation with existing management and production practices, develop an organizational culture where Energy Efficiency is a priority, partner with customers to develop and implement training programs, enhance sub-metering and building automation systems to include predictive modeling, issue resolution protocols, communication protocols, and effective reporting. Union will provide education, coaching and incentives to industrial customers through the development, implementation and persistence phases of the program. The following three elements will be key components required from customers who participate in this program:

- Completion of an IEMS plan
- Completion of measurement system implementation
- Regular reports showing system persistence

- **Program Timing:**

The program is expected to launch a year-long pilot in 2012, and then extend for two additional years, including 2013 and 2014.

- **Estimated Participation:**

Two participants are expected in year one (2012), two the following year (2013), and three more the year after (2014), resulting in a total of seven program participants over three years.

- **Budget:**

The first-year pilot program is budgeted at a total cost of $690,000, of which $300,000 is for incentives, and the remaining $390,000 is for program development and support costs. The full budget for the 3 year program (including the pilot year) is $2.145 million.

Incentive levels for Integrated Energy Management Systems will be up to 75% of the incurred customer study cost and up to 50% of the incurred implementation cost. Specific incentive details are as follows:

- 75% of assessment report costs up to a cap of $20,000
- 50% of project implementation expenditures up to a cap of $100,000
  - 20% upon approval of plan
  - 20% after 50% of costs incurred
  - 20% after 75% of costs incurred
  - 10% upon completion of implementation
  - 30% during plan persistence phase to ensure continued use of system
- Incentives will be directed towards end use customers and will be paid at the completion of defined milestones

Program Theory / Program Logic Model

In summary, the program theory is described by short, medium and long term outcomes:

- In the short-term:
  - strategic partners engaged in the market
  - customers agree to participate in IEMS program
  - internal performance metrics established
  - customer identifies improvement targets and plan
  - customer implements plan
  - monitoring and Tracking (M&T) system in place
  - incentive payouts for EE activities

- In the medium-term:
  - process improvements implemented in facility
  - customer has increased capacity to manage energy use
  - customer develops a culture of energy management

- In the long-term:
  - long term energy savings
  - increased energy efficiency
  - ongoing systems management in place and customer's energy management is transformed

<table>
<tr>
<td>Evaluation Goals and Objectives</td>
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The focal point of the evaluation activities derive from four key pillars: base-lining & market characterization, process evaluation, causality & attribution evaluation, and impact & verification. The following highlights the goals and objectives of the evaluation efforts proposed for consideration for this program. Evaluation activities will be used in support of Union's Incentive and LRAM claims.

Key Evaluation Elements

Evaluation studies may be used to:

develop market characterization and profile to establish external baseline
establish effectiveness of program through a process evaluation
establish causality & attribution to assess the program's causal effects on the market
determine energy savings and verify program components by project (verified program related natural gas savings will be used for the purpose of LRAM adjustments and to support Incentive claims) through impact and verification evaluation

Research Questions

Research questions include:

What is the market baseline? (Impact and Market Effect Evaluation)
Was UGL's marketing and communication strategy effective? (Process Evaluation)
Are program design and organization adequate? (Process Evaluation)
What are the positive outcomes attributable to the program? (Attribution Evaluation)
Have target market(s) been transformed? (Market Effect Evaluation)
Is the program cost effective? (Process Evaluation)

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Impact & verification evaluation assesses the likely impact of the program in the market in addition to verifying key program elements.

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As the program develops, the market can be monitored and characterized in relation to the external baselines established prior to the program to understand the ongoing impact the program is having in the market and to re-adjust program elements as required.

☐ Persistence of IEMS After Program Participation
To understand the long-term persistence of IEMS in the market.

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• # of participants / facilities
• # of facilities at each program milestone
• incentive amounts paid
• project costs</td></tr>
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<table>
<tr><td></td><td>m3 savings by project
service provider and contractor involved with project</td></tr>
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Filed: 2011-09-23
EB-2011-0327
Exhibit A
Tab 1
Appendix K

ICF MARBEK NATURAL GAS ENERGY EFFICIENCY POTENTIAL STUDY

2008 Natural Gas Energy Efficiency Potential Study

with 2011 Summary Report Update

Submitted to

Union Gas Ltd

Submitted by

ICF Marbek

Reports and Appendices – March 2009

Summary Report – July 2011

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Marbek

Natural Gas Energy Efficiency Potential
Residential, Commercial and Industrial Sectors

Summary Report – Update 2011

Project
114103

Submitted to
Union Gas Distribution

Submitted by
ICF Marbek

July 2011

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List of Exhibits

1 Introduction

1.1 Background

Union Gas Ltd. (Union) is a natural gas utility serving almost 1.3 million customers in the residential, commercial and industrial markets. Union is a regulated utility with a franchise area spread across the province of Ontario, including northern, southwestern and southeastern cities and towns.

Since 1997, Union has delivered demand side management (DSM) programs to its customers under a mandate from the provincial regulator, the Ontario Energy Board (OEB). Union offers DSM programs to all in-franchise customer rate classes and across all sectors. The DSM savings target and budget are determined through a rate proceeding with the OEB.

Union's customers have become increasingly aware of the importance of energy efficiency in recent years. Similarly, energy efficiency codes and standards have also continued to strengthen, reflecting Ontario's increasing emphasis on energy efficient technologies and buildings. In the eleven year period from 1997 to 2008 Union delivered approximately 614 million m^3 of natural gas savings and over $1 billion in net Total Resource Cost (TRC) benefits.

In the DSM Generic Proceeding held in 2006, Union committed to creating an updated Market Potential Study to be filed with its next multi-year DSM Plan. In 2008, Union initiated this study in preparation for the next generation DSM Framework to begin in 2010. The best available primary economic data for the 2008 study was compiled during the period April to June of 2008. However, the OEB subsequently deferred consideration of the DSM Framework and directed the natural gas utilities to file one year DSM Plans under the existing DSM Framework for 2010 and 2011.

Following completion of the 2008 study, Canada and other global economies entered a period of economic recession, one that could have significant impact on the results of the 2008 study, particularly in the short term. Examples of economic changes that have occurred since the 2008 study was completed and their respective impacts include:

- In January 2009, the Canadian dollar was worth 81 cents U.S. Today the Canadian dollar is worth approximately $1.02. The effect of this on the competitiveness of Ontario manufactured products bound for the U.S. has been serious, limiting the amount of capital available for upgrade projects.

- In January 2009, the natural gas delivered price was approximately $7.50/GJ, having fallen sharply from prices as high as $10.00/GJ only a few months earlier. The outlook for natural gas prices is now approximately $5.50/GJ. This change in price has had the effect of increasing the payback period of all natural gas savings projects, making them harder for natural gas customers to justify.

- Electricity prices have been climbing steadily since 2009, as a result of a changing generation mix and subsidies of renewable energy. The combination of this change in prices and the increase in incentives being offered by the Ontario Power Authority (OPA) and by electricity utilities for electric upgrades means that proportionately less human and financial resources are available to be devoted to natural gas savings projects.

- Multi-national companies with significant presence in Europe and North America are making energy efficient practices a Corporate value, and building in equipment and management standards developed under European energy and carbon pricing scenarios, increasing the uptake of energy efficiency measures.

In light of these considerations, Union commissioned an economic update to the 2008 study in 2011. The purpose of this work was to update the assumptions and baseline data used in the initial 2008 Natural Gas Efficiency Potential Study to better reflect the impacts of economic changes such as those noted. The estimated achievable and economic potential for DSM measures was updated across all applicable technologies, markets and sectors in Union's franchise area. Therefore, the values noted in this summary are updated from those included in the full 2008 report and should be considered best available information.

1.2 Objectives and Scope

Union initiated this study within the context of the conditions noted above. The results of this Natural Gas Efficiency Potential Study will provide a foundation that Union can use into the future to guide the development of its longer-term DSM strategy, including new measures and targets. More specifically, this includes support to Union's application to the Ontario Energy Board regulatory application for the next multi year DSM plan by:

- Estimating the achievable and economic potential for DSM measures across all applicable technologies, markets and sectors in Union's franchise area
- Giving shape to, and refining, ongoing energy efficiency work by Union Gas in order to develop Union's next multi-year DSM plan, and
- Provide information that is actionable and can be easily converted to plan and program development.

The scope of this study is summarized below.

- **Sector Coverage:** The study addresses three sectors: Residential, Commercial[1] and Industrial.

  Geographical Coverage: The study results are presented for the total Union Service Area and for two service regions: Southern and Northern. The Southern region of Union's system extends through Southwestern Ontario from Windsor to just west of Toronto. The Northern region of Union's system extends throughout Northern Ontario from the Manitoba border to the North Bay/Muskoka area and across Eastern Ontario from Port Hope to Cornwall. The study results are disaggregated by service region due to differences in building stock and weather conditions (heating degree days).

- **Study Period**: This study covers a 10-year period. The Base Year is the calendar year 2007, with milestone periods at five-year increments: 2012 and 2017. The Base Year of 2007 was selected, as it was the most recent calendar year for which complete customer data was available when the study was initiated in 2008.

[1] Throughout this report the term "Commercial" also includes institutional sectors, such as schools, hospitals, etc., unless otherwise noted.

- **Technologies:** The study addresses the full range of natural gas energy efficiency measures together with selected renewable energy technologies that are currently commercially available, or are expected to be available within the first 5 years of this study period.

1.2.1 Data Caveat

As in any study of this type, the results presented in this report are based on a large number of important assumptions. Assumptions such as those related to the current penetration of energy efficient technologies, the rate of future economic growth and customer willingness to implement new energy efficiency measures are particularly influential.

Wherever possible, the assumptions used in this study are consistent with those used by Union and are based on best available information, which in many cases includes the professional judgement of the consultant team, client personnel and/or local experts. The reader should use the results presented in this report as best available estimates; major assumptions, information sources and caveats are noted throughout the report.

1.3 Definitions

This study employs numerous terms that are unique to analyses such as this one and consequently it is important to ensure that all readers have a clear understanding of what each term means when applied to this study. Below is a brief description of some of the most important terms.

Base Year Natural Gas Use The Base Year is the starting point for the analysis. It provides a detailed description of "where" and "how" natural gas is currently used in each sector. The bottom up profile of energy use patterns and market shares of energy using technologies was calibrated to actual Union customer sales data.

Reference Case Forecast The Reference Case is a projection of natural gas consumption to 2017, in the absence of any new Union DSM market interventions after 2007. It is the baseline against which the scenarios of energy savings are calculated. The Reference case forecast incorporates an estimation of "natural conservation", namely, changes in end use efficiency over the study period that are projected to occur in the absence of new market interventions by Union.

Measure Total Resource Cost The Measure TRC calculates the net present value of natural gas, electricity and water savings that result from an investment in an efficiency technology or measure. The measure TRC is equal to its full or incremental capital cost (depending on application) plus any change (positive or negative) in the combined annual energy, water and equipment O&M costs. This calculation includes, among others, the following inputs: the avoided natural gas, electricity and water supply costs, the life of the technology, and the selected discount rate, which in this analysis has been set at 10%.

The Measure TRC test is the primary determinant of whether a measure is included in the economic potential.

Economic Potential Forecast

The Economic Potential Forecast is the level of natural consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost-effective from Union's perspective. All the energy efficiency technologies and measures that have a positive measure TRC are incorporated into the Economic Potential Forecast. These technologies and measures are applied at either natural stock turnover rates or at designated years for immediate application.

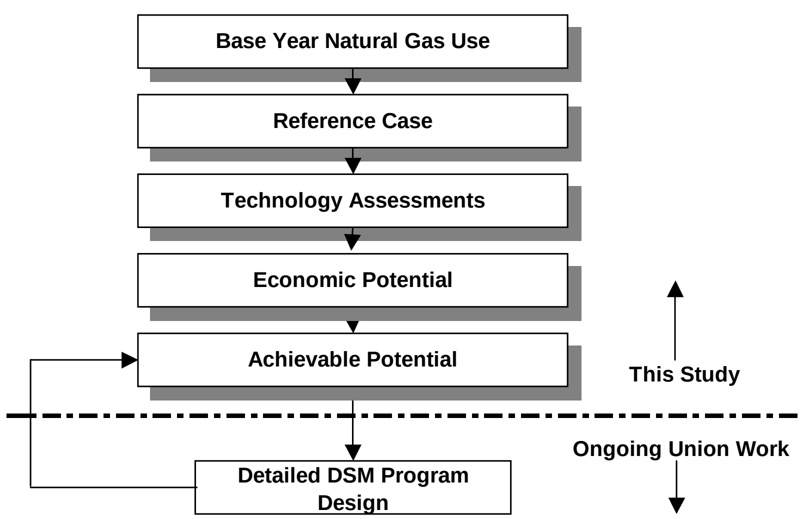
Achievable Potential

The Achievable Potential is the proportion of the natural gas savings identified in the Economic Potential Forecast that could realistically be achieved within the study period. Achievable Potential recognizes that it is practically difficult to induce customers to purchase and install all the efficiency technologies that meet the criteria defined by the Economic Potential Forecast.

1.4 Approach

To meet the objectives outlined above, the study was conducted within an iterative process that involved a number of well-defined steps. At the completion of each step, the client reviewed the results and, as applicable, revisions were identified and incorporated into the interim results. The study then progressed to the next step. A summary of the steps is presented in Exhibit 1 and briefly discussed below.

Exhibit 1: Major Study Steps



Step 1: Develop Base Year Calibration Using Actual Union Sales Data

The Base Year (2007) is the starting point for the analysis. It provides a detailed description of "where" and "how" natural gas is currently used, based on actual natural gas sales.

The consultants compiled the best available data and used sector-specific macro models to estimate natural gas use; they then compared the results to Union's actual billing data to verify their accuracy.

Step 2: Develop Reference Case

The Reference Case uses the same sector-specific macro models to estimate the expected level of natural gas consumption that would occur over the study period with no new (post-2007) Union DSM initiatives. The Reference Case includes projected increases in natural gas consumption based on expected rates of population and economic growth; using the growth rates included in the Union 2007 load forecast for the period from 2007 to 2009, and the growth rates included in the Union 2010 load forecast for the period from 2010 to 2017. The Reference Case also makes an estimate for some "natural conservation", that is, conservation that occurs even in the absence of new Union DSM programs. The Reference Case provides the point of comparison for the calculation of Technical, Economic and Achievable natural gas saving potentials.

Step 3: Assess DSM Technologies

The consultants researched a wide range of commercially available DSM technologies and practices that can enable Union's customers to use natural gas more efficiently. In each case, the consultants assessed how much natural gas the DSM measures could save together with the expected cost, including purchase (capital), operating and maintenance costs.

For each DSM measure the consultants calculated the measure Total Resource Cost (TRC). The measure TRC calculates the net present value of changes to natural gas, electricity and water use that result from an investment in an efficiency technology or measure. The measure TRC is equal to its full or incremental capital cost (depending on application) plus any change (positive or negative) in the combined annual energy, water and equipment O&M costs. This calculation includes, among others, the following inputs: the changes in energy and water use, the supply costs of natural gas, electricity and water, the life of the technology, and the selected discount rate, which in this analysis has been set at 10%.

This approach allowed the consultants to compare a standardized cost for new technologies and measures with the cost of new natural gas supply, or other natural gas conserving measures, and to determine whether or not to include the DSM measure in the Economic Potential Forecast.

Step 4: Estimate Economic Natural Gas Savings Potential

The Economic Potential Forecast incorporates all "cost-effective" DSM measures reviewed in Step 3. To forecast the potential natural gas savings that are defined as economic, the consultants used the sector-specific macro models to calculate the level of natural gas consumption that would occur if Union's customers installed all "cost-effective" technologies. "Cost effective" for the purposes of this study means that the measure has a positive measure TRC.

Step 5: Estimate Achievable Natural Gas Savings Potential

The Achievable Potential is the proportion of the savings identified in the Economic Potential Forecast that could realistically be achieved within the study period. Achievable Potential recognizes that it is difficult to induce customers to purchase and install all the energy efficiency technologies that meet the criteria defined by the Economic Potential forecast. The results are, therefore, presented within ranges. Consequently, the study assessed Achievable Potential under two differing scenarios[2]:

- **A Financially Unconstrained scenario**, in which potential is limited by market constraints but not by available DSM budgets.

- **A Static Marketing scenario**, in which potential is limited by DSM budgets on an individual technology[3] basis as well as by market constraints.

1.5 Study Organization and Reports

The 2008 study was organized and conducted by sector using a common methodology, as outlined above. That study was composed of a series of technical reports developed for Union Gas. They are:

- Natural Gas Energy Efficiency Potential, Residential Sector
- Natural Gas Energy Efficiency Potential, Commercial Sector
- Natural Gas Energy Efficiency Potential, Industrial Sector

As is noted in the "Note to Reader" section in each of the technical reports:

> "The primary economic data for this study was compiled during the period April to June of 2008. They represented the best available at the time. However, since that time, Canada and other global economies have entered a period of unprecedented economic uncertainty that may have significant impact on the results of this study, particularly in the short term."

The findings presented in this summary report vary from those presented in each of the technical reports, as they represent the results of the updated models. As was described in Section 1.1, the purpose of updating the models was to modify the assumptions and baseline data used in the initial 2008 Natural Gas Efficiency Potential Study to better reflect the impacts of economic changes.

1.5.1 This Report

The updated results of the individual sector reports are combined into this Summary Report, which is organized as follows:

- Section 2 presents the combined natural gas savings for the three sectors
- Section 3 presents a summary of the natural gas savings for the Residential sector
- Section 4 presents a summary of the natural gas savings for the Commercial sector
- Section 5 presents a summary of the natural gas savings for the Industrial sector

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[2] It should be emphasized that the estimation of Achievable Potential scenarios is not synonymous with program design or program targets. While closely linked to the discussion of Achievable Potential, program design and the setting of specific targets involve more detailed analysis that is beyond the scope of this study.

[3] It should be noted that the Static Marketing scenario results presented in this study are financially constrained at the level of an individual technology, not by a total DSM program budget. That step occurs at the point of detailed program design, which is beyond the scope of this study.

2 Summary of Study Findings

The study findings confirm that, despite the impacts of the economic recession, significant cost-effective natural gas DSM opportunities remain in the Residential, Commercial, and Industrial sectors within Union's service area.

2.1 Total Natural Gas savings Potential

Exhibit 2 and Exhibit 3 summarize the total combined natural gas savings for the Residential, Commercial, and Industrial sectors that have been identified in each of the individual sector technical reports. Highlights of the results for the total Union service area are shown in Exhibit 2. They include:

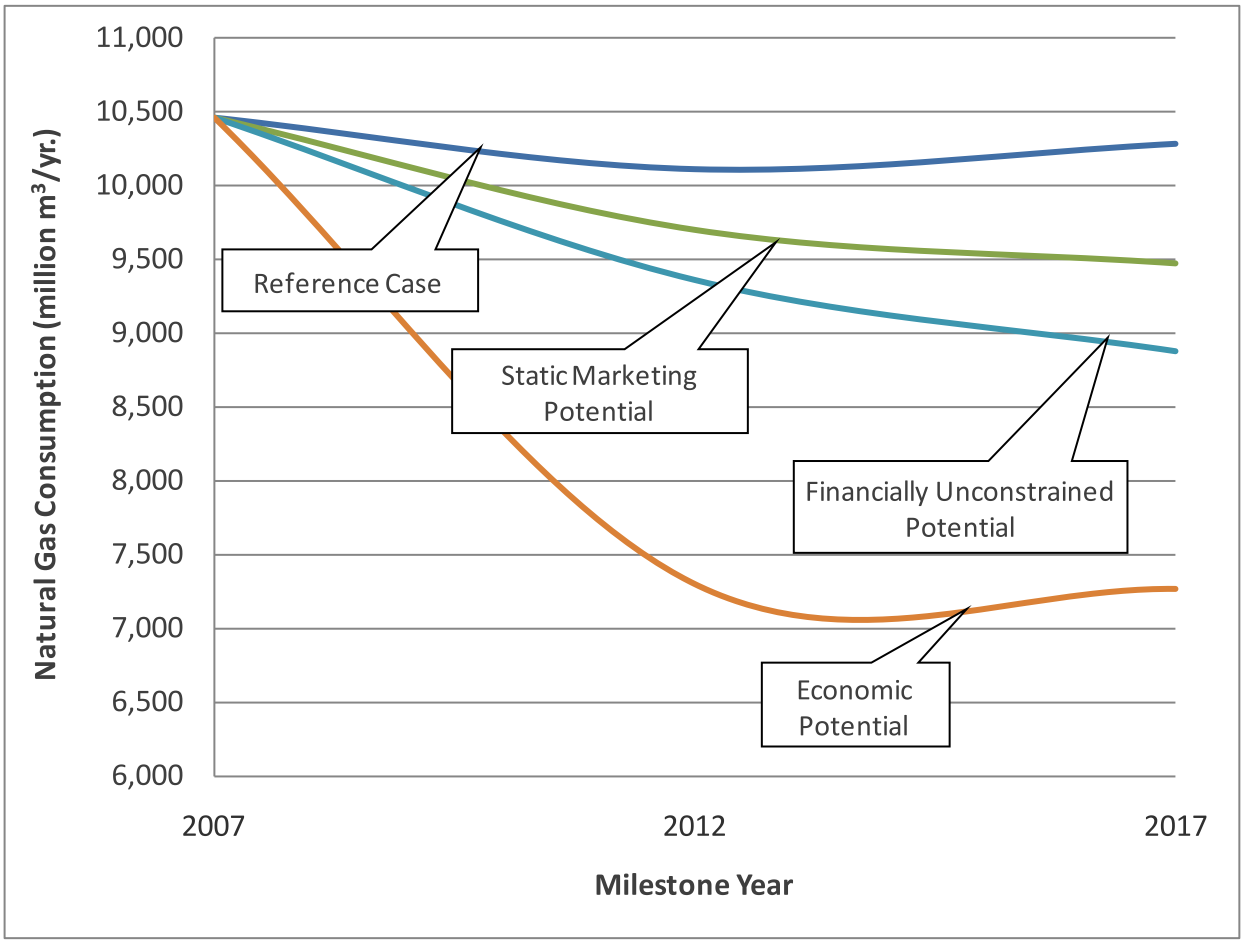
- In the Reference Case, total natural gas consumption for Union's service area decreases from approximately 10,457 million m^3/yr. in 2007 to about 10,284 million m^3/yr. by 2017, a decrease of about 1.7%.
- In the Economic Potential scenario, total natural gas consumption for Union's service area is estimated to reach 7,302 million m^3/yr. by 2012, and 7,270 million m^3/yr. by 2017. This represents a decrease in annual consumption of 2,814 million m^3/yr. by 2012 and 3,014 million m^3/yr. by 2017, relative to the Reference Case.[4]
- In the Financially Unconstrained Achievable Potential scenario, total natural gas consumption for Union's service area is estimated to reach 9,365 million m^3/yr. by 2012, and 8,885 million m^3/yr. by 2017. This represents a decrease in annual consumption of 752 million m^3/yr. by 2012 and 1,399 million m^3/yr. by 2017, relative to the Reference Case
- In the Static Achievable Potential scenario, total natural gas consumption for Union's service area is estimated to reach 9,698 million m^3/yr. by 2012, and 9,471 million m^3/yr. by 2017. This represents a decrease in annual consumption of 419 million m^3/yr. by 2012 and 813 million m^3/yr. by 2017, relative to the Reference Case
- If the Static Achievable Potential scenario natural gas savings for the total Union service area by 2017 are assessed from the perspective of average savings for the measures installed in each year, the approximate natural gas savings per year are 81.3 million m^3/yr. This compares with the 92.6 million m^3 of natural gas savings that were reported in Union's Demand Side Management 2009 Annual Report.

[4] The reported natural gas savings in each milestone year include the savings achieved by measures implemented in the years up to and including that milestone year, not just of the measures implemented in the reported milestone year. This means that although the savings reported occur in the milestone year alone, they are the result of several years of measure implementation.

Exhibit 2: Summary of Forecast Results for the Total Union Service Area, Annual Natural Gas Consumption and Savings, by Milestone Year and Forecast Scenario, 3 Sectors

Milestone Year	Annual Consumption, All 3 Sectors (million m³/yr.)				Potential Annual Savings (million m³/yr.)		
	Reference Case	Economic Potential	Achievable Potential: Financially Unconstrained	Achievable Potential: Static	Economic Potential	Achievable Potential: Financially Unconstrained	Achievable Potential: Static
	(A)	(B)	(C)	(D)	(A-B)	(A-C)	(A-D)
2007	10,457						
2012	10,116	7,302	9,365	9,698	2,814	752	419
2017	10,284	7,270	8,885	9,471	3,014	1,399	813

Exhibit 3: Forecast Results for the Total Union Service Area, Annual Natural Gas Consumption and Savings by Milestone Year and Forecast Scenario, 3 Sectors



2.2 Key Changes from 2008 Study

As part of the update process described in Section 1, ICF Marbek and Union Gas staff engaged in an iterative process to update the reference case. The 2017 achievable potential market penetration rates and their associated implementation curves were also updated. Updates were made for both the financially unconstrained and the static achievable potential scenarios. The exhibit below shows a comparison of the original and updated reference cases.

Exhibit 4: Summary of Changes to Natural Gas Consumption in the Reference Case, 3 Sectors

Milestone Year	Original Reference Case	Updated Reference Case	Difference
		million m³/year	
2007	10,457	10,457	-
2012	10,520	10,116	- 404
2017	10,754	10,284	-470

The changes to the reference case, achievable participation rates, and adoption curves described above resulted in changes to savings in the static and financially unconstrained scenarios, as shown in Exhibit 5 and Exhibit 6, respectively.

Exhibit 5: Summary of Changes to Natural Gas Savings in the Static Achievable Potential Scenario, 3 Sectors

Milestone Year	Original Savings	Updated Savings	Difference
		thousand m³/year	
2012	561,197	418,538	-142,660
2017	1,044,940	812,941	-231,999
% Savings relative to Reference Case, 2017	9.72%	7.91%	-2.26%

Exhibit 6: Summary of Changes to Natural Gas Savings in the Financially Unconstrained Achievable Potential Scenario, 3 Sectors

Milestone Year	Original Savings	Updated Savings	Difference
		thousand m³/year	
2012	917,671	751,842	-165,828
2017	1,592,832	1,398,988	-193,843
% Savings relative to Reference Case, 2017	14.81%	13.60%	-1.88%

Compared to the original (2008) results, key differences in the updated study results include:

- The updates resulted in a lower reference case consumption and slightly lower potential savings in both the static and financially unconstrained scenarios.
- The scope of changes resulting from the updates vary by sector, with the greatest reduction in savings occurring in the commercial sector.

2.3 Key Observations

As illustrated in the preceding exhibits, despite a decade of successful DSM program implementation, there remains significant cost-effective DSM potential within Union's service area. This remaining opportunity reflects, in part, continued technology cost and performance improvements over the period. Key study observations are highlighted below.

2.3.1 Key Technologies and Measures

In the Residential sector, the measures that provide the most significant contribution to annual savings are technologies that reduce space heating requirements, such as high-performance windows, programmable thermostats, and air sealing in older homes.

In the Commercial sector, the most significant opportunities are actions that reduce space heating loads in existing buildings (e.g., building recommissioning, advanced building automation systems, space heating equipment upgrades and heat recovery), and actions that reduce hot water loads in existing buildings, including low-flow fixtures and water heating equipment upgrades. Building recommissioning is a particularly large opportunity.

In the Industrial sector, the most significant opportunities for natural gas savings are technologies that reduce gas usage for process heating, specifically ovens, dryers, kilns and furnaces. Implementation of energy-efficiency measures in boiler steam systems is also a significant opportunity. Measures that improve the total plant (referred to as system wide) energy efficiency are the third most significant opportunity area.

2.3.2 Markets and Trends

As the DSM market matures within Union's service area, niche or target markets are becoming increasingly important. Measures that may not pass the TRC test in a "typical" or "average" application often will pass in niche applications. Air sealing and insulation in older homes (built before 1980) is one example that was included in this study, as data was available.

Measures such as drain water heat recovery (DWHR) systems and DHW recirculation systems become more economically attractive as the number of household occupants increases. However, this group of measures were not included in the current results as suitable data was not available.

Market transformation approaches warrant additional consideration, particularly in the Residential and Commercial sectors. Alternately, opportunities such as those listed below suggest that the composition of the TRC calculation itself may need to be revisited to better consider non-energy benefits. For example:

- In the Residential sector, there remain significant untapped potential savings from technically mature measures that do not currently pass the TRC screen. The largest share of these additional potential savings is from air sealing and envelope insulation in existing homes. These measures do not pass the TRC screen as currently defined. However, they provide non-energy benefits such as increased comfort and reduced noise that are not currently captured in the TRC calculation. In addition, industry specialists emphasized that as insulation levels increase, proper air and moisture sealing is becoming increasingly essential to the long-term structural integrity of Ontario's housing stock. This situation presents both an opportunity and a possible technical issue that may be better addressed through a market transformation approach.

- In the Commercial sector, there remain significant untapped potential savings from technically mature measures that do not currently pass the TRC screen. The largest share of these additional potential savings are from air sealing and envelope upgrades, including wall insulation and more energy efficient glazing measures in existing buildings. These measures do not pass the TRC screen as currently defined. However, they provide non-energy benefits such as increased comfort and reduced noise that are not currently captured in the TRC calculation.

- In addition, industry specialists emphasized that some emerging technologies, such as solar preheated make-up air may be better addressed in a market transformation context. They provide “soft” benefits, such as visible contribution to corporate greening goals, which are not included in the TRC calculation.

3 Residential Sector

The Residential sector includes single-family detached homes, attached duplex, row and multi-family dwellings and apartments as well as a small number of other dwellings.

3.1 Approach

The detailed end-use analysis of energy efficiency opportunities in the Residential sector employed two linked modelling platforms: **HOT2000,** a commercially supported residential building energy-use simulation software; and **RSEEM** (Residential Sector Energy End-use Model), an ICF Marbek in-house spreadsheet-based macro model.

The major steps in the general approach to the study are outlined in Section 1.4 above (Approach). Specific procedures for the Residential sector were as follows:

- **Modelling of Base Year:** The consultants used the Union customer data to break down the Residential sector by four factors:
  - Type of dwelling (single detached, attached, apartment, etc.)
  - Heating category (natural gas or electric heat)
  - The age of the building
  - Service region.

To estimate the natural gas used for space heating, the consultants factored in building characteristics such as insulation levels, floor space and air tightness using a variety of data sources, including the Ontario EnerGuide for Houses database, Union billing data, local climate data and discussions with local contractors. They also used the results of Union customer surveys that provided data on type of heating system, number and age of household appliances, renovation activity, etc. Based on the available data sources, the consultants calculated an average natural gas use by end use for each dwelling type. The consultant's models produced a close match with actual Union sales data.

- **Reference Case Calculations:** For the Residential sector, the consultants developed profiles of new buildings for each type of dwelling. They estimated the growth in building stock using the same data as that contained in Union's most recent load forecast and estimated the amount of natural gas used by both the existing building stock and the projected new buildings and appliances. As with the Base Year calibration, the consultant's projection closely matches Union's own forecasts of future natural gas requirements.

- **Assessment of DSM Measures:** To estimate the economic and achievable energy savings potentials, the consultants assessed a wide range of commercially available energy efficiency measures and technologies such as:
  - Thermal upgrades to the walls, roofs and windows of existing buildings
  - More efficient space heating equipment and controls
  - More efficient water heating equipment and measures to reduce usage
  - Improved designs for new buildings
  - Addition of solar thermal technologies.

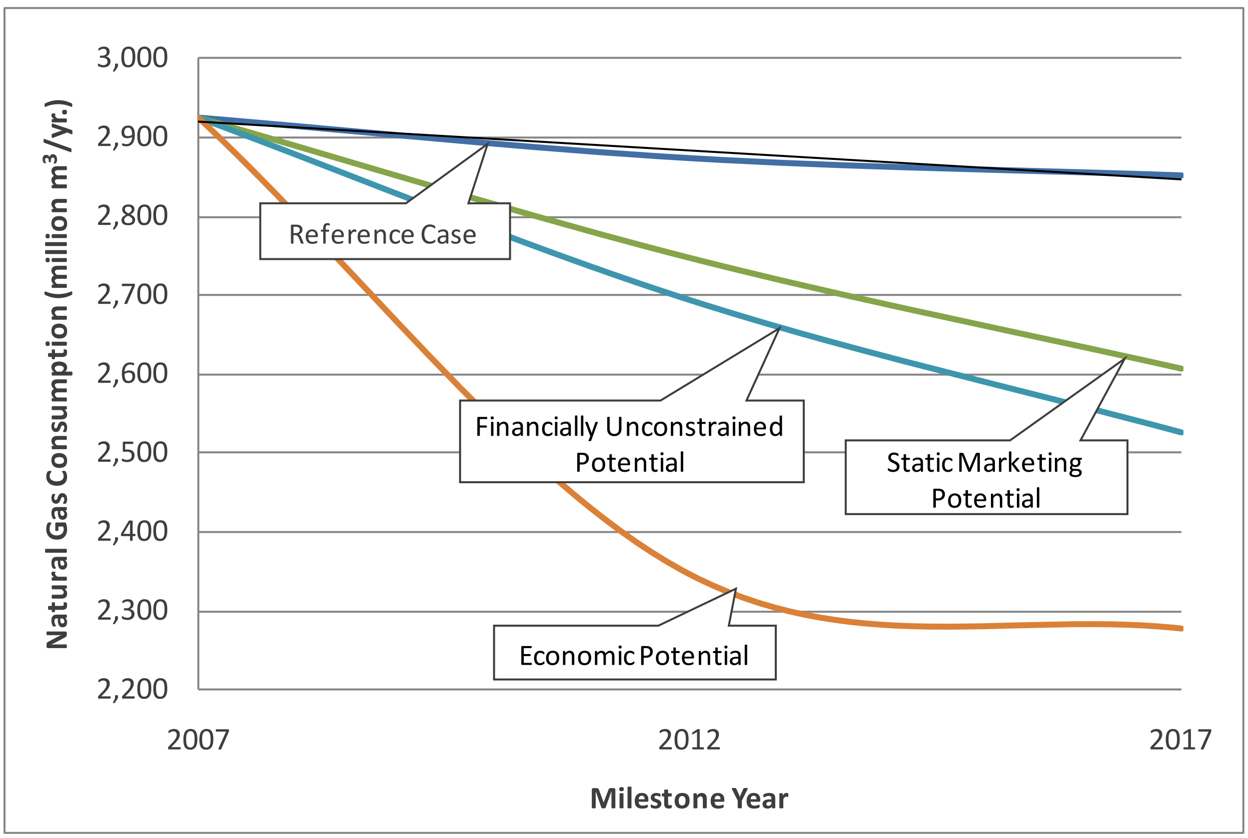
3.2 Residential Natural Gas Savings Potential

A summary of the levels of annual natural gas consumption and potential natural gas savings contained in each of the Residential sector forecasts addressed by the study is presented in Exhibit 7 and Exhibit 8, and is discussed briefly in the sub sections that follow.

Exhibit 7: Summary of Forecast Results for the Total Union Service Area, Annual Natural Gas Consumption and Savings, by Milestone Year and Forecast Scenario, Residential Sector

Milestone Year	Annual Consumption, Residential Sector (million m^3/yr.)				Potential Annual Savings (million m^3/yr.)		
	Reference Case	Economic Potential	Achievable Potential: Financially Unconstrained	Achievable Potential: Static	Economic Potential	Achievable Potential: Financially Unconstrained	Achievable Potential: Static
	(A)	(B)	(C)	(D)	(A-B)	(A-C)	(A-D)
2007	2,925						
2012	2,873	2,347	2,693	2,747	526	179	126
2017	2,851	2,278	2,526	2,607	527	325	244

Exhibit 8: Graphic of Forecast Results for the Total Union Service Area, Annual Natural Gas Consumption and Savings by Milestone Year and Forecast Scenario, Residential Sector



3.3 Base Year Natural Gas Use

In the Base Year of 2007, the residential sector in Union's total service area consumed about 2,925 million m^3 of natural gas. As illustrated in Exhibit 9, approximately 94% of this natural gas consumption occured in the single-family detached/duplex category of dwellings. The attached row housing/triplexes and quads category accounts for almost all the rest, with less than 0.1% consumed in mobile and other.

The Southern service region accounted for about 80% of the residential natural gas consumption in the Union Gas Service Area.

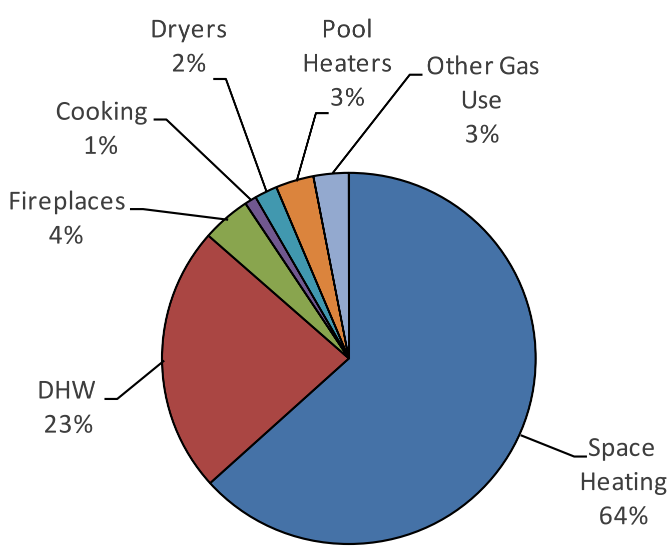
Exhibit 9: Base Year Residential Sector Natural Gas Use for the Total Union Service Area (1000 m^3/yr.)

Segment	Annual Consumption in Residential Sector (1000 m^3/yr.)							
	Space Heating	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use	Totals
Single-Family Detached/ Duplex	1,737,149	631,184	114,694	28,140	54,695	89,580	83,956	2,739,396
Attached/Row Housing/Tris & Quads	113,708	44,320	7,859	1,684	3,060	6,751	5,801	183,183
Other	1,433	397	74	13	26	51	54	2,048
TOTAL	1,852,289	675,900	122,627	29,837	57,781	96,382	89,810	2,924,627

Note: Any difference in totals is due to rounding.

As illustrated in Exhibit 10, space heating accounted for about 64% of total residential natural gas use. Domestic hot water (DHW) accounted for about 23% of the total natural gas use, followed by fireplaces (4%), and pool heaters (3%). Clothes dryers, cooking and selected other uses, such as barbeques and patio heaters, accounted for the remaining natural gas consumption.

Exhibit 10 Base Year Residential Sector Natural Gas Use for the Total Union Service Area, by End Use



3.4 Reference Case

In the absence of new DSM initiatives, the study estimates that natural gas consumption in the Residential sector will decrease from 2,925 million m^3/yr. in 2007 to about 2,851 million m^3/yr. by 2017. This represents an overall decrease of about 2.5% in the period and compares very closely with Union's own forecast, which also includes consideration of the impacts of "natural conservation".

Exhibit 11 shows the forecast levels of Residential sector natural gas consumption for the entire Union service area. The results are presented for each milestone year and end use.

Exhibit 11: Residential Sector Reference Case Natural Gas Use for the Total Union Service Area, by Dwelling Type, End Use and Milestone Year (1000 m^3/yr.)

Dwelling Type	Milestone Year	Gas Consumption (1000 m^3/yr.)							
		Total	Space Heating	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use
Single-Family Detached/ Duplex	2007	2,739,396	1,737,149	631,184	114,694	28,140	54,695	89,580	83,956
	2012	2,665,194	1,660,917	626,643	108,020	29,858	57,986	91,892	89,878
	2017	2,611,800	1,619,351	604,643	104,250	31,715	61,548	94,075	96,217
Attached/Row Housing/Tris & Quads	2007	183,183	113,708	44,320	7,859	1,684	3,060	6,751	5,801
	2012	205,475	122,578	52,185	8,704	2,164	3,926	8,393	7,526
	2017	236,766	136,659	61,859	10,226	2,790	5,057	10,412	9,764
Other	2007	2,048	1,433	397	74	13	26	51	54
	2012	1,997	1,379	396	70	14	28	53	58
	2017	1,969	1,358	384	67	15	29	54	62
TOTAL	2007	2,924,627	1,852,289	675,900	122,627	29,837	57,781	96,382	89,810
	2012	2,872,665	1,784,875	679,223	116,793	32,036	61,940	100,337	97,461
	2017	2,850,535	1,757,367	666,886	114,544	34,520	66,635	104,540	106,043

Note: Any difference in totals is due to rounding.

3.5 Economic Potential Forecast

Under the conditions of the Economic Potential Forecast[5], the study estimated that natural gas consumption in the Residential sector would decline to about 2,278 million m^3/yr. by 2017 for the total Union service area. Annual savings relative to the Reference Case are about 572 million m^3/yr. by 2017, or about 20%.

3.6 Achievable Potential

The Achievable Potential is the proportion of the economic natural gas savings (as noted above) that could realistically be achieved within the study period. In the Residential sector, the Achievable Potential for natural savings through technology adoption by 2017 was estimated to be 325 million m^3/yr. and 244 million m^3/yr., for the Financially Unconstrained and Static

[5] The level of natural gas consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost-effective. In this study, "cost-effective" means that the technology upgrade passes the measure Total Resource Cost (TRC) test, as discussed previously in Section 1.3.

Marketing scenarios, respectively. These savings represent about 57% and 43% of the savings identified in the Economic Potential Forecast.

The most significant opportunities for natural gas savings are technologies that reduce space heating requirements, such as high-performance windows, programmable thermostats, and air sealing in older homes.

3.7 Key Changes from 2008 Study

As part of the update process described in Section 1, ICF Marbek and Union Gas staff engaged in an iterative process to update the reference case to 2017. The 2017 achievable potential market penetration rates and their associated implementation curves were also updated. Updates were made for both the financially unconstrained and the static achievable potential scenarios. Exhibit 12 shows a comparison of the original and updated reference cases.

Exhibit 12: Summary of Changes to Natural Gas Consumption in the Reference Case, Total Residential Sector

Milestone Year	Original Reference Case	Updated Reference Case	Difference
		thousand m^3/year	
2007	2,924,627	2,924,627	0
2012	2,952,264	2,872,665	-79,599
2017	2,998,515	2,850,535	-147,980

The changes to the reference case, achievable participation rates and adoption curves described above, resulted in changes to savings in the static and financially unconstrained scenarios, as shown in Exhibit 10 and Exhibit 11, respectively.

Exhibit 13: Summary of Changes to Natural Gas Savings in the Static Achievable Potential Scenario, Total Residential Sector

Milestone Year	Original Savings	Updated Savings	Difference
		thousand m^3/year	
2012	131,012	125,679	-5,334
2017	261,401	243,739	-17,662
% Savings relative to Reference Case, 2017	8.7%	8.6%	-0.2%

Exhibit 14: Summary of Changes to Natural Gas Savings in the Financially Unconstrained Achievable Potential Scenario, Total Residential Sector

Milestone Year	Original Savings	Updated Savings	Difference
		thousand m^3/year	
2012	188,235	179,245	-8,989
2017	356,581	324,818	-31,763
% Savings relative to Reference Case, 2017	11.9%	11.4%	-0.5%

Compared to the original (2008) results, key differences in the updated study results include:

- In general, the updates resulted in a lower reference case consumption and a slightly lower potential savings in both the static and financially unconstrained scenarios.
- Updated savings are lower in the space heating and DHW end uses but slightly higher in the remaining end uses (i.e. fireplaces, dryers, and pool heaters).
- The reduction in savings potential is most significant in single-family detached homes in the Southern region.

3.8 Additional Observations

In addition to the preceding conclusions, two additional observations warrant note as they may affect future program strategies. They include:

- **Niche Markets Warrant Greater Program Focus:** As the DSM market matures within Union's service area, niche or target markets are becoming increasingly important. For example, measures that may not pass the TRC test in a "typical" or "average" application often will pass in niche applications. Air sealing and insulation in older homes (built before 1980) is one example that was included in this study, because the available data permitted an estimate of the higher heat loss in these older homes. Similarly, additional domestic hot water measures may be feasible in homes with a larger number of occupants. For example, drain water heat recovery systems and DHW recirculation systems become more economically attractive with larger household sizes. These latter measures have not been included in the current results as suitable data were not available.
- **Market Transformation Approaches Warrant Additional Consideration:** There remains additional untapped potential savings from technically mature measures that do not currently pass the TRC screen. The largest share of these additional potential savings is from air sealing and envelope insulation in existing homes. These measures do not pass the TRC screen as currently defined. However, they provide non-energy benefits such as increased comfort and reduced noise that are not currently captured in the TRC calculation. Similarly, industry specialists emphasized that as insulation levels increase, proper air and moisture sealing is becoming increasingly essential to the long-term structural integrity of Ontario's housing stock. This situation presents both an opportunity and a possible technical issue that may be better addressed through a market transformation approach.

4 Commercial Sector

The Commercial sector includes office and retail buildings, hotels and motels, restaurants, high-rise and mid-rise apartments, warehouses and a variety of small buildings. In this study, it also includes buildings that are often classified as "institutional," such as hospitals and nursing homes, schools and universities.

Throughout this report, use of the word "commercial" includes both commercial and institutional buildings unless otherwise noted.

4.1 Approach

The detailed end-use analysis of energy efficiency opportunities in the Commercial sector employed two linked modelling platforms: **CEEAM** (Commercial Energy and Emissions Analysis Model), an ICF Marbek in-house simulation model developed in conjunction with Natural Resources Canada (NRCan) for modelling natural gas use in commercial/institutional building stock, and **CSEEM** (Commercial Sector Energy End-use Model), an in-house spreadsheet-based macro model.

The major steps in the general approach to the study were outlined earlier in Section 1.4 (Approach). Specific procedures for the Commercial sector were as follows:

- **Modelling of Base Year:** ICF Marbek compiled data that defines "where" and "how" natural gas is currently used in existing commercial buildings. The consultants then created building energy use simulations for each type of commercial building and calibrated the models to reflect actual Union customer sales data. Estimated savings for the Other Commercial Buildings category were derived from the results of the modelled segments. They did not directly model that category because it is extremely diverse and the natural gas use of individual facility types is relatively small. The consultant's model produced a close match with actual Union sales data.

- **Reference Case Calculations:** For the Commercial sector, ICF Marbek developed detailed profiles of new buildings in each of the building segments, estimated the growth in building stock and estimated "natural" changes affecting natural gas consumption over the study period. As with the Base Year calibration, the consultant's projection closely matches Union's forecasts of future natural gas requirements.

- **Assessment of DSM Measures:** To estimate the economic and achievable natural gas savings potentials, the consultants assessed a wide range of commercially available DSM measures and technologies such as:
  - Measures to improve building envelope efficiency
  - Measures to reduce domestic hot water use, including solar hot water systems
  - Upgraded heating and ventilating systems
  - Improved construction in new buildings
  - Efficient cooking appliances.

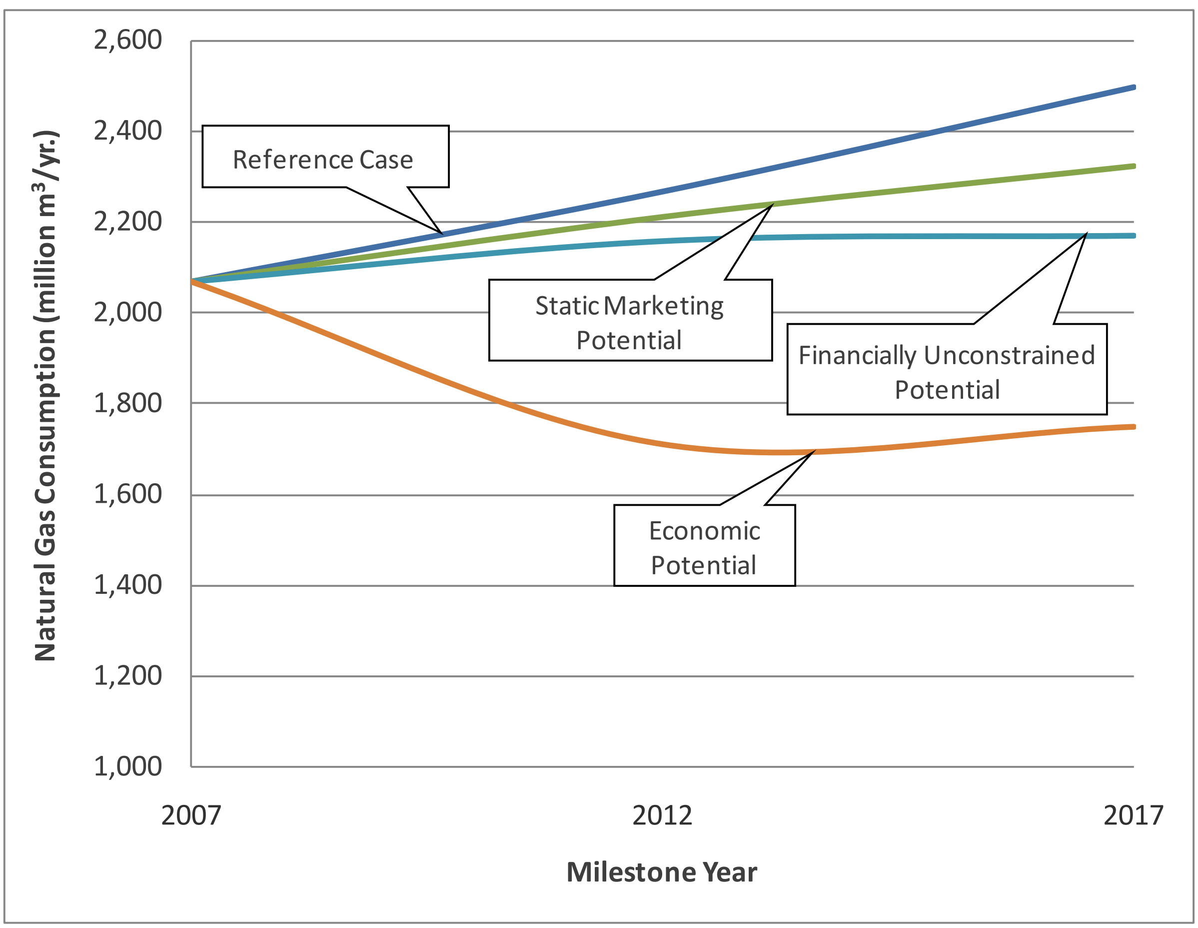
4.2 Commercial Natural Gas Savings Potential

A summary of the levels of annual natural gas consumption and potential natural gas savings contained in each of the Commercial sector forecasts addressed by the study is presented in Exhibit 15 and Exhibit 16, and is discussed briefly in the sub sections that follow.

Exhibit 15: Summary of Forecast Results for the Total Union Service Area Annual Natural Gas Consumption and Savings, by Milestone Year and Forecast Scenario, Commercial Sector

Milestone Year	Annual Consumption, Commercial Sector (million m³/yr.)				Potential Annual Savings (million m³/yr.)		
	Reference Case	Economic Potential	Achievable Potential		Economic Potential	Achievable Potential	
			Financially Unconstrained	Static		Financially Unconstrained	Static
	(A)	(B)	(C)	(D)	(A-B)	(A-C)	(A-D)
2007	2,067						
2012	2,266	1,712	2,159	2,211	554	107	55
2017	2,496	1,750	2,171	2,323	746	325	173

Exhibit 16: Graphic of Forecast Results for the Total Union Service Area Annual Natural Gas Consumption and Savings by Milestone Year and Forecast Scenario, Commercial Sector



4.3 Base Year Natural Gas Use

In the Base Year of 2007, the Commercial sector in Union's total service area consumed about 2,067 million m^3 of natural gas. The Southern service region accounted for approximately 77% of the total commercial sector sales shown in Exhibit 17, while the Northern service region accounted for the remaining 23%.

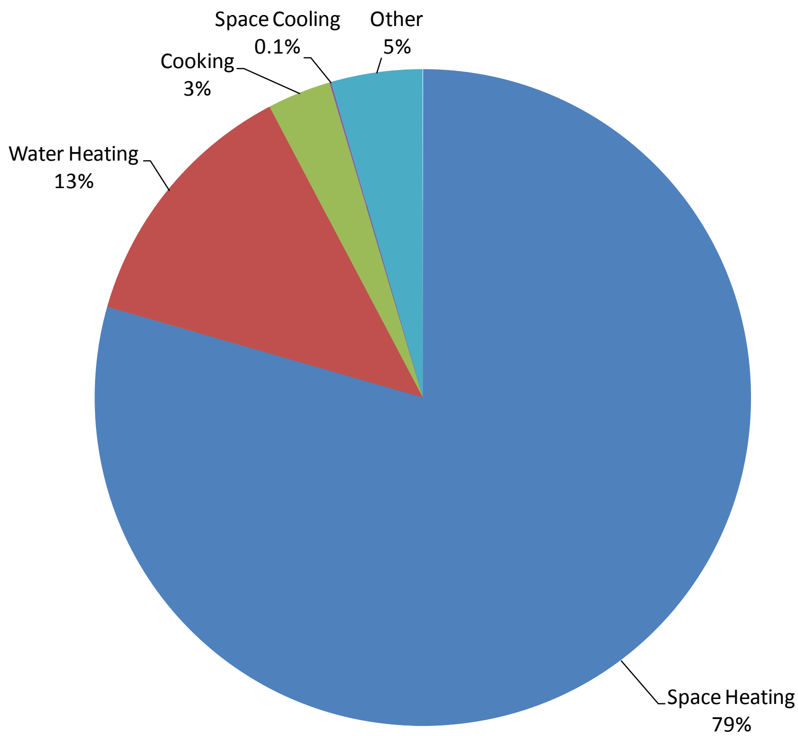
Among the modelled sub sectors shown in Exhibit 17, small offices, retail and high-rise apartments are the three largest natural gas users.

Exhibit 17: Base Year Commercial Sector Natural Gas Use for the Total Union Service Area ($1000\ m^3$/yr.)

Sub Sector	Natural Gas Consumption by End Use (1000 m^3/yr.)					
	Space Heating	Water Heating	Cooking	Space Cooling	Other	Total
Large Office	99,744	7,774	324	185	11,716	119,743
Small Office	213,790	15,367	626	0	12,519	242,302
Retail	147,344	9,583	4,219	0	5,274	166,419
Large Hotel	7,649	4,766	643	0	919	13,978
Small Hotel/Motel	4,849	2,718	59	0	588	8,214
Contract Hospital	41,177	10,879	1,096	291	7,026	60,469
Hospital	18,650	3,762	489	70	1,361	24,332
Nursing Home	42,669	12,719	2,843	0	4,045	62,276
School	127,355	7,415	1,783	0	841	137,394
Contract University/College	58,582	10,173	2,868	617	7,170	79,409
University/College	12,355	1,837	444	118	846	15,600
Restaurant/Food Service	39,992	15,664	25,853	0	326	81,836
Warehouse	61,965	3,307	138	0	2,752	68,162
Contract Apartment	5,038	1,854	22	0	179	7,093
High-rise Apartment	120,369	40,913	522	0	4,176	165,980
Mid-rise Apartment	74,936	24,848	484	0	1,210	101,478
Other Buildings						391,810
Other Contract Institutional Buildings						320,568
Total	1,076,463	173,581	42,413	1,280	60,948	2,067,064

Exhibit 18 (overleaf) shows that space heating accounts for about 79% of total commercial sector natural gas use. Domestic hot water (DHW) accounts for about 13% of the total natural gas use, followed by cooking (3%). A variety of miscellaneous end uses account for the remaining natural gas consumption.

Exhibit 18: Base Year Commercial Sector Natural Gas Use for the Total Union Service Area, by End Use[6]



4.4 Reference Case

In the absence of new DSM initiatives, the study estimates that natural gas consumption in the Commercial sector will grow from 2,067 million m^3/yr. in 2007 to about 2,496 million m^3/yr. by 2017. This represents an overall increase of about 21% in the period and compares very closely with Union's own forecast, which also includes consideration of the impacts of "natural conservation".

Exhibit 19 (overleaf) shows the forecast levels of Commercial sector natural gas consumption for the entire Union service area. The results are presented for each milestone year and end use.

[6] The pie chart in Exhibit 18 presents percentage of gas consumption by end use for modelled buildings only; the sub sectors "Other Commercial Buildings" and "Other" are included in the total load of Exhibit 4.1, but not included in the pie chart.

Exhibit 19: Commercial Sector Reference Case Natural Gas Use for the Total Union Service Area, by Building Type, End Use and Milestone Year (1000 m^3/yr.)

Sub Sector	Milestone Year	Total	Space Heating	Water Heating	Cooking	Space Cooling	Other
Large Office	2007	119,743	99,744	7,774	324	185	11,716
	2012	129,582	107,723	8,723	387	185	12,564
	2017	140,983	116,983	9,823	460	185	13,532
Small Office	2007	242,302	213,790	15,367	626	0	12,519
	2012	261,784	230,466	16,952	737	0	13,628
	2017	284,072	249,571	18,764	862	0	14,876
Retail	2007	166,419	147,344	9,583	4,219	0	5,274
	2012	183,110	161,262	10,912	4,860	0	6,075
	2017	202,740	177,668	12,470	5,601	0	7,001
Large Hotel	2007	13,978	7,649	4,766	643	0	919
	2012	15,329	8,261	5,305	726	0	1,037
	2017	16,881	8,968	5,925	819	0	1,170
Small Hotel/Motel	2007	8,214	4,849	2,718	59	0	588
	2012	8,990	5,263	3,024	66	0	637
	2017	9,880	5,738	3,375	74	0	692
Contract Hospital	2007	60,469	41,177	10,879	1,096	291	7,026
	2012	66,451	45,335	12,047	1,246	335	7,488
	2017	73,559	50,288	13,437	1,421	386	8,027
Hospital	2007	24,332	18,650	3,762	489	70	1,361
	2012	26,362	20,085	4,143	538	83	1,512
	2017	28,664	21,717	4,575	593	97	1,682
Nursing Home	2007	62,276	42,669	12,719	2,843	0	4,045
	2012	68,126	46,621	13,948	3,161	0	4,397
	2017	74,746	51,100	15,342	3,515	0	4,789
School	2007	137,394	127,355	7,415	1,783	0	841
	2012	149,769	138,209	8,571	2,030	0	958
	2017	164,205	150,885	9,914	2,314	0	1,092
Contract University/College	2007	79,409	58,582	10,173	2,868	617	7,170
	2012	87,596	65,294	11,035	3,120	617	7,530
	2017	96,885	72,913	12,018	3,403	617	7,934
University/College	2007	15,600	12,355	1,837	444	118	846
	2012	17,173	13,644	2,004	492	118	915
	2017	18,946	15,097	2,193	546	118	991
Restaurant/Food Service	2007	81,836	39,992	15,664	25,853	0	326
	2012	90,215	43,611	17,338	28,900	0	365
	2017	99,697	47,732	19,242	32,315	0	408
Warehouse	2007	68,162	61,965	3,307	138	0	2,752
	2012	75,226	68,253	3,695	156	0	3,121
	2017	83,384	75,523	4,143	177	0	3,541
Contract Apartment	2007	7,093	5,038	1,854	22	0	179
	2012	7,833	5,498	2,104	26	0	206
	2017	8,703	6,039	2,397	30	0	237
High-rise Apartment	2007	165,980	120,369	40,913	522	0	4,176
	2012	182,706	130,796	46,530	598	0	4,782
	2017	202,258	143,024	53,070	685	0	5,479
Mid-rise Apartment	2007	101,478	74,936	24,848	484	0	1,210
	2012	111,285	81,241	28,099	556	0	1,389
	2017	122,800	88,666	31,900	638	0	1,595
Other Buildings	2007	391,810					
	2012	430,942					
	2017	476,470					
Other Contract Institutional Buildings	2007	320,568					
	2012	353,226					
	2017	391,274					
Total	2007	2,067,064	1,076,463	173,581	42,413	1,280	60,948
	2012	2,265,704	1,171,562	194,431	47,600	1,337	66,605
	2017	2,496,147	1,281,914	218,587	53,453	1,403	73,046

4.5 Economic Potential Forecast

Under the conditions of the Economic Potential Forecast[7], the study estimated that natural gas consumption in the Commercial sector would decline to about 1,750 million m^3/yr. by 2017 for the total Union service area. Annual savings relative to the Reference Case would be about 746 million m^3/yr. by 2017, or about 30%.

4.6 Achievable Potential

The Achievable Potential is the proportion of the economic natural gas savings (as noted above) that could realistically be achieved within the study period. In the Commercial sector, the Achievable Potential for natural savings through technology adoption by 2017 was estimated to be 325 million m^3/yr. and 173 million m^3/yr., for the Financially Unconstrained and Static Marketing scenarios, respectively. These savings represent about 44% and 23% of the savings identified in the Economic Potential Forecast.

The most significant opportunities for natural gas savings are technologies that reduce space heating and water heating requirements.

4.7 Key Changes from 2008 Study

As part of the update process described in Section 1, ICF Marbek and Union Gas staff engaged in an iterative process to update the reference case to 2017. The 2017 achievable potential market penetration rates and their associated implementation curves were also updated. Updates were made for both the financially unconstrained and the static achievable potential scenarios. Exhibit 20 shows a comparison of the original and the updated reference cases.

Exhibit 20: Summary of Changes to Natural Gas Consumption in the Reference Case, Total Commercial Sector

Milestone Year	Original Reference Case	Updated Reference Case	Difference
	thousand m^3/year		
2007	2,067,064	2,067,064	0
2012	2,110,220	2,265,704	155,483
2017	2,157,072	2,496,147	339,075

The changes to the reference case, achievable participation rates and adoption curves described above, resulted in changes to savings in the static and financially unconstrained scenarios, as shown in Exhibit 21 and Exhibit 22, respectively.

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[7] The level of natural gas consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost-effective. In this study, "cost-effective" means that the technology upgrade passes the measure Total Resource Cost (TRC) test, as discussed previously in Section 1.4.

Exhibit 21: Summary of Changes to Natural Gas Savings in the Static Achievable Potential Scenario, Total Commercial Sector

Milestone Year	Original Savings	Updated Savings	Difference
		thousand m^3/year	
2012	112,609	55,170	-57,439
2017	259,202	172,704	-86,498
% Savings relative to Reference Case, 2017	10.4%	6.9%	-3.5%

Exhibit 22: Summary of Changes to Natural Gas Savings in the Financially Unconstrained Achievable Potential Scenario, Total Commercial Sector

Milestone Year	Original Savings	Updated Savings	Difference
		thousand m^3/year	
2012	172,330	107,180	-65,150
2017	390,076	325,301	-64,775
% Savings relative to Reference Case, 2017	15.6%	13.0%	-2.6%

Compared to the original (2008) results, key differences in the updated study results include:

- In general, updates result in a higher reference case consumption and lower potential savings in both the static and financially unconstrained scenarios.
- In absolute terms, updated savings are lower for all end uses and sub sectors.
- In relative terms, space heating savings make up a smaller share of overall savings in both achievable scenarios. Conversely, water heating savings account for a larger relative share in both achievable scenarios.
- As a consequence of the above, sub sectors with high water heating natural gas use, such as hotels, hospitals, restaurants and apartments make up a larger share of overall savings in both achievable scenarios.

4.8 Additional Observations

In addition to the preceding conclusions, three additional observations warrant note as they may affect future program strategies. They include:

- **Rate of measure implementation has a large effect on overall savings:** For measures that pass the TRC screen on an incremental cost basis, low participation rates in early milestone years create a significant "lost opportunity." This is particularly relevant to the replacement of equipment with a very long life (i.e. space heating equipment), building renovations such as envelope improvements, and new building construction. The gap between Economic Potential and Achievable Potential savings presented in this study is due in large part to this significant lost opportunity that occurs in early milestone years.

- **Savings arising from full cost measures may be delayed without eroding overall potential:** This is a corollary of the above point, and most pertinent to the discussion of the largest opportunity identified in this study, recommissioning. As recommissioning passes the TRC screen at full cost, eligible buildings that are not recommissioned remain as future opportunities, while incremental cost opportunities that are not exploited represent lost opportunities. This may be especially relevant to programming strategy during periods of economic downturn, when building owners and managers may be less likely to implement measures despite an attractive payback.

- **Market transformation approaches warrant additional consideration:** There remains an additional untapped potential savings from technically mature measures that do not currently pass the TRC screen. The largest share of these additional potential savings are from air sealing and envelope upgrades, including wall insulation and more energy efficient glazing measures in existing buildings. These measures do not pass the TRC screen as currently defined. However, they provide non-energy benefits such as increased comfort and reduced noise that are not currently captured in the TRC calculation. In addition, industry specialists emphasized that some emerging technologies, such as solar preheated make-up air, may be better addressed in a market transformation context. They provide "soft" benefits, such as visible contribution to corporate greening goals, which are not included in the TRC calculation.

5 Industrial Sector

The Industrial sector consists of the eight largest natural gas consuming industrial sub sectors within the Union service area plus an additional miscellaneous category that combines the remaining smaller industry groups. As applicable, each of the eight large industrial sub sectors was further divided into the very large "Contract" customers and the remaining "Other" sites. The large Contract customers, which are the primary focus of this study, are: Primary Metal, Chemical, Paper, Transportation and Machinery, Petroleum Refineries, Mining, Food and Beverage and Non-metallic Mineral.

5.1 Approach

The detailed end-use analysis of energy efficiency opportunities in the Industrial sector employed ICF Marbek's customized macro model. The model is organized by major industrial sub sector and major end use.

Natural gas end-use profiles were developed for the nine sub sectors described above. The profiles map proportionally how much natural gas is used by each of the end uses for each sub sector. These profiles represent the sub sector archetypes and are used in the model to calculate the natural gas used by each end use for each sub sector.

The major steps in the general approach to the study are outlined in Section 1.4 above (Approach). Specific procedures for the Industrial sector were as follows:

- **Modelling of Base Year:** The consultants compiled Base Year data on the industrial sector from a variety of sources, including Union's customer information, the study team's own energy assessment experience within many of the sub sectors and secondary data sources. The macro model results produced a close match with actual Union sales data.

- **Reference Case Calculations:** The consultants prepared a Reference Case forecast based on projected growth forecasts provided by Union, which includes anticipated closing of existing facilities and opening of new facilities.

- **Assessment of DSM Measures:** To estimate the economic and achievable natural gas savings potentials, the consultants assessed a wide range of commercially available energy efficiency measures and technologies such as:

    - Integrated control systems
    - More efficient boiler, steam and hot water systems
    - Efficient process heating technologies
    - Efficient space heating and ventilation, including solar thermal technologies.

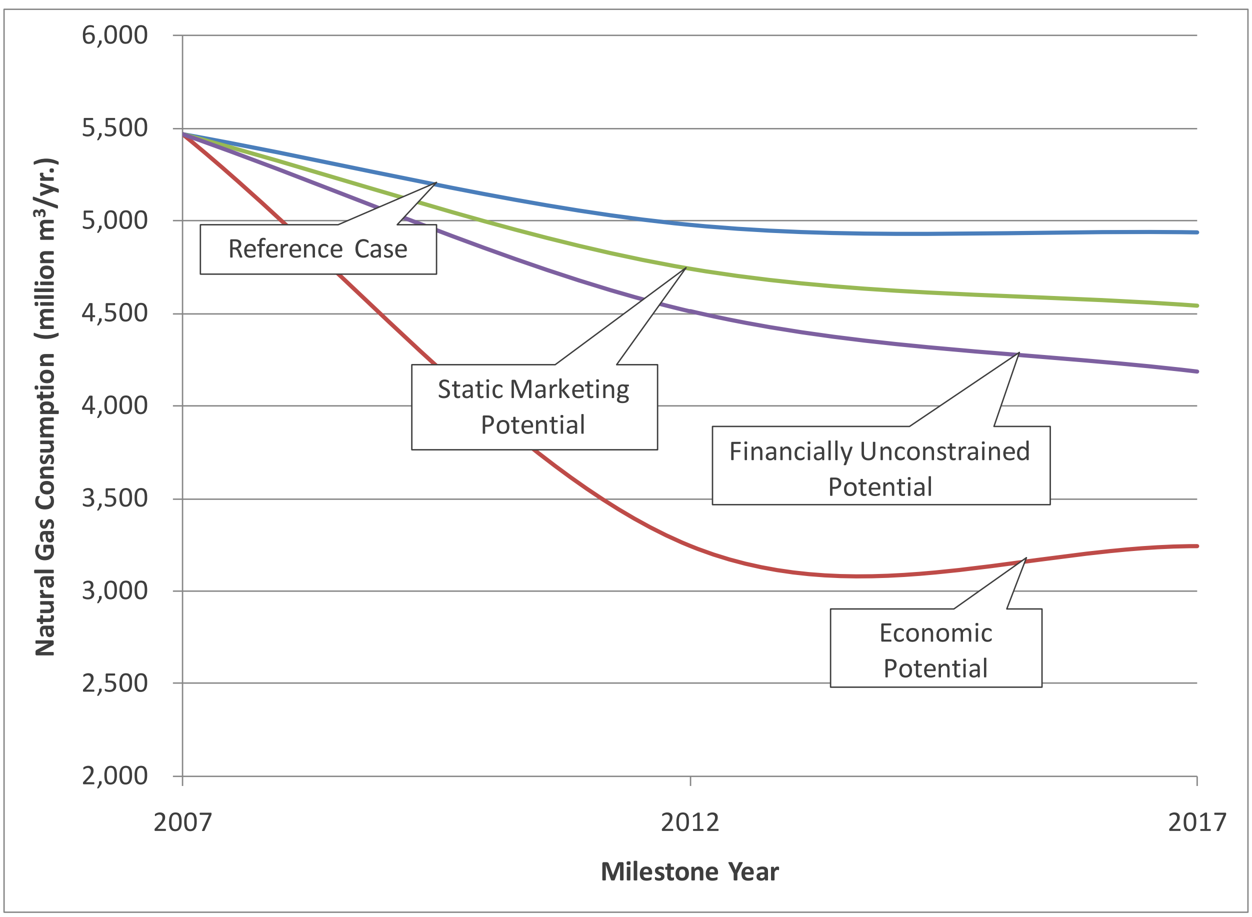
5.2 Industrial Natural Gas Savings Potential

A summary of the levels of annual natural gas consumption and potential natural gas savings contained in each of the Industrial sector forecasts addressed by the study is presented in Exhibit 23 and Exhibit 24, and is discussed briefly in the sub sections that follow.

Exhibit 23: Summary of Forecast Results for the Total Union Service Area Annual Natural Gas Consumption and Savings, by Milestone Year and Forecast Scenario, Industrial Sector

Milestone Year	Annual Consumption, Industrial Sector (million m^3/yr.)				Potential Annual Savings (million m^3/yr.)		
	Reference Case	Economic Potential	Achievable Potential		Economic Potential	Achievable Potential	
			Financially Unconstrained	Static		Financially Unconstrained	Static
2007	5,465						
2012	4,978	3,244	4,513	4,740	1,734	465	238
2017	4,937	3,242	4,189	4,541	1,695	749	396

Exhibit 24: Graphic of Forecast Results for the Total Union Service Area Annual Natural Gas Consumption and Savings by Milestone Year and Forecast Scenario, Industrial Sector



5.3 Base Year Natural Gas Use

In the Base Year of 2007, the Industrial sector in Union's total service area consumed about 5,465 million m^3 of natural gas. This volume excludes natural gas used for power generation, co-generation and industrial feedstock, as these uses of natural gas are beyond the scope of this study.

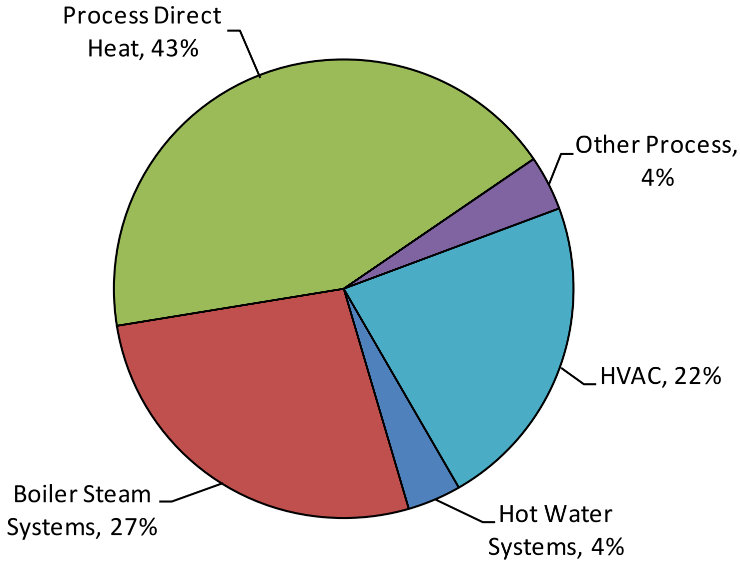
The twelve core industrial sub sectors (both contract and other customers), shown in Exhibit 25, account for 88% of the total industrial natural gas consumption. About 70% of the total industrial natural gas consumption occurs in the Southern service region.

Exhibit 25: Base Year Industrial Sector Natural Gas Consumption for the Total Union Service Area (1,000 m^3/yr.)

Sub Sector	End Use					Total	
	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC		
Contract Primary Metal	27,568	161,964	963,099	31,428	194,357	1,378,415	25%
Contract Chemical	20,117	408,369	331,925	74,222	171,201	1,005,834	18%
Other Chemical	741	15,034	12,220	2,732	6,303	37,030	0.7%
Contract Paper	11,344	353,887	107,431	10,380	84,175	567,218	10%
Contract Transportation and Machinery	7,827	91,046	117,313	15,868	159,278	391,332	7%
Other Transportation and Machinery	2,984	34,718	44,734	6,051	60,736	149,223	3%
Contract Petroleum Refineries	7,520	72,251	253,607	6,738	35,873	375,989	7%
Contract Mining	64,023	80,029	112,041	16,006	48,017	320,117	6%
Other Mining	4.9	6.1	8.6	1.2	3.7	25	0.0004%
Contract Food and Beverage	20,142	120,397	69,212	15,585	26,436	251,771	5%
Other Food and Beverage	4,463	26,680	15,337	3,454	5,858	55,793	1%
Contract Non-Metallic Mineral	5,598	33,477	198,345	10,581	31,910	279,911	5%
Miscellaneous Industrial	33,945	75,984	127,031	17,690	398,131	652,781	12%
Total	206,277	1,473,842	2,352,303	210,736	1,222,280	5,465,438	
%	4%	27%	43%	4%	22%		

As illustrated in Exhibit 26, process direct heat accounts for about 43% of total industrial sector natural gas use in the base year. Boiler steam systems account for about 27% of the total natural gas use, followed by heating, ventilation and air conditioning (HVAC), which accounts for about 22%. Other processes and hot water systems account for the remaining natural gas consumption.

Exhibit 26: Base Year Industrial Sector Natural Gas Use for the Total Union Service Area, by End Use



5.4 Reference Case

In the absence of new DSM initiatives, the study estimates that natural gas consumption in the Industrial sector will decrease from 5,465 million m^3/yr. in 2007 to about 4,937 million m^3/yr. by 2017. This represents an overall decrease of about 9.7% in the period and compares very closely with Union's own forecast, which also includes consideration of the impacts of "natural conservation".

Exhibit 27 shows the forecast levels of Industrial sector natural gas consumption for the Union service area. The results are presented for each milestone year, service region and sub sector.

Exhibit 27: Industrial Sector Reference Case Natural Gas Use for the Total Union Service Area, by Sub Sector and Milestone Year (1000 m^3/yr.)

Sub Sector	Northern Region			Southern Region			All Regions		
	2007	2012	2017	2007	2012	2017	2007	2012	2017
Contract Primary Metal	398,032	461,065	467,735	980,383	1,011,357	1,010,852	1,378,415	1,472,422	1,478,587
Contract Chemical	256,247	214,125	211,763	749,587	675,774	621,166	1,005,834	889,900	832,929
Other Chemical	2,310	1,930	1,909	34,720	31,301	28,772	37,030	33,231	30,681
Contract Paper	537,762	202,027	179,666	29,456	28,632	28,632	567,218	230,660	208,298
Contract Transportation and Machinery	10,593	10,582	10,582	380,739	181,276	181,276	391,332	191,858	191,858
Other Transportation and Machinery	1,411	1,410	1,410	147,811	70,375	70,375	149,223	71,785	71,785
Contract Petroleum Refineries	-	-	-	375,989	587,605	587,605	375,989	587,605	587,605
Contract Mining	307,752	229,235	223,060	12,365	11,791	11,791	320,117	241,026	234,851
Other Mining	-	-	-	25	23	23	25	23	23
Contract Food and Beverage	39,603	74,402	75,460	212,168	240,232	241,044	251,771	314,634	316,504
Other Food and Beverage	2,527	4,747	4,815	53,266	60,311	60,515	55,793	65,058	65,330
Contract Non-Metallic Mineral	21,239	20,799	20,799	258,672	97,129	97,129	279,911	117,928	117,928
Miscellaneous Industrial	76,363	37,532	37,532	576,418	724,392	763,575	652,781	761,924	801,107
Total	1,653,839	1,257,855	1,234,730	3,811,599	3,720,200	3,702,756	5,465,438	4,978,056	4,937,486

5.5 Economic Potential Forecast

Under the conditions of the Economic Potential Forecast[8], the study estimated that natural gas consumption in the Industrial sector would decline to about 3,242 million m^3/yr. by 2017 for the total Union service area. Annual savings relative to the Reference Case are about 1,695 m^3/yr. by 2017, or about 34%.

5.6 Achievable Potential

The Achievable Potential is the proportion of the economic natural gas savings (as noted above) that could realistically be achieved within the study period. In the Industrial sector, the Achievable Potential for natural savings through technology adoption by 2017 was estimated to be 749 million m^3/yr. and 396 million m^3/yr., for the Financially Unconstrained and Static Marketing scenarios, respectively. These savings represent about 44% and 23% of the savings identified in the Economic Potential Forecast.

5.7 Key Changes from 2008 Study

As part of the update process described in Section 1, ICF Marbek and Union Gas staff engaged in an iterative process to update the reference case to 2017. The 2017 achievable potential market penetration rates and their associated implementation curves were also updated. Updates were made for both the financially unconstrained and the static achievable potential scenarios. Exhibit 28 shows a comparison of the original and updated reference cases.

Exhibit 28: Summary of Changes to Natural Gas Consumption in the Reference Case, Total Residential Sector

Milestone Year	Original Reference Case	Updated Reference Case	Difference
	million m^3/year		
2007	5,465	5,465	-
2012	5,458	4,978	-480
2017	5,598	4,937	-661

The changes to the reference case, achievable participation rates, and adoption curves described above resulted in changes to savings in the static and financially unconstrained scenarios, as shown in Exhibit 29 and Exhibit 30, respectively.

[8] The level of natural gas consumption that would occur if all equipment was upgraded to the level that is cost-effective. In this study, "cost-effective" means that the technology upgrade passes the measure Total Resource Cost (TRC) test, as discussed previously in Section 1.3.

Exhibit 29: Summary of Changes to Natural Gas Savings in the Static Achievable Potential Scenario, Total Industrial Sector

Milestone Year	Original Savings	Updated Savings	Difference
		thousand m^3/year	
2012	317,576	237,689	-79,887
2017	524,337	396,498	-127,839
% Savings relative to Reference Case, 2017	9.4%	8.0%	-1.3%

Exhibit 30: Summary of Changes to Natural Gas Savings in the Financially Unconstrained Achievable Potential Scenario, Total Industrial Sector

Milestone Year	Original Savings	Updated Savings	Difference
		thousand m^3/year	
2012	557,106	465,417	-91,689
2017	846,175	748,869	-97,305
% Savings relative to Reference Case, 2017	15.1%	15.2%	0.05%

Compared to the original (2008) results, key differences in the updated study results include:

- The updates resulted in a lower reference case consumption and slightly lower potential savings in both the static and financially unconstrained scenarios.
- Updated savings are lower in all end uses, but the reduction is greatest in the Boiler Steam System and Other Process end uses.
- Updated savings are lower in all sub sectors, except the Contract Petroleum Refineries, Contract Food and Beverage, Other Food and Beverage, and Miscellaneous Industrial sub sectors. The greatest decrease in savings occurs in the Contract Non-Metallic Mineral sub sector.

5.8 Additional Observations

In addition to the preceding conclusions, three additional observations warrant note as they may affect future program strategies. They include:

- ***Rate of measure implementation has a large effect on overall savings.*** For measures that pass the TRC screen on an incremental cost basis, low participation rates in early milestone years create a significant “lost opportunity.” This is particularly relevant to the replacement of equipment with a very long life, which is applicable to most industrial technologies and measures. The gap between Economic Potential and Achievable Potential savings presented in this study is due in large part to this significant lost opportunity that occurs in early milestone years.

- ***Bundling of measures to develop program concepts has an impact on the achievable potential results.*** To model the achievable potential scenario measures were grouped into bundles that were manageable within the scope and budget of the project. The results provide an indication of savings potential based on the specific set of measures included in the bundles. In defining specific programs it will be important to interpret the Achievable Potential savings potential by assessing individual measures within the context of the Economic Potential and the measure TRC results.

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Natural Gas
Energy Efficiency Potential

Residential Sector

–Final Report–

Submitted to:

Union Gas

Submitted by:

Marbek Resource Consultants Ltd.

March 18, 2009

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Note to Reader

The primary economic data for this study was compiled during the period April to June of 2008. They represented the best available at the time. However, since that time, Canada and other global economies have entered a period of unprecedented economic uncertainty that may have significant impact on the results of this study, particularly in the short term. Three elements that affect this study's results are particularly impacted by these economic changes:

- Sector growth rates
- DSM Program participation rates that are used to determine the estimates of achievable potential
- Type of DSM investment

Sector Growth Rates

Key factors underlying Union's industrial load forecast and the study's Reference Case such as gross domestic product (GDP), energy prices, commodity prices, currency values etc. are expected to change under the current conditions. The impact of these changes, at least in the short term, is expected to be reduced industrial output accompanied by reduced consumption of natural gas. At this time, it is impossible to predict either the extent or the duration of the economic downturn and its consequent impact on natural gas consumption.

DSM Program Participation Rates

The participation rates estimated during the Achievable Potential workshops do not explicitly take into account changes in industry outlook as a result of the economic downturn. In the short term, the expected impact would be lower discretionary investment and, hence, lower program participation rates than those presented in this report. As neither the extent nor the duration of the economic downturn is known at this time, it is not possible to estimate the total reduction in program participation rates over the full study period.

Type of DSM Investment

Many of the DSM investments included in this study's results pass the economic screen on a full cost basis and can be implemented at any time over the study period. This means that even if program participation rates are reduced in the short term, there remains the possibility of recapturing some of these opportunities in later portions of the study period. However, some of the DSM investment opportunities included in the study's results occur only when existing equipment is replaced at the end of its life. This means that if program participation rates are reduced in the short term, then the opportunity to implement the energy efficient model is lost until the equipment again comes up for replacement, which in most applications will be beyond the period covered by this study.

EXECUTIVE SUMMARY

❑ Background and Objectives

Union Gas Ltd. (Union) is a natural gas utility serving almost 1.3 million customers in the residential, commercial and industrial markets. Union is a regulated utility with a franchise area spread across the Province of Ontario, including northern, southwestern and southeastern cities and towns. Union distributes approximately 13.9 billion m^3 (489.9 billion ft^3) of natural gas to its customers annually.

Since 1997, Union has delivered demand side management (DSM) programs to its customers under a mandate from the provincial regulator, the Ontario Energy Board (OEB). Union offers DSM programs to all in-franchise customer rate classes and across all sectors and the DSM savings target and budget are determined through a rate proceeding with the OEB. Over the past eleven years Union has delivered approximately 614 million m^3 of natural gas savings and over $1 billion in net Total Resource Cost (TRC) benefits.

Union has been participating in a market of increasing DSM program maturity. This market is continually evolving in its engagement with energy efficiency through growing voluntary initiatives and more stringent codes and standards. In addition, changes in the economy have started to show signs of negatively impacting the commercial and industrial marketplace in Union's Service Area.

In the DSM Generic Proceeding held in 2006, Union committed to creating an updated Market Potential Study for input into the next DSM plan. This study will support the identification of potential energy savings for Union's next multi-year plan and be part of Union's regulatory filing in the next DSM rate case.

Union has initiated this current study within the context of the conditions noted above. When completed, the results of this natural gas Efficiency Potential Study will provide a foundation that Union can use to guide the development of its longer-term DSM strategy, including new measures and targets.

In the DSM Generic Proceeding held in 2006, Union committed to creating an updated Market Potential Study for input into the next DSM plan. Union has initiated this current study within the context of the conditions noted above. When completed, the results of this Natural Gas Efficiency Potential Study will provide a foundation that Union can use to guide the development of its longer-term DSM strategy, including new measures and targets. More specifically, this includes support for Union's filing to the OEB regulatory application for the next multi-year DSM plan by:

- Estimating the achievable and economic potential for DSM measures across all applicable technologies, markets and sectors in Union's franchise area

- Giving shape to, and refining ongoing energy-efficiency work by Union in order to develop its next multi-year DSM plan, and

- Provide information that is actionable and can be easily converted to plan and program development.

❑ Scope and Organization

This study covers a 10-year study period from 2007 to 2017 and addresses the Residential, Commercial and Industrial sectors. The 2007 calendar year was selected as the Base Year as this is the most recent year for which complete customer data are available.

The study addresses the full range of natural gas efficiency measures. Results are presented for the total Union Service Area and for two service regions: Southern and Northern. The study results are disaggregated by service region due to differences in building stock and weather conditions (heating degree days).

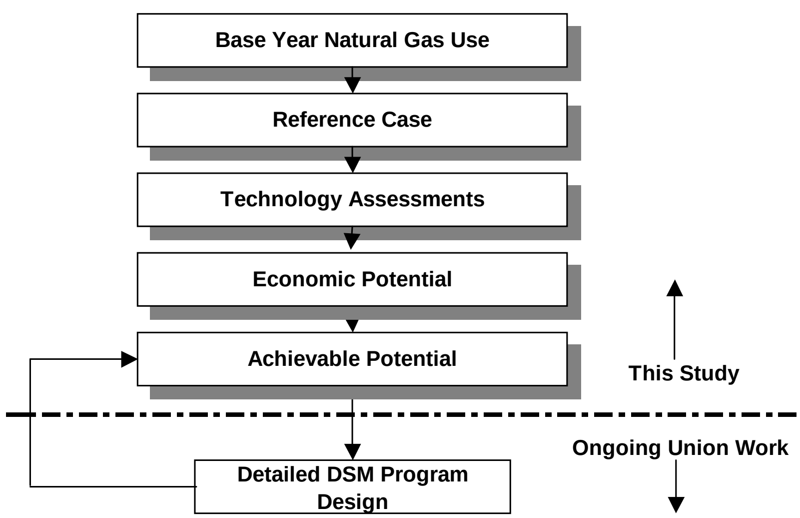
This report presents the results for Union's Residential sector.

❑ Approach

The detailed end-use analysis of energy-efficiency opportunities in the Residential sector employed two linked modelling platforms: **HOT2000,** a commercially supported residential building energy-use simulation software, and **RSEEM** (Residential Sector Energy End-use Model), a Marbek in-house spreadsheet-based macro model. The models are described in further detail in Section 1.

The major steps involved in the analysis are shown in Exhibit ES1 and are discussed in greater detail in Section 1. As illustrated in Exhibit ES1, the results of this study, and in particular the estimation of Achievable Potential,[1] support Union's on-going DSM program planning; however, it should be emphasized that the estimation of Achievable Potential is not synonymous with either the setting of specific targets or with detailed program design, which are beyond the scope of this study.

Exhibit ES1: Study Approach - Major Analytical Steps



[1] The proportion of savings identified that could realistically be achieved within the study period, under various program spending and market conditions.

- ❑ Overall Study Findings

As in any study of this type, the results presented in this report are based on a large number of important assumptions. Assumptions such as those related to the current penetration of energy-efficient technologies, the rate of future growth in the province's building stock and customer willingness to implement new efficiency measures are particularly influential. Wherever possible, the assumptions used in this study are consistent with those used by Union and are based on best available information, which in many cases includes the professional judgement of the consultant team, Union personnel and local experts. The reader should, therefore, use the results presented in this report as best available estimates; major assumptions, information sources and caveats are noted throughout.

The study findings confirm the existence of significant cost-effective DSM potential in Union's Residential sector. Savings estimates were based on two marketing scenarios: the Financially Unconstrained marketing scenario assumes both an aggressive program approach and a very supportive context (e.g., healthy economy, very strong public commitment to climate change mitigation, etc.) while the Static Marketing scenario assumes that market interest and customer commitment to energy efficiency and sustainable environmental practices remain approximately as current. Similarly, federal, provincial and municipal government energy-efficiency and GHG mitigation efforts remain similar to the present.

It was found that natural gas savings from efficiency improvements within the Union Service Area would provide between 357 and 261 million m^3/year of natural gas savings by 2017 in, respectively, the Financially Unconstrained and the Static Marketing Achievable scenarios. The most significant Achievable Savings opportunities were in the actions that reduce space heating loads in existing dwellings (e.g., high-performance windows, programmable thermostats and air sealing and insulation in older homes).

Although program costs for the Financially Unconstrained and the Static Marketing scenarios will vary depending on the specific composition of the future program portfolio, both scenarios show an evident trend towards higher future costs to achieve natural gas savings and TRC benefits.[2] This trend recognizes that savings from DSM programs tend to become more expensive over time, as the most attractive measures gain greater market penetration and only the more challenging and expensive measures remain.[3] However, to counteract this trend, it is also expected that some relatively new technologies, such as tankless water heaters and high-performance windows, may become less expensive as they gain greater sales volumes. These technologies would then become more financially attractive from a DSM program perspective.

[2] Design of a DSM program portfolio is beyond the scope of this current study.

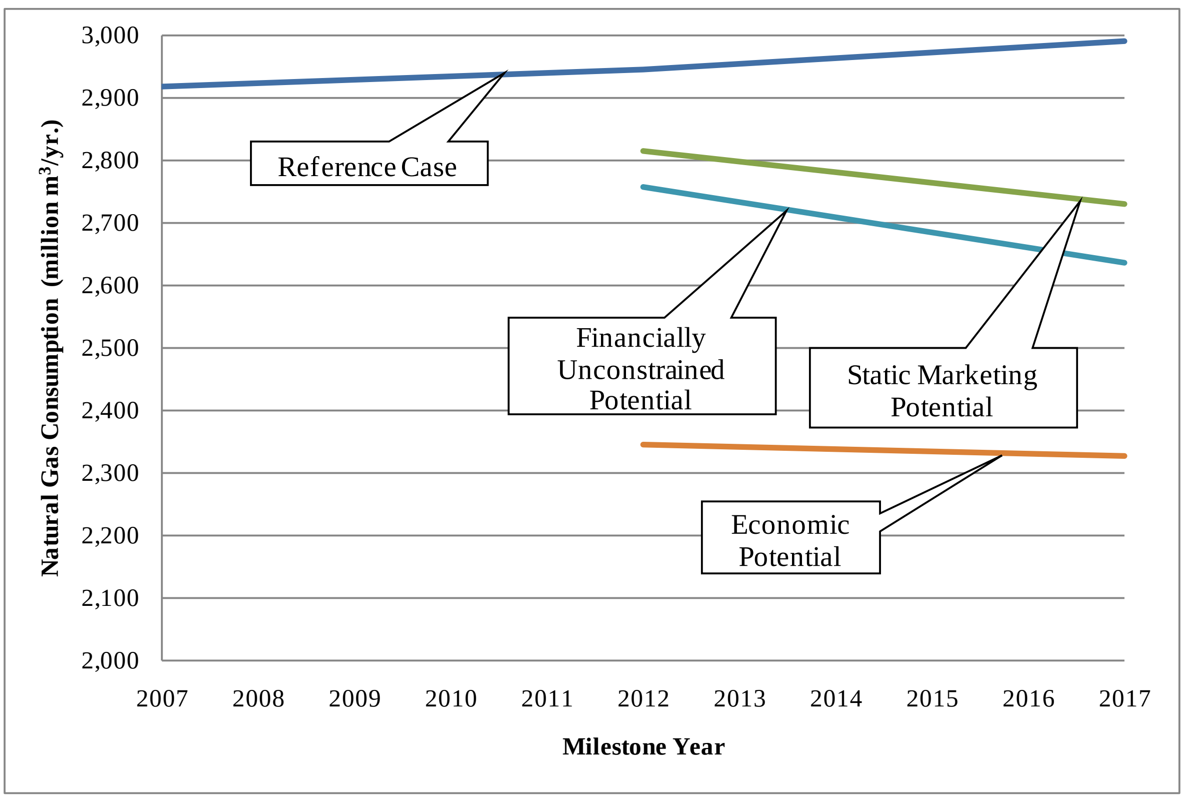
❑ Summary of Natural Gas Savings

A summary of the levels of annual natural gas consumption contained in each of the forecasts addressed by the study is presented in Exhibits ES2 and ES3, by milestone year, and discussed briefly in the paragraphs below.

Exhibit ES2: Summary of Forecast Results for the Total Union Service Area – Annual Natural Gas Consumption and Savings, Residential Sector (million m^3/yr.)

Annual Consumption in Residential Sector (million m^3)					Potential Annual Savings (million m^3/yr.)		
Milestone Year	Reference Case	Economic Potential	Achievable Potential		Economic Potential	Achievable Potential	
			Financially Unconstrained	Static		Financially Unconstrained	Static
	(A)	(B)	(C)	(D)	(A-B)	(A-C)	(A-D)
2007	2,925						
2012	2,952	2,350	2,764	2,821	602	188	131
2017	2,999	2,332	2,642	2,737	666	357	261

Exhibit ES3: Graphic of Forecast Results for the Total Union Service Area – Annual Natural Gas Consumption, Residential Sector (million m^3/yr.)



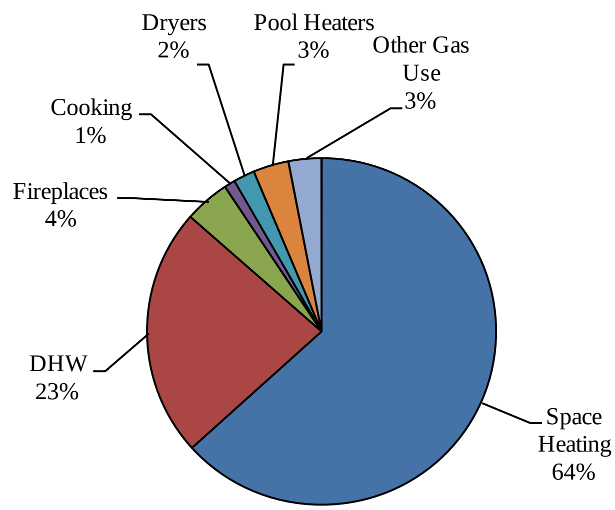
Base Year Natural Gas Use

In the Base Year of 2007, Union's Residential sector consumed about 2,925 million m^3 of natural gas. Exhibit ES4 depicts graphically the end use applications that make up this consumption.

Exhibit ES4: Base Year Natural Gas Use by End Use for the Total Union Service Area, Residential Sector

Segment	Space Heating	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use	Totals
	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.
Single-Family Detached/ Duplex	1,737,149	631,184	114,694	28,140	54,695	89,580	83,956	2,739,396
Attached/Row Housing/Tris & Quads	113,708	44,320	7,859	1,684	3,060	6,751	5,801	183,183
Other	1,433	397	74	13	26	51	54	2,048
TOTAL	1,852,289	675,900	122,627	29,837	57,781	96,382	89,810	2,924,627

Note: Any difference in totals is due to rounding.



Union's residential customers primarily reside in single family dwellings. As a result, nearly 94% of the natural gas consumption in the Residential sector occurs in the single-family detached/duplex category of dwellings. Attached/row housing/triplexes & quads accounts for almost all the rest, with less than 0.1% consumed in mobile and other.

In addition, the Southern service region accounts for nearly 77% of the residential natural gas consumption in the total Union Service Area.

Reference Case

In the absence of new Union DSM initiatives, the study estimates that natural gas consumption in Union's Residential sector will grow from 2,925 million m^3 in 2007 to about 2,999 million m^3 by 2017. This represents an overall growth of about 2.5% in the period and compares very closely with Union's load forecast, which also included consideration of the impacts of "natural conservation".

Economic Potential Forecast

Under the conditions of the Economic Potential Forecast,[4] the study estimated that natural gas consumption in Union's Residential sector would decline from the Base Year levels of 2,925 million m^3 to about 2,332 million m^3 by 2017. Annual savings relative to the Reference Case are 666 million m^3, or about 23%.

Achievable Potential

As noted above, the Achievable Potential is the proportion of the economic natural gas savings that could be realistically achieved within the study period under various program spending and marketing conditions.

Under the conditions defined by the Financially Unconstrained scenario, total Residential sector natural gas savings in 2017 are estimated to be approximately 357 million m^3/yr. This represents a saving of approximately 12%, relative to the Reference Case, and is equal to approximately 54% of the savings identified in the Economic Potential Forecast.

The most significant opportunities for natural gas savings in this scenario are technologies that reduce space heating requirements. Air sealing in older homes is, however, a particularly large opportunity in this scenario together with high-performance windows and programmable thermostats.

Under the conditions defined by the Static Marketing scenario, total Residential sector natural gas savings in 2017 are estimated to be approximately 261 million m^3/yr. This represents a saving of approximately 9%, relative to the Reference Case, and is equal to approximately 39% of the savings identified in the Economic Potential Forecast.

The most significant opportunities for natural gas savings are technologies that reduce space heating requirements, such as high-performance windows, programmable thermostats and air sealing in older homes.

[4] The level of natural gas consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective. In this study, "cost effective" means that the technology upgrade passes the measure Total Resource Cost (TRC) test.

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Appendices

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1. INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

Union Gas Ltd. (Union) is a natural gas utility serving almost 1.3 million customers in the residential, commercial and industrial markets. Union is a regulated utility with a franchise area spread across the Province of Ontario including northern, southwestern and southeastern cities and towns. Union distributes approximately 13.9 billion m^3 (489.9 billion ft^3) of natural gas to its customers annually.

Since 1997, Union has delivered demand side management (DSM) programs to its customers under a mandate from the provincial regulator, the Ontario Energy Board (OEB). Union offers DSM programs to all in-franchise customer rate classes and across all sectors and the DSM savings target and budget are determined through a rate proceeding with the OEB. Over the past eleven years Union has delivered approximately 614 million m^3 of natural gas savings and over $1 billion in net Total Resource Cost (TRC) benefits.

Union has been participating in a market of increasing DSM program maturity. This market is continually evolving in its engagement with energy efficiency through growing voluntary initiatives and more stringent codes and standards. In addition, changes in the economy have started to show signs of negatively impacting the commercial and industrial marketplace in Union's Service Area.

In the DSM Generic Proceeding held in 2006, Union committed to creating an updated Market Potential Study for input into the next DSM plan. This study will support the identification of potential energy savings for Union's next multi-year plan and be part of Union's regulatory filing in the next DSM rate case.

Union has initiated this current study within the context of the conditions noted above. When completed, the results of this natural gas Efficiency Potential Study will provide a foundation that Union can use to guide the development of its longer-term DSM strategy, including new measures and targets. More specifically, this includes support for Union's filing to the OEB regulatory application for the next multi-year DSM plan by:

- Estimating the achievable and economic potential for DSM measures across all applicable technologies, markets and sectors in Union's Service Area

- Giving shape to, and refining, ongoing energy-efficiency work by Union in order to develop its next multi-year DSM plan, and

- Provide information that is actionable and can be easily converted to plan and program development.

1.2 STUDY SCOPE

The scope of this study is summarized below.

- **Sector Coverage:** The study addresses three sectors: Residential, Commercial[5] and Industrial.

- **Geographical Coverage**: The study results are presented for the total Union Service Area and for two service regions: Southern and Northern. The southern region of Union's system extends through Southwestern Ontario from Windsor to just west of Toronto. The Northern region of Union's system extends throughout Northern Ontario from the Manitoba border to the North Bay/Muskoka area and across Eastern Ontario from Port Hope to Cornwall. The study results are disaggregated by service region due to differences in building stock and weather conditions (heating degree days).

- **Study Period**: This study covers a 10-year period. The Base Year is the calendar year 2007, with milestone periods at five-year increments: 2012 and 2017. The Base Year of 2007 was selected as it is the most recent calendar year for which complete customer data are available.

- **Technologies:** As shown in Exhibit 1.1, this study addresses a broad selection of natural gas energy-efficiency measures.

[5] Throughout this report the term "Commercial" also includes institutional sectors, such as schools, hospitals, etc., unless otherwise noted.

Exhibit 1.1: Residential Energy-Efficiency Technologies

Building Envelope
- High-Performance (ENERGY STAR®) Windows
- Super High-Performance Windows
- Retrofit Windows with Low-E Films
- Air Leakage Sealing
- Attic Insulation
- Wall Insulation
- Foundation Insulation
- Crawlspace Insulation
- Vacuum Panel Insulation
- Air Leakage Sealing and Insulation (Old Homes)

New Building Design
- High-Performance Homes (EGH 80/ R2000/ENERGY STAR®)
- Under-Slab Insulation

Space Heating and Ventilation Equipment
- Condensing Furnaces
- Condensing Boilers
- High-Efficiency Heat Recovery Ventilators (HRVs)
- Programmable Thermostats
- Integrated Mechanical System (Heating and DHW)
- Gas-Fired Heat Pumps
- Duct Sealing
- Furnace Tune-Ups
- Furnace Filter Alarms
- EnerGuide Natural Gas Fireplaces
- Solar Pre-Heated Make-Up Air (e.g., SolarWall®)

Domestic Hot Water
- Ultra Low-Flow Showerheads
- Hot Water Pipe Insulation
- DHW Heat Trap
- DHW Temperature Reduction
- Water Heater Timers
- Condensing Water Heaters
- Tankless Gas-Fired DHW
- Wastewater Heat Recovery
- Solar Hot Water Systems (DHW)
- DHW Recirculation Systems (e.g. Metlund D'MAND®)

Major Appliances
- High-Efficiency Gas Ranges
- High-Efficiency Gas Dryers
- DHW Savings from Efficient Dishwashers
- DHW and Dryer Savings from Efficient Clothes Washers
-

Pool Heaters
- Insulating Swimming Pool Covers
- High-Efficiency Pool Heaters
- Solar Pool Heaters

1.2.1 Data Caveat

As in any study of this type, the results presented in this report are based on a large number of important assumptions. Assumptions such as those related to the current penetration of energy-efficient technologies, the rate of future growth in Union's customer base and customer willingness to implement new energy-efficiency measures are particularly influential.

Wherever possible, the assumptions used in this study are consistent with those used by Union and are based on best available information, which in many cases includes the professional judgement of the consultant team, Union personnel and/or local experts. The reader should use the results presented in this report as best available estimates; major assumptions, information sources and caveats are noted throughout.

1.3 DEFINITIONS[6]

This study employs numerous terms that are unique to analyses such as this one and consequently it is important to ensure that readers have a clear understanding of what each term means when applied to this study. Below is a brief description of some of the most important

[6] A Glossary is provided in Section 9.

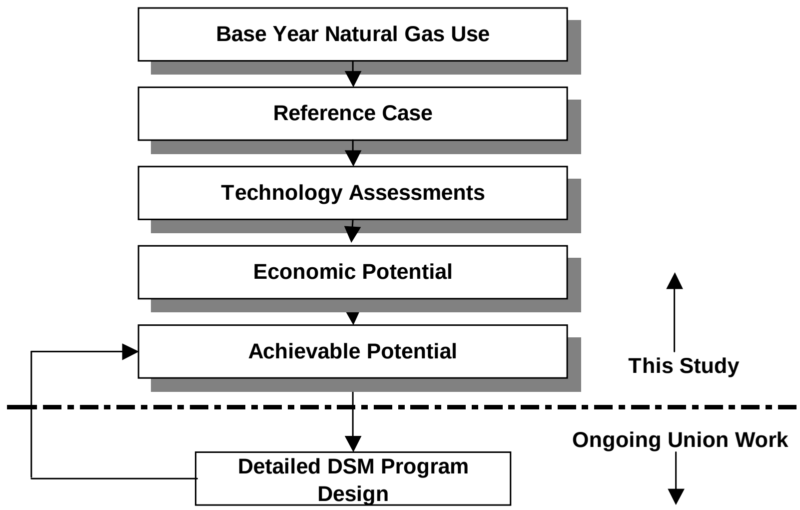
terms. A more comprehensive set of definitions may be found in the Glossary section of this report.

Base Year Natural Gas Use	The Base Year is the starting point for the analysis. It provides a detailed description of "where" and "how" natural gas is currently used in the Residential sector. A bottom up profile of energy use patterns and market shares of energy-using technologies was calibrated to actual Union customer sales data.
Reference Case Forecast	The reference case is a projection of natural gas consumption to 2017, in the absence of any new Union DSM market interventions after 2008. It is the baseline against which the scenarios of energy savings are calculated. The reference case forecast incorporates an estimation of "natural conservation", namely, changes in end-use efficiency over the study period that are projected to occur in the absence of new market interventions.
Measure Total Resource Cost (TRC)	The measure TRC calculates the net present value of energy and water savings that result from an investment in an efficiency technology or measure. The measure TRC is equal to its full or incremental capital cost (depending on application) plus any change (positive or negative) in the combined annual energy and equipment operating and maintenance (O&M) costs. This calculation includes, among others, the following inputs: the avoided natural gas, electricity and water supply costs, the life of the technology and the selected discount rate, which in this analysis has been set at 10%. The measure TRC test is the primary determinant of whether a measure is included in the economic potential forecast.
Economic Potential Forecast	The Economic Potential Forecast is the level of natural gas consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective, from Union's perspective. All of the energy-efficiency technologies and measures that have a positive measure TRC are incorporated into the Economic Potential Forecasts. These technologies and measures are applied at either natural stock turnover rates or at designated years for immediate application.
Achievable Potential	The Achievable Potential is the proportion of the natural gas savings identified in the Economic Potential Forecast that could realistically be achieved within the study period. Achievable Potential recognizes that it is difficult to induce customers to purchase and install all of the efficiency technologies that meet the criteria defined by the Economic Potential Forecast.

1.4 APPROACH

To meet the objectives outlined above, the study was conducted within an iterative process that involved a number of well-defined steps. At the completion of each step, the client reviewed the results and, as applicable, revisions were identified and incorporated into the interim results. The study then progressed to the next step. A summary of the steps is presented in Exhibit 1.2 and briefly discussed below.

Exhibit 1.2: Major Study Steps



Year Calibration Using Actual Union Gas Billing Data

- Compile and analyze available data on Union's existing building stock, including both customer billing data and information from residential end-use surveys
- Develop detailed technical descriptions of the existing building stock
- Divide building stock into logical regions and sub sectors
- Undertake computer simulations of energy use in each building type and compare these with actual building billing and audit data, including data from the EnerGuide for Houses and ecoENERGY Retrofit program[7] databases
- Compile actual Union billing data
- Create sector model inputs and generate results (where the sector model is the macro model for an entire sector, such as the Residential sector)
- Calibrate sector model results using actual utility billing data.
- The output of Step 1 forms Section 2 of this report.

Step 2: Develop Reference Case Forecast for the Study period

- Compile and analyze building design, equipment and operations data and develop detailed technical descriptions of the new building stock
- Develop computer simulations of energy use in each new building type

[7] EnerGuide for Houses, and its successor ecoENERGY Retrofit, were created by the Government of Canada to help homeowners get independent, expert advice about the energy efficiency of their homes. Developed by the Office of Energy Efficiency (OEE) of Natural Resources Canada (NRCan), in cooperation with CMHC, these programs have supported a pool of qualified energy experts to provide homeowners with information on energy-efficient improvements for their homes. The Government of Canada provides grants to homeowners who complete energy-efficiency retrofits based on the advisors' recommendations. The grant amount depends on a comparison of the pre-retrofit and post-retrofit EnerGuide for Houses rating of the home.

- Compile data on forecast levels of building stock growth and "natural" changes in equipment efficiency levels and/or practices
- Define sector model inputs and create forecasts of energy use for each of the milestone years
- Compare sector model results with Union's forecast for the period.
- The output of Step 2 forms Section 3 of this report.

Step 3: Develop and Assess Energy-efficiency Upgrade Options

- Develop list of energy-efficiency measures
- Compile detailed cost and performance data for each measure
- Identify the baseline technologies employed in the Reference case using secondary research, the Residential End-use Survey, and client consultation
- Develop energy-efficiency upgrade options for each end use
- Determine the measure TRC for each upgrade option
- The output of this task forms Section 4 of this report.

Step 4: Estimate Economic Energy Savings Potential

- Compile utility economic data on the forecast cost of new natural gas supply
- Screen the identified energy-efficiency upgrade options from Step 3 against the utility economic data
- Identify the combinations of energy-efficiency upgrade options and building types where the measure TRC is positive
- Apply the economically attractive efficiency measures from Step 3 within the energy use simulation model developed previously for each building type
- Determine annual energy consumption in each building type when the economic efficiency measures are employed
- Compare the energy consumption levels when all economic efficiency measures are used with the Reference case consumption levels and calculate the energy savings
- The output of this task forms Section 5 of this report.

Step 5: Estimate Achievable Energy Savings Potential

- "Bundle" the energy saving opportunities identified in the Economic Potential Forecast into a set of Actions
- Create "Action Profiles" for each of the identified Actions that provide a "high-level" rationale and direction, including target technologies and sub-markets as well as key barriers and a broad intervention strategy
- Review historical achievable program results and prepare preliminary Action Assessment Worksheets
- Conduct achievable potential workshops involving utility and consultant team personnel, selected trade allies and technology and market experts to reach general agreement on a range of achievable potential based on different funding scenarios
- The output of this task forms Section 6 of this report.

1.5 ANALYTICAL MODELS

The analysis of the Residential sector employed two linked modeling platforms as follows:

- **HOT2000,** a commercially supported, residential building energy-use simulation software

- **RSEEM** (Residential Sector Energy End-use Model), a Marbek in-house spreadsheet-based macro model.

HOT2000 was used to define household heating, cooling and domestic hot water (DHW) energy use for each of the residential building archetypes. HOT2000 uses state-of-the-art heat loss/gain and system modeling algorithms to calculate household energy use. It addresses:

- Electric, natural gas, oil, propane and wood space heating systems
- DHW systems from conventional to high-efficiency condensing systems
- The interaction effect between space heating appliances and non-space heating appliances, such as lights and refrigerators.

The outputs from HOT2000 provide the space heating/cooling energy-use intensity (EUI) inputs for the thermal archetype module of RSEEM.

RSEEM consists of three modules:

- A General Parameters module that contains general sector data (e.g., number of dwellings, growth rates, etc.)
- A Thermal Archetype module, as noted above, that contains data on the heating and cooling loads in each archetype
- An Appliance Module that contains data on appliance saturation levels, fuel shares, unit energy use, etc.

RSEEM combines the data from each of the modules and provides total use of energy by service region, dwelling type and end use. In this application, the RSEEM model functions as a system for tracking the disaggregation of natural gas consumption down to the level of individual end uses and types of dwellings, so that the effects of natural gas conserving measures can be evaluated at the same level of detail.

HOT2000 models are developed after the estimates of heating and DHW energy consumption have emerged from the RSEEM Base Year analysis. Models are constructed that incorporate information on standard house construction in the utility's service region, but which also mimic the energy performance figures derived from the utility sales data using RSEEM. These models can then be used to test the net improvement in energy performance that will result from various energy conserving measures. The results are fed back into RSEEM to produce estimates of energy-efficiency potential.

1.6 THIS REPORT

This report addresses the Residential sector and provides a summary of the results to date. This initial report is presented in the following sections.

- Section 2 presents a profile of Base Year natural gas use in Union's Ontario service area, including a discussion of the major steps involved and the data sources that were employed.

- Section 3 presents the Residential sector Reference Case for the study period 2007 to 2017.

- Section 4 provides a financial and economic assessment of the identified Residential sector energy-efficiency measures.
- Section 5 presents the Residential sector Economic Potential Forecast for the study period 2007 to 2017.
- Section 6 presents the estimated range of Achievable Potential for natural gas savings, under differing scenarios, for the study period 2007 to 2017.
- Section 7 presents the conclusions.
- Section 8 presents a listing of major references.
- Section 9 provides a glossary of commonly used terms.

2. BASE YEAR NATURAL GAS USE

2.1 INTRODUCTION

This section presents a description of natural gas use in Union's Residential sector in the Base Year of 2007. Drawing on the best available data, this section presents total natural gas consumption in Union's Residential sector, together with an estimate of how that consumption is distributed by service area, sub sector, end use and technology.

The remainder of this section outlines the steps involved in preparing the Base Year calibration and presents a summary of the results. The discussion is organized into the following subsections:

- Segmentation of residential building stock
- Estimation of net space heating loads
- Annual appliance energy use
- Appliance saturation
- Natural gas fuel share by end use
- Base Year average natural gas use, by dwelling type
- Summary of model results.

2.2 SEGMENTATION OF RESIDENTIAL BUILDING STOCK

The first major task in developing the description of Base Year natural gas consumption involved the segmentation of the residential building stock on the basis of three factors:

- Dwelling type
- Heating category (natural gas, electric)
- Service area.

As agreed at the study's outset, dwelling types used in this analysis are:

- Single-family detached/duplex
- Attached/Row/Multi (including all row houses, townhouses, triplexes, and quads)
- Other/Mobile

Union customer billing data were used to develop a composite breakdown of the Residential sector by dwelling type. This information is summarized in Exhibit 2.1 and highlights are presented below:

- There are about 1.1 million dwelling units in the regions served by Union
- On a regional basis, almost 77% of dwelling units are in the Southern region and the remaining 23 % are located in the Northern region
- On the basis of dwelling type, 94% of the residential stock is single-family. Almost all of the rest fall in the Attached/Row/Multi category. Only one-tenth of one percent (0.1%) are mobile homes or other residential buildings (such as heated sheds).
- In terms of fuel share, approximately 93% of Union residential customers use natural gas as their primary heating fuel.

Exhibit 2.1: Base Year (2007) Residential Units, by Dwelling Type, Heating Source and Service Region

Segment	Residential Units		
	Southern Region	Northern Region	Total
Single-Family Detached/ Duplex- Gas Heated	717,861	221,799	939,660
Single-Family Detached/ Duplex- Non-Gas Heated	70,997	36,107	107,104
Attached/Row Housing/Tris & Quads	93,131	7,926	101,057
Other	779	617	1,396
Subtotal	882,768	266,449	1,149,217

2.2.1 Transfers of Dwelling Units Between Residential and Commercial Datasets

The analysis of energy-efficiency opportunities is facilitated if similar types of buildings can be grouped together. To this end, a small number of customers in the residential rate classes that appeared to be large apartment complexes were transferred to the Commercial sector, and a small number of customers in the commercial rate classes that appeared to be small multi-family complexes were transferred to the Residential sector. Both the number of customers and their accompanying volume of consumption were transferred.

In the Southern region, a total of 18,979 apartment and condominium units were transferred to the Commercial sector, along with 21,560,457 m^3 of natural gas consumption. 2,015 multi-family other and row/townhouse complexes were transferred in from the commercial dataset, along with 13,748,546 m^3 of natural gas consumption. Row/townhouse complexes in the Southern region were found to use approximately eight times as much natural gas as townhouse units. The numbers of townhouse complexes, including both the ones that were already in the residential dataset and those transferred from commercial, were multiplied by eight to obtain the number of units.

In the Northern region, a total of 2,303 apartment and condominium units were transferred to the Commercial sector, along with 4,111,227 m^3 of natural gas consumption. 552 multi-family other and row/townhouse complexes were transferred in from the commercial dataset, along with 3,510,218 m^3 of natural gas consumption. Row/townhouse complexes in the Northern region were found to use approximately three times as much natural gas as townhouse units. The numbers of townhouse complexes, including both the ones that were already in the residential dataset and those transferred from commercial, were multiplied by three to obtain the number of units.

2.3 ESTIMATION OF NET SPACE HEATING LOADS

Net space heating load is the space heating load of a building that must be met by the space heating system. This is equal to the total heat loss through the building envelope minus solar and internal gains.

The net space heating loads for single-family detached and row houses in the two service regions were developed based on the following combination of sources:

- Union's residential customer sales data, by dwelling type
- Union's *2007 Residential Penetration Study* (RPS),[8] which provided data showing the saturation of supplementary heating systems, by dwelling type
- Knowledge of the energy consumption and saturation of other natural gas end uses within each residential dwelling type
- Marbek's database of residential energy consumption from other jurisdictions.

The net space heating load for each dwelling type is given by the following equation:

$$NetHL_1 = HL_1 + a_{i,1} * s_{i,1}$$

Where: $NetHL_1$ = Net heating load for dwelling type #1
HL_1 = Load on primary heating appliance for dwelling type #1
$a_{i,1}$ = Average consumption for supplementary heating in dwelling type #1
$s_{i,1}$ = Saturation of supplementary heating in dwelling type #1

For the purposes of this discussion, the focus is on the estimation of the space heating load on the primary heating appliance (HL_1) in the above equation. Note that all dwellings are assumed to have a primary heating appliance (of whatever fuel), so no saturation for the primary heating appliance is included in the equation.

The load on the primary heating appliance (i.e., natural gas furnace or boiler) was estimated for each dwelling type and service region, based on Union's customer sales data for each dwelling type and combined with data on the natural gas consumption of non-space heating end uses and the estimated contribution of natural gas fireplaces. Data specific to Union's Service Area were used wherever possible, with any gaps filled in by drawing on Marbek's database on energy end uses. The values for $a_{i,1}$ and $s_{i,1}$ were developed based on the estimated share of space heating that is provided by natural gas (versus supplementary fuels), as taken from Union's Residential Penetration Study. The natural gas space heating share is not given directly by the data presented in that study, but is estimated based on the surveyed preference for natural gas as a space heating fuel, and the presence of supplementary heating sources in the dwellings.

Exhibit 2.2 summarizes the estimated load on the primary space heating system, by dwelling type and location. These estimates refer to the load that the space heating system must meet after internal heat losses and gains, including fireplaces, are accounted for. Estimated unit energy consumption (UEC) is also shown, based on an average house in which all the space heating load is met by a natural gas furnace of average efficiency.

The values in the exhibit are actually derived in reverse. The analysis starts with the average natural gas consumption for the dwellings and uses all the known data for consumption, saturation, and fuel share for all the end uses in the dwelling to derive the consumption of natural gas for space heating. The estimated fuel share for natural gas space heating is used to arrive at

[8] Union Gas. *2007 Residential Penetration Study – Single Family and New Housing Segments, Top Line Results,* Chatham, ON, January 15, 2008.

the UEC figures. Average furnace efficiency and the conversion factor for MJ/m^3 of natural gas are then used to estimate net space heating loads. These were used to develop the HOT2000 house models.

Exhibit 2.2: Base Year (2007) Residential Units—Estimated Net Space Heating Load (MJ/yr.) and Space Heating UEC[9] (m^3/yr.), for Primary Heating System, by Dwelling Type and Service Region

Segment	Net Space Heating Load (MJ/yr)		Space Heating UEC (m^3)	
	Southern	Northern	Southern	Northern
Single-Family Detached/ Duplex	55,417	61,074	1,801	2,002
Attached/Row Housing/Tris & Quads	37,129	51,143	1,207	1,677
Other	27,228	46,293	885	1,518

A brief discussion of some of the most important variables affecting the net space heating loads provided above is presented below.

2.3.1 Envelope Area and Exposure

Attachment type is the main influence on building envelope area and exposure of buildings. Moving from greatest exposure to least, dwelling types include mobile homes, single-family, duplex, triplexes and quads, and townhouses and row houses. Duplexes are built in a similar fashion to single-family homes but, from an exposure perspective, are more similar to row houses. Townhouses, which also share one or two walls, are, on average, smaller than single-family detached dwellings.

2.3.2 Weather Conditions

The Union Service Area is divided into two service regions: Northern and Southern. The major population centres included in the Southern region are: Brantford, Chatham, Halton, Hamilton, Kitchener-Waterloo, London, Sarnia, Windsor, Burlington, and Guelph. The major population centres included in the Northern region are: Kingston, North Bay, Sault-Ste. Marie, Sudbury, Thunder Bay and Timmins. In each region there is a range in severity of climate, but there is a relatively clear division between the two regions.[10]

For modelling purposes, weather data from London and North Bay were used to create thermal simulations of the Southern and Northern regions, respectively.

2.3.3 Floor Area and Shape

Exhibit 2.3 presents the typical floor area by region and vintage for single-family houses. As shown in the exhibit, there has been a general increase in floor area over time, and

[9] Unit energy consumption (UEC) is the approximate consumption of a natural gas furnace to meet the net space heating load shown, assuming there are no supplementary heating devices and the furnace has an average efficiency of approximately 82%.

[10] The 99% design dry-bulb temperatures for Southern cities ranges from approximately -13ºC in Hamilton to approximately -16ºC in London. The 99% design dry-bulb temperatures for Northern cities ranges from approximately -19ºC in Kingston to approximately -31ºC in Timmins.

houses in the Southern region are generally larger than those in the Northern region. The biggest changes in housing size have occurred since the mid-1980s, when changing demographics and growing affluence resulted in larger floor areas for new homes.

The shapes of houses within the Union Service Area have also changed over the years, as they have in other Canadian provinces. Pre-1970 houses typically have half storeys and simple floor plans. Post-1970 houses are most likely to include split-levels, ranches and two-storey houses, with more complex floor plans. As a result, newer houses generally have more wall area relative to their floor area. In other words, average wall area in new homes is increasing even faster than floor area. Finally, due to the improved performance of newer windows and homebuyers' preferences, the area of glazing has increased by about 15%.

Both this exhibit and the airtightness discussion that follows draw on data from the ecoENERGY Retrofit database. This database currently contains audit data on over 30,000 homes in Ontario. These dwellings are not a random sample; self-selection bias may mean that the sample is skewed. The database does, however, permit the examination of trends in housing construction, such as the variation in floor area with vintage of home, keeping in mind that the relative differences are more reliable and therefore more useful than the absolute numbers. The house models developed for the study are always calibrated back to energy performance derived from utility sales data.

Exhibit 2.3: Typical Floor Areas for Single-family Detached Dwellings by Vintage and Service Region, (m^2)

Vintage	**Floor Space including basement area, (m^2)**	
	Southern Region	**Northern Region**
Pre-1980	215.7	198.5
1981-1993	287.0	258.5
Post-1993	308.1	278.2
Number in sample	16,071 dwellings	2,089 dwellings

Notes: 1 m^2 = 10.76 ft^2

Figures include basement area, which averages 30% of totals.

Source: ecoENERGY Retrofit database (Ontario)

2.3.4 Airtightness

Air test data for single-family houses were measured as part of the ecoENERGY Retrofit program, and Exhibit 2.4 summarizes the results by vintage and region. As demonstrated, there has been a continued improvement in the airtightness of buildings in all regions, with the most airtight being newer homes located in the Northern region.

As discussed previously, there is a self-selection bias in the ecoENERGY Retrofit database. However, the trend data, as shown in Exhibit 2.4, is nonetheless useful in developing inputs for the HOT2000 models.

Exhibit 2.4: Average Air Changes per Hour in Single-family Detached Dwellings by Vintage and Service Region, (ACH @ 50 Pa)

Vintage	Southern Region	Northern Region
Pre-1980	9.1	7.1
1981-1993	4.7	4.5
Post-1993	3.9	3.3
Number in sample	16,071 dwellings	2,089 dwellings

Source: ecoENERGY Retrofit database (Ontario)

2.3.5 Heating Set Point

The assumptions made relating to heating set points throughout a dwelling affect the calculation of net space heating load. The set points employed in the HOT2000 simulations were 20.8ºC for main and upper floors and 19.8ºC for basements. These set points were selected based on averages obtained from the EnerGuide for Houses database.

2.3.6 Average Furnace Efficiency

Union's 2007 Residential Penetration Study provides data on the distribution of high-efficiency, mid-efficiency, and standard efficiency furnaces in the surveyed population of homes. The distribution was combined with an assumed efficiency for each category, to arrive at an approximate average efficiency of the existing stock of furnaces in the Union Service Area. As shown in Exhibit 2.5, the approximate average efficiency is 82%.

Exhibit 2.5: Calculation of Average Efficiency of Existing Stock of Furnaces

Furnace Type	Assumed Efficiency	Distribution	Efficiency x Distribution
Conventional	68%	30%	20%
Mid-Efficiency	78%	21%	16%
High-Efficiency	90%	50%	45%
Average Efficiency of Existing Stock of Furnaces			81.8%

Sources: Distribution is from the *2007 Residential Penetration Study*. The average efficiency calculated here agrees well with the Residential Furnace Efficiency Index used in Union's forecasting process.

2.3.7 Fireplace Contribution to Space Heat Load

The contribution to space heating made by fireplaces (natural gas, propane or wood) and woodstoves is not included in the net space heating loads presented in Exhibit 2.2. The fireplace contribution is highly variable. Modern fireplaces that take combustion air from outside the house make a heating contribution, albeit at a much lower efficiency than a condensing furnace (the maximum efficiency of a natural gas fireplace is approximately 77%). Fireplaces that draw combustion air from the room operate at efficiencies as low as

25%. Decorative natural gas log sets can have efficiencies of 0% and consume as much natural gas as heating fireplaces, while contributing no net heat to the dwelling. Wood fireplaces that draw combustion air from the room and have dampers that are not properly closed when the fireplace is not in use can actually cause a net heat loss to the dwelling.

Due to this variability, fireplaces are treated as a separate end use and are separated from the space heating end use (see Section 2.4.5).

2.3.8 Supplemental Heating

Union's 2007 Residential Penetration Study data show that 45% of its residential customers have some form of supplementary space heating equipment. More specifically:

- 72% of customers with supplementary heating equipment have fireplaces and 6% have wood-burning stoves, all of which are treated under the fireplaces end use in this study.
- 16% of customers with supplementary space heating equipment have electric baseboard heaters, 15% have portable electric heaters, 3% have space heaters and 0.3% have heat pumps.

Since only 7% of Union customers heat predominantly with a fuel other than gas, most of the baseboards, portable electric heaters and space heaters are used for supplemental heating in a gas-heated home. Portable electric heaters are more frequently found in older homes, according to residential market survey work in other jurisdictions.

In addition to fuel conversions and substitutions, there are many home renovations and additions that have involved the installation of electric space heating in previously non-electrically heated houses. Electric baseboards are a convenient, low first-cost installation for a new room in an existing house. This phenomenon has been occurring since the mid-1960s and growing in proportion to the rapidly increasing rates of renovation and addition building in the 1970s and 1980s. Renovations to add electric baseboards would be more likely in older homes, because newer homes are less likely to have required an addition.

Determining the number of homes with supplementary electric heating is only the first step in estimating the actual energy consumption of the heating appliances. The percentage of floor space heated by electric heaters, the thermostat set point in the rooms with electric baseboards (often set lower than the main furnace thermostat) and the runtime of portable heaters are important factors. The overall heating fuel share for electric supplementary heating devices is estimated to be 5%, in addition to the share from primary electric heating.

In homes with a primary heating fuel other than gas, there is very little supplemental heating with natural gas appliances. The natural gas fuel share for supplementary heat is therefore essentially zero.

2.4 ANNUAL APPLIANCE ENERGY USE

Exhibits 2.6 and 2.7 summarize the estimated average annual UEC for each of the major natural gas appliances included in this study for the Southern and Northern service regions, respectively.

The values shown in Exhibits 2.6 and 2.7 apply to the current stock mix; the values vary slightly by service region, primarily due to differences in weather, dwelling size and/or occupancy levels.

Exhibit 2.6: Annual Base Year Appliance Natural Gas Use (UEC) for the Southern Service Region (m^3/yr.)

Segment	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use
	m^3/yr.	m^3/yr.	m^3/yr.	m^3/yr.	m^3/yr.	m^3/yr.
Single-Family Detached/ Duplex	660	278	122	131	2,012	80
Attached/Row Housing/Tris & Quads	473	199	68	73	1,440	57
Other	317	134	46	49	967	39

Exhibit 2.7: Annual Base Year Appliance Natural Gas Use (UEC) for the Northern Service Region (m^3/yr.)

Segment	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use
	m^3/yr.	m^3/yr.	m^3/yr.	m^3/yr.	m^3/yr.	m^3/yr.
Single-Family Detached/ Duplex	650	309	115	128	2,237	80
Attached/Row Housing/Tris & Quads	465	221	78	72	1,601	57
Other	312	149	52	48	1,074	39

Further discussion is provided below for each end-use appliance.

2.4.1 Domestic Hot Water

UEC estimates for DHW are drawn from several sources. Hot water consumption estimates developed for previous studies were compared against the estimate of gas consumption from Union's internal estimates, which are based on a review of external literature, customer surveys and engineering estimates. The resulting estimates were adjusted for the estimated average number of occupants in the different housing segments.

Detached homes have more occupants on average than attached homes, according to the residential surveys carried out in several jurisdictions and Statistics Canada's table of average household sizes for Ontario, as shown in Exhibit 2.8.[11] Exhibit 2.8 also indicates that the average number of occupants is slightly higher in Southern region homes than it is in Northern region homes. This latter difference is somewhat mitigated by a difference in average ground temperature. The cold water inlet to the DHW system in North Bay is, on average, more than 3°C colder than in London.

[11] Statistics Canada. *Private households by structural type of dwelling, by province and territory* (2006 Census).

The end use modeling in this study is primarily driven by utility customer and sales data showing average sales of natural gas to each household type, by survey results indicating the penetration of different types of gas-using appliances in the households, and by house modeling to estimate the effects of climate on space heating consumption. The best fit between the model and the data requires that end uses affected by household occupancy (DHW, cooking and clothes drying) consume slightly less natural gas in the average Northern region household than in the average Southern region household. The regional variation in occupancy indicated in Exhibit 2.8 provides confirmation of this approach.

Exhibit 2.8: Household Occupancy in Ontario, by Dwelling Type and Municipality

Region	Municipality	Single-Detached	Apartment, 5 or more Storeys*	Mobile	Other (Attached, etc.)	Weighted Average
South	Hamilton	2.9	1.7	2.2	2.3	2.6
	London	2.8	1.6	1.7	2.2	2.4
	Windsor	2.8	1.5	1.8	2.1	2.5
North	Sudbury	2.7	1.4	2.2	2.0	2.4
	Thunder Bay	2.6	1.3	2.3	1.9	2.3
Ontario Average		2.9	2.0	2.1	2.4	2.6

* Apartments are excluded from the residential analysis for this study.

Exhibit 2.9 shows the estimated distribution of DHW load by major end use.

Exhibit 2.9: Distribution of DHW Energy Use by End Use in Existing Stock

End Use	Energy Use (m^3/yr.)	%
Personal Use	231	35
Dishwashing	152	23
Clothes Washing	178	27
Standby Losses	99	15
Total	660	100

2.4.2 Cooking

UEC estimates for the existing stock of cooking appliances were obtained from Union internal estimates, which are based on a review of external literature, customer surveys and engineering estimates. Energy consumption was adjusted for occupancy rates.

2.4.3 Dryers

UEC estimates for the existing stock of gas dryers were obtained from Union internal estimates, which are based on a review of external literature, customer surveys and engineering estimates. They were subsequently adjusted for occupancy rates.

2.4.4 Pool Heaters

Union has internal UEC estimates for the existing stock of pool heaters, based on a review of external literature, customer surveys and engineering estimates. Based on preceding work for utilities across Canada, these estimates were adjusted upwards. On average, pool heaters are expected to have similar annual energy consumption to a residential furnace.

Union's 2007 Residential Penetration Study identified the percentage of customers in each of four regions with pool heaters. This additional information was used to adjust the pool heater average consumption for the Union Service Area. The resulting average figure was adjusted for climate differences between the regions.

2.4.5 Fireplaces

UEC estimates for the existing stock of fireplaces were obtained from Union internal estimates, which are based on a review of external literature, customer surveys and engineering estimates. These were adjusted based on Union's 2007 Residential Penetration Study, which contains detailed penetration data for gas fireplaces; it also provides data on the number of fireplaces per home and the incidence of wood-burning, electric and natural gas fireplaces.

2.4.6 Other

A variety of other gas end uses are found in the homes of Union residential customers, including gas barbecues, spa/hot tub heaters, outdoor fireplaces or campfires, garage or patio heaters and outdoor gas lights. These end uses each account for a small portion of Union's residential load and are therefore not modeled separately. The model does not specifically track other end uses that consume fuels other than natural gas or electricity.

2.4.7 Electric End Uses

Marbek's energy model tracks energy consumption for both electricity and natural gas. Several electrical end uses, such as furnace fans and air conditioning systems, are directly affected by some of the efficiency measures applicable to natural gas space heating. The electrical savings attributable to these measures are factored into the measure TRC results presented in Section 4.

2.5 APPLIANCE SATURATION

Exhibits 2.10 and 2.11 summarize the appliance saturation[12] levels assumed for the Southern and Northern regions, respectively. End-use saturation figures are from Union's 2007 Residential Penetration Study.

[12] Saturation refers to the incidence of each appliance within each dwelling type, regardless of the type of fuel that is used to operate it.

The term "saturation," as used in this study, refers to the presence of an end use in the dwelling, regardless of what fuel it uses. For end uses where the most convenient unit of analysis is the dwelling (such as DHW), saturation refers to the percentage of dwellings that have that end use. Virtually all dwellings have DHW, so the saturation is 100%. For end uses where the most convenient unit of analysis is the appliance (such as dryers), the saturation indicates the average number of appliances per dwelling. A saturation of 97% indicates that in an average group of 100 dwellings, there would be 97 dryers (which could be either gas or electric).

To calculate the penetration of gas appliances in Union's service regions, the saturation can be multiplied by the gas fuel share shown in Exhibits 2.12 and 2.13. The result of this calculation should be comparable to the penetrations found in Union's 2007 Residential Penetration Study.

Exhibit 2.10: Base Year Appliance Saturation Levels for the Southern Service Region (%)

Segment	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use
	%	%	%	%	%	%
Single-Family Detached/ Duplex	100%	54%	100%	97%	6%	100%
Attached/Row Housing/Tris & Quads	100%	54%	100%	97%	6%	100%
Other	100%	54%	100%	97%	6%	100%

Exhibit 2.11: Base Year Appliance Saturation Levels for the Northern Service Region (%)

Segment	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use
	%	%	%	%	%	%
Single-Family Detached/ Duplex	100%	54%	100%	97%	3%	100%
Attached/Row Housing/Tris & Quads	100%	54%	100%	97%	3%	100%
Other	100%	54%	100%	97%	3%	100%

2.6 NATURAL GAS FUEL SHARE

Exhibits 2.12 and 2.13 summarize the estimated natural gas fuel shares by end use for the Southern and Northern regions, respectively.

The fuel share of 100% for "Other Gas" reflects the fact that "Other" end uses that do not use gas are treated in a separate category within the model (but are not shown in these exhibits).

These figures come from Union's 2007 Residential Penetration Study. As discussed previously, space heating fuel shares are challenging because there are data on the presence of auxiliary heating devices, but not on how much they are used. The values shown reflect the most reasonable assumptions based on Marbek's engineering judgment and experience.

Exhibit 2.12: Base Year Natural Gas Fuel Shares for the Southern Service Region (%)

Segment	Space Heating	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use
	%	%	%	%	%	%	%
Single-Family Detached/ Duplex	91%	94%	72%	26%	44%	81%	100%
Attached/Row Housing/Tris & Quads	91%	94%	72%	26%	44%	81%	100%
Other	91%	94%	72%	26%	44%	81%	100%

Exhibit 2.13: Base Year Natural Gas Fuel Shares for the Northern Service Region (%)

Segment	Space Heating	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use
	%	%	%	%	%	%	%
Single-Family Detached/ Duplex	86%	86%	68%	12%	35%	81%	100%
Attached/Row Housing/Tris & Quads	86%	86%	68%	12%	35%	81%	100%
Other	86%	86%	68%	12%	35%	81%	100%

2.7 BASE YEAR (2007) AVERAGE NATURAL GAS CONSUMPTION PER DWELLING UNIT

Exhibits 2.14 and 2.15 combine the efficiency, saturation and fuel share data presented in the preceding exhibits and shows the resulting energy use, by end use, for each dwelling type in the Southern and Northern regions, respectively

Exhibit 2.14: Base Year (2007) Average Natural Gas Use per Dwelling Unit in the Southern Service Region (m^3/yr)

Segment	Space Heating	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use	TOTAL
	m^3/yr.	m^3/yr.	m^3/yr.	m^3/yr.	m^3/yr.	m^3/yr.	m^3/yr.	m^3/yr.
Single-Family Detached/ Duplex	1,639	617	108	31	55	97	80	2,628
Attached/Row Housing/Tris & Quads	1,098	442	77	17	31	69	57	1,792
Other	805	297	52	12	21	47	39	1,271

Note: Any difference in totals is due to rounding.

Exhibit 2.15: Base Year (2007) Average Natural Gas Use per Dwelling Unit in the Northern Service Region (m^3/yr)

Segment	Space Heating	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use	TOTAL
	m^3/yr.	m^3/yr.	m^3/yr.	m^3/yr.	m^3/yr.	m^3/yr.	m^3/yr.	m^3/yr.
Single-Family Detached/ Duplex	1,722	559	114	14	44	51	80	2,583
Attached/Row Housing/Tris & Quads	1,442	400	81	9	24	36	57	2,051
Other	1,305	269	55	6	16	24	39	1,714

Note: Any difference in totals is due to rounding.

2.7.1 Sample Calculations

The following examples illustrate the method used to generate the values shown in the preceding Exhibits 2.14 and 2.15. Exhibits 2.16 and 2.17 show how the data from the previous exhibits are combined to estimate annual natural gas use for, respectively, primary space heating and appliances.

Exhibit 2.16: Sample Calculation of Annual Space Heating Natural Gas Use for a SFD/Duplex in the Southern Region

Primary Space Heat load, from Exhibit 2.2	55,417 MJ/yr.
Average Furnace Efficiency	81.8%
Assumed Heating Content of Fuel	37.62 MJ/m^3
Saturation of Heating as an End use	100%
Natural Gas Fuel Share, from Exhibit 2.12	91%

Annual Space Heating UEC = 55,417 / 81.8% /37.62 = 1,801 m^3/yr. (as shown in Exhibit 2.2)

Annual Natural Gas Use = 1,801 m^3/yr. x 100% x 91% = 1,639 m^3/yr. (as shown in Exhibit 2.14)

The penetration of natural gas heating would be obtained by multiplying saturation (100%) by fuel share (91%) to get 91%. In the case of space heating, the fuel share is the percentage of dwellings whose primary heating appliance is gas-fired, reduced by the estimated percentage of heating load that is met by non-gas supplementary heating devices.

Exhibit 2.17: Sample Calculation of Annual DHW Natural Gas Use in SFD/Duplex in the Southern Region

UEC, from Exhibit 2.6	660 m^3/yr.
Saturation, from Exhibit 2.10	100%
Natural Gas Fuel Share, from Exhibit 2.12	93.5% (rounded to 94% in the exhibit)

Annual DHW Natural Gas Use = 660 x 100% x 93.5% = 617 m^3/yr. (as shown in Exhibit 2.14)

The penetration of natural gas DHW would be found by multiplying the saturation (100%) by the natural gas fuel share (93.5%), to get 93.5%.

2.8 SUMMARY OF MODEL RESULTS

This section presents the results of the model runs for the Base Year 2007. They are presented in three separate exhibits:

- Exhibit 2.18 presents the model results for the total Union Service Area. The results are broken out by dwelling type and end use. Exhibit 2.18 also includes a pie chart showing gas consumption by end use.

- Exhibits 2.19 and 2.20 present the same results for each of the service regions defined for this study.

Exhibit 2.18: Base Year (2007) Natural Gas Consumption in the Total Union Gas Service Area (1000 m^3/yr.)

Segment	Space Heating	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use	Totals
	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.
Single-Family Detached/ Duplex	1,737,149	631,184	114,694	28,140	54,695	89,580	83,956	2,739,396
Attached/Row Housing/Tris & Quads	113,708	44,320	7,859	1,684	3,060	6,751	5,801	183,183
Other	1,433	397	74	13	26	51	54	2,048
TOTAL	1,852,289	675,900	122,627	29,837	57,781	96,382	89,810	2,924,627

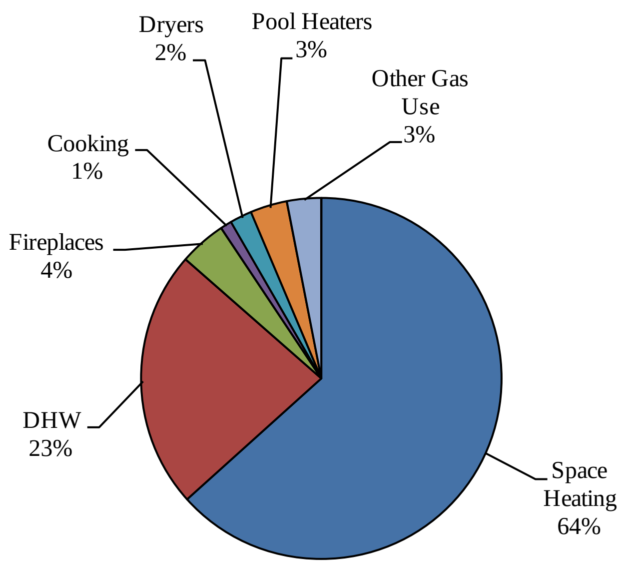


Exhibit 2.19: Base Year (2007) Natural Gas Consumption in the Southern Service Region (1000 m^3/yr)

Segment	Space Heating	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use	Totals
	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.
Single-Family Detached/ Duplex	1,293,067	487,016	85,388	24,584	43,452	76,498	63,270	2,073,275
Attached/Row Housing/Tris & Quads	102,280	41,149	7,215	1,610	2,867	6,463	5,346	166,930
Other	627	231	41	9	16	36	30	990
TOTAL	1,395,974	528,396	92,643	26,203	46,335	82,997	68,646	2,241,195

Exhibit 2.20: Base Year (2007) Natural Gas Consumption in the Northern Service Region (1000 m^3/yr.)

Segment	Space Heating	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use	Totals
	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.	1000 m^3/yr.
Single-Family Detached/ Duplex	444,082	144,168	29,306	3,555	11,243	13,082	20,685	666,121
Attached/Row Housing/Tris & Quads	11,428	3,171	645	74	193	288	455	16,254
Other	805	166	34	4	10	15	24	1,057
TOTAL	456,315	147,505	29,984	3,634	11,446	13,385	21,164	683,432

2.8.1 Interpretation of Results

Selected highlights of the information presented in Chapter 2 are presented below.

Segments

Nearly 94% of the natural gas consumption in the Residential sector occurs in the single-family detached/duplex category of dwellings. Attached/row housing/triplexes & quads accounts for almost all the rest, with less than 0.1% consumed in mobile and other.

End Use

Space heating accounts for 64% of natural gas consumption in the Residential sector. DHW consumes approximately 23%. Fireplaces consume about 4% and pool heaters consume approximately 3%. Natural gas dryers consume approximately 2% and natural gas ranges consume approximately 1% of the natural gas consumption in the Residential sector.

Service Region

The Southern Service region accounts for nearly 77% of the residential natural gas consumption in Union's Service Area.

Characteristics of Existing Housing

The stock of housing in the Union Gas service territory varies considerably with the age of the house. Building code changes in Ontario have increasingly stressed energy efficiency, improving the air tightness and insulation requirements in new home construction. The high efficiency, condensing furnace has also become the norm in new homes. Countering these trends towards reduced consumption, newer houses are typically larger than houses built in previous decades and have more and larger windows.

Stratifying housing by year of construction can be useful in evaluating some efficiency upgrades. An envelope improvement measure that does not appear viable in an average house may be attractive in older houses with low insulation values and large space heating loads. Stratifying Union's residential survey by year of construction would improve the analysis of such measures.

3. REFERENCE CASE NATURAL GAS USE

3.1 INTRODUCTION

This section presents the Residential sector Reference Case for the study period 2007 to 2017. The Reference Case estimates the expected level of natural gas consumption that would occur over the study period in the absence of new Union DSM initiatives. Thus, the Reference Case provides the point of comparison for the calculation of opportunities associated with each of the subsequent scenarios that are assessed within this study.

The Reference Case discussion is presented within the following subsections:

- Estimation of net space heating loads – new dwellings
- “Natural” changes to space heating loads – existing dwellings
- “Natural” changes to appliance energy use
- Stock growth
- Fuel shares and saturation levels
- Summary of model results.

3.2 ESTIMATION OF NET SPACE HEATING LOADS – NEW DWELLINGS

The first task in building the Reference Case involved estimating the net space heating loads for new buildings. Since building envelope is the single largest determinant of a building’s space heating load, it was important to assess changes in building codes and standards that would affect the building envelope of new homes.

The Ontario Building Code (OBC) was recently amended (O. Reg. 350/06), with several changes coming into effect on December 31, 2006, and others scheduled to come into effect sequentially until the end of 2011. The 2006 Building Code includes over 700 technical changes from the 1997 version; many of these changes significantly increase the energy efficiency of new buildings. OBC changes that are particularly relevant to this Reference Case include:

- Minimum requirements for the thermal resistance of building insulation are increased, as presented in Exhibit 3.1.

- Minimum AFUE (Annual Fuel Utilization Efficiency) of natural gas- and propane-fired furnaces are increased to 90%.

- Effective at the end of 2008, near-full height basement insulation will require that basement insulation in new homes extend at least down to 0.38 m (15 inches) above the basement floor.

Exhibit 3.1: Minimum Thermal Resistance of Insulation (RSI) for Residential Buildings, ($m^2 \cdot °C/W$)

Assembly	Thermal Resistance (RSI)* Required			
	1997 Building Code (O.Reg. 403/97)		2006 Building Code (O.Reg. 350/06)	
	Less than 5,000 Degree Days	5,000 or More Degree Days	Less than 5,000 Degree Days	5,000 or More Degree Days
Ceiling below Attic or Roof Space	5.40	6.70	7.24	7.24
Roof without Attic or Roof Space	3.52	3.52	5.21	5.21
Walls (Non-Foundation)	3.00	3.87	3.80	4.67
Foundation Walls	1.41	2.11	2.40	2.40
Floors (Non Slab-on-Ground)	4.40	4.40	4.70	4.70
Slab-on-Ground (with Heating Pipes, Tubes, Ducts, or Cables)	1.76	1.76	2.11	2.11
Slab-on- Ground (without Heating Pipes, Tubes, Ducts, or Cables)	1.41	1.41	1.76	1.76

NOTE: Degree days refers to the number of degree days below 18°C

Although still at the proposal stage, the new OBC would require new homes built in 2012 and later to meet standards that are in accordance with EnerGuide for Homes (EGH 80). This is substantially higher than current standards. Based on the ecoENERGY Retrofit database, the average EnerGuide rating of new homes prior to the 2006 update of the OBC was about 73. Improvement to EGH 80 would result in about a 26% space heating reduction for new homes compared to the pre-2006 standard of construction.[13] However, this component of the proposed changes to the OBC remains under active debate; consequently, the scope and timing of this proposed change remains uncertain.

Given these uncertainties, the Reference Case assumes a gradual thermal improvement for new homes constructed over the study period. The average new house is assumed to reach a rating of approximately EGH 78 by the end of the study period, representing approximately three-quarters of the improvement that would occur if the proposed changes to the OBC were completely accepted. The degree to which the OBC changes will be adopted is largely a function of political lobbying.

[13] The EnerGuide for Homes scale is a linear scale, based on energy consumption of the house as predicted by a HOT2000 simulation. A net-zero house, producing as much energy as it uses on an annual basis, has a rating of 100, by definition. A house that uses as much energy as an R2000 house of the same size has a rating of 80, again by definition. The equation is then EGH = 100 – 20 * (Predicted Annual Energy for Your House) / (Annual Energy for R2000 House). An EGH 90 home is expected to use half as much energy as the R2000 home while an EGH 60 home is expected to use twice as much as the R2000 home. An EGH 73 house would use 1.35 times as much as the R-2000 house. Inverting this means that an improvement from 73 to 80 represents a 26% reduction in energy consumption. More recent information from staff at OMMAH indicates that the current OBC results in homes with an average EGH rating of 76 or even 77. This would reduce estimated savings for EGH 80 further, to less than 17%.

However, there are a number of trends that counteract the thermal improvements in Ontario's construction standards:

- The amount of window area in new houses has increased by up to 20% compared to typical existing homes.[14]

- In both the Southern and Northern service regions, new residential stock floor areas increased by 8% to 10% between the 1980-1993 period and the 1993-2007 period.[15] Recent Union residential surveys have indicated that the increase has now levelled off. Consequently, the average size of newly constructed homes is assumed to remain stable throughout the study period.

- Buildings in both service regions also feature an increase in exterior wall surface area of 5% to 20%.[16] This reflects both the increased floor area and a tendency for homes to include architectural features with more corners and details that diverge from the standard rectangular shapes.

- The Federal and Ontario governments are proposing to phase out incandescent lights by 2012.[17] This change would result in a reduction of internal gains and a corresponding increase in the net space heating load that must be met by furnaces.

The net effect of the above trends is that the improvement in thermal efficiencies is expected to be a much stronger influence than any further increases in house size, window area, etc. The model therefore assumes an approximate 25% reduction in the net space heating load of new homes for the 2012 milestone year, relative to the current average ***existing*** house. Most of this 25% improvement is already incorporated into standard practices for new construction, because of the 2006 OBC revision.

The 25% improvement reflects an improvement in overall performance of the building envelope and the heating equipment. Specific construction changes used to attain the improved performance would vary with each housing design. In general, however, they would be expected to include:

- Condensing furnaces (already mandatory)
- Improved air tightness (to approximately 1.5 ACH at 50 Pa)
- ENERGY STAR® windows
- Wall insulation to an RSI value of 3.5
- Attic insulation to an RSI value of 7
- Floor to ceiling foundation insulation

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[14] ecoENERGY Retrofit database (Ontario). The houses in the database are likely larger than the average in the overall population, but this is expected to be true of both the older and newer homes in the database, so it can be used to give an indication of the rate of increase.

[15] ecoENERGY Retrofit database (Ontario).

[16] ecoENERGY Retrofit database (Ontario).

[17] Natural Resources Canada, Office of Energy Efficiency. *Bulletin on Developing Energy Efficiency Standards for General Service Lighting*, Dec. 2007.

Exhibit 3.2 illustrates how the model assumes new houses built later in the study period will compare with existing houses and with those constructed in the Base Year 2007. The example is based on the space heating load of average single-family dwellings in the Southern Region.

Exhibit 3.2: New Residential Units – Illustration of Efficiency Changes in New Construction Through the Study Period

Exhibit 3.3 summarizes the resulting new net space heating loads for new homes built in the first milestone period.

Exhibit 3.3: New Residential Units – Net Space Heating Load[18] by Dwelling Type and Service Region (MJ/yr. and m^3/yr.)

Segment	Net Space Heating Load (MJ/yr.)		Space Heating UEC (m^3)	
	Southern	Northern	Southern	Northern
Single-Family Detached/ Duplex	46,641	49,920	1,348	1,455
Attached/Row Housing/Tris & Quads	31,250	41,802	903	1,218
Other	22,916	37,838	662	1,103

3.3 "NATURAL" CHANGES TO SPACE HEATING – EXISTING DWELLINGS

In addition to the construction of new buildings, the Reference Case also assumes that a portion of the existing building stock is subject to energy retrofits in each period. To provide a reasonable estimate of the impact of these "naturally" occurring retrofit activities on the net heating loads, the study employed the following steps:

- A bundle of upgrade measures associated with a "typical" retrofit within each dwelling type was defined.
- The rate at which the bundle of measures is introduced into the existing stock of buildings was estimated.

[18] Net space heating load is the space heating load of a building that must be met by the space heating system over a full year. This is equal to the total heat loss through the building envelope minus solar and internal gains.

- The energy impacts of these upgrades were estimated and the resulting overall volumes were compared to the Union forecast volumes for agreement.

The results of this process are summarized in the following sections.

3.3.1 Energy Retrofit and Activity Levels – Existing Dwellings

Exhibit 3.4 presents a summary of the major energy retrofit measures and the reported annual participation rates by dwelling type. The percentages were based on responses to a large national survey and indicate the percentage of all respondents who had the retrofit measure applied to their dwellings in 1995.[19] It is particularly useful in giving the frequency of different retrofit measures relative to each other. Although this study is fairly dated, it can be used as an indicator to show that window and door retrofits are by far the most common. It is anticipated that this trend has not changed significantly in recent years.

Exhibit 3.4: Annual Energy Retrofit Activity by Dwelling Type (%)

Retrofit Measure	Dwelling Type and Participation Rate (%)			
	Single	Row	Apartment	Mobile/Other
Insulation Improvements	4.20	2.40	2.30	4.10
Exterior Doors	5.40	5.90	2.80	5.30
Window Replacements	6.70	7.00	4.10	6.60
Fireplace Improvements	2.90	1.60	1.20	2.70
Heating System Conversions	0.90	0.40	0.10	0.90
Energy Source Conversions	0.90	0.80	0.10	0.90
Heating Equipment Replacements	2.90	2.10	1.00	2.90
Averages	3.41	2.89	1.66	3.34

Source: Home Energy Retrofit Survey – Statistical Report (NRCan, 2000)

3.3.2 Net Impact on Space Heating Loads – Existing Homes

Trial energy simulation runs were undertaken in HOT2000, assuming a variety of combinations of the retrofit measures shown in Exhibit 3.4. The results varied widely, from a 2% to 15% reduction in space heating loads, depending on assumptions related to type and scale of retrofits performed (e.g., the number of windows or doors replaced). For example, a typical post-1980s detached house in the Southern Region in which the only improvement is the addition of a layer of fiberglass batts to the attic would experience a reduction of approximately 2%. A typical pre-1980s detached house in the Northern Region in which the attic insulation is increased to RSI-7 (R-40), all the windows are replaced with ENERGY STAR® windows and the basement walls are insulated up to RSI-4 (R-22) would experience a reduction of approximately 15%.

In the absence of more comprehensive data, this analysis assumes the retrofit participation rates presented in Exhibit 3.4 and assumes that each renovated unit

[19] Natural Resources Canada. *Home Energy Retrofit Survey - Statistical Report*, 2000.

experiences a net space heat reduction of 9%. This reflected a package of activities that included replacing half of the windows with ENERGY STAR® windows (savings of approximately 6% on average) plus one other building envelope retrofit saving 6% in half of the projects.

The development of Ontario's new building codes is expected to play a role in the degree of improvement caused by a retrofit or renovation project, but is expected to be gradual, not dramatic.

3.4 "NATURAL" CHANGES TO ANNUAL APPLIANCE ENERGY USE

Changes in the annual energy consumption of residential appliances and heating equipment result from improvements in the energy efficiency of new models. The gradual penetration of these new, more efficient models into the stock of new and existing residences results in a gradual decrease in the consumption of each type of appliance.

NRCan data[20,21] show that significant improvements occurred in the energy efficiency of new appliances and heating equipment during the late 1980s and mid-1990s. During the post-1997 period, however, the efficiency of new natural gas appliances (clothes dryers and cooking ranges) remained relatively unchanged. Consequently, this Reference Case assumes that, in the absence of new initiatives, further improvements in the efficiency of new appliances will be relatively minor over the forecast period. However, the energy consumption of the stock of natural gas appliances and heating equipment will continue to decrease as the existing stock is replaced over the study period.

Further discussion of assumptions applied to the major natural gas appliance appliances and heating equipment is provided below. The discussion is organized as follows:

- Furnaces
- Domestic Hot Water
- Cooking
- Dryers
- Pool Heaters
- Fireplaces
- Other

3.4.1 Furnaces

Program evaluation work and market surveys undertaken by Union show that there is a trend towards the use of more efficient furnaces in both new construction and replacement markets. As noted previously, 2006 changes to the Ontario Building Code require that high-efficiency furnaces (minimum AFUE of 90%) be installed in new homes.

[20] Natural Resources Canada. *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2005*, Dec. 2007.

[21] Natural Resources Canada. *Energy Use Data Handbook*, p. 38-39, 2005.

In addition, NRCan's Office of Energy Efficiency (OEE) is currently in the process of updating the Minimum Energy Performance Standards (MEPS) for residential furnaces; a minimum AFUE of 90% is currently proposed, beginning at the end of 2009.[22]

The above measures will increase the average efficiency of residential natural gas furnaces. This Reference Case assumes that furnace efficiencies improve in accordance with Union's Residential Furnace Efficiency Index, which improves from a current level of 81.7% to 87.9% by 2012. The Reference Case assumes a continuation of this trend to 2017 when the average furnace efficiency will be approximately 92%.

3.4.2 Domestic Hot Water

Exhibit 3.5 summarizes DHW UECs by application for new dwellings. A comparison with the values presented previously for existing dwellings (see Section 2) shows significant reductions for hot water use in dishwashing and clothes washing; however, slightly more modest changes have been assumed for personal consumption.

Factors that will affect DHW energy use include trends towards more efficient water heaters and front loading washers (which use less water) and an improvement in the MEPS for residential dishwashers, proposed to come into effect in 2010.[23]

Exhibit 3.5: Distribution of DHW Energy Use by End Use in New Stock (m^3yr.)

End Use	Energy Use (m^3/yr.)	%
Personal Use	215	36
Dishwashing	138	23
Clothes Washing	153	25
Standby Losses	99	16
Total	604	100%

Note: Any difference in totals is due to rounding.

For existing dwellings, the DHW UEC is assumed to decrease by 0.5% per year based on the estimated impact of the changes described above.

3.4.3 Cooking

Only a modest contribution to reduced natural gas consumption in cooking ranges will come from the gradual penetration of new, more efficient models into the stock of new and existing residences. The efficiency of new units is not expected to improve significantly over the study period. Some change in consumption has been occurring due to changing occupancy per household and changes in occupant behaviour over time.[24] In

[22] Natural Resources Canada, Office of Energy Efficiency. *Proposed Amendment to Canada's Energy Efficiency Regulations for Gas Furnaces*, Jan. 2008.

[23] Natural Resources Canada, Office of Energy Efficiency. *Proposed Regulations for Residential Dishwashers,* Aug. 2007.

[24] Natural Resources Canada, Office of Energy Efficiency. *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2005*, 2008.

general, the number of occupants per household has been declining, and people have been cooking fewer large meals at home. These trends were assumed to continue; therefore, this Reference Case assumes that the current gas cooking UEC declines (in a straight line) by 1.6% by the final milestone year.

3.4.4 Dryers

As in the case of cooking ranges, only a modest contribution to reduced natural gas consumption in gas clothes dryers will come from the gradual penetration of new, more efficient models into the stock of new and existing residences. The efficiency of new units is not expected to improve significantly over the study period. Some change in consumption has been occurring due to changing occupancy per household, which has been declining.[25] In addition, the advent of horizontal axis clothes washers with faster spin speeds has been further reducing dryer energy consumption. These trends were assumed to continue; therefore, this Reference Case assumes that the current clothes dryer UEC declines (in a straight line) by 1.8% by the final milestone year.

3.4.5 Pool Heaters

The UEC for pool heaters was assumed to decline over the study period, due to increased natural adoption of insulating pool blankets and solar pool heaters. Penetration of these two technologies is currently approximately 70% (i.e., 30% of heated pools have neither of them).[26] Over the study period, total penetration of the two technologies was assumed to reach 85% (i.e., 15% of heated pools would have neither). Overall UEC would consequently fall by just over 8% over the study period.

3.4.6 Fireplaces

Fireplaces currently have a very wide range of efficiencies, and the average efficiency of units currently sold has not been extensively studied. Based on previous study team experience and industry discussions, it was estimated that the average efficiency of current fireplace stock is approximately 35% to 40%. According to NRCan data, the average efficiency of fireplaces sold as recently as 2003 was just over 45% (nearly two-thirds of sales were between 40% and 49.9% efficient). By 2005, just two years later, the average efficiency had risen to nearly 60% (units with efficiency below 50% had fallen to less than 10% of sales, with the remainder split nearly evenly between units between 50% and 59.9% efficient and those 60% and over). Average efficiency was assumed to continue rising slightly, to just over 60%, and with natural stock turnover, the average efficiency of fireplaces in homes would rise to slightly over 55% by the end of the study period.

3.4.7 Other

In the absence of any new initiatives, other gas uses (spas, barbecues, etc.) were not assumed to change during the study period.

[25] Ibid.

[26] Based on Union Gas residential market survey data.

3.5 APPLIANCE SATURATION TRENDS

The Reference Case assumed that the estimated Base Year natural gas appliance saturation levels remain constant over the study period.

3.6 STOCK GROWTH

The next step in developing the Reference Case involved the development and application of estimated levels of growth in each dwelling type and service region over the study period. The stock growth rates employed are based on those used in Union's most recent load forecast and were derived from data provided by Union's Load Forecasting Group.[27] However, the most recent Union forecast only extends to 2012 and is not broken out by the dwelling types used in this study. Consequently, it was necessary to extrapolate the Union forecast data from 2012 to 2017 and to estimate the growth rates for the individual dwelling types, based on housing stock data from NRCan and housing start data from the Canadian Mortgage and Housing Corporation (CMHC).[28,29]

Exhibit 3.6 presents a summary of the rates employed and Exhibit 3.7 presents the resulting number of units, by year and dwelling type.

Exhibit 3.6: Annual Growth Rates in Period by Dwelling Type and Service Region (%)

	Single/ Duplex	Attached/ Row, etc.	Mobile/ Other
Southern			
2007-2012	1.1%	4.3%	1.1%
2012-2017	1.0%	4.1%	1.0%
Northern			
2007-2012	1.0%	4.0%	1.0%
2012-2017	1.0%	3.9%	1.0%

[27] It is important to note that both future natural gas sales and building stock growth are heavily dependent on prevailing economic conditions.

[28] Natural Resources Canada. *Comprehensive Energy Use Database*, 2005, with the addition of new housing starts data from CMHC; *Housing Now: Ontario*, 2006 and 2007.

[29] Canadian Mortgage and Housing Corporation. *Housing Market Outlook: Canada Edition*, p. 13, 2008.

Exhibit 3.7: Residential Stock, 2007 and 2017 (Number of Units)

Segment	2007 Base Year			2012 Milestone Year			2017 Milestone Year		
	Southern Region	Northern Region	Total	Southern Region	Northern Region	Total	Southern Region	Northern Region	Total
Single-Family Detached/Duplex, Gas Heated	717,861	221,799	939,660	717,861	221,799	939,660	717,861	221,799	939,660
Single-Family Detached/Duplex, Gas Heated (New)				40,364	11,636	52,000	80,436	23,623	104,058
Single-Family Detached/Duplex, Non-Gas Heated	70,997	36,107	107,104	70,997	36,107	107,104	70,997	36,107	107,104
Single-Family Detached/Duplex, Non-Gas Heated (New)				3,992	1,894	5,886	7,955	3,846	11,801
Attached/Row Housing/Tris & Quads	93,131	7,926	101,057	93,131	7,926	101,057	93,131	7,926	101,057
Attached/Row Housing/Tris & Quads (New)				21,869	1,729	23,598	47,154	3,788	50,943
Other	779	617	1,396	779	617	1,396	779	617	1,396
Other (New)				44	32	76	87	66	153
Subtotal	882,768	266,449	1,149,217	949,037	281,740	1,230,777	1,018,401	297,771	1,316,172

Note: Any difference in totals is due to rounding.

3.7 FUEL SHARES

Fuel shares were assumed to remain constant over the study period.

3.8 AVERAGE NATURAL GAS CONSUMPTION PER DWELLING UNIT

Exhibits 3.8 and 3.9 combine the efficiency, saturation and fuel share data presented in the preceding exhibits and show the resulting average natural gas consumption, by end use, for each dwelling type. For milestone years 2012 and 2017, the average figures are based on all the dwellings in each category, including both those existing in the Base Year and those constructed during the study period.

Exhibits 3.8 and 3.9 present the average natural gas consumption per dwelling unit, broken out by dwelling type and end use for the Southern and Northern service regions, respectively.

Exhibit 3.8 Average Natural Gas Consumption per Dwelling Unit in the Southern Service Region (m^3/yr.)

Dwelling Type	Milestone Year	Annual Gas Consumption per Dwelling Unit (m^3/yr.)							
		Total	Space Heating	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use
Single-Family Detached/ Duplex	2007	2,628	1,639	617	108	31	55	97	80
	2012	2,514	1,553	607	95	31	55	93	80
	2017	2,414	1,500	574	86	31	54	89	80
Attached/Row Housing/Tris & Quads	2007	1,792	1,098	442	77	17	31	69	57
	2012	1,652	983	431	67	17	30	67	57
	2017	1,542	903	411	60	17	30	64	57
Other	2007	1,271	805	297	52	12	21	47	39
	2012	1,216	763	292	46	12	20	45	39
	2017	1,167	737	276	41	11	20	43	39
OVERALL AVERAGE	2007	2,539	1,581	599	105	30	52	94	78
	2012	2,409	1,483	586	92	29	52	90	77
	2017	2,293	1,417	551	82	29	51	85	77

Note: Any difference in totals is due to rounding.

Exhibit 3.9 Average Natural Gas Consumption per Dwelling Unit in the Northern Service Region (m^3/yr.)

Dwelling Type	Milestone Year	Annual Gas Consumption per Dwelling Unit (m^3/yr.)							
		Total	Space Heating	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use
Single-Family Detached/ Duplex	2007	2,583	1,722	559	114	14	44	51	80
	2012	2,386	1,572	528	100	14	43	49	80
	2017	2,254	1,490	490	90	14	43	46	80
Attached/Row Housing/Tris & Quads	2007	2,051	1,442	400	81	9	24	36	57
	2012	1,818	1,248	374	70	9	24	35	57
	2017	1,665	1,127	351	63	9	24	33	57
Other	2007	1,714	1,305	269	55	6	16	24	39
	2012	1,578	1,191	254	48	6	16	23	39
	2017	1,492	1,130	236	43	6	16	22	39
TOTAL	2007	2,565	1,713	554	113	14	43	50	79
	2012	2,365	1,560	522	99	14	42	48	79
	2017	2,229	1,475	484	89	13	42	46	79

Note: Any difference in totals is due to rounding.

3.9 SUMMARY OF MODEL RESULTS

This section presents the results of the model runs for the entire study period. The results are measured at the customer's point-of-use and do not include distribution system losses. Model results were compared to Union's forecast of residential consumption assuming no new DSM initiatives. Adjustments were made to the model to produce reasonable agreement, as shown in Section 3.9.1. The model results are presented in three separate exhibits.

Exhibit 3.10 presents the model results for the total Union Service Area. The results are broken out by dwelling type and end use.

Exhibits 3.11 and 3.12 present the same results, broken out by dwelling type and end use for the Southern and Northern service regions, respectively.

Exhibit 3.10: Reference Case Natural Gas Use for the Total Union Service Area, Modelled by End Use and Dwelling Type (1000 m^3/yr.)

Dwelling Type	Milestone Year	Gas Consumption (1000 m^3/yr.)							
		Total	Space Heating	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use
Single-Family Detached/ Duplex	2007	2,739,396	1,737,149	631,184	114,694	28,140	54,695	89,580	83,956
	2012	2,742,719	1,720,850	649,255	106,739	29,457	57,181	90,638	88,599
	2017	2,760,651	1,740,846	643,571	101,281	30,772	59,672	91,260	93,248
Attached/Row Housing/Tris & Quads	2007	183,183	113,708	44,320	7,859	1,684	3,060	6,751	5,801
	2012	207,520	125,057	53,191	8,337	2,059	3,735	7,986	7,155
	2017	235,835	139,827	61,753	9,197	2,496	4,522	9,316	8,725
Other	2007	2,048	1,433	397	74	13	26	51	54
	2012	2,025	1,402	405	69	14	27	52	57
	2017	2,029	1,409	400	65	14	29	52	60
TOTAL	2007	2,924,627	1,852,289	675,900	122,627	29,837	57,781	96,382	89,810
	2012	2,952,264	1,847,308	702,851	115,145	31,530	60,944	98,675	95,811
	2017	2,998,515	1,882,082	705,724	110,544	33,282	64,222	100,628	102,033

Note: Any difference in totals is due to rounding.

Exhibit 3.11: Reference Case Natural Gas Consumption for the Southern Service Region, Modelled by End Use and Dwelling Type (1000 m^3/yr.)

Dwelling Type	Milestone Year	Gas Consumption (1000 m^3/yr.)							
		Total	Space Heating	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use
Single-Family Detached/ Duplex	2007	2,073,275	1,293,067	487,016	85,388	24,584	43,452	76,498	63,270
	2012	2,095,114	1,294,231	505,878	79,526	25,747	45,460	77,444	66,828
	2017	2,117,439	1,315,594	503,646	75,490	26,901	47,455	77,992	70,360
Attached/Row Housing/Tris & Quads	2007	166,930	102,280	41,149	7,215	1,610	2,867	6,463	5,346
	2012	189,964	113,004	49,577	7,660	1,969	3,503	7,650	6,601
	2017	216,330	126,627	57,642	8,455	2,386	4,241	8,926	8,053
Other	2007	990	627	231	41	9	16	36	30
	2012	1,000	628	240	38	9	17	37	32
	2017	1,011	638	239	36	10	18	37	33
TOTAL	2007	2,241,195	1,395,974	528,396	92,643	26,203	46,335	82,997	68,646
	2012	2,286,078	1,407,863	555,695	87,224	27,725	48,980	85,131	73,461
	2017	2,334,780	1,442,859	561,527	83,981	29,297	51,714	86,955	78,446

Note: Any difference in totals is due to rounding.

Exhibit 3.12: Reference Case Natural Gas Consumption for the Northern Service Region, Modelled by End Use and Dwelling Type (1000 m³/yr.)

Dwelling Type	Milestone Year	Gas Consumption (1000 m³/yr.)							
		Total	Space Heating	DHW	Fireplaces	Cooking	Dryers	Pool Heaters	Other Gas Use
Single-Family Detached/ Duplex	2007	666,121	444,082	144,168	29,306	3,555	11,243	13,082	20,685
	2012	647,605	426,619	143,377	27,213	3,710	11,721	13,194	21,771
	2017	643,212	425,252	139,925	25,791	3,871	12,217	13,268	22,888
Attached/Row Housing/Tris & Quads	2007	16,254	11,428	3,171	645	74	193	288	455
	2012	17,557	12,052	3,614	677	90	233	336	554
	2017	19,505	13,200	4,111	742	110	280	390	672
Other	2007	1,057	805	166	34	4	10	15	24
	2012	1,024	774	165	31	4	11	15	25
	2017	1,018	771	161	30	4	11	15	26
TOTAL	2007	683,432	456,315	147,505	29,984	3,634	11,446	13,385	21,164
	2012	666,186	439,445	147,157	27,921	3,805	11,964	13,545	22,350
	2017	663,736	439,223	144,197	26,562	3,985	12,508	13,673	23,587

Note: Any difference in totals is due to rounding.

3.9.1 Comparison with Union Load Forecast

This section presents a comparison of the model results with Union data, for the Base Year and for the two milestones in the 10-year period being evaluated. The Union forecast for 2012 was adjusted to exclude any new DSM activity. The 2017 consumption values attributed to Union are extrapolations based on the same growth rates employed between 2007 and 2012.

The deviation between the model results and the Union forecasts is very minimal in 2012, with an overall deviation of 0.1% and a difference of 0.4% in the Northern service territory. The variation is somewhat larger in the 2017 milestone, with the model results somewhat under-predicting the Union forecast in general. The overall deviation here is 2.4% and the maximum difference, seen in the Southern service territory, is about 3%.

The model is based on the assumptions of growth and improvement in the stock of housing and appliances that were best supported by available data, and the forecast is based on econometric modelling. The deviations quoted above represent the best agreement that could be achieved between the two. Indeed, it is remarkable that two independent modelling approaches, based on entirely different methodologies, agree as closely as they do.

3.9.2 Interpretation of Results

Selected highlights of the information presented in Chapter 3 are presented below.

Dwelling Type

The rate of growth in Ontario attached housing is approximately three times the rate of growth in detached housing. As a result, although attached housing accounts for only 6%

of existing housing, it is estimated that it will account for close to 30% of new housing during the study period. (These percentages do not include apartments, which are analyzed under the commercial sector.)

End Use

The division of residential gas consumption by end use is expected to be relatively constant over the study period, with a slight decrease in the proportion used for space heating, due primarily to improved building envelopes in new dwellings and to the increasing dominance of condensing furnaces.

Service Region

The proportion of residential natural gas consumption by region is expected to remain relatively constant over the study period.

Characteristics of New Housing

The 2006 Ontario Building Code revision is currently estimated to result in new dwellings with EnerGuide ratings of approximately 76 to 77. This is a substantial improvement over the pre-2006 new houses, which had average EnerGuide ratings of approximately 73. As a result, the potential improvements available in new housing are reduced, and the diminishing returns will tend to make further efficiency gains from DSM programs more challenging.

Equipment and Appliances

Union Gas has been successful in reaching over 50% penetration of condensing furnaces among its residential customers. Next year, the standard will require a minimum efficiency of 90% for residential furnaces. The efficiency of new gas fireplaces is also improving rapidly: the average efficiency of gas fireplaces being sold is now approximately 60%, according to NRCan statistics. This is a dramatic improvement over the units currently installed, which average below 40% efficiency. Opportunities for DSM programs affecting furnaces and fireplaces will be substantially reduced going forward.

4. ENERGY-EFFICIENCY MEASURES

4.1 INTRODUCTION

This section identifies and assesses the financial and economic attractiveness of the selected energy-efficiency measures for the Residential sector. The discussion is organized and presented as follows:

- Methodology
- Summary of energy-efficiency results
- Description of energy-efficiency technologies and measures.

4.2 METHODOLOGY

The following steps were employed to assess the energy-efficiency measures:

- Select candidate energy-efficiency measures
- Establish technical performance for each option within a range of applicable load sizes and/or service region conditions (e.g., degree days)
- Establish the capital, installation and operating costs for each option
- Calculate the simple payback from the customer's perspective
- Calculate the measure total resource cost (measure TRC)
- Calculate the benefit/cost ratio

Step 1: Select Candidate Measures

The candidate measures were selected in close collaboration with Union personnel based on a combination of a literature review and the previous experience of the consultants and Union personnel. The selected measures are considered to be technically proven and commercially available, even if only at an early stage of market entry.[30] Technology costs, which will be addressed in this section, were not a factor in the initial selection of candidate technologies.

Step 2: Establish Technical Performance

Information on the performance improvements provided by each measure was compiled from available secondary sources, including the experience and on-going research work of study team members. As applicable, the energy impacts of the measures are reported for both natural gas and electricity.

[30] During completion of this study step, it was decided that a few of the originally selected measures were not feasible. They are identified in the text.

Step 3: Establish Capital, Installation and Operating Costs for Each Measure

Information on the cost of implementing each measure was also compiled from secondary sources, including the experience and on-going research work of study team members. As applicable, both the incremental and full cost of each measure was estimated.

The incremental cost is applicable when a measure is installed in a new facility, or is replacing equipment that is at the end of its useful life in an existing facility. In this case, incremental cost is defined as the difference between the energy-efficiency measure and the "baseline" technology. The full cost is applicable when an operating piece of equipment is replaced with a more efficient model prior to the end of its useful life.

In both cases, the costs and savings are annualized, based on the number of years of equipment life and the discount rate, which for this study is 10%. The costs incorporate applicable changes in annual equipment O&M costs and all cost are expressed in constant (2008) dollars.

Step 4: Calculate Simple Payback

The simple payback is generated to show the customer's financial perspective. Simple payback is "a measure of the length of time required for the cumulative savings from a project to recover its initial investment cost and other accrued costs, without taking into account the time value of money. The simple payback period is usually measured from the service date of the project."[31] The cost of the measure (incremental or full, as appropriate) is divided by the expected annual savings. The answer is given in years**.**

The following equation illustrates how this calculation is applied to a situation where an upgrade has a higher upfront cost than the baseline technology, but lower ongoing operating costs:

$$\text{Payback}_{\text{(years)}} = (\text{Cost}_{\text{upgrade}} - \text{Cost}_{\text{base}})/(\text{Ann}_{\text{base}} - \text{Ann}_{\text{upgrade}})$$

where, $\text{Cost}_{\text{upgrade}}$ = initial capital cost of the upgrade measure ($)
$\text{Cost}_{\text{base}}$ = initial capital cost of the baseline measure ($)
$\text{Ann}_{\text{upgrade}}$ = ongoing operating cost of the upgrade ($/yr.)
Ann_{base} = ongoing operating cost of the baseline measure ($/yr.)

Step 5: Calculate the Measure Total Resource Cost (TRC)

The measure TRC calculates the net present value of energy and water savings that result from an investment in an efficiency measure. The measure TRC is equal to its full or incremental capital cost (depending on application) plus any change (positive or negative) in the combined annual energy and equipment O&M costs. This calculation includes, among others, the following inputs: the avoided natural gas, electricity and water supply costs,the life of the technology and the selected discount rate, which in this analysis has been set at 10%.

[31] Fuller, S. K. and Petersen, S. R. *Life Cycle Costing Manual for the Federal Energy Management Program*, National Institute of Standards and Technology Handbook 135, 1995 Edition, Washington, DC.

A technology or measure with a positive TRC value is included in subsequent phases of the analysis, which consists of the economic and achievable potential scenarios. A measure with a negative TRC value is not economically attractive and is therefore not included in subsequent stages of the analysis.

It should be noted that the measure TRC provides an initial screen of the technical options. Considerations such as program delivery costs, free riders and incentives are incorporated in later detailed program design stages, which are beyond the scope of this study.

Step 6: Calculate Benefit/Cost Ratio

The measure benefit/cost ratio indicates the relative attractiveness of the measures. If a measure has a benefit/cost ratio in excess of 1.0, it means that the measure's benefits outweigh its costs. Such a measure would be included in subsequent stages of the analysis. A measure with a benefit/cost ratio that is well in excess of one (e.g., 3.0) is particularly attractive. Conversely, if a measure has a benefit/cost ratio of less than 1.0, its costs outweigh its benefits. Such a measure would not be included in subsequent stages of the analysis.

4.2.1 Energy Costs

The financial and economic results that are presented in this section are based on the following:

- Avoided supply cost of natural gas
- Avoided supply cost of electricity and water
- Customer energy prices.

A brief discussion of each is provided below.

Avoided Supply Cost of Natural Gas

Natural gas avoided supply costs were provided by Union. The data provided were segmented into baseload and weather-sensitive rates and their resulting NPVs (Net Present Values). The rates were forecast for a 30-year timespan and represent Union's 2008 avoided costs. These costs are updated on an annual basis, as prescribed by the Ontario Energy Board (OEB). The same avoided costs are used for Union's entire service region.

A GHG adder was added to the raw avoided supply costs to account for carbon dioxide emissions resulting from natural gas consumption. A cost of \$15/tonne CO_2e (per tonne of CO_2 equivalent) is employed until 2012 and the price is increased to \$20 /tonne CO_2e starting in 2013. An emissions coefficient of 0.001903 tonnes CO_2e/m^3 (1903 g CO_2e/m^3) is used in this analysis.[32] The resulting avoided supply costs for natural gas are shown in Exhibit 4.1.

[32] Based on emission factors and Global Warming Potentials (GWPs) presented in Environment Canada, National Inventory Report (1990-2005): Greenhouse Gas Sources and Sinks in Canada," p. 23 and 583, April 2007.

Exhibit 4.1: Union Gas 2008 Avoided Supply Costs (Natural Gas)

Year	Baseload		Weather Sensitive	
	Gas Rates ($/m^3)	NPV ($/m^3)	Gas Rates ($/m^3)	NPV ($/m^3)
1	0.39898	0.39898	0.40143	0.40143
2	0.38189	0.74614	0.38823	0.75436
3	0.36510	1.04787	0.36231	1.05378
4	0.37148	1.32698	0.36864	1.33075
5	0.37799	1.58515	0.37510	1.58694
6	0.39425	1.82995	0.39130	1.82991
7	0.40101	2.05631	0.39800	2.05457
8	0.40790	2.26562	0.40483	2.26231
9	0.41492	2.45919	0.41179	2.45442
10	0.42207	2.63818	0.41889	2.63207
11	0.42936	2.80372	0.42611	2.79635
12	0.43678	2.95681	0.43348	2.94828
13	0.44435	3.09839	0.44098	3.08879
14	0.45206	3.22934	0.44863	3.21874
15	0.45992	3.35045	0.45642	3.33893
16	0.46793	3.46247	0.46436	3.45010
17	0.47608	3.56608	0.47245	3.55292
18	0.48440	3.66191	0.48070	3.64802
19	0.49287	3.75056	0.48910	3.73599
20	0.50150	3.83256	0.49766	3.81736
21	0.51030	3.90841	0.50639	3.89263
22	0.51927	3.97858	0.51528	3.96226
23	0.52840	4.04349	0.52433	4.02668
24	0.53771	4.10354	0.53357	4.08626
25	0.54719	4.15910	0.54297	4.14139
26	0.55686	4.21049	0.55256	4.19239
27	0.56671	4.25804	0.56232	4.23957
28	0.57674	4.30204	0.57228	4.28322
29	0.58697	4.34274	0.58242	4.32361
30	0.59739	4.38040	0.59275	4.36098

Note: *Union's avoided costs have been modified by the addition of a GHG adder*

Avoided Supply Cost of Electricity and Water

The avoided supply costs of electricity and water used in this analysis were also provided by Union and are shown in Exhibit 4.2. A GHG adder was also added to the electricity costs to account for average CO_2 emissions from electricity production in Ontario. A method similar to that described for the natural gas avoided costs was used. An emissions coefficient of 0.000220 tonnes CO_2e/kWh (220 g CO_2e/kWh) is used in this analysis.[33] The same electricity avoided cost values were used for both service regions.

[33] Based on Ontario emission factors presented in Environment Canada, National Inventory Report (1990-2005): Greenhouse Gas Sources and Sinks in Canada," p. 521, April 2007.

Exhibit 4.2: Union Gas 2008 Avoided Supply Costs (Electricity and Water)

Year	Water Rates		Electricity Rates	
	Rates ($/1000 L)	NPV ($/1000 L)	Rates ($/kWh)	NPV ($/kWh)
1	1.68504	1.68504	0.08032	0.08032
2	1.71705	3.24599	0.08177	0.15465
3	1.74967	4.69200	0.08324	0.22345
4	1.78292	6.03154	0.08474	0.28712
5	1.81679	7.27243	0.08627	0.34604
6	1.85131	8.42195	0.08922	0.40144
7	1.88649	9.48682	0.09081	0.45271
8	1.92233	10.47328	0.09243	0.50014
9	1.95886	11.38710	0.09408	0.54403
10	1.99607	12.23363	0.09577	0.58464
11	2.03400	13.01783	0.09748	0.62223
12	2.07265	13.74428	0.09923	0.65701
13	2.11203	14.41723	0.10101	0.68919
14	2.15215	15.04064	0.10282	0.71897
15	2.19304	15.61813	0.10467	0.74654
16	2.23471	16.15311	0.10655	0.77204
17	2.27717	16.64869	0.10847	0.79565
18	2.32044	17.10777	0.11042	0.81750
19	2.36453	17.53305	0.11242	0.83772
20	2.40945	17.92702	0.11445	0.85643
21	2.45523	18.29197	0.11652	0.87375
22	2.50188	18.63005	0.11862	0.88978
23	2.54942	18.94324	0.12077	0.90461
24	2.59786	19.23336	0.12296	0.91835
25	2.64722	19.50212	0.12519	0.93106
26	2.69751	19.75109	0.12747	0.94282
27	2.74877	19.98173	0.12978	0.95371
28	2.80099	20.19538	0.13214	0.96379
29	2.85421	20.39330	0.13455	0.97312
30	2.90844	20.57665	0.13700	0.98176

Note: *Union's avoided costs for electricity have been modified by the addition of a GHG adder*
1 kWh=3.6 MJ; 1 GJ=1000 MJ

Customer Resource Costs

The customer resource costs used in this analysis are presented in Exhibit 4.3. These values are used in the calculation of customer payback periods that are presented in later sections of this report. In the case of both electricity and natural gas, the prices shown are based on July 2008 rate schedules.

Exhibit 4.3: Customer Resource Costs

Service Region	Nat. Gas[34] ($/m^3)	Electricity[35] ($/kWh)	Water[36] ($/1000L)
Northern	0.540	0.095	1.675
Southern	0.458	0.098	1.650

4.3 SUMMARY OF ENERGY-EFFICIENCY SCREENING RESULTS

A summary of the screening results for the energy-efficiency measures is presented in Exhibits 4.4 and 4.5. Due to the number of measures assessed, the following exhibits only show results for those options that pass the screen. The following measures did not pass the economic screen:

Building Envelope:

- Retrofit Windows with Low-E Films
- Air Leakage Sealing
- Attic Insulation
- Wall Insulation
- Foundation Insulation
- Crawlspace Insulation

New Building Design:

- High-Performance Homes (EGH 80/R2000/ENERGY STAR®)
- Under-Slab Insulation

Space Heating and Ventilation Equipment:

- Condensing Furnaces
- Condensing Boilers
- High-Efficiency Heat Recovery Ventilators (HRVs)
- Integrated Mechanical System (Heating and DHW)
- Gas-Fired Heat Pumps
- Duct Sealing
- Furnace Tune-Ups
- Furnace Filter Alarms

Domestic Hot Water (DHW):

- DHW Heat Traps
- Condensing Water Heaters
- Wastewater Heat Recovery Systems
- Solar Hot Water Systems (DHW)

[34] Natural gas rates are approximate estimates based on Union rates (as of July 1, 2008) in each service region and average natural gas consumption levels in each service region. Rates exclude current $17.00 monthly charge.

[35] Customer electricity rates are based on electricity rates charged by EnWin (utility which services Windsor) and North Bay Hydro (according to their websites, as of July 2008). Fixed customer charges are not included.

[36] Water rates based on water and wastewater rates in several municipalities in both service regions. A weighted average is obtained based on the populations in these municipalities and an assumed annual water consumption of 300,000 L. Fixed charges are not included.

Major Appliances:

- High-Efficiency Gas Ranges
- High-Efficiency Gas Dryers

Pool Heaters:

- High-Efficiency Pool Heaters

The calculations for all of the measures, including the options that did not pass the screen, are contained in Appendix A.

Exhibit 4.4: Summary of Measure TRC Screening Results Residential Sector Energy-efficiency Options – Southern Region

Measure	Measure Description	Full/Incr	Simple Payback (Years)	Measure TRC ($)	Benefit/Cost Ratio
Air Sealing and Insulation (Old Homes)	Single Detached (Old Existing)	Full	7.1	$335	1.16
High-Performance Windows (ENERGY STAR®)	Single Detached (Existing)	Incr.	5.7	$234	1.47
High-Performance Windows (ENERGY STAR®)	Attached (Existing)	Incr.	5.0	$246	1.70
High-Performance Windows (ENERGY STAR®)	Single Detached (New)	Incr.	3.2	$488	2.63
High-Performance Windows (ENERGY STAR®)	Attached (New)	Incr.	2.7	$440	3.20
Super High-Performance Windows	Single Detached (Existing)	Incr.	8.2	$29	1.03
Super High-Performance Windows	Attached (Existing)	Incr.	7.4	$94	1.13
Super High-Performance Windows	Single Detached (New)	Incr.	5.0	$424	1.71
Super High-Performance Windows	Attached (New)	Incr.	4.3	$400	2.00
Programmable Thermostats	Single Detached (Existing)	Full	0.5	$820	13.61
Programmable Thermostats	Attached (Existing)	Full	0.8	$531	9.16
Programmable Thermostats	Single Detached (New)	Incr.	0.7	$628	10.66
Programmable Thermostats	Attached (New)	Incr.	1.0	$402	7.19
High-Efficiency Fireplaces	Single Detached (Existing)	Incr.	3.3	$86	1.86
High-Efficiency Fireplaces	Attached (Existing)	Incr.	4.6	$33	1.33
High-Efficiency Fireplaces	Single Detached (New)	Incr.	4.6	$36	1.36
Solar Pre-Heated Make-Up Air	Single Detached (Existing)	Full	6.7	$74	1.06
Ultra Low-Flow Showerheads	Single Detached (Existing)	Full	0.2	$570	39.01
Ultra Low-Flow Showerheads	Attached (Existing)	Full	0.2	$419	28.92
Ultra Low-Flow Showerheads	Single Detached (New)	Full	0.2	$551	37.71
Ultra Low-Flow Showerheads	Attached (New)	Full	0.2	$405	27.99
Hot Water Pipe Insulation	Single Detached (Existing)	Full	0.1	$65	66.30
Hot Water Pipe Insulation	Attached (Existing)	Full	0.1	$46	47.45
DHW Temperature Reduction	Single Detached (Existing)	Full	0.0	$37	N/A
DHW Temperature Reduction	Attached (Existing)	Full	0.0	$27	N/A
Tankless Gas-Fired DHW	Single Detached (Existing)	Incr.	5.9	$134	1.19
Tankless Gas-Fired DHW	Single Detached (New)	Incr.	6.4	$76	1.11
DHW Recirculation Systems	Single Detached (Existing)	Full	6.9	$39	1.08
DHW Recirculation Systems	Single Detached (New)	Full	7.4	$12	1.02
Efficient Dishwashers	Single Detached (Existing)	Incr.	1.2	$195	4.90
Efficient Dishwashers	Attached (Existing)	Incr.	1.7	$132	3.65
Efficient Dishwashers	Single Detached (New)	Incr.	1.3	$182	4.63
Efficient Dishwashers	Attached (New)	Incr.	1.8	$123	3.45

Measure	Measure Description	Full/Incr	Simple Payback (Years)	Measure TRC ($)	Benefit/Cost Ratio
Efficient Clothes Washers	Single Detached (Existing)	Incr.	3.5	$524	2.05
Efficient Clothes Washers	Attached (Existing)	Incr.	4.6	$303	1.61
Efficient Clothes Washers	Single Detached (New)	Incr.	3.6	$495	1.99
Efficient Clothes Washers	Attached (New)	Incr.	4.7	$283	1.57
Swimming Pool Covers	Single Detached (Existing)	Full	2.8	$916	1.76
Swimming Pool Covers	Attached (Existing)	Full	3.9	$315	1.26
Swimming Pool Covers	Single Detached (New)	Full	2.9	$828	1.69
Swimming Pool Covers	Attached (New)	Full	4.0	$252	1.21
Solar Pool Heaters	Single Detached (Existing)	Full	1.7	$5,824	4.15
Solar Pool Heaters	Attached (Existing)	Full	2.4	$3,642	2.97
Solar Pool Heaters	Single Detached (New)	Full	1.8	$5,505	3.98
Solar Pool Heaters	Attached (New)	Full	2.5	$3,414	2.85

Exhibit 4.5: Summary of Measure TRC Screening Results Residential Sector Energy-efficiency Options – Northern Region

Measure	Measure Description	Full/Incr	Simple Payback (Years)	Measure TRC ($)	Benefit/Cost Ratio
Air Sealing and Insulation (Old Homes)	Single Detached (Old Existing)	Full	6.5	$562	1.27
Air Sealing and Insulation (Old Homes)	Attached (Old Existing)	Full	6.7	$377	1.21
High-Performance Windows (ENERGY STAR®)	Single Detached (Existing)	Incr.	5.6	$247	1.49
High-Performance Windows (ENERGY STAR®)	Attached (Existing)	Incr.	4.8	$256	1.73
High-Performance Windows (ENERGY STAR®)	Single Detached (New)	Incr.	3.4	$451	2.50
High-Performance Windows (ENERGY STAR®)	Attached (New)	Incr.	2.8	$405	3.03
Super High-Performance Windows	Single Detached (Existing)	Incr.	7.5	$117	1.12
Super High-Performance Windows	Attached (Existing)	Incr.	6.4	$210	1.30
Super High-Performance Windows	Single Detached (New)	Incr.	4.7	$485	1.81
Super High-Performance Windows	Attached (New)	Incr.	3.6	$541	2.35
Programmable Thermostats	Single Detached (Existing)	Full	0.5	$908	14.96
Programmable Thermostats	Attached (Existing)	Full	0.6	$736	12.33
Programmable Thermostats	Single Detached (New)	Incr.	0.6	$675	11.39
Programmable Thermostats	Attached (New)	Incr.	0.7	$541	9.33
High-Efficiency Fireplaces	Single Detached (Existing)	Incr.	3.0	$106	2.06
High-Efficiency Fireplaces	Attached (Existing)	Incr.	4.2	$48	1.48
High-Efficiency Fireplaces	Single Detached (New)	Incr.	4.1	$51	1.51
High-Efficiency Fireplaces	Attached (New)	Incr.	5.7	$8	1.08
Solar Pre-Heated Make-Up Air	Single Detached (Existing)	Full	6.0	$227	1.17
Ultra Low-Flow Showerheads	Single Detached (Existing)	Full	0.2	$566	38.72
Ultra Low-Flow Showerheads	Attached (Existing)	Full	0.2	$416	28.71
Ultra Low-Flow Showerheads	Single Detached (New)	Full	0.2	$532	36.48
Ultra Low-Flow Showerheads	Attached (New)	Full	0.2	$392	27.11
Hot Water Pipe Insulation	Single Detached (Existing)	Full	0.1	$64	65.27
Hot Water Pipe Insulation	Attached (Existing)	Full	0.1	$46	46.71
DHW Temperature Reduction	Single Detached (Existing)	Full	0.0	$37	N/A

Measure	Measure Description	Full/Incr	Simple Payback (Years)	Measure TRC ($)	Benefit/Cost Ratio
DHW Temperature Reduction	Attached (Existing)	Full	0.0	$26	N/A
Tankless Gas-Fired DHW	Single Detached (Existing)	Incr.	6.0	$121	1.17
Tankless Gas-Fired DHW	Single Detached (New)	Incr.	6.9	$20	1.03
DHW Recirculation Systems	Single Detached (Existing)	Full	7.0	$33	1.07
Efficient Dishwashers	Single Detached (Existing)	Incr.	1.3	$192	4.84
Efficient Dishwashers	Attached (Existing)	Incr.	1.7	$130	3.60
Efficient Dishwashers	Single Detached (New)	Incr.	1.4	$169	4.37
Efficient Dishwashers	Attached (New)	Incr.	1.9	$113	3.27
Efficient Clothes Washers	Single Detached (Existing)	Incr.	3.5	$516	2.03
Efficient Clothes Washers	Attached (Existing)	Incr.	4.6	$298	1.60
Efficient Clothes Washers	Single Detached (New)	Incr.	3.7	$468	1.94
Efficient Clothes Washers	Attached (New)	Incr.	4.9	$264	1.53
Swimming Pool Covers	Single Detached (Existing)	Full	2.5	$1,152	1.96
Swimming Pool Covers	Attached (Existing)	Full	3.5	$484	1.40
Swimming Pool Covers	Single Detached (New)	Full	2.6	$1,054	1.88
Swimming Pool Covers	Attached (New)	Full	3.6	$413	1.34
Solar Pool Heaters	Single Detached (Existing)	Full	1.5	$6,679	4.61
Solar Pool Heaters	Attached (Existing)	Full	2.1	$4,254	3.30
Solar Pool Heaters	Single Detached (New)	Full	1.6	$6,323	4.42
Solar Pool Heaters	Attached (New)	Full	2.2	$4,000	3.16

4.4 DESCRIPTION OF ENERGY-EFFICIENCY TECHNOLOGIES AND MEASURES

This section provides a brief description of each of the energy-efficiency technologies and measures that are included in this study, as listed in Exhibit 4.6.

Exhibit 4.6: Energy-efficiency Technologies and Measures - Residential Sector

Building Envelope
- High-Performance (ENERGY STAR®) Windows
- Super High-Performance Windows
- Retrofit Windows with Low-E Films
- Air Leakage Sealing
- Attic Insulation
- Wall Insulation
- Foundation Insulation
- Crawlspace Insulation
- Vacuum Panel Insulation
- Air Leakage Sealing and Insulation (Old Homes)

New Building Design
- High-Performance Homes (EGH 80) R2000/ENERGY STAR®)
- Under-Slab Insulation

Space Heating and Ventilation Equipment
- Condensing Furnaces
- Condensing Boilers
- High-Efficiency Heat Recovery Ventilators (HRVs)
- Programmable Thermostats
- Integrated Mechanical System (Heating and DHW)
- Gas-Fired Heat Pumps
- Duct Sealing
- Furnace Tune-Ups
- Furnace Filter Alarms
- EnerGuide Natural Gas Fireplaces
- Solar Pre-Heated Make-Up Air (e.g., SolarWall®)

Domestic Hot Water
- Ultra Low-Flow Showerheads
- Hot Water Pipe Insulation
- DHW Heat Trap
- DHW Temperature Reduction
- Water Heater Timers
- Condensing Water Heaters
- Tankless Gas-Fired DHW
- Wastewater Heat Recovery
- Solar Hot Water Systems (DHW)
- DHW Recirculation Systems (e.g. Metlund D'MAND®)

Major Appliances
- High-Efficiency Gas Ranges
- High-Efficiency Gas Dryers
- DHW Savings from Efficient Dishwashers
- DHW and Dryer Savings from Efficient Clothes Washers

Pool Heaters
- Insulating Swimming Pool Covers
- High-Efficiency Pool Heaters
- Solar Pool Heaters

4.4.1 Building Envelope

Building envelope measures improve the thermal performance of the building's walls, roof and/or windows. These measures also provide significant co-benefits, such as increased occupant comfort, improved resale value, etc. Ten building envelope energy-efficiency upgrade options were identified and assessed:[37]

- High-performance (ENERGY STAR®) Windows
- Super High-performance Windows
- Retrofit Windows with Low-E Films

[37] All input assumptions that are not otherwise referenced are from the Marbek internal database.

- Air Leakage Sealing
- Attic Insulation
- Wall Insulation
- Foundation Insulation
- Crawlspace Insulation
- Vacuum Panel Insulation
- Air Leakage Sealing and Insulation (Old Homes).

High-Performance (ENERGY STAR®) Windows

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$\$43/m^2$ incremental cost in existing • $500 in existing single detached • $350 in existing attached $\$21.50/m^2$ incremental cost in new • $300 in new single detached • $200 in new attached
Savings	Southern: 7.5%-12% of HVAC energy Northern: 7%-9% of HVAC energy
Useful Life	30 years

High-performance windows have an RSI value of 0.5 (R-2.8) or higher, compared to standard double glazed windows, which are clear with no gas filling and typically have an RSI value of 0.34 (R-1.9) or less. High-performance windows are double glazed with a ½"-inch air space. They incorporate a number of additional energy-saving features, including low-e (soft coating), insulating spacers, argon fill, and low conductivity frames (a mix of sliders, hinged and picture). The more efficient windows reduce heat loss through the window by 25% or more, compared to the average low- or mid-efficiency replacement windows, depending on dwelling type and region. High-performance windows also provide occupant co-benefits, such as reduced interior noise, reduced air leakage, greater thermal comfort and fewer condensation problems.

This analysis employs an incremental cost of $\$43/m^2$ ($\$4/ft^2$) of window area to renovate an existing attached or detached dwelling to high-performance windows as opposed to standard windows. The comparable cost in a new home is assumed to be 50% of those for existing homes.[38, 39] The total costs shown above assume that half of the window area in an average existing home is replaced. The corresponding savings range from about 7.5% to 12% of space heating energy in the Southern region and 7% to 9% of space heating

38 Cost data from personal communications with window distributors and installers. High-performance windows are cheaper in new homes due to different purchasing patterns. Most windows used for new homes are purchased by tract builders at wholesale prices. In the wholesale market, the incremental cost between standard windows and ENERGY STAR® level performance is modest. In contrast, most windows purchased for retrofit, either by homeowners or by retrofit contractors, are priced at retail. In the retail market, there is a substantial mark-up applied to the increment between standard and ENERGY STAR® level windows. Competitive pressures may reduce this mark-up with time in some markets.

39 New home cost is more than half of existing home cost due to a higher average window area in new homes.

energy in the Northern region. Savings also include similar percentages of air conditioning and ventilation fan energy.[40]

If the upgrade is chosen as part of a new construction, the incremental cost per unit window area is about 50% lower and the potential savings are higher (as a percentage of space heating use) because new homes tend to have more and larger windows. Since the other building shell components are better in a new home, windows account for a larger fraction of the heat loss than they do in an older home. Therefore, they represent a larger proportion of new home heating energy consumption. The product lifetime for windows is approximately 30 years.[41]

Super High-Performance Windows

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$86/m^2 incremental cost in existing • $950 in existing single detached • $700 in existing attached $43/m^2 incremental cost in new • $600 in new single detached • $400 in new attached
Savings	Southern: 10%-15% of HVAC energy Northern: 10%-14% of HVAC energy
Useful Life	30 years

In addition to low-e coating, argon fill, and insulating spacers, super-high performance windows incorporate features such as triple glazing, transparent insulating films or fibreglass frames and their equivalent R-values range from RSI-1.0 (R-5.7) to RSI-1.9 (R-11). These windows are approximately twice the cost of the high-performance windows; incremental costs would be approximately $86 per square meter; the costs for new homes are assumed to be 50% of those for existing homes. The total costs shown above assume that half of the window area in an average existing home is replaced. In this situation, the energy savings for the entire residential HVAC system would range from 10% to 15% in the Southern service region and 10% to 14% in the Northern service region.[42]

Although triple-glazed units are considerably heavier and can sometimes present fastening issues for existing vinyl window frame extrusions, this does not cause the installation cost to increase.[43] A measure life of 30 years is assumed in this analysis.

[40] Based on HOT2000 models of both attached and detached homes in both service regions.

[41] Personal communications with window distributors and installers.

[42] Based on HOT2000 models of both attached and detached homes in both service regions.

[43] Personal communications with window distributors and installers.

Retrofit Windows with Low-E Films

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing
Costs	$75/m^2 full cost in existing • $800 in existing single detached • $500 in existing attached
Savings	1.5% of space heating energy 12% of space cooling energy
Useful Life	20 years

Improving the energy performance of existing windows can be achieved by installing low-e films on the interior surface of the glass. These films are often coated with very thin layers of certain metals that are nearly clear. Low-e films improve the energy performance of windows by greatly reducing the amount of non-visible radiation that is absorbed and transmitted through the window. In the summer, heat is kept out, and in the winter, heat is kept in. In addition, these films improve the thermal resistance (i.e., insulation value) of windows.

Several brands of low-e window films are available, including Solar Gard (Bekaert Specialty Films) and Llumar and Vista (both CPFilms Inc.). These films have emissivities of about 0.33 and solar heat gain coefficients around 0.25. In addition, they improve window insulation by up to RSI-0.10 (R-0.59).[44] Based on these specifications, it is estimated that low-e films can reduce space heating requirements by about 1.5% and space cooling energy consumption by about 12%.[45] In an average retrofit situation where they are installed on half of the windows in a home, the approximate installed cost of low-e films is $75/m^2 ($7/ft^2) or $800 in an average single detached dwelling and $500 in an average attached dwelling. Although the manufacturers often offer limited lifetime warranties, they are estimated to have practical lifetimes of about 20 years.[46]

As added benefits, these films reduce glare and fading and make windows more secure by preventing them from shattering.

[44] Based on personal communication with Solar Gard representative. A double-glazed window was modeled (using WINDOW 5.2) before and after the application of their low-e film to estimate the change in insulation value.

[45] Based on HOT2000 models of both attached and detached homes in both service regions.

[46] Cost and lifetime data based on personal communications with several window film distributors.

Air Leakage Sealing

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	Single Detached • $1,800 full cost in existing • $1,200 full cost in new Attached • $1,400 full cost in existing • $1,000 full cost in new $20 annual equipment O&M cost in both new and existing
Savings	11% of HVAC energy
Useful Life	25 years

Air leakage sealing of building envelopes includes completion of a blower door test to quantify leakage levels and to identify the location of air leaks. Generally, major leakage occurs at window-to-wall interfaces, around doors (especially patio doors), through electrical and plumbing penetrations, and at the top of foundation walls. Installation of sealant and gaskets are generally accepted methods for reducing air leakage in buildings. Other sources of air leaks include pot lights, wall-to-floor interfaces (i.e., top and bottom of baseboards), and bathroom and kitchen exhaust piping.

Air sealing also provides important co-benefits, including reduced drafts, increased occupant comfort and greater control over ventilation capability. In addition, reduced air leakage around windows and attic penetrations eliminates one of the key contributors to water ingress into exterior envelope assemblies.

In existing dwellings, a comprehensive job can typically reduce air leakage by 30% to 40%, which results in average space heating savings of about 11%. Electricity savings from air conditioning, if applicable, and ventilation fans would be approximately the same percentage. The cost of air leakage sealing is approximately $1,800 per existing single-family dwelling, if undertaken by an air-sealing contractor who can perform an air test as part of the work.[47] If homeowners undertake the air sealing work, significant cost savings can be achieved, but the resulting energy savings would typically be reduced significantly as well. As noted in the table above, this cost is assumed to be slightly lower for attached homes.

Similar savings are assumed for this measure in new homes but lower incremental costs are used in the analysis, as noted above. The life of this measure is approximately 25 years. However, some elements of air leakage sealing, such as weather stripping and calking, require more frequent replacement; consequently, an annual equipment O&M cost of $20 has been added to account for this.[48]

[47] Based on personal communication with Tony Woods, CanAm Building Envelope Specialists.

[48] Energy impacts are from HOT2000 simulations; cost data are based on discussions with installation contractors. Similar estimates were used in recent studies for Enbridge and BC Hydro.

Attic Insulation

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing
Costs	\$600 full cost in single detached \$450 full cost in attached
Savings	5% of HVAC energy
Useful Life	30 years

Insulation levels can be increased in attics/ceilings by blowing insulation into the attic spaces to fill and cover the space within the roof frame. One technique is to make sure loose-fill or batt insulation fills the attic floor joists fully and then add an additional layer of unfaced fibreglass batt insulation across the joists. To reduce cost, it is also possible to blow in cellulose insulation (~\$0.50/ft^2 for R-20) on top of the existing insulation.[49] This analysis assumes attic insulation is improved to RSI-7.0 (R-30).[50]

It is estimated that the incremental cost of this measure is about \$600 in single detached homes and \$450 in attached homes (due to their smaller size), with resulting savings of approximately 5% of the space heating costs. Energy savings from air conditioning and ventilation fans, if applicable, would be approximately the same percentage. The life of this measure is estimated at 30 years.[51]

Wall Insulation

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing
Costs	\$1,600 incremental cost in single detached \$1,200 incremental cost in attached
Savings	13% of space heating energy 5% of space cooling and ventilation energy
Useful Life	30 years

Wall insulation is usually challenging to retrofit in an existing home because the inside surfaces of the exterior walls are already finished. It is sometimes possible to add insulation to a wall by blowing insulating materials into the wall cavity, if sufficient space exists. Alternatively, if the siding is old and due for replacement, rigid foam insulation can be added before the new siding is installed. Since the cost of implementing this measure at full cost is very high, it is assumed that the homeowner is replacing the home's siding and improving the wall insulation on an incremental basis.

[49] Based on personal communication with Tony Woods, CanAm Building Envelope Specialists.

[50] Although the current standards for attic insulation are much higher (R-40 or R-50), HOT2000 modeling has shown that the additional energy savings resulting from these levels of insulation may not warrant the additional costs. Thus, a more conservative level of insulation is assumed here.

[51] Energy impacts are from HOT2000 simulations; cost data are based on discussions with retailers and installation contractors. Lifetime is based on Enbridge 2004 CPR.

Insulation levels are assumed to increase to RSI-3.5 (R-20).[52] In this situation, it would also be quite cost effective to install a more effective vapour and air barrier (e.g., Dupont™ Tyvek®) to reduce the amount of air leakage through the walls.

The incremental cost of adding the exterior insulation, as not all walls have sufficient space for blown-in insulation, is assumed to be about $1,600 for single detached homes and $1,200 for attached homes. Savings are estimated to be 13% of space heating energy. Energy savings from air conditioning and ventilation fans, if applicable, would be approximately 5%. The life of this measure is about 30 years.[53]

Foundation Insulation

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$40/m^2 incremental cost in existing • $2,500 incremental in existing detached • $2,000 incremental in existing attached
Savings	13% of space heating energy
Useful Life	30 years

In older homes the basement is often under-insulated or even left un-insulated. Increasing the insulation level in basements can be achieved in a number of ways, including: constructing a new insulated frame wall, moving the existing frame wall to increase the insulation level, adding extra insulation to the existing frame wall, adding rigid board insulation to the exterior of the foundation, or using a combination of interior and exterior rigid board insulation. As a lower cost alternative, it is also possible to use polyurethane foam (~$4/ft^2 for R-24, or 4 inches at R-6 per inch).[54]

For purposes of this report, increased basement insulation was assumed to be achieved by either moving an existing frame wall or constructing a new frame wall with an upgrade to RSI-4 (R-22.7) insulation. This measure is regarded as an incremental cost measure since it is most cost effective to implement when the basement is being finished or redone. Co-benefits of improved basement insulation include improved thermal comfort, fewer drafts, and more usable living space. If properly installed, improved basement insulation can also result in less condensation.

The incremental cost of adding insulation to the foundation is approximately $40/m^2 (~$4/ft^2) of basement wall area, or $2,500 for a typical single detached dwelling and $2,000 for a typical attached dwelling. Adding this insulation reduces space heating energy by about 13%. Energy savings from air conditioning and ventilation fans, if

[52] Unless the wall cavity is empty, the reliability of this upgrade measure cannot be certain. The cost of siding replacement is not included in the costs presented. If insulation is added under the siding, it is assumed to occur during a siding replacement project happening for other reasons.

[53] Lifetime is based on Enbridge 2004 CPR.

[54] Based on personal communication with Tony Woods, CanAm Building Envelope Specialists.

applicable, are not significant for this measure. This measure has a life of approximately 30 years.[55]

Crawlspace Insulation

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing
Costs	$600 full cost
Savings	5% of HVAC energy
Useful Life	30 years

Insulation levels remain below code in many homes that include crawlspaces as part of the basement design. If the floor is exposed, it would first be necessary to install a vapour barrier (e.g., 6 mil (600 gauge/0.15 mm) polyurethane barrier). Polyurethane foam could then be applied to the ceiling of the crawlspace. In addition to increasing the insulation of the crawlspace, this would help to eliminate any air leaks. Co-benefits include improved thermal comfort, fewer drafts and less condensation.

The addition of crawlspace insulation in existing houses to bring the thermal resistance values up to existing code levels of RSI-2.1(R-12) provides annual energy savings of approximately 5%. Energy savings from air conditioning and ventilation fans, if applicable, would be approximately the same percentage. This measure has a life of approximately 30 years. Typical installed costs depend on the size of the crawlspace but are about $600 on average.[56]

Vacuum Panel Insulation

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	N/A
Savings	N/A
Useful Life	N/A

Vacuum panel insulation (VPI) can achieve thermal resistance levels that are three to seven times those provided by conventional insulation materials, such as rigid foam boards and fibreglass. The technology consists of a core panel enclosed in an airtight, vacuum-sealed envelope. Such panels can attain thermal resistances of approximately RSI-3.5/in. Although targeted primarily to refrigerators and specialized containers, VPI can be manufactured in any size and thus has potential for buildings.

Vacuum panel insulation for buildings is not currently commercially available.

[55] Energy impacts are from HOT2000 simulations; cost data are based on discussions with retailers and installation contractors. Lifetime is based on Enbridge 2004 CPR.

[56] Energy impacts are from HOT2000 simulations; cost data are based on discussions with retailers and installation contractors. Lifetime is based on Enbridge 2004 CPR.

Air Leakage Sealing and Insulation (Old Homes)

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing
Costs	$2,000 full cost in existing single detached $1,700 full cost in existing attached $10 annual equipment O&M cost in both
Savings	20% of HVAC energy
Useful Life	30 years

This measure is targeted at homes that are at least 30 years old, since many of these homes haven't had any work done in order to improve their insulation and air sealing deficiencies. If an upgrade is being considered for any portion of the building envelope of an older home, it is generally most effective to upgrade the insulation and the air sealing at the same time. This includes wall, attic, foundation, and crawlspace retrofits of older homes. For the purposes of this analysis, it is assumed that a retrofit is being conducted on the attic.

The air sealing portion of the work could be accomplished by segmenting the attic. In each segment, the existing insulation could be moved to one side and polyurethane foam sprayed in (serves as an air sealant in addition to its insulating properties). It may also be necessary to install or refurbish top plates to prevent airflow into the attic through exterior wall cavities. Other considerations that would increase the cost and may be present in some homes include sealing pot lights and kitchen or bathroom exhaust piping. When completed, these measures would dramatically improve the airtightness of an older home. The attic insulation could subsequently be cost-effectively improved by blowing in cellulose insulation (~$0.50/ft^2 for R-20) over the existing insulation.[57]

It is assumed that, on average, the air leakage rate is improved from 10 ACH @ 50Pa to 6 ACH and that the attic insulation is improved from RSI-1.76 (R-10) to RSI-5.29 (R-30).[58] Combined, these modifications represent energy savings of about 20% of HVAC energy.[59] Additional assumptions include a lifetime of 30 years and approximate costs of $2,000 and $1,700 for single detached and attached homes, respectively. In addition, an equipment O&M cost of $10 per year is added to reflect the cost of air sealing measures that can be completed and maintained by the homeowner, such as replacing weather stripping and caulking.

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[57] Based on personal communication with Tony Woods, CanAm Building Envelope Specialists.

[58] Although the current standards for attic insulation are much higher (R-40 or R-50), HOT2000 modeling has shown that the additional energy savings resulting from these levels of insulation may not warrant the additional costs. Thus, a more conservative level of insulation is assumed here.

[59] Energy savings estimate based on HOT2000 models of old leaky homes with these energy-efficiency upgrades being implemented.

4.4.2 New Building Design

New building design integrates advances in both building envelope and space/water conditioning technologies. Two energy-efficiency upgrades that are applicable to new buildings were addressed:[60]

- High-performance Homes (EGH 80/R2000/ENERGY STAR®)
- Under-Slab Insulation.

High-Performance New Homes (EGH 80/R2000/ENERGY STAR®)[61]

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	New
Costs	$3,000 incremental cost
Savings	26% of all HVAC energy
Useful Life	30 years

There are several certification schemes for energy-efficient new homes that incorporate integrated design and multiple envelope measures. An EnerGuide for Houses rating is a standard measure of a home's energy performance, calculated by a professional EnerGuide for Houses advisor. The rating is based on information on the construction of the home and the results of a blower door test performed once the house has been built. A blower door test measures air leakage when the air pressure within the house is lowered a specified amount below the air pressure outside. EnerGuide ratings for new houses fall within the following ranges:

- Typical new houses: 70 to 74 (a house built to code would typically receive a rating of 72)
- Energy-efficient new houses: 77 to 82
- R2000 houses: 80 minimum
- Highly energy-efficient new houses: 80 to 90
- Advanced houses using little or no purchased energy: 91 to 100.

The R2000 standard is one method of achieving an EGH 80 rating. However, R2000 homes are required to achieve a stringent energy budget that is determined by a combination of factors related to heating fuel, house size and climatic data. In addition, R2000 homes are required to achieve an air tightness level of 1.5 ACH @ 50Pa. The key difference between the R2000 standard and the more flexible requirement to meet the EGH 80 rating is that builders do not need to install a heat recovery ventilator (HRV) or meet other environmental requirements of the R2000 program to achieve a rating of EGH 80. This substantially reduces the cost of the measure.[62] The ENERGY STAR® for New

[60] All input assumptions that are not otherwise referenced are from the Marbek internal database.

[61] Cost and savings values shown are based on best available data at the time of this study's assessment of this measure. Assumptions related to the cost and savings for this measure are currently under review and may result in improved economic attractiveness.

[62] The adequacy of ventilation levels in EGH 80 homes may be an issue in the absence of an HRV unit.

Homes program has requirements that are similar to the R2000 program and requires that homes be rated EGH 80.

This analysis estimates that annual space heating savings are 26% relative to standard, non-electrically heated new houses.[63] Electricity savings from air conditioning and ventilation fans, if applicable, would be approximately the same percentage. Typical incremental construction costs for an EGH 80 home are assumed to be $3,000.[64] In addition, a lifetime of 30 years is assumed.

Under-Slab Insulation

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	New
Costs	$4.85/m^2 or about $450 incremental cost
Savings	1.5% of space heating energy
Useful Life	New home lifetime

Several new basement slab insulation products have been developed in recent years. The most popular product for this application is 50mm extruded polystyrene panels. However, a recent CMHC study that compared different types of under-slab insulation concluded that the most cost-effective and best-performing product is composed of 44mm thick polyurethane with steel door skins on each side. This material was originally sourced from window cut-outs of steel-skin doors.[65]

The initial insulation value of the steel-skinned polyurethane was calculated to be RSI-2.56. However, the CMHC study noted that thermal performance of this product decreases moderately with age. Thus a lifetime average insulation value of RSI-2.0 is assumed for this analysis. Based on this assumption, this measure represents approximate space heating energy savings of 1.5%. The CMHC study estimates that the cost of the steel-skinned polyurethane material to be $4.85/m^2, or about $450 for a new home. Its lifetime is equivalent to that a new home.

4.4.3 Space Heating and Ventilation Equipment

Space heating refers to the equipment and controls used to heat residential dwellings. In addition, ventilation equipment circulates fresh air into the home. Nine energy-efficiency upgrade options were identified and assessed for this end use:[66]

- Condensing Furnaces

[63] Assuming a baseline EGH 73 home, which requires 35% more space heating energy than an EGH 80 home. Going from an EGH 73 home to an EGH 80 home represents savings of 35/135=26%. A footnote in Section 3.2 provides more detail on how energy consumption varies with EGH rating number.

[64] Energy impacts are from HOT2000 simulations; cost data are based on discussions with installation contractors (R2000 incremental cost, less the cost of installing an HRV).

[65] CMHC. Comparison of Under-Floor Insulation Systems, Oct. 2004.

[66] All input assumptions that are not otherwise referenced are from the Marbek internal database.

- Condensing Boilers
- High-Efficiency Heat Recovery Ventilators (HRV)
- Programmable Thermostats
- Integrated Mechanical Systems (Heating and DHW)
- Gas-Fired Heat Pumps
- Duct Sealing
- Furnace Tune-ups
- Solar Pre-Heated Make-Up Air.

Condensing Furnaces

Assumptions used for Analysis	
Target Segments	Single detached and attached
Vintage	Existing
Costs	$1,500 incremental cost
Savings	6% of space heating energy
Useful Life	18 years

High-efficiency condensing furnaces feature advanced heat exchanger designs that extract more heat from the flue gases before they are exhausted. So much heat is extracted that the flue gases condense and must be discharged as a condensate rather than a gas. As discussed in Section 3 (Reference Case), the federal government has proposed to increase the minimum performance standard of residential furnaces to 90% by the end of 2009. This means that mid-efficiency non-condensing furnaces (AFUE ~80%) will likely not be available before the first milestone of this study.

As a result, a condensing furnace with an efficiency of 90% is used as a base case and an upgrade to a furnace with an efficiency of 96% is assumed. This unit represents an incremental cost of roughly $1,500 over a 90% AFUE model and would provide about 6% savings in heating energy.[67] Some furnaces also feature variable speed fan motors that can save between 600 kWh/year to 700 kWh/year of the electrical energy use (at an additional incremental cost) but this feature is not assumed to be part of this measure. The typical life of a furnace is 18 years.[68]

Condensing Boilers

Assumptions used for Analysis	
Target Segments	Single detached and attached
Vintage	Existing and new
Costs	$3,200 incremental cost in new and existing
Savings	10% of space heating energy
Useful Life	25 years

[67] Cost information is based on a survey of six HVAC contractors in Southern Ontario.

[68] Efficiency ranges and costs are from manufacturer’s estimates. Estimated life is from ASHRAE.

High-efficiency condensing boilers feature advanced heat exchanger designs that extract more heat from the flue gases before they are exhausted. So much heat is extracted that the flue gases condense and must be discharged as a condensate rather than a gas.

This analysis employs an incremental cost of $3,200 for a residential condensing boiler compared to the price of a mid-efficiency boiler. Non-condensing mid-efficiency boilers have AFUEs ranging from 80% to 87% while condensing high-efficiency units have AFUEs in the range of 88% to 97%. Thus, on average (comparing average efficiencies of 83.5% and 92.5%), an efficient condensing unit can reduce consumption by 10% compared to a non-condensing unit. A high-efficiency boiler also saves up to 50 kWh/year in electrical energy savings from the pump motor. The typical life of a boiler is 18 years.[69]

It should be noted that, in retrofit applications where condensing boilers are replacing non-condensing units, it may be necessary to modify the radiating system. Otherwise, the units may not actually condense the flue gas and realize their full efficiency potential. It is assumed that the cost of any necessary modifications is included in the incremental cost stated above.

High-Efficiency Heat Recovery Ventilators (HRVs)

Assumptions used for Analysis	
Target Segments	Single detached and attached
Vintage	New and existing
Costs	$650 incremental cost in new and existing
Savings	6.5% of space heating energy
Useful Life	15 years

Many new homes now have heat recovery ventilators installed to recover wasted heat energy from centralized exhausts. This analysis assumes that a standard heat recovery ventilator costs approximately $2,500 and results in a 13% reduction in space heating costs. It is further assumed that, in contrast to the standard HRV model, new, high-efficiency HRV units recover approximately 50% more of the energy escaping in ventilation air, which results in an additional 6.5% reduction in space heating costs.

It is also possible to install HRVs in existing homes, especially in cases where the occupants are concerned about air quality. In both new and existing homes, the incremental cost of installing more efficient HRVs rather than standard models is approximately $650. This technology has an estimated life of 15 years.[70]

[69] Efficiency ranges and costs are from manufacturer's estimates. Estimated life is from ACEEE (ASHRAE estimates life of a steel boiler at 25 years, and a cast iron boiler at 35 years).

[70] E-Source Heating Technology Atlas. Data used in 2007 BC Hydro Conservation Potential Review.

Programmable Thermostats

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached with central thermostat
Vintage	New and existing
Costs	$65 full cost in existing $65 incremental cost in new
Savings	12% of space heating 6% of space cooling and ventilation
Useful Life	18 years

Digital programmable thermostats provide improved temperature setting accuracy and are capable of multiple time settings. When combined with an assumed 4ºC temperature setback during night and unoccupied periods, typical space heat savings are in the range of 10% to 15% relative to the baseline, depending on the dwelling's vintage and type of detachment.[71] Other utility studies have indicated that a lower savings percentage should be used to reflect the fact that the thermostat's setback capabilities do not completely reflect how they are used.[72] For example, some home occupants reliably set back manual thermostats while others do not use the setback features on their electronic thermostats. For this study, it is assumed that programmable thermostats result in space heating savings of 12% and space cooling and ventilation savings of 6%.[73]

These thermostats can be installed in both new and existing dwellings. An incremental cost of $65 is assumed for new homes while a full cost of $65 is assumed for existing homes.[74] These units have an expected life of 18 years.[75]

Integrated Mechanical Systems (Heating and DHW)

Assumptions used for Analysis	
Target Segments	Single detached and attached
Vintage	Existing and new
Costs	$800 incremental cost in existing and new
Savings	33% of DHW energy
Useful Life	18 years

Integrated mechanical systems bring the most efficient technologies for residential space heating, water heating and ventilation into one package. For example, the Matrix system by NTI NY Thermal incorporate a condensing furnace, condensing boiler, condensing water heater and HRV all in one unit. Primary benefits of the integrated units include:

- Compact construction

[71] Canadian ENERGY STAR® Savings Calculator.

[72] Enbridge Gas Distribution, Inc., consumer awareness campaign literature, supported by unpublished internal studies.

[73] Savings based on Union DSM measure assumptions.

[74] Pricing based on Union DSM measure assumptions.

[75] Lifetime based on Union DSM measure assumptions.

- Lower cost of installation (only one set of gas, water and ventilation connections are required)
- The price for the integrated system is expected to be lower than the total price for comparable individual systems for heating air and water, once the technology is mature.
- Higher efficiency at lower installation and maintenance costs.

As discussed earlier, the minimum performance standards for furnaces are likely to be brought up to 90% efficiency by the end of 2009. Thus, condensing furnaces can be considered as the baseline and only the DHW savings of the integrated mechanical systems remain. Considering the efficiency improvements of condensing DHW units (see profile for condensing water heaters), reductions in gas use are approximately 33% for DHW energy. This conservative estimate doesn't take into account possible energy savings from the HRV system, which is sometimes integrated.

The estimated installed cost of integrated mechanical systems is approximately $800 more than for conventional furnace and DHW systems. The lifetime of integrated mechanical systems is about 18 years.[76, 77, 78]

Gas-Fired Heat Pumps

Assumptions used for Analysis	
Target Segments	Single detached and attached
Vintage	Existing and new
Costs	$4,000 incremental cost in existing and new
Savings	24% of space heating energy
Useful Life	25 years

Early gas-fired heat pumps, such as the York Triathlon, were unsuccessful due to their bulky size and poor quality design. A new generation of Gas Absorption Heat Pumps (GAHP) is currently available through Robur, an Italian manufacturer. These systems can either be ground-source or air-source (i.e., the heat sink may be either an underground fluid loop or an above ground heat exchanger coil). Air-source systems are substantially less expensive since they don't employ drilled underground fluid loops. However, they can also be much less efficient than ground-source versions since their efficiency is a function of outside air temperature.

Commercial-sized GAHP systems have been available in Canada since mid-2007 but residential-sized systems are not currently available outside of Europe.[79] However, it is anticipated that residential-sized units will become available in Canada within the study period. It is estimated that air-source systems can operate at temperatures as low as -

[76] Nichols, David. Emerging Technologies for a Second Generation of Gas Demand-Side Management, prepared for Enbridge Gas Distribution Inc. (EGDI), 2004.

[77] E Source Technology Profile on eKOCOMFORT.

[78] EKOCOMFORT.

[79] Personal communication with D-B Cooling Systems, Canadian distributor of Robur products.

29°C and have annual efficiencies of 105% in cold winter locations such as Montreal.[80] Compared to a mid-efficiency furnace with an efficiency of about 80%, this represents potential natural gas savings of about 24%. It is estimated that the incremental cost of air-source GAHP systems will be in the range of $4,000. The life of this measure is assumed to be 25 years.[81]

Unlike electric heat pump systems, GAHP do not require any auxiliary heating equipment. In addition, the lack of a mechanical compressor extends their lifetime and allows air-source systems to withstand more extreme temperatures.

Ground-source GAHP have efficiencies (COPs) ranging from 120% to 130% but are prohibitively expensive for most residential applications.

Duct Sealing

Assumptions used for Analysis	
Target Segments	Single detached and attached
Vintage	New and existing
Costs	$1,000 full cost
Savings	5% of HVAC energy
Useful Life	18 years

An estimated 15% to 30% of a home's heating and cooling energy leaks out of the ductwork. Air leaks in and out of ducts at all the connections within a system allow heated or cooled air to escape and, where the duct work is exposed to the outside, can also introduce additional outside air. Even with the heating and cooling system off, the leaks in the ducts increase the ventilation rate of the house, increasing the need for heating or cooling. The problem is particularly pronounced in homes where ductwork is external to the conditioned spaces (such as in the southern U.S., where it often runs through attics). In Canada, where most ducts run within the conditioned space, there is still savings potential. Reducing leakage into the basement will minimize overheating of little-used areas of the house. Reducing leakage can also eliminate the under-heating of rooms at the end of long duct runs, so the thermostat setting can be lowered.

Duct leakage is the result of improper installation and poor materials. Duct tape, which is commonly used, does not adequately seal joints between ducts and has a short life. More stable and permanent materials are needed such as foil tape, fiberglass tape and mastic, or new advanced duct tape. Lawrence Berkeley Laboratory has developed a method for internally sealing heating and cooling ducts using a pressurized aerosol sealant that can reduce duct leakage by up to 90%, reducing energy use by up to 25% in southern climates where ducts run through the attic. In Canada, the savings would be closer to 5%.[82]

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[80] Gaz Métro. Unveiling the results of the geothermal natural gas demonstration project, June 2008.

[81] Personal communication with D-B Cooling Systems, Canadian distributor of Robur products.

[82] Marbek staff participated in studies of the LBL technology in Wisconsin in the mid-1990s to assess its potential in heating-dominated climates with interior ducts. The savings estimate of 5% comes from that first-hand experience.

The Aeroseal® method, marketed by Carrier, is based on this pressurized aerosol sealant. The sealing procedure involves quantifying the percentage of air leaking from the ductwork and identifying the sources of leaks. Next, all intake and exhaust ports are temporarily plugged and the adhesive particles are blown into the air duct system. These particles attach directly onto the edge of any hole or crack and accumulate there until these areas are sealed. This duct sealing process requires 4-8 hours.

A thorough sealing job performed by a knowledgeable contractor with good quality materials can typically reduce heating, cooling and ventilation energy costs by 10% to 20% in homes where the ducts mainly run outside the conditioned space, with costs ranging from $500 to $1,500.[83, 84] This analysis employs an estimate of 5% savings of HVAC energy, reflecting the construction standards more typical of the Ontario climate, where the ducts are within the conditioned space. A measure lifetime of 18 years is assumed.[85]

Furnace Tune-Ups

Assumptions used for Analysis	
Target Segments	Single detached and attached
Vintage	Existing
Costs	$100 full cost
Savings	2% of space heating and ventilation energy
Useful Life	3 years

In addition to improving the efficiency and extending the lifetime of natural gas furnaces, furnace tune-ups result in improved safety and comfort. A qualified professional will assess and adjust several things during a routine inspection/tune-up. For example, they will inspect the venting system, mechanical parts, furnace filter and interior of the combustion chamber. The burners are also generally removed and cleaned and the carbon monoxide level of the flue gas is assessed to ensure that the furnace is burning as cleanly as possible. Based on this assessment, it may be necessary to adjust the burners or air flow.

Other steps that are often carried out in a routine furnace tune-up include testing the heat exchanger for carbon monoxide leaks, checking and adjusting all controls, inspecting wiring and thermocouples and making recommendations on any repairs that are required to the furnace.

On average, it is estimated that furnace tune-ups result in a 2% reduction of space heating and ventilation energy. A low savings percentage is assumed since furnaces no longer incorporate primary air shutters. Thus, it is now more likely that the furnace is optimally burning its fuel. In addition, a cost of $100 and a lifetime of 3 years are assumed in this analysis.

[83] U.S. Department of Energy. ENERGY STAR®.

[84] From Toolbase Services: Technical Resource and discussions with contractors.

[85] BC Hydro, Power Smart. QA standard, Technology: Effective Measure Life, p. 10, Sept. 11, 2006.

Furnace Filter Alarms

Assumptions used for Analysis	
Target Segments	Single detached and attached
Vintage	Existing
Costs	$20 full cost
Savings	N/A
Useful Life	18 years

Furnace filter alarms, such as FilterTone™, are small (~3 inches in diameter) discs that attach to the blower side of furnace filters with push-on pins. As dirt builds up on the filter, the ventilation system must work harder to pull air through it. This increased pressure triggers the filter alarm, and it produces a continuous, pleasant tone to remind homeowners that it's time to clean or replace their filter. The filter alarm is easily removed and reinstalled. Furthermore, since the filter alarm operates much like a whistle, it doesn't require any batteries.

The cost of this product is about $20 and, due to its simple design, it is assumed that its lifetime is equal to that of a furnace, about 18 years.[86] Although filter alarms can extend the life of ventilation equipment and improve indoor air quality, research indicates that they do not result in space heating savings. In fact, filter alarms may cause furnaces to use more natural gas since ventilation fans motors don't need to work as hard. The motors would thus supply less heat to the system.

EnerGuide Natural Gas Fireplaces

Assumptions used for Analysis	
Target Segments	Single detached and attached
Vintage	Existing and new
Costs	$100 incremental cost in existing and new
Savings	20% of fireplace energy
Useful Life	15 years

All vented gas fireplaces sold in Canada must now be tested for their energy efficiency using the Canadian Standards Association CSA-P.4.1-02 standard, if they are shipped across provincial lines. The energy-efficiency rating of the fireplace is printed on the EnerGuide label. Fireplace efficiency ranges from about 20% to 80% but the average efficiency of natural gas fireplaces currently being sold is 60%.[87] EnerGuide recommends that direct vented fireplaces as the safest and most energy-efficient type of fireplace. EnerGuide does not set a minimum efficiency level, so savings are possible by using the EnerGuide label to choose the more efficient unit. The price of natural gas fireplaces has more to do with "add-ons" (e.g., mantles, etched glass, etc.) than with efficiency. As such, an incremental price of $100 is assumed for higher-efficiency models.

[86] Smarthome: Home Automatation Superstore. FilterTone Air System Filter Alarm.

[87] Based on NRCan presentation slide.

This analysis assumes fireplace energy savings of 20% (75% efficiency versus 60% efficiency). Installing a direct vented fireplace also reduces the heating load on the main heating appliance in the home (due to heat losses up the fireplace flue when not in operation). To be conservative, these additional savings have not been included in this analysis. The expected useful life is 15 years.

Solar Pre-Heated Make-Up Air

Assumptions used for Analysis	
Target Segments	Single detached and attached
Vintage	Existing and new
Costs	\$1,300 full cost in existing \$1,300 incremental cost in new
Savings	20% of space heating
Useful Life	20 years

Solar pre-heated ventilation systems consist of perforated steel or aluminum absorber sheets that are mounted vertically on a building's exterior surface. In order to collect the maximum amount of solar radiation, these systems are ideally mounted on southerly facing walls, plus or minus 20 degrees. The dark coloured metal sheets that make up the system are mounted 10 cm to 20 cm away from the building's surface, creating an air cavity between the building and the metal sheets. A negative pressure is created within the cavity by ventilation fans and air is drawn through holes that are typically 1/32" (0.08 mm) in diameter and spaced about 1 cm apart in the metal panels. Before being drawn into the building's ventilation system, the air in the cavity is heated by solar radiation that is absorbed by the dark metal sheets.

On a sunny day, these systems can raise incoming air temperatures by 25°C to 35°C.[88] The collector preheats incoming ventilation air and also reduces heat loss through the portion of the building shell covered by it. In summer months, ventilation air can be drawn directly from the outside through a bypass damper while heated air is rejected through vents at the top of the air cavity.

Several manufacturers produce these types of systems; the best known is the Solarwall® system, manufactured by Conserval Engineering. In addition, Matrix Energy manufactures the MatrixAir™ system while Enerconcept Technologies produces the Unitair™ system. These systems are generally used in commercial and industrial applications with buildings that have large areas of window-less walls. However, they have seen some limited residential use.

Conserval's Solarwall® panels cost about \$32/m^2 for steel and \$43/m^2 for aluminium. With fans, ducts, and controls, the installed cost is on the order of \$130/m^2 of Solarwall® system.[89] Required system size depends on several factors, including location, system orientation and size and required ventilation flow rate. However, a rough estimate based

[88] SolSource Inc. Design Guide for the SolarWall™ Air Heating System.

[89] Personal communication with Conserval Engineering.

on study results suggests that to achieve a 50% reduction in natural gas space heating use, one square meter of paneling should be used for every ten square meters of floor space.[90]

For this analysis, a 10 m^2 system is assumed due to limitations with residential window space and aesthetic issues. Based on the above analysis, this system is estimated to cost $1,300 and represent a 20% reduction in furnace space heating energy. The approximate lifetime of these systems is 20 years. New or existing homes with HRV systems are considered as the baseline for this measure.

As an added benefit, these systems supply homes with make-up air, a feature that is often not present in many homes. The collector surface can also protect aging building material such as brick or stucco in retrofit situations, further improving the financial payback period of these types of systems.

4.4.4 Domestic Hot Water (DHW)

Domestic hot water (DHW) refers to the heated water used for showers, baths, hand washing and clothes and dishwashing (DHW savings for clothes and dishwashers are treated separately in the Major Appliances end-use). Eleven energy-efficiency upgrade options were identified and assessed for this end-use:[91]

- Ultra Low-Flow Showerheads
- DHW Tank Insulating Blanket
- Hot Water Pipe Insulation
- DHW Heat Trap
- DHW Temperature Reduction
- Water Heater Timers
- Condensing Water Heaters
- Tankless Gas-fired DHW
- Wastewater Heat Recovery
- Solar Hot Water Systems (DHW)
- DHW Recirculation Systems (e.g., Metlund D'MAND®).

Ultra Low-Flow Showerheads

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$15 full cost
Savings	16% of DHW energy in existing 45% of personal use water
Useful Life	10 years

Ultra low-flow showerheads have aerators and flow restrictors to reduce water use. At 4.75 LPM (1.25 GPM), their flow rates are substantially lower than traditional low flow

[90] CANSIA. 50% Heat Savings with SolarWall, According to New Report.

[91] All input assumptions that are not otherwise referenced are from the Marbek internal database.

fixtures, whose flow rates range between 7.6 and 9.5 LPM (2.0-2.5 GPM). For this analysis, a baseline flow rate of 9.5 LPM (2.5 LPM) is assumed, partly due to the fact that low-flow fixtures have not completely penetrated the marketplace. Thus, some showerheads have flow rates above 10 LPM.

Based on this assumption, ultra low-flow showerheads result in a 50% reduction in hot water use for showers relative to traditional shower models. Since showers represent about 90% of personal use DHW (also includes faucets) and personal use is assumed to account for approximately 35% of total DHW energy, this represents a 16% reduction in DHW energy. Installed costs are approximately $15 for a single-family dwelling and this measure has an expected life of 10 years.[92]

Although ultra low-flow showerheads use substantially less water than even the low-flow fixtures, initial market studies have shown that customers are fairly accepting of the technology, with a low change-out rate of 5% to 6%.[93]

Hot Water Pipe Insulation

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing
Costs	$1 full cost
Savings	3% of DHW energy
Useful Life	15 years

Hot water pipe insulation reduces the distribution losses for DHW, which account for approximately 5% to 10% of the total water heater energy consumption. In general, however, only the first one or two metres of pipe nearest the DHW tank are accessible enough to insulate. Insulating this section of piping affects both the delivery of hot water and the losses from the tank. Delivery temperature is slightly increased during a hot water draw and the water in the piping does not lose its stored heat as quickly between draws. In theory, the user may respond to the improved delivery temperature by using less hot water (mixing in a higher percentage of cold water, for example), and savings could be as much as 1% from these effects. In reality, users are unlikely to change their behaviour significantly, and the reduction in hot water consumption would be less than 1%. The reduction in losses from the tank is more significant, however. Approximately the first 60 cm of piping acts as a fin, dissipating heat from the tank 24 hours a day. 10 mm of insulation on the first metre or two of piping would reduce this loss by up to 80%, saving between 2% and 3% of DHW energy.

This analysis assumes that hot water pipe insulation reduces total DHW energy consumption by 3%.[94] The materials cost an average of $1 per house and are assumed to be installed by the homeowner. The measure has an expected life of 15 years.[95]

92 Cost and lifetime assumptions are based on Union DSM measure assumptions. This cost reflects a program where these units are purchased in bulk.

93 Based on market research performed by Union in 2008.

DHW Heat Trap

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing (pre-2004 water heaters)
Costs	$65 incremental cost
Savings	3% of DHW energy
Useful Life	9 years

Heat traps are installed on the exit side of the hot water tank to reduce thermal siphoning (i.e., prevent hot water from rising in the pipes when not in use) and related standby losses. A change in DHW tank performance standards in 2004 has meant that heat traps are now an integral component of new water heaters, so this measure only applies to tanks installed before this date. Furthermore, since heat traps are now included with new water heaters, this measure only applies to cases where the homeowner wishes to install this energy saving feature without replacing their water heater. The potential for this measure will diminish with time as older tanks are replaced.

This analysis estimates that in a typical application, total hot water consumption is reduced by about 3%.[96] Typical installed costs are assumed to be $65.[97] However, this installed cost represents the incremental cost of installing a heat trap if a plumber is already visiting the home for another reason. Having a plumber visit just to install a heat trap is deemed to be cost prohibitive. The lifetime of this measure is assumed to be about nine years, or equal to the expected lifetime of a new water heater minus the number of years that DHW heat traps have been mandatory. This accounts for the fact that water heaters must be at least four years old already in order for this measure to apply.

[94] The savings estimate is based on calculations that take into account heat loss from the piping due to both radial heat transfer (i.e., from the hot water in the piping) and axial heat transfer (i.e., from the pipe acting as a hot water tank fin).

[95] Cost and lifetime data based on Union DSM measure assumptions.

[96] Acker, L. Advanced Conservation Technology Inc. Improving the Efficiency of Hot Water Distribution Systems, ACEEE Forum, p. 12, 2008.

[97] Cost and savings data based on Enbridge 2004 CPR.

DHW Temperature Reduction

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached, where water heaters are set above 54°C
Vintage	Existing
Costs	No cost
Savings	2.5% of DHW
Useful Life	Remaining lifetime of water heater Existing: ~ 8 years

In some homes, residential hot water heaters are set at 60°C. This is becoming less common as most modern water heaters are delivered from the factory set to heat to approximately 54°C. For this reason, this measure is only considered for existing homes. In cases where this measure is applicable, reducing the temperature setting on a water heater doesn't typically result in a decrease in hot water consumption since users tend to adjust the amount of cold water to compensate for the reduced hot water temperature. Instead, it results in a reduction of the standby losses associated with hot water storage since it reduces the temperature difference between the heated water and the environment.

For each 1°C reduction in the water heater temperature set point, stand-by losses are reduced by about 2.5%.[98] To avoid an increased risk of bacterial growth in the tank, it is recommended that the hot water temperature not be lowered below 54°C.[99] Thus, a 6°C temperature reduction, which leads to a 15% reduction in stand-by losses, is assumed in this analysis. Since standby losses account for about 16% of DHW energy, this measure represents a potential 2.5% reduction in overall DHW energy. There is no cost associated with this measure since it can be performed by homeowners with minimal effort. In addition, its lifetime is equal to the remaining lifetime of the hot water heater.

Added benefits of this measure include a reduced risk of scalding and a reduction of mineral build-up and corrosion in both the hot water heater and pipes.[100] However, since dishwashers require water that is quite hot, this measure may increase the electricity consumption of many dishwashers by requiring them to use their booster heaters more extensively. This consideration is not addressed in this analysis.

As mentioned above, the potential savings for this measure are diminished, both in reality and in the model constructed for this study, by the fact that some water heaters are already set to 54°C by default. In addition, since most water heater controls are not marked for temperature, it can be difficult to accurately adjust temperature. To overcome this difficulty, hot water temperature can be measured at the tap.

[98] Assuming an ambient air temperature of about 20°C near the storage tank.

[99] Canadian Safety Council. Heated Debate about Hot Water, 2005.

[100] U.S. DOE. Energy Efficiency and Renewable Energy. Lower Water Heating Temperature for Energy Savings, 2007.

Water Heater Timers

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	N/A
Savings	N/A
Useful Life	N/A

Water heater timers can be used to shut off water heaters at times when they aren't being used (e.g., overnight, while at work). This concept is easily adapted to electric water heaters but is more difficult to implement in gas water heaters since many of them are not directly vented. However, this measure can be applied to power vented gas units.

Although this concept is reasonable in principal, water heater timers are redundant in practice. This is because water heater insulation and controls have improved to the point that water heaters can stay in standby mode for up to 15 hours if there is no hot water draw.[101] Therefore, this measure is not considered in the TRC analysis.

Condensing Water Heaters

Assumptions used for Analysis	
Target Segments	Single detached and attached
Vintage	Existing and new
Costs	$1,150 incremental cost in existing and new
Savings	32% of DHW energy
Useful Life	13 Years

Conventional storage water heaters have energy factors in the range of 0.58, meaning that they capture about 58% of the input energy. In contrast, condensing water heaters capture almost all of the heat value of the condensing flue gas water vapour to liquid (about 10% for natural gas), resulting in an overall efficiency of about 85%.[102] In addition, their forced draft burners eliminate off-cycle heat transfer to the flue.

The incremental cost of a condensing water heater relative to a conventional unit is estimated to be $1,150. Based on the efficiencies stated above, incremental DHW savings relative to a conventional water heater are assumed to be 32%. In addition, condensing water heaters are assumed to have a life of 13 years.[103, 104, 105]

[101] Personal communication with Union.

[102] Water heater efficiencies based on *Directory of Certified Product Performance*, Air Conditioning, Heating, and Refrigeration Institute (AHRI) in association with the Gas Appliance Manufacturers Association (GAMA), accessed Aug. 2008.

[103] Emerging Technologies for a Second Generation of Gas Demand-Side Management, 2004, submitted by David Nichols for Enbridge Gas.

[104] ACEEE. Emerging Energy-Saving Technologies and Practices for the Buildings Sector, 2004.

[105] ACEEE. Efficient Water Heating.

Tankless Gas-Fired DHW

Assumptions used for Analysis	
Target Segments	Single detached and attached
Vintage	Existing and new
Costs	$700 incremental cost in existing and new
Savings	33% of DHW energy
Useful Life	20 years

In-line tankless water heaters heat water on demand, eliminating hot water storage. The efficiency of tankless water heaters depends on the water heater's characteristics and on the temperature of the water being heated. Operating efficiencies can be as high as 90% but are more typically in the 75% to 80% range. The absence of hot water storage reduces standby heat losses. One concern with promoting the uptake of on-demand water heaters is that they have a very high energy demand, ranging from two to four times the maximum demand of a standard water heater. This is less of an issue with gas-fired units than it is for electric ones, which pose a significant demand problem for electric utilities. The savings may be somewhat overstated, because standby heat losses from a tank heater during the heating season contribute to meeting the space heating load. Eliminating these losses will tend to increase the gas consumption of the furnace. This effect has not been considered in the saving assumption.

Prices have dropped significantly in the recent past as the technology has matured; however, a significant price gap continues to exist between this technology and the standard tank system. The applicability of tankless gas-fired DHW systems is somewhat limited by venting constraints; the burner is significantly larger than for a standard water heater, so a larger vent is required. Some houses cannot accommodate the larger flue because of requirements for clearance from other structures, windows, etc.

A market-mature incremental cost of $700 is used in this analysis for a tankless water heater relative to a conventional water heater with a storage tank.[106] The seasonal efficiency of a tankless water heater is estimated to be 80%. In combination with reduced standby losses, this results in DHW energy savings of about 33% relative to a conventional tank system. Their useful life is assumed to be 20 years due to the high-quality materials used in tankless water heaters.[107, 108]

[106] This incremental cost is based on cost data from Enbridge Gas DSM measure assumptions. Based on numerous consultations with contractors, this source states that the average installed costs of conventional water heaters and tankless water heaters are $1,956 and $3,273, respectively. Accounting for the differing lifetimes of these water heaters (~12 years for conventional and ~20 years for tankless) and the discount rate employed in this study, the incremental cost of tankless water heaters was found to be about $830. Over the study period, the incremental cost between these technologies is likely to decrease due to maturing technology and increased sales volumes. Thus, a market mature incremental cost of $700 is assumed in this study.

[107] ACEEE. Emerging Energy-Saving Technologies and Practices for the Buildings Sector, 2004.

[108] ACEEE. A Comparative Study of High-Efficiency Residential Natural Gas Water Heating, 2002.

Drain Water Heat Recovery

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$900 full cost in existing $700 full cost in new
Savings	15% of DHW energy
Useful Life	20 years

Residential wastewater heat recovery systems transfer waste heat from drains to pre-heat make-up water. These systems work well only for DHW uses in which the hot water use and the draining of wastewater are simultaneous. Thus, in homes, application to anything other than showers is difficult. Examples of this technology include the GFX system, originally developed with a grant from the U.S. Department of Energy and currently manufactured by Doucette Industries, and the Powerpipe, designed and manufactured by RenewABILITY Energy Inc., a firm based in Waterloo, Ontario. These heat recovery systems incorporate shell-and-tube heat exchangers that typically have efficiencies in the range of 40% to 55%. The cost of these systems varies according to the application, the heat exchanger length and the installation difficulty.

This analysis estimates that, on average, the incremental costs are $900 in existing homes and $700 in new homes. The savings are assumed to be approximately 48% of DHW used for showers.[109, 110] Showers represent about 90% of the personal use of DHW, which in turn is approximately 35% of overall DHW energy use. Thus, the savings potential is approximately 15% of total DHW energy use. The life of this measure is assumed to be 20 years.

Solar Hot Water Systems (DHW)

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$7,000 full cost in existing $7,000 incremental cost in new $70 annual equipment O&M cost in new and existing
Savings	60% of DHW energy
Useful Life	25 years

Solar DHW systems use the energy of the sun to heat water. The primary components of a solar water heating system are a solar collector, a heat transfer fluid and a well-insulated storage tank. Due to Canada's colder climate and the higher likelihood of freezing, active closed-loop systems are generally used. These systems use a pump to

[109] RenewABILITY Energy Inc. Power-Pipe: Backgrounder for Homes.

[110] Natural Resources Canada. Sustainable Buildings and Communities. Drain Water Heat Recovery Characterization and Modeling, July 19, 2007.

circulate a non-freezing heat transfer fluid through the collectors and then through a heat exchanger so that the thermal energy can be transferred to the water.

Two different types of solar collectors are used in solar DHW systems. Glazed flat-plate collectors are insulated shallow rectangular boxes that consist of a tempered glass cover and a black backing to which dark tubing is affixed. The tubing runs back and forth along the dark backing in a serpentine fashion and the heat transfer fluid flows through it. Evacuated tube collectors are made up of rows of parallel transparent glass tubes. Each tube consists of an inner glass tube and an outer glass tube. The space between the tubes is evacuated to reduce heat loss and the inner tube is coated with a special dark coating that absorbs the maximum solar radiation possible. The heat transfer fluid flows within the inner, thermally isolated, tube. Dark fins are also sometimes attached to the inner tube to improve heat transfer. These types of systems work well when cold weather and/or high water temperature are involved.

Solar DHW systems only partially offset the energy requirements of DHW, thus a conventional water heating system is typically used in conjunction with the solar system. Based on a recent study that was completed for the Ontario Ministry of Energy, solar DHW systems can offset about 60% of a home's DHW energy in both service regions.[111,112] Based on this study, the cost of an average solar DHW system is $7,000 and its expected lifetime is 25 years. A 1% annual equipment O&M cost of $70 is assumed in this analysis.

DHW Recirculation Systems (e.g., Metlund D'MAND®)

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$500 full cost
Savings	16% of DHW energy 16% of water for personal use
Useful Life	18 years

When turning on the hot water tap, it is often necessary to wait for extended periods of time before hot water begins to flow from it. This effect is especially prevalent in older homes and is dependent on factors such as the distance between the point of use and the hot water tank and the location, type and diameter of piping being used. While waiting for hot water to flow from the tap, the lukewarm water exiting from it is usually flushed down the drain.

DHW recirculation systems can be used to pump hot water to a faucet at the demand of the user. Lukewarm water that is in the hot water lines is pumped back to the water heater either through the cold water lines or through a dedicated line. This pumping

111 Marbek Resource Consultants. Characterization of the Ontario Residential Solar Hot Water Industry: Draft Final Report, for the Ontario Ministry of Energy, July 15, 2008.

112 Calculations verified for both regions being considered using RETScreen. Solar fraction is largely dependent on the desired water heating temperature; 54°C is assumed in this analysis.

continues until the temperature of the hot water at the point of use reaches a specified value. In retrofit situations, this pumping system is generally installed at the faucet furthest away from the water heater and the system is enabled by remote activation from the other points of use.

On average, systems such as the Metlund Hot Water D'MAND® get hot water to the fixture four to five times quicker than traditional systems.[113] Along with improved convenience and water savings (since water isn't flushed down the drain), energy savings are achieved since the water that is pumped back to the water heater is generally warmer than city water. In addition, since the pump gets water to the fixture more quickly, there is an overall reduction of hot water use.

It is difficult to estimate savings from this measure since hot water use is difficult to predict and highly behaviour-dependent. However, based on a 2001 case study of five buildings, it was estimated that DHW recirculation systems could reduce water consumption by 30,000 L per year and DHW energy use by 16% to 32%.[114] Since the homes that were used in the study were all quite old (more than 50 years), the lower end of this scale, or 16% DHW savings, is assumed as an average for this analysis.

The material cost (not including installation) of Metlund D'MAND® systems was found to vary from $250 to $500, depending mostly on the pump size that is required for each application. An average installed cost of $500 and a lifetime of 18 years are assumed in this analysis.

4.4.5 Major Appliances

Major appliances include clothes washers, dishwashers, ranges and clothes dryers. Four energy-efficiency upgrade options were identified and assessed for this end use:[115]

- High-Efficiency Gas Ranges
- High-Efficiency Gas Dryers
- DHW Savings from Efficient Dishwashers
- DHW and Dryer Savings from Efficient Clothes Washers.

High-Efficiency Gas Ranges

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$650 incremental cost
Savings	20% of cooking energy
Useful Life	20 years

[113] Manufacturer's website, ACT Metlund D'MAND Systems.

[114] Oak Ridge National Laboratory. Water and Energy Savings using Demand Hot Water Recirculating Systems in Residential Homes: A Case Study of Five Homes in Palo Alto, California, Sept. 2002.

[115] All input assumptions that are not otherwise referenced are from the Marbek internal database.

Since gas stovetops involve cooking with an open flame, where combustion is difficult to control and thus inherently inefficient, there is potential for energy-efficiency improvements. Some recent innovations include improved gas valve rotation, meaning that flames exit the valve at a larger proportion of its diameter. This allows for more even heating and a broader range of control from high to low. In addition, some burners bring the flame closer to the surface, spread it over a larger area, and attempt to radiate any wasted heat upwards.

The efficiency of gas ovens can be improved if they include convection cooking features. Convection improves heat transfer to food and can lead to significant reductions in cooking time.

It is assumed that the incremental cost of energy-efficient gas ranges is $650.[116] These units result in a 20% approximate reduction in natural gas consumption for cooking. A lifetime of 20 years is used for this measure.[117]

High-Efficiency Gas Dryers

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$50 incremental cost
Savings	5% of dryer energy (natural gas)
Useful Life	13 years

Since fuel switching is beyond the scope of this study, this measure assesses the savings potential of high-efficiency gas dryers as compared to conventional gas dryers. The major distinction with energy-efficient models is that they incorporate termination controls to sense dryness and turn off automatically. The most efficient models have moisture sensors in the drum for sensing dryness, while other lower-cost and slightly less efficient models infer dryness by sensing the temperature of the exhaust air.

The majority of the retail models currently available employ some type of dryness sensing technology. An incremental cost of $50 is assumed for models with moisture sensors rather than temperature sensors.[118] Models with moisture sensors offer potential natural gas savings of 5% over those with temperature sensors.[119] The lifetime of natural gas dryers is about 13 years.[120]

116 Based on a retail scan of ranges with and without convection.

117 BC Hydro, Power Smart. QA standard, Technology: Effective Measure Life, p. 10, Sept. 11, 2006.

118 Based on a retail scan of low-cost gas dryers with and without moisture sensors.

119 Citizen Gas. Buyer's Guide: Natural Gas Clothes Dryers.

120 Flex your Power: Residential Product Guides.

DHW Savings from Efficient Dishwashers

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$50 incremental cost
Savings	41% of DHW dishwasher energy 41% of dishwasher electrical energy 41% of dishwater water
Useful Life	13 years

ENERGY STAR® dishwashers save energy by using improved technology for the primary wash cycle and by using less hot water to clean. Construction includes more effective washing action, energy-efficient motors and other advanced technologies, such as sensors, that determine the length of the wash cycle and the temperature of the water necessary to clean the dishes. In addition, some advanced dishwashers can sense and adjust for the amount of soil on dishes, using only as much water as necessary.

As of January 1, 2007, the ENERGY STAR® level for dishwashers was changed with a corresponding increase in energy efficiency from 26% better than standard to 41% better. These savings affect both the energy used for heating the water and the mechanical energy of the dishwasher. The incremental cost of a unit meeting these new criteria is assumed to be $50.[121] The estimated life of a dishwasher is 13 years.[122]

DHW and Dryer Savings from Efficient Clothes Washers

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$500 incremental cost
Savings	70% of DHW used for clothes washing 50% of clothes washer electricity 35% of dryer energy 70% of water for clothes washing
Useful Life	14 years

In January 2007, the ENERGY STAR® standard for clothes washers was increased. As a result, the large majority of clothes washers that currently meet ENERGY STAR® requirements are front-loading (horizontal axis) models. Compared to standard models, front-loading clothes washers use 60% to 80% less hot water. In addition, mechanical energy use is reduced by about 50% and dryer energy is reduced by approximately 35%, due to faster spin cycle speeds.[123]

[121] Based on discussions with retailers.

[122] Canadian ENERGY STAR® Calculator.

[123] Savings data based on earlier analysis conducted for Terasen Gas.

This analysis assumes the energy savings outlined above. Incremental costs are assumed to be about $500 more than conventional non-ENERGY STAR® machines, although some high-end models have incremental costs of about $1,000.[124] Horizontal axis clothes washer designs also result in less wear and tear on and fewer wrinkles in clothes. They are assumed to have a life of 14 years.[125]

4.4.6 Swimming Pool Heating

The pool heating end use refers to natural gas heaters for swimming pools that are usually outdoors. The saturation of heated pools in Ontario is relatively low but, where they are present, pool heaters often use as much natural gas as the home's primary space heating appliance. Three energy-efficiency upgrade options were identified and assessed:[126]

- Insulating Swimming Pool Covers
- High-Efficiency Pool Heaters
- Solar Pool Heaters.

Insulating Swimming Pool Covers

Assumptions Used for Analysis	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	New and existing
Costs	$1,200 full cost
Savings	40% of pool heating energy
Useful Life	10 years

Between 30% and 50% of the heat loss from a swimming pool is due to evaporation and can equate to about 500 MJ of lost energy per week. In an outdoor pool, this heat loss either adds to the cost of heating the pool or shortens the swimming season. In an indoor pool, the evaporation not only adds to the cost of heating the pool itself but must also be removed from the pool room by a ventilation system, further increasing the cost. Evaporation also increases the quantity of chemicals that must be added to the pool. A pool cover can reduce evaporation and other heat losses but can also reduce heat gains depending on the design.

An insulating vinyl pool cover is assumed for this analysis. Although substantially more expensive than the bubble type covers, insulating vinyl pool covers are much more robust, and thus, have much longer lifetimes. They are also more effective at trapping heat. This analysis assumes that the installation and regular use of a swimming pool cover will save 40% of the energy used for heating the swimming pool.[127] The reduction in pool chemicals is an additional benefit that is not included in the cost savings. For a

[124] Cost data based on retailer scan.

[125] Canadian ENERGY STAR® Calculator.

[126] All input assumptions that are not otherwise referenced are from the Marbek internal database.

[127] CanREN. How Can I Best Manage My Pool's Energy Use? 2002.

50 m^2 pool, a cover with a manual reel is assumed to cost about $1,200.[128] It is assumed that a swimming pool cover has a life of approximately 10 years.

High-Efficiency Pool Heaters

Assumptions used for Analysis	
Target Segments	Single detached and attached
Vintage	Existing and new
Costs	$2,900 incremental cost
Savings	11% of pool heating energy
Useful Life	15 years

High-efficiency pool heaters incorporate advanced heat exchangers, forced draft combustion systems, pilot-less ignitions and innovations in hydraulics, which result in performance efficiencies between 90% and 95%, compared to efficiencies of 80% to 85% for standard models. If a pool heater is more than eight years old, it is likely only 65% to 75% efficient.

This analysis assumes that the incremental cost of a high-efficiency pool heater is $2,900 and energy savings are 11% relative to a standard efficiency model.[129]

Solar Pool Heaters

Assumptions used for Analysis	
Target Segments	Single detached and attached
Vintage	Existing and new
Costs	$1,850 full cost
Savings	100% of pool heating energy
Useful Life	20 years

Solar pool heaters are similar to solar DHW systems in some respects but do not include storage tanks, and, since they are only used in warmer weather, they generally employ unglazed solar collectors that are mounted of the roofs of houses. These types of collectors are designed for low-temperature applications and are made of some type of polymer. The heat transfer fluid flows within the polymer in a serpentine array. Although solar DHW systems do require a pump, its consumption is similar to that used in natural gas pool heaters.

Solar pool heaters can completely offset the natural gas consumption of conventional pool heaters. They are also much simpler than solar DHW systems and more affordable. Based on a recent study conducted for NRCan and assuming a 7.4 m^2 (80 ft^2) system, the approximate average cost of solar pool heaters is $1,850.[130] A lifetime of 20 years is assumed for this analysis.

128 Cost data is based on supplier quotes.

129 Personal communications with Jandy pool heater manufacturers.

130 Marbek Resource Consultants. Basis of Payment and Level of Incentives for ecoENERGY For Renewable Heat Program, prepared for Natural Resources Canada, March 31, 2008.

5. ECONOMIC POTENTIAL FORECAST

5.1 INTRODUCTION

This section presents the Residential sector Economic Potential Forecast for the study period (2007 to 2017). The Economic Potential Forecast estimates the level of natural gas consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective. In this study, "cost effective" means that the technology upgrade passes the measure total resource cost (TRC) test, as discussed in Section 4.

The discussion in this section is organized into the following subsections:

- Major modelling tasks
- Technologies included in economic potential forecast
- Presentation of results
- Interpretation of results.

5.2 MAJOR MODELLING TASKS

By comparing the results of the Residential sector Economic Potential Forecast with the Reference Case, it is possible to determine the aggregate level of potential natural gas savings within the Residential sector, as well as identify which specific building segments, end uses and technologies can provide the most significant opportunities for savings.

To develop the Residential sector Economic Potential Forecast, the following tasks were completed:

- The measure TRC results for each of the energy-efficiency upgrades presented previously in Exhibits 4.4 and 4.5 were reviewed. The results of the economic analysis for each measure can be found in Appendix A.

- Technology upgrades that had positive measure TRC results were selected for inclusion either on a "full cost" or "incremental" basis. Technical upgrades passing the measure TRC test on a "full cost" basis were implemented in the first forecast year. Those upgrades that only passed the measure TRC test on an "incremental" basis were introduced as the existing stock reached the end of its useful life. If more than one cost-effective measure existed for the same end use application, the study selected the most energy-efficient one.

- Energy use within each of the dwelling types was modelled with the same energy models used to generate the Reference Case. However, for this forecast, the remaining standard efficiency technologies included in the Reference Case forecast were replaced with the most efficient "technology upgrade option" that passed the measure TRC test.

- When more than one upgrade option was applied to a given end use, the first measure selected was the one that reduced the energy load. For example, measures to reduce the overall DHW load (e.g., low-flow showerheads and more efficient dishwashers) would be applied before a high-efficiency water heater. Similarly, the cost effectiveness of the high-efficiency water heater was tested at the new, lower annual load and included only if it continued to pass the measure TRC test.

5.3 TECHNOLOGIES INCLUDED IN ECONOMIC POTENTIAL FORECAST

Exhibit 5.1 provides a listing of the technologies selected for inclusion in this forecast. In each case, the exhibit shows:

- End use affected
- Upgrade option(s) selected
- Dwelling types to which the upgrade options were applied
- Rate at which the upgrade options were introduced into the stock.

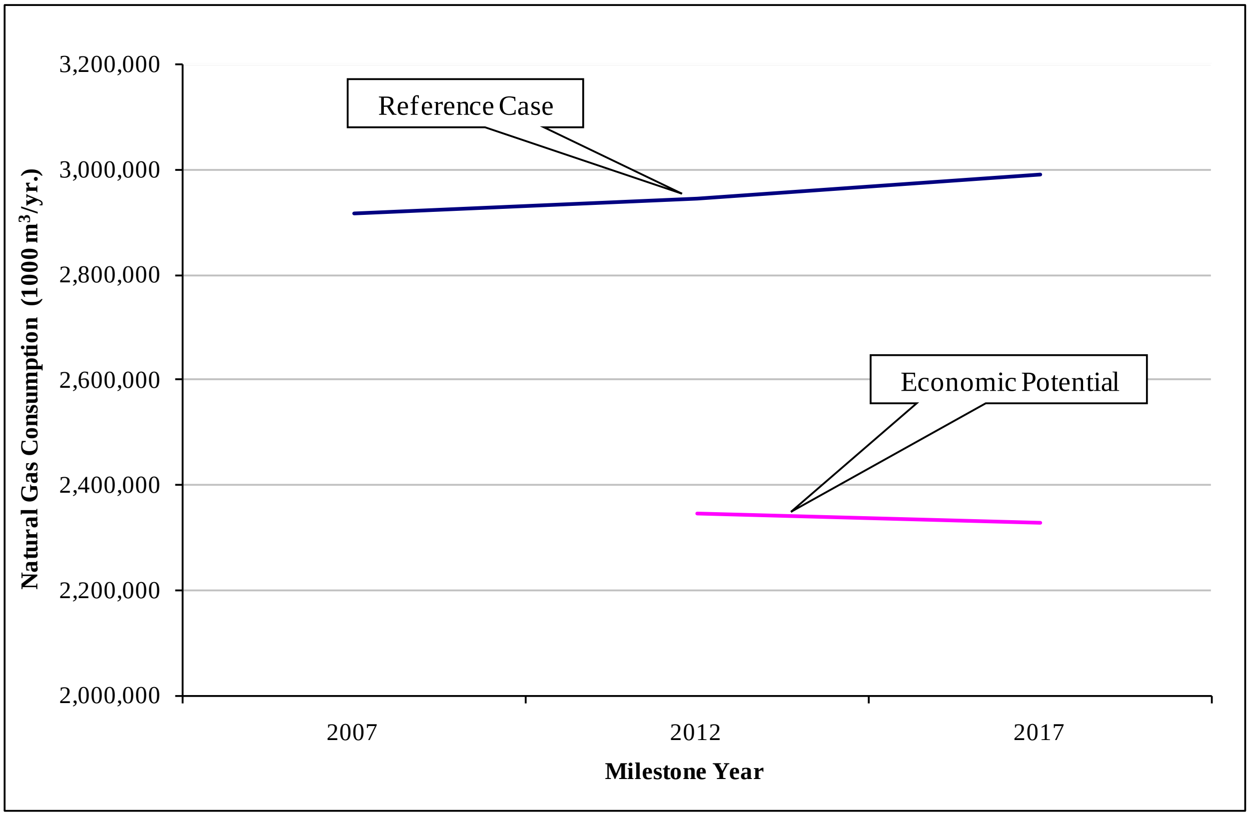
Exhibit 5.1: Technologies Included in Economic Potential

End Use	Upgrade Option	Applicability of Upgrade Options by Dwelling Type	Rate of Stock Introduction
Space Heating	Air sealing and insulation (old homes)	• All existing except Southern Attached	• Old existing homes, immediate
	High -and Super-high performance windows	• All	• New construction, immediate • Existing, at rate of window replacement
	Programmable thermostats	• All	• Immediate
	Solar pre-heated make-up air	• All SFD/Duplex with make-up air systems and/or HRVs	• At rate of renovation for other reasons
DHW	Savings from new washers and dishwashers	• All	• See below for appliances
	Ultra low-flow showerheads	• All Existing	• Immediate
	DHW pipe insulation	• All existing	• Immediate
	DHW temperature reduction	• All	• Immediate
	Instantaneous gas-fired DHW	• All existing or new SFD/Duplex	• New construction, immediate • At rate of heater replacement
	DHW recirculation systems (e.g., Metlund D'MAND®)	• SFD/Duplex, except for new Northern SFD/Duplex	• New construction, immediate • Existing construction, where feasible, immediate
Appliances	ENERGY STAR® dishwashers	• All	• Existing stock, at turnover • New stock, immediate
	ENERGY STAR® clothes washers	• All	• Existing stock, at turnover • New stock, immediate
Pools	Insulating pool cover	• All homes with existing gas heated pools	• Immediate
	Solar pool heater	• All homes with existing gas heated pools	• At rate of heater replacement • New stock, immediate
Fireplace	Efficient fireplaces	• All homes with fireplaces, except Attached new homes in Southern Region	• Existing stock, at turnover • New stock, immediate

5.4 PRESENTATION OF RESULTS

Exhibit 5.2 compares the Reference Case and Economic Potential Forecast levels of residential energy consumption. As illustrated, under the Reference Case residential natural gas consumption would grow from the Base Year level of approximately 2,925 million m^3/year to 2,999 million m^3/year by 2017. This contrasts with the Economic Potential Forecast, in which natural gas consumption would decrease to approximately 2,332 million m^3/year, a difference of approximately 666 million m^3/year or about 22%.

Exhibit 5.2: Reference Case versus Economic Potential - Natural Gas Consumption in Residential Sector, (1000 m^3/yr.)



5.4.1 Natural Gas Savings

Further detail on the total potential natural gas savings provided by the Economic Potential Forecast is provided in the following exhibits:

- Exhibit 5.3 presents the results by region and milestone year.
- Exhibit 5.4 presents the results by sub sector and milestone year.
- Exhibit 5.5 presents the results by end use and milestone year.
- Exhibit 5.6 presents the results end use, technology and milestone year.

Exhibit 5.3: Natural Gas Savings by Service Region and Milestone Year, (1000 m^3/yr.)

Milestone Year	Southern Region	Northern Region	Total	% Savings Relative to Ref Case
	1000 m^3/yr.			
2012	471,615	130,653	602,268	20%
2017	525,765	140,501	666,265	22%
% Savings 2017 Re: Reference Case	23%	21%	22%	
% Savings 2017 Re: Total	79%	21%	100%	

Exhibit 5.4: Natural Gas Savings by Dwelling Type and Milestone Year, (1000 m^3/yr.)

Dwelling Type	Milestone Year		% Savings 2017	
	2012	2017	Re: Ref Case	Re: Total
	1000 m^3/yr.			
Single-Family Detached/ Duplex	571,211	625,640	23%	94%
Attached/Row Housing/Tris & Quads	30,675	40,213	17%	6%
Other	382	412	20%	0%
Total	602,268	666,265	22%	100%

Exhibit 5.5: Natural Gas Savings by End Use and Milestone Year, (1000 m^3/yr.)

End Use	Milestone Year		% Savings 2017	
	2012	2017	Re: Ref Case	Re: Total
	1000 m^3/yr.			
Space Heating	275,993	273,060	15%	41%
DHW	243,312	301,322	43%	45%
Fireplaces	2,912	5,335	5%	1%
Dryers	6,942	13,811	22%	2%
Pool Heaters	73,108	72,738	72%	11%
Total	602,268	666,265	22%	100%

Note: DHW savings include savings from reduced DHW consumption by efficient clothes washers and dishwashers.

Exhibit 5.6: Natural Gas Savings and Benefit/Cost Ratios by End Use, Technology, and Milestone Year (1000 m^3/yr.)[131]

End Use	Technology	Economic Potential (1000 m^3/yr.)		Average B/C Ratio
		2012	2017	
DHW	Hot Water Pipe Insulation	12,045	8,925	64.84
DHW	Ultra Low-Flow Showerheads	110,360	109,616	17.93
Space Heating	Programmable Thermostats	80,568	82,446	11.86
Pools	Solar Pool Heaters	58,293	63,590	4.08
DHW	Efficient Dishwashers	21,603	41,051	3.73
Fireplaces	High-Efficiency Fireplaces	2,912	5,335	1.79
Pools	Swimming Pool Covers	14,815	9,148	1.74
Space Heating	High-Performance Windows	9,118	13,966	1.32
DHW	Tankless Gas-Fired DHW	17,803	31,063	1.15
Space Heating	Solar Pre-Heated Make-Up Air	25,528	25,037	1.09
Dryer	Efficient Clothes Washers	6,942	13,811	1.00
Space Heating	Air Sealing and Insulation (Old Homes)	150,937	132,646	1.00
Space Heating	Super High-Performance Windows	9,842	18,965	1.00
DHW	Efficient Clothes Washers	38,134	72,520	1.00
DHW	DHW Recirculation (Metland D'Mand)	36,971	32,747	0.77
DHW	DHW Temperature Reduction	6,396	5,400	N/A
TOTAL		602,268	666,265	

Note: Any difference in totals is due to rounding.

5.4.2 Electricity Savings

Implementation of the measures contained in the Economic Potential Forecast would also result in collateral electricity savings. For example, measures that improve the building envelope (such as efficient windows) also reduce furnace runtime, thereby saving ventilation fan energy. Similarly, ENERGY STAR® clothes washers and dishwashers use less electricity as well as less hot water.

Further detail on the total potential energy savings provided by the Economic Potential Forecast is provided in the following exhibits:

- Exhibit 5.7 presents the results by service region and milestone year
- Exhibit 5.8 presents the results by dwelling type and milestone year
- Exhibit 5.9 presents the results by end use and milestone year.

131 DHW temperature reduction has no benefit/cost ratio, because it is essentially a no-cost measure.

Exhibit 5.7: Total Electricity Savings by Service Region and Milestone Year, (MWh/yr.)

Milestone Year	Southern Region	Northern Region	Total
	MWh/yr.		
2012	61,596	18,840	80,436
2017	93,423	28,690	122,112

Exhibit 5.8: Total Electricity Savings by Dwelling Type and Milestone Year, (MWh/yr.)

Dwelling Type	Milestone Year		Re: Total
	2012	2017	
	MWh/yr.		
Single-Family Detached/ Duplex	73,563	110,753	91%
Attached/Row Housing/Tris & Quads	6,802	11,251	9%
Other	71	109	0%
Total	80,436	122,112	100%

Exhibit 5.9: Total Potential Electricity Savings by End Use and Milestone Year, (MWh/yr.)

End Use	Milestone Year		Re: Total
	2012	2017	
	MWh/yr.		
Clothes Washers	11,399	24,292	20%
Dishwashers	8,462	18,985	16%
Space Cooling	28,587	37,273	31%
Ventilation	31,988	41,562	34%
Total	80,436	122,112	100%

5.5 INTERPRETATION OF RESULTS

Highlights of the results presented in the preceding exhibits are summarized below:

Savings by Service Region

The Southern region represents 79% of the identified savings. This is to be expected given the large number of customers in this service region.

Savings by Milestone Year

About 90% of the identified economic potential savings in 2017 were identified as economically feasible by 2012. This is because a large number of measures are cost effective at full cost (i.e., it is economically attractive to implement them before the equipment they affect or replace has reached the end of its useful life). Under the economic potential scenario, they would therefore be implemented right away. The other factor that causes 2012 savings to look relatively large as a proportion of 2017 is the natural conservation expected in the Residential sector over the course of the study. Savings are calculated based on the expected difference between the Reference Case forecast (which includes savings from natural conservation) and the Economic Potential Forecast. As naturally occurring savings gradually increase, they erode some of the economic potential.

Savings by Dwelling Type

Single-family dwellings and duplexes account for approximately 94% of the potential savings; this reflects their larger market share and their generally higher level of energy intensity per dwelling.

Savings by End Use

DHW accounts for approximately 45% of the total energy savings in the Economic Potential Forecast. There are several significant DHW energy-saving measures that are economically attractive, including ultra low-flow showerheads, efficient clothes washers and dishwashers, DHW recirculation systems and instantaneous gas-fired DHW systems.

Space heating accounts for approximately 41% of the total energy savings in the Economic Potential Forecast. The largest contributor to these savings is insulation and air sealing in older homes, followed by programmable thermostats, high- and super high-performance windows, and solar pre-heated air systems. While the building envelope measures offer substantial savings, their benefit/cost ratios are typically relatively low; i.e., it will be relatively expensive to achieve savings with programs targeting building envelope measures.

Swimming pool heaters account for approximately 11% of the total savings in the Economic Potential Forecast. Insulating pool covers account for about one sixth of the potential savings and solar pool heaters account for the remainder. Although only approximately 4% of residential gas customers have natural gas pool heaters, the large consumption per unit (on the same order of magnitude as a furnace) and the dramatic savings available (depending on usage patterns, a solar pool heater can reduce natural gas consumption to zero) mean that swimming pool measures offer substantial savings potential.

Clothes dryers account for approximately 2% of the total savings in the Economic Potential Forecast. These savings result from the faster spin cycles of efficient clothes washers.

Fireplaces account for approximately 1% of the savings in the Economic Potential Forecast. The savings measure is a fireplace (or insert) with an efficiency level of at least 75% as measured by EnerGuide. The potential for fireplace measures has been reduced in recent years because of the rise in average efficiency of units being sold.

Measure Summary

The most significant measures in terms of their overall economic saving potential are air sealing and insulation (old homes), ultra low-flow showerheads, programmable thermostats, efficient clothes washers, and solar pool heaters. Combined, these measures account for over 70% of the economic potential in 2017.

The most attractive measure in terms of its benefit/cost ratio is hot water pipe insulation. However, the potential savings for this measure represent only about 1% of the economic savings potential. The ultra low-flow showerheads, programmable thermostats, solar pool heaters, and efficient dishwashers measures all have very attractive benefit/cost ratios as well. However, the economic potential savings for each of these measures is also quite significant. Together, they represent nearly 45% of the economic potential in 2017.

5.5.1 Caveats on Interpretation of Results

A systems approach was used to model the energy impacts of the efficiency upgrades presented in the preceding section. In the absence of a systems approach, there would be double counting of savings and an accurate assessment of the total contribution of the energy-efficient upgrades would not be possible.

For example, a solar pre-heated make-up air system (e.g., SolarWall®) reduces space heating natural gas use, as does the installation of new energy-efficient windows. On its own, each measure will reduce overall space heating energy use. However, the two savings are not cumulative. The order in which some upgrades are introduced is also important. In this study, the approach has been to select and model the impact of measures that reduce the load for a given end use (e.g., wall insulation or window upgrades that reduce the space heating load) and then to introduce measures that meet the remaining load more efficiently (e.g., a high-efficiency space heating system).

The above approach means that where there is interaction between measures that affect the same end use, the savings for those individual measures shown in Exhibit 5.6 are reduced. For example, if the solar pre-heated make-up air system measure was implemented in the absence of any other space heating measures, its savings would be greater than those shown in Exhibit 5.6. As appropriate, this issue is addressed in the Achievable Potential section of this report.

6. ACHIEVABLE POTENTIAL FORECAST

6.1 INTRODUCTION

This section presents the Residential sector Achievable Potential natural gas savings for the study period (2007 to 2017). The Achievable Potential is defined as the proportion of the gross savings identified in the Economic Potential Forecast that could realistically be achieved within the study period.

The discussion is organized into the following sub sections:

- Description of Achievable Potential
- Approach to the Estimation of Achievable Potential
- Achievable Potential Workshop Organization
- Achievable Potential Workshop Results
- Achievable Potential Results
- Summary and Interpretation of Results

6.2 DESCRIPTION OF ACHIEVABLE POTENTIAL

Achievable Potential recognizes that it is difficult to induce all customers to purchase and install all of the energy-efficiency measures that meet the criteria defined by the Economic Potential Forecast presented in the preceding section.

Exhibit 6.1 presents an illustration of the level of natural gas consumption that is estimated in Achievable Potential scenarios. As illustrated in Exhibit 6.1, reductions in natural gas consumption under Achievable Potential are "banded" by the two forecasts presented in previous sections, namely the Reference Case and the Economic Potential Forecast.

Exhibit 6.1: Illustration of Achievable Potential Versus Reference Case and Economic Potential Forecasts

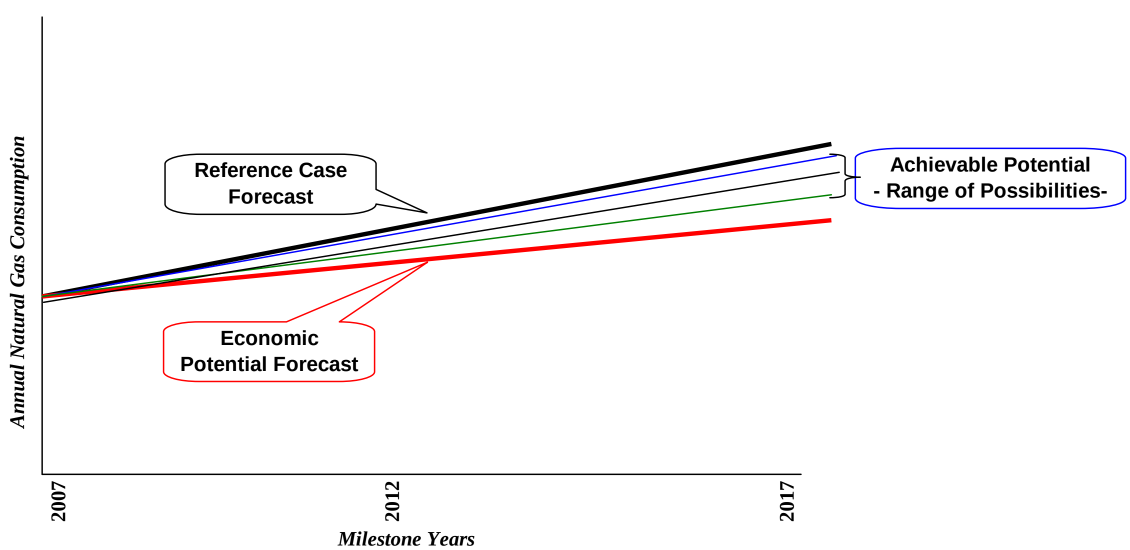


Exhibit 6.1 shows that future natural gas consumption under the Reference Case is greater than in any of the Achievable Potential forecasts. This is because the Reference Case represents a “worst case” situation in which there are no additional utility market interventions and hence no additional natural gas savings beyond those that occur “naturally.”

Exhibit 6.1 also shows that future natural gas consumption under the Achievable Potential is greater than in the Economic Potential Forecast. This is because the Economic Potential Forecast assumes that efficient new technologies fully penetrate the market as soon as it is cost effective to do so. However, the Achievable Potential recognizes that under “real world” conditions, the rate at which customers are likely to implement energy-efficiency measures will be influenced by market constraints and, as a result, implementation will occur more slowly than under the assumptions employed in the Economic Potential Forecast. Exhibit 6.2 illustrates some of the types of market constraints that often affect customer implementation of energy-efficiency measures.

Exhibit 6.2 Illustration of “Typical” Market Constraints Affecting Energy-efficiency (EE) Implementation

Category	Barrier
Price Signals	• No monetization of externalities • Tax and subsidies that affect the playing field between EE and the fuels being displaced
Customer EE Awareness	• Awareness that EE opportunities and products exist • Awareness of benefits – cost and co-benefits • Customers’ technical ability to assess the options.
Product and Service Availability	• Local or national product availability • Existence of a viable infrastructure of trade allies • Vendor or trade ally awareness of the efficiency options and their understanding of the technical issues
Financing of EE Measures	• Access to appropriate financing • Size of required EE investment vs. asset base • Payback Ratio – Actual vs. Required
Transaction Costs	• Level of effort/hassle required to become informed, select products, choose contractor(s) and install
Perceived Risk/Reward	• Level of perceived risk that the EE product may not perform as promised • Level of positive external/personal recognition for “doing the right thing” by installing the EE measure(s)
Split Incentive/Motivation	• Level to which the incentives of the agent charged with purchasing the EE are aligned with those of the person(s) that would benefit
Regulatory	• Codes or standards that prohibit implementation of innovative EE technologies • Level of EE performance that is required in codes or standards

The Achievable Potential scenarios shown in Exhibit 6.1 are presented as a range. This recognizes not only that any estimate of Achievable Potential over a 10-year period is necessarily subject to uncertainty but also that there are different types and levels of potential DSM program intervention. Government and utility DSM program experience throughout North America has shown that energy-efficiency market barriers can be addressed and customer willingness to accept and purchase energy-efficient products can be positively influenced by a variety of potential DSM market intervention strategies, such as those noted below in Exhibit 6.3.

The same body of DSM program experience also recognizes that there are limits to the scope of influence of any utility. It recognizes that some markets or sub markets may be so price sensitive or constrained by market barriers beyond the influence of utility DSM programs that they will only fully act if forced to by legal or other legislative means. It also recognizes that there are practical constraints related to the pace that existing inefficient equipment can be replaced by new, more efficient models or that existing building stock can be retrofitted to new energy performance levels. In addition, the design and implementation of DSM market interventions such as those noted in Exhibit 6.3 require staff and financial resources. In "real world" conditions these resources are also subject to constraints.

Exhibit 6.3 "Illustration" of Potential DSM Market Intervention Strategies[132]

Strategy Type	Description
Alliances	• Vertical integration of market between upstream and downstream market actors (i.e., forming a relationship between contractors and suppliers).
Audit	• An assessment of a building's energy efficiency made by a trained inspector.
Contractor Certification	• An assurance that a given contractor is knowledgeable about the product or service, verified through training and/or testing.
Demonstration	• Providing demonstration of the use/performance of energy-efficient technologies to market actors.
Design Assistance	• Providing recommendations on building or product design.
Financing	• Providing loans to finance the acquisition of a product or service.
Financial Incentives (and Rebates)	• Per measure dollars provided to market participants (generally either end users or distribution channel members) to encourage energy conservation measure installation.
Information	• Passive provision of information to market participants.
Linking Vendors & Customers	• Providing customer contacts to contractors, or contractor/vendor contacts to customers.
Non-Financial Incentives	• Products, changes in procedures, or administrative consolidation to encourage product or service provision.
Promotion	• Active advertising and information made available to the market.
Sales Training	• Providing sales, marketing and/or technical training about products or services to individuals responsible for selling it.
Standards, Labelling	• Setting specific standard levels for energy-efficient technologies. Labelling these technologies accurately for easy consumer/contractor recognition.
Technical Information	• Provision of technical information on energy-efficient products or services.
Technical Support	• Providing answer to technical questions from market actors about energy-efficient products/services after installation.
Technical Training	• Providing training to trade-allies so that they better understand new or existing practices or procedures.
Testing Protocols & Standards	• Standardization of testing protocols for installation and repair.
Third Party Verification	• Inspection and verification provided by an unbiased party on the results of an inspection to insure correct product or service performance.

Source: American Council for an Energy Efficient Economy (ACEEE) Proceedings: 2001.

[132] As in the preceding Exhibit, the strategies shown in Exhibit 6.3 are not necessarily exhaustive; rather, they illustrate the types of options that may be available to DSM program planners.

6.3 APPROACH TO THE ESTIMATION OF ACHIEVABLE POTENTIAL

Consistent with the description outlined above, this study approached the estimation of Achievable Potential by preparing a number of future scenarios, each representing differing assumptions related to the level of DSM program investment over the study period.

In consultation with Union personnel, the study identified two Achievable Potential scenarios to be assessed in this final stage of the study.[133] They are:

- A financially unconstrained DSM investment scenario
- A financially constrained DSM investment scenario, based on the maintenance of historic Union DSM program funding levels

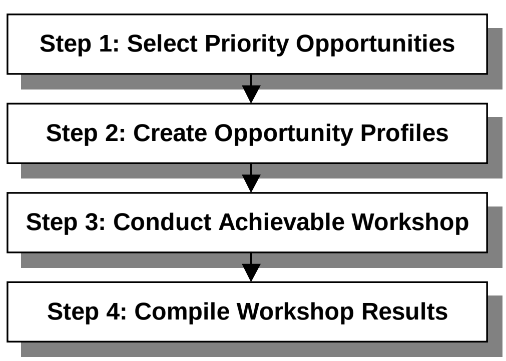
Development of the assumptions employed in each of the above scenarios was based on a combination of Union's own DSM program experience and the results of a one-day workshop involving Union DSM personnel, trade allies and consultant team members.

The workshop results were particularly valuable in generating the DSM investment scenarios; consequently, a brief description of the workshop organization and results is provided in the following sections.

6.4 ACHIEVABLE POTENTIAL WORKSHOP ORGANIZATION

The design and implementation of the Achievable Potential workshop was organized into four steps. The major steps are shown in Exhibit 6.4 and each step is briefly discussed below.

Exhibit 6.4: Approach to Achievable Potential Workshop



[133] It should be emphasized that the estimation of Achievable Potential scenarios is not synonymous with either the setting of specific program targets or with program design. While both are closely linked to the discussion of Achievable Potential, they involve more detailed analysis that is beyond the scope of this study.

Step 1: Select Priority Opportunities

The first step was to review the energy saving opportunities identified in the Economic Potential Forecast and to select a set of those opportunities for discussion in the Achievable Potential workshop. The amount of time available in the Achievable Potential workshop for the discussion of energy-efficiency opportunities was limited. Consequently, the number of opportunities selected for discussion in the workshop was limited to eight, which prior experience had shown to be about the maximum allowable within the available timeframe.

Exhibit 6.5 shows the eight energy-efficiency measures selected for inclusion in the workshop discussions. Selection of the opportunities was based on a qualitative application of criteria that were intended to ensure that the workshop discussions would include:

- Technologies and measures that represent a significant share of the potential energy savings identified in the Economic Potential Forecast
- Review of conditions in a variety of sub markets
- Consideration of new products or markets where little prior DSM experience existed.

Exhibit 6.5: Residential Sector Opportunity Areas

Opportunity Area	Title	Approximate % of Economic Savings Potential
R1a	ENERGY STAR® Windows	2%
R1b	Super-high Performance Windows	3%
R2	Air Sealing and Insulation for Old Homes	20%
R3	Efficient Dishwashers	6%
R4	DHW Recirculation Systems (e.g. Metlund D'MAND)	5%
R5	Instantaneous (Tankless) Water Heaters	5%
R6	Ultra Low-flow Showerheads	16%
R7	Solar Pool Heaters	10%
R8	Programmable Thermostats	12%
	Total	79%

Step 2: Create Opportunity Profiles

Brief profiles were prepared for each Opportunity selected in Step 1. The profiles, which were used to introduce the workshop discussion of each opportunity, provided the following information:

- **Technology description**, e.g., retrofit of existing windows to high-performance models

- **Sub sector and service region**, e.g. existing single-family detached home in Southern service region

- **Selection of a "Typical" application** for discussion purposes

- **Financial and economic indicators for the "Typical" application**, e.g., installed cost, useful life, annual energy savings simple payback, benefit/cost ratio, basis of assessment (incremental versus full cost)

- **Eligible participants** in each milestone period.[134]

Copies of the Opportunity Profile slides are provided in Appendix B.

Step 3: Conduct Achievable Potential Workshop

A one-day Residential sector Achievable Potential workshop was held on September 24, 2008. Workshop participants consisted of core members of the consultant team, DSM personnel from Union, and trade allies operating in the Union Gas franchise area. Together, the participants represented a wide range of expertise and experience related to both the DSM technologies and the markets that were discussed during the workshop.

Following a brief consultant presentation that summarized the study results to date, the workshop provided a structured assessment of each of the selected Opportunities. The assessment of each Opportunity began with a brief consultant presentation, as outlined in Step 2 above. The majority of each assessment consisted of a facilitated discussion of the key elements affecting successful promotion and implementation of the DSM Opportunity. More specifically:

- What are the major constraints/challenges constraining customer adoption of the identified energy-efficiency opportunities
  - How big is the "won't" portion of the market for this opportunity?

- Preferred strategies and potential partners for addressing the identified constraints (high level only)
  - Key criteria that determine customers' willingness to proceed
  - Key potential channel partners
  - Optimum intervention strategies e.g., push, pull, combo
  - How sensitive is this opportunity to incentive levels?

Following discussion of market constraints and potential intervention strategies, participants' views on potential participation rates were recorded. The achievable results were recorded as a band of possibilities. To facilitate workshop discussion, two "high-level" DSM program scenarios were defined:

- **The Aggressive Marketing scenario,** which assumes both an aggressive program approach and a very supportive context, e.g., healthy economy, very strong public commitment to climate change mitigation, etc. The results of this component of the

[134] For the purposes of the workshop, eligible participants were defined as: total population (e.g., existing single-family dwellings) minus those who have already installed the energy-efficiency measure (e.g., 10% of population) or, due to technical constraints, "can't" install the measure (e.g., 5% of population).

discussion provided valuable input into the estimation of the "Financially Unconstrained Scenario."

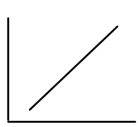
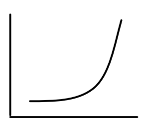
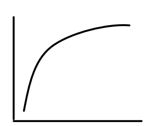
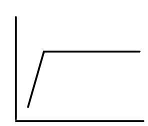
- **The Static Marketing scenario,** which assumes that market interest and customer commitment to energy efficiency and sustainable environmental practices remain approximately as current. Similarly, federal, provincial and municipal government energy-efficiency and GHG mitigation efforts remain similar to the present.

Exhibit 6.6 lists the steps employed in developing the estimated participation rates.

Exhibit 6.6: Workshop Process for Estimating Participation Rates

The steps involved were as follows:

- The participation rate for the Aggressive Marketing scenario in 2017 was estimated.
- The shape of the adoption curve was selected for the Aggressive Marketing scenario. Rather than seek consensus on the specific values to be employed in each of the intervening years, workshop participants selected one of four curve shapes that best matched their view of the appropriate "ramp-up" rate for each opportunity (see below).
- The process was then repeated for the Static scenario.
- Once participation rates had been established for the specific technology, sub sector and service region selected for the Opportunity discussion, workshop participants provided the consultants with guidelines for extrapolating the discussion results to the other sub sectors and service regions included in the Opportunity, but not discussed in detail during the workshop.

Curve A	Curve B	Curve C	Curve D
			

- **Curve A** represents a steady increase in the expected participation rate over the 10-year study period
- **Curve B** represents a relatively slow participation rate during the first half of the 10-year study period followed by a rapid growth in participation during the second half of the 10-year study period
- **Curve C** represents a rapid initial participation rate followed by a relatively slow growth in participation during the remainder of the 10-year study period
- **Curve D** represents a very rapid initial participation rate that results in virtual full saturation of the applicable market during the first milestone year of the 10-year study period.

Step 4: Compile Workshop Results

The results of the eight Opportunities discussed during the workshop were then aggregated and the results of the remaining Opportunities (identified in the Economic Potential Forecast but not discussed during the workshop) were extrapolated.

6.5 ACHIEVABLE POTENTIAL WORKSHOP RESULTS

A summary of the workshop results for each of the Residential sector Opportunities noted previously in Exhibit 6.5 is provided below. In each case, the following information is provided:

- Brief description of the Opportunity and the specific "typical" application selected for the workshop discussion

- Highlights from the workshop discussions related to:
  - Constraints and challenges
  - Potential strategies and partners
  - Incentive sensitivity

- Summary of the estimated participation rates under the Aggressive and Static Marketing scenarios for the selected sub sector
  - Shape of adoption curve selected by the workshop participants

- Summary of the major assumptions employed by the consultants for extrapolating the workshop results to other sub sectors.

6.5.1 R1a - ENERGY STAR® Windows

- **Description**

ENERGY STAR® windows incorporate features such as double glazing, low-e coatings, insulating spacers, argon fills and low conductivity frames to attain insulation values of at least RSI-0.5 (R-2.8). For discussion purposes, the workshop focused on new single detached homes in the Southern service region for this opportunity.

- **Discussion Highlights**

Constraints & Challenges

- The incremental cost of higher-efficiency windows is still significant
- Labelling is a major problem since consumers can't tell the difference or the savings that each type of window represents
- The limited visual effect is also a major factor (i.e., homebuyers don't recognize the benefits since they're hidden. People are more likely to notice and value features such as granite countertops)
- Advances in the standard are possible over the study period but these windows will still represent the same percentage of savings over the baseline.

Potential Strategies and Partners

- ENERGY STAR® standards for windows vary significantly in different regions, based on typical local weather patterns
    - The large majority of Union customers are in Zone B and the incremental cost of these windows in this zone is quite low
- Other benefits of high-performance windows (e.g., improvements related to condensation) need to be "sold" in addition to energy benefits
- Education is vital; must educate both builders and buyers
- The current standard for ENERGY STAR® windows is likely to become the base case in the near future.

Incentive Sensitivity

- This measure is somewhat sensitive to incentive levels.

- **Participation Rates**

Workshop participants concluded that, under the conditions represented by the Aggressive Marketing scenario, a participation rate up to 100% could be achieved in new detached homes in the Southern service region by 2017. A gradually increasing adoption curve, Curve B, seemed the most likely to the workshop participants for the intervening years.

Under the more modest market conditions represented by the Static Marketing scenario, it was decided that the participation rate would only be slightly lower, perhaps 70%. A similar adoption curve would be followed in this case.

- **Participation Rates in Remaining Sub Sectors**

Based on the workshop discussions, it was decided that participation rates would be lower for attached homes and for homes in the Northern service region. The participation rates for existing homes were deemed to be about the same as those derived for new homes, although the measure would only be applied at the rate of natural stock turnover in these cases.

6.5.2 R1b - Super High-performance Windows

- **Description**

To attain insulation values of at least RSI-1.0 (R-5.7), super high-performance windows incorporate features such as triple glazing, transparent insulating films and fibreglass frames. These windows offer additional energy-efficiency gains when compared to ENERGY STAR® windows. For discussion purposes, the workshop focused on new single detached homes in the Southern service region for this opportunity.

- **Discussion Highlights**

Constraints & Challenges

- Cost is the major limiting factor
- Labelling is a major problem since consumers can't tell the difference or the savings that each type of window represents
- The limited visual effect is also a major factor (i.e., homebuyers don't recognize the benefits since they're hidden. People are more likely to notice and value features such as granite countertops)
- Penetration is extremely low right now (generally a luxury option)
- Not every company knows how to handle such windows due to their weight.

Potential Strategies and Partners

- May be beneficial to use a "push" strategy rather than a "pull" strategy (i.e., go up the chain and offer incentives/guaranteed pricing to builders)
- Other benefits of super high-performance windows (e.g., improvements related to condensation) need to be "sold" in addition to energy benefits
- Education is vital; must educate both builders and buyers.
- Retrofit market looks a lot like the custom new build market
- Homes that are oriented towards the south may represent an important sub market (i.e., greatest benefits could be realized here).

Incentive Sensitivity

- Measure is very incentive sensitive.

- **Participation Rates**

Under the conditions represented by the Aggressive Marketing scenario, workshop participants concluded that a participation rate of 30% could be achieved in new detached homes in the Southern service region by 2017. It was also decided that a gradually increasing adoption curve, Curve B, seemed the most likely for the intervening years.

Under the more modest market conditions represented by the Static Marketing scenario, it was decided that the participation rate would be about 3%. A similar adoption curve would be followed in this case.

- **Participation Rates in Remaining Sub Sectors**

Based on the workshop discussions, it was decided that participation rates would be lower for attached homes and for homes in the Northern service region. However, the participation rates for existing homes were deemed to be much higher than those derived for new homes. For existing homes, this measure would only be applied at the rate of natural stock turnover.

6.5.3 R2 - Air Sealing and Insulation for Old Homes

- **Description**

Weatherization measures are often not cost effective if assessed on an average home but they can have a much larger impact on older homes (considered to be at least 30 years old in this analysis). This measure sought to address the large potential presented by older homes by considering separate measures for air sealing and attic/ceiling insulation. For discussion purposes, the workshop focused on existing single detached homes in the Southern service region for this opportunity.

- **Discussion Highlights**

Constraints & Challenges

- Air sealing is usually incorporated with other measures (difficult to sell even though it's very effective in older homes)
- Important to properly seal and insulate the attic, otherwise the increased moisture and heat that is kept inside the home can have a significantly negative impact on roof lifetime
- There seems to be a shortage of air sealing contractors.

Potential Strategies and Partners

- Important to try to group these measures. Can dramatically improve savings for a small increase in cost
- Example niche market for wall insulation is for homes that are replacing the siding (i.e., can improve insulation and air sealing at the same time for a small incremental cost)
- Important to form a strategic alliance between all weatherization contractors, including air sealers, insulators and window installers.

Incentive Sensitivity

- This measure is somewhat sensitive to incentive levels.

- **Participation Rates**

This opportunity was presented at the workshop as two different measures: air sealing for old homes and attic insulation for old homes. From the workshop discussion, it became clear that it was more reasonable for air sealing and insulation to be regarded together as a bundled measure, especially since cost savings can be realized. Further discussion pointed to the fact that the cost assumptions being used were a little low. Since changes were required in framing this opportunity, workshop participants were not able to provide participation rates or adoption curves for either of the marketing scenarios. Participation rates for the resulting air sealing and insulation measure were developed through consultant experience and subsequent consultations with workshop participants.

6.5.4 R3 - Efficient Dishwashers

- **Description**

This measure discusses ENERGY STAR® dishwasher models, which are at least 41% more efficient than what is required by the minimum energy performance standards for dishwashers. Savings include DHW energy (natural gas), electricity (for motor and booster) and water. For discussion purposes, the workshop focused on existing single detached homes in the Southern service region for this opportunity.

- **Discussion Highlights**

Constraints & Challenges

- Free ridership for this measure will be very high, which is obviously negative from a program perspective.

Potential Strategies and Partners

- The retail industry is largely driven by "spiffs" (i.e., small bonuses which are offered to salespeople, either by manufacturers or employers, for the sale of a product)
- May need to train salespeople so that they are able to communicate the advantages of energy-efficient models to customers
- Other energy-efficiency features include timers and the ability to choose whether both levels or just top or bottom racks are to be cleaned.

Incentive Sensitivity

- This measure is thought to have a fairly low sensitivity to incentives.

- **Participation Rates**

Workshop participants concluded that, under the conditions represented by the Aggressive Marketing scenario, a participation rate up to 100% could be achieved in existing detached homes in the Southern service region by 2017. It was also decided that adoption Curve C best represents the fit with the pace of participation in the intervening years. Under the more modest market conditions represented by the Static Marketing scenario, it was decided that the participation rate would be the same and would follow a similar adoption curve in the intervening years.

- **Participation Rates in Remaining Sub Sectors**

Based on the workshop discussions, it was further decided that participation rates would be similar in the Northern service region but slightly lower for attached homes. The participation rates for new homes were deemed to be about the same as those derived for new homes.

6.5.5 R4 - DHW Recirculation Systems (e.g., Metlund D'MAND)

- **Description**

DHW recirculation systems, such as the Metlund D'MAND system, reduce wait times for hot water to reach the tap by a factor of four or five. These systems consist of a pump, valves and a temperature sensor/timer that are all installed at the point of use furthest from the water heater. Lukewarm water in the hot water lines is recirculated back to the inlet of the hot water tank. In addition to reducing the overall water consumption, this reduces DHW energy since the water returning to the tank is warmer than the municipal water supply. For discussion purposes, the workshop focused on existing single detached homes in the Southern service region for this opportunity.

- **Discussion Highlights**

Constraints & Challenges

- A very large detractor is that savings data for this product is very hard to substantiate
    - A limited number of studies have been done on these types of products
    - Needs more field validation, especially in Canada
    - Difficult to design effective testing for this type of technology
- Not well recognized and difficult even for professionals to identify source of savings
- Early stage of market entry, thus DHW recirculation systems are hard to find and installers may not be familiar with them
- Need both a plumber and an electrician in order to install
- Systems can be more effective if a dedicated line is used but cost is also much higher.

Potential Strategies and Partners

- Water savings go a long way in helping this measure pass the economic screen
    - In water-sensitive locations, this will be a much easier sell
- Important to sell co-benefits of technology
    - Can eliminate complaints for hot water wait times, especially effective in new homes and rental units
    - Potential for slight increase in water heater lifetime, due to reducing the shock of cold water (affects the enamel coating of water heaters)
- Important for this product to become recognized by ENERGY STAR® or LEED (especially important for penetration into new build market)
- Possibly an add-on to bathroom renovations but this could be a much slower channel.

Incentive Sensitivity

- Incentives are fairly important to this measure.

- **Participation Rates**

Workshop participants concluded that, under the conditions represented by the Aggressive Marketing scenario, a participation rate up to 10% could be achieved in existing detached homes in the Southern service region by 2017. A gradually increasing adoption curve, Curve B, seemed the most likely to the workshop participants for the intervening years.

Under the more modest market conditions represented by the Static Marketing scenario, it was decided that the participation rate would be quite low, perhaps 1%. A similar adoption curve would be followed in this case.

- **Participation Rates in Remaining Sub Sectors**

Based on the workshop discussions, it was decided that participation rates would be lower for attached homes (since many of these units are rented) and slightly lower in homes in the Northern service region. The potential participation rates for new homes were deemed to be about three times higher, in both the Aggressive and Static Marketing scenarios.

6.5.6 R5 - Tankless Gas-Fired Water Heaters

- **Description**

Tankless water heaters heat water on demand, eliminating stand-by losses associated with storage tanks. For discussion purposes, the workshop focused on new single detached homes in the Southern service region for this opportunity.

- **Discussion Highlights**

Constraints & Challenges

- Actual performance of tankless heaters may be much worse than advertised since efficiency testing is based on unrealistic operating conditions (i.e., testing based on fewer longer draws rather than many short draws)
- Lower cost units don't modulate (i.e., units can only be run at full power)
- In areas with hard water, lifetime could be even more limited
    - May have to install a water softener
- Often returned since they don't meet customer expectations, especially due to a weak support network and general unfamiliarity with these types of water heaters
- Difficult to overcome history of bad experiences.

Potential Strategies and Partners

- Passive systems are best since they can't malfunction nearly as easily.

Incentive Sensitivity

- This measure is somewhat sensitive to incentive levels.

- **Participation Rates**

Workshop participants concluded that, under the conditions represented by the Aggressive Marketing scenario, a participation rate up to 30% could be achieved in new detached homes in the Southern service region by 2017. A steady adoption curve, Curve A, was chosen as the best fit for participation rates in the intervening years. Under the more modest market conditions represented by the Static Marketing scenario, it was decided that the participation rate would be lower, perhaps up to 10%. A similar adoption curve would be followed in this case.

- **Participation Rates in Remaining Sub Sectors**

Based on the workshop discussions, it was decided that participation rates would be lower for attached homes and higher for homes in the Northern service region. The potential participation rates for existing homes were deemed to be about the same as those agreed upon for existing homes. For existing homes, this measure would only be applied at the rate of natural stock turnover.

6.5.7 R6 – Ultra Low-flow Showerheads

- **Description**

Ultra low-flow showerheads consume 4.75 LPM (1.25 GPM), while most traditional low flow models use 9.5 LPM (2.5 GPM). Thus, these showerheads can save about 50% of both the DHW energy and water associated with showers. For discussion purposes, the workshop focused on existing single detached homes in the Southern service region for this opportunity.

- **Discussion Highlights**

Constraints & Challenges

- 20% to 25% of customers will resist this product since they enjoy wand/Waterpik® showerheads
- Multiple setting models don't seem to be commercially available, but handheld version is currently available
- Potential problem may be a risk of shutdown with the plumbing systems in some homes if the flow rate is lower than 1.6 GPM.

Potential Strategies and Partners

- Has been found that performance issues are quite minimal
- Opportunity to educate homeowners since many don't realize how easy it is to replace their showerheads.

Incentive Sensitivity

- The very high benefit/cost ratio associated with this measure suggests that it is not sensitive to the incentive level.

- **Participation Rates**

Workshop participants concluded that, under the conditions represented by the Aggressive Marketing scenario, a participation rate up to 75% could be achieved in existing detached homes in the Southern service region by 2017. It was also decided that adoption Curve C best represents the fit with the pace of participation in the intervening years.

Under the more modest market conditions represented by the Static Marketing scenario, it was decided that the participation rate would also be 75%. However, a steady adoption curve would best represent the intervening years in this case.

- **Participation Rates in Remaining Sub Sectors**

Based on the workshop discussions, it was decided that participation rates would be similar for both attached homes and homes in the Northern service region. Participation rates for new homes would be slightly higher (80%) and would follow the same adoption curves in the intervening years.

6.5.8 R7 - Solar Pool Heaters

- **Description**

Solar pool heaters generally employ unglazed solar collectors that are mounted on the roofs of houses. These systems are much simpler than solar DHW systems and much more affordable. For discussion purposes, the workshop focused on existing single detached homes in the Southern service region for this opportunity.

- **Discussion Highlights**

Constraints & Challenges

- Not easy to install in every house (best to have south or southwest orientation; distance from pool is also a consideration)
- Pool distributors and installers may be a barrier since they want to guarantee that their customers can swim for a certain length of season (i.e., many may not be recommending solar heaters as an option for new pools)
- Other barriers include aesthetics, maintenance issues and some poor systems that were installed in the past (i.e., may have a stigma for some people).

Potential Strategies and Partners

- Since this is a full cost measure and doesn't necessarily need to replace natural gas heaters, it can be promoted to customers as an add-on as well as a replacement
- Technology and market are fairly mature
- The lifetimes of these products have greatly improved in the recent past
- Important to have a strong educational component for a program related to this measure
    - Many customers may not realize that solar heaters can be used in conjunction with their existing heaters
- With growing concerns about climate change, promotional efforts can capitalize on the fact that solar panels are visible and provide tangible evidence that the customer is acting in an environmentally appropriate manner.

Incentive Sensitivity

- Not very sensitive to incentives since the measure is financially very attractive. Free ridership will also probably be very low.

- **Participation Rates**

Workshop participants concluded that, under the conditions represented by the Aggressive Marketing scenario, a participation rate up to 20% could be achieved in existing detached homes in the Southern service region by 2017. It was also decided that a steep and gradually levelling off adoption curve, Curve C, best represents the fit with the pace of participation in the intervening years.

Under the more modest market conditions represented by the Static Marketing scenario, it was decided that the participation rate would be 10%. The same adoption curve would apply in for this scenario.

- **Participation Rates in Remaining Sub Sectors**

Based on the workshop discussions, it was decided that participation rates would be lower for attached homes but similar for homes in the Northern service region. Participation rates for new homes would also be similar.

6.5.9 R8 - Programmable Thermostats

- **Description**

Programmable thermostats allow for temperature setback during nights and unoccupied periods. They also provide improved temperature setting accuracy and more efficient control systems. However, there is an important behavioural aspect associated with the use of these types of thermostats. For discussion purposes, the workshop focused on existing single detached homes in the Southern service region for this opportunity.

- **Discussion Highlights**

Constraints & Challenges

- Very difficult for customers to program some of these on their own
- Some customers may find them difficult to use, especially those who are older. These customers will resist having them installed and may even change them out if they've already been installed
- Proportion of homes that don't have the Internet is about 20%. These people are likely to resist other technologies as well.

Potential Strategies and Partners

- An educational component is needed since many homeowners believe that thermostats act like gas pedals
- Some homeowners may have to have the thermostat installed for them (i.e., could be associated with a furnace replacement).

Incentive Sensitivity

- This measure is somewhat sensitive to incentive levels.

- **Participation Rates**

Workshop participants concluded that, under the conditions represented by the Aggressive Marketing scenario, a participation rate up to 90% could be achieved in existing detached homes in the Southern service region by 2017. It was also decided that a steady adoption curve, Curve A, best represents the fit with the pace of participation in the intervening years.

Under the more modest market conditions represented by the Static Marketing scenario, it was decided that the participation rate would be 70%. The same adoption curve would apply in for this scenario.

- **Participation Rates in Remaining Sub Sectors**

Based on the workshop discussions, it was decided that participation rates would be much lower for attached homes but similar for homes in the Northern service region. Participation rates for new homes would also be similar.

6.5.10 Extrapolated Participation Rates for Remaining Opportunities

As noted previously, the workshop results were used as a reference point. This knowledge was combined with follow-up discussions with some of the workshop participants and consultant experience to estimate participation rates for the remaining energy-efficiency opportunities contained in the Economic Potential Forecast. The extrapolated participation rates are summarized in Exhibits 6.7 and 6.13, presented in Section 6.6.

6.6 ACHIEVABLE POTENTIAL RESULTS

Consistent with the description presented earlier in this section, the Achievable Potential results are presented as a range, which is defined by the following two scenarios:

- A Financially Unconstrained scenario, in which potential is limited by market constraints but not by program budget
- A Static Marketing scenario, in which potential is limited by market constraints as well as DSM program budgets that are approximately similar to current Union levels (although the specific programs and technologies addressed would not necessarily be the same).

The results of each achievable scenario are presented below.

6.6.1 Financially Unconstrained DSM Investment Scenario

The Financially Unconstrained scenario provides an overview of the level of potential natural gas savings that could be achieved if a comprehensive portfolio of DSM programs was launched without any constraint on the availability of program funding. This scenario is based largely on the results of the Aggressive Marketing DSM scenario explored during the Achievable Potential workshop.

Although the results of this scenario are not constrained by program funding, the results do incorporate consideration of the market constraints identified during the Achievable Potential workshop (see Exhibit 6.2), such as product and service availability, customer transaction costs, etc.

This scenario, therefore, provides a high level estimate of the upper level of natural gas savings that could be achieved by Union's residential customers over the nine-year period beginning in 2009 and ending in 2017. It also provides Union's residential DSM program personnel with a view of the relative potential contribution of individual sub sectors, end uses, technologies and service regions.

Major Assumptions: Financially Unconstrained Scenario

- All measures that pass the measure TRC screen are included
- No program financial limit is set, except that all measures must continue to pass the measure TRC screen
- Participation rates are constrained by the market barriers noted in the workshop
- Participation rates for measures discussed in the workshop are employed directly and are shown in Exhibit 6.7. These measures are identified in the exhibit with a Workshop Reference #, and in the notes column. The 2017 participation rate and the adoption curve shape (from those shown in Exhibit 6.6) are those chosen by the workshop participants.
- Participation rates for the remaining measures are extrapolated from the workshop results and/or consultant experience and are shown in Exhibit 6.7. These measures in the exhibit have no Workshop Reference #. The extrapolation method is noted.
- Fixed program costs (e.g., advertising, training workshops, contractor certification etc.,) and incentive costs are included for each measure. The levels selected for the scenario are summarized in Exhibit 6.8. In each case the values shown draw on the workshop results and recent Union DSM program experience.

Exhibit 6.7: Participation Rates for Financially Unconstrained Scenario

Workshop Reference #	Upgrade Technology/Measures	Participation Rate 2017	Adoption Curve Shape	Notes
R1a	High-Performance Windows	100%	B	Workshop measure R1a
R1b	Super High-Performance Windows	30%	B	Workshop measure R1b
	Air Sealing and Insulation (Old Homes)	30%	B	Based on consultant experience
R8	Programmable Thermostats	90%	A	Workshop measure R8
	Solar Pre-Heated Make-Up Air	20%	B	Based on workshop measure R7
R6	Ultra Low-Flow Showerheads	75%	C	Workshop measure R6
R3	Efficient Dishwashers	100%	C	Workshop measure R3
	Efficient Clothes Washers	100%	C	Based on workshop measure R3
	DHW Temperature Reduction	50%	C	Based on consultant experience
	Hot Water Pipe Insulation	90%	A	Based on workshop measure R8
R4	DHW Recirculation (Metland D'Mand)	10%	B	Workshop measure R4
R5	Tankless Gas-Fired DHW	30%	C	Workshop measure R5
	High-Efficiency Fireplaces	50%	A	Based on consultant experience
	Swimming Pool Covers	50%	C	Based on consultant experience
R7	Solar Pool Heaters	20%	B	Workshop measure R7

Exhibit 6.8: Summary of Program Cost Assumptions – Financially Unconstrained Scenario[135]

Upgrade Technology/Measures	Fixed Program Costs ($/yr.)	Measure Basis	Measure Cost ($)[A]	Incentive Level (% of cost)[B]	Payback After Incentive (yrs.)
High-Performance Windows	50,000	Incr.	500	100%	0.0
Super High-Performance Windows		Incr.	950	100%	0.0
Air Sealing and Insulation (Old Homes)		Full	2,000	30%	5.0
Programmable Thermostats	50,000	Full	65	75%	0.1
Solar Pre-Heated Make-Up Air	50,000	Full	1,300	30%	4.7
Ultra Low-Flow Showerheads	440,000	Full	15	100%	0.0
Hot Water Pipe Insulation		Full	1	100%	0.0
Efficient Dishwashers	50,000	Incr.	50	100%	0.0
Efficient Clothes Washers		Incr.	500	20%	2.8
DHW Temperature Reduction	50,000	Full	N/A	0%	0.0
DHW Recirculation (Metland D'Mand)	50,000	Full	500	30%	4.9
Tankless Gas-Fired DHW	50,000	Incr.	700	100%	0.0
High-Efficiency Fireplaces	50,000	Incr.	100	50%	1.7
Swimming Pool Covers	50,000	Full	1,200	13%	2.4
Solar Pool Heaters		Full	1,850	11%	1.5

[A] Where measure cost varies by region and/or housing type, the cost for existing single detached homes in the Southern service region is shown

[B] The percentage of the cost reflects whether a full or incremental cost measure is being considered

Results: Financially Unconstrained Scenario

Under the conditions defined by the Financially Unconstrained scenario, total Residential sector natural gas savings in 2017 are estimated to be approximately 357 million m^3/yr. This represents a saving of approximately 12%, relative to the Reference Case and is equal to approximately 54% of the savings identified in the Economic Potential Forecast. Further detail is provided in the following exhibits:

- Exhibit 6.9 shows total natural gas savings by service region and milestone year.
- Exhibit 6.10 shows total natural gas savings by dwelling type and milestone year for the total Union Service Area.
- Exhibit 6.11 shows total natural gas savings by end use and milestone year for the total Union Service Area.

[135] Fixed program costs and incentive levels were provided by Union based on workshop results and current experience. Where fixed program costs apply to a bundle of measures, costs are distributed among the measures weighted by total savings potential. Salary and related overhead costs are not included in program cost estimates. Also, the incentive levels are capped at 100% of the indicated measure cost.

- Exhibit 6.12 shows annual natural gas savings for the year 2017, by technology, together with the estimated program costs and TRC benefits for the total Union Service Area. (Note: the values shown in Exhibit 6.11 are for the single year 2017 only; consequently, they do not add to the same values shown in the preceding exhibits.)

Exhibit 6.9: Natural Gas Savings by Service Region and Milestone Year, Financially Unconstrained Scenario (1000 m^3/yr.)

Milestone Year	Southern Region	Northern Region	Total	% Savings Relative to Ref Case
	1000 m^3/yr.			
2012	148,130	40,105	188,235	6%
2017	281,305	75,276	356,581	12%
% Savings 2017 Re: Reference Case	12%	11%	12%	
% Savings 2017 Re: Total	79%	21%	100%	

Exhibit 6.10: Natural Gas Savings by Dwelling Type and Milestone Year for the Total Union Service Area, Financially Unconstrained Scenario (1000 m^3/yr.)

Dwelling Type	Milestone Year 2012	Milestone Year 2017	% Savings 2017 Re: Ref Case	% Savings 2017 Re: Total
	1000 m^3/yr.			
Single-Family Detached/ Duplex	175,460	332,182	12%	93%
Attached/Row Housing/Tris & Quads	12,657	24,176	10%	7%
Other	117	223	11%	0%
Total	188,235	356,581	12%	100%

Exhibit 6.11: Natural Gas Savings by End Use and Milestone Year for the Total Union Service Area, Financially Unconstrained Scenario (1000 m^3/yr.)

End Use	Milestone Year 2012	Milestone Year 2017	% Savings 2017 Re: Ref Case	% Savings 2017 Re: Total
	1000 m^3/yr.			
Space Heating	55,827	133,973	7%	38%
DHW	117,635	190,789	27%	54%
Fireplaces	728	1,940	2%	1%
Dryers	5,207	12,075	19%	3%
Pool Heaters	8,838	17,804	18%	5%
Total	188,235	356,581	12%	100%

Note: DHW savings include savings from reduced DHW consumption by efficient clothes washers and dishwashers.

Exhibit 6.12: Annual Natural Gas Savings by Technology for One Year of Program Activity (2017) for the Total Union Service Area, Financially Unconstrained Scenario

End Use	Technology	Financially Unconstrained Potential 2017		Program Costs, 2017 (thousands $)	Program Costs per Unit	
		Gas Savings (1000 m^3/yr.)	TRC Benefits (thousands $)		per Natural Gas Savings ($/$m^3$)	per TRC Benefits ($/$)
Space Heating	High-Performance Windows	1,687	3,267	5,777	$3.42	$1.77
Space Heating	Super High-Performance Windows	712	0	3,147	$4.42	*
Space Heating	Programmable Thermostats	7,616	28,818	1,782	$0.23	$0.06
Space Heating	Solar Pre-Heated Make-Up Air	1,026	301	1,131	$1.10	$3.75
Space Heating	Air Sealing and Insulation (Old Homes)	7,561	6,081	9,908	$1.31	$1.63
DHW	Ultra Low-Flow Showerheads	828	4,503	332	$0.40	$0.07
DHW	Efficient Dishwashers	302	936	268	$0.89	$0.29
DHW & Appliances	Efficient Clothes Washers	623	2,000	438	$0.70	$0.22
DHW	DHW Temperature Reduction	30	69	50	$1.65	$0.73
DHW	Hot Water Pipe Insulation	908	2,993	277	$0.31	$0.09
DHW	DHW Recirculation (Metland D'Mand)	798	249	1,202	$1.51	$4.82
DHW	Tankless Gas-Fired DHW	112	62	418	$3.72	$6.78
Fireplaces	High-Efficiency Fireplaces	194	278	231	$1.19	$0.83
Pools	Swimming Pool Covers	46	50	10	$0.21	$0.19
Pools	Solar Pool Heaters	2,514	7,217	302	$0.12	$0.04
	Weighted Average				$1.01	$0.44

* Super high-performance windows have a positive TRC with respect to the base case, but not when compared to the high-performance windows. Therefore, the TRC benefits of the super windows are actually included in the line above.
Note: Program costs = fixed program costs plus incentives.

6.6.2 Static Marketing Scenario

The Static Marketing scenario is based largely on the results of the Static Marketing scenario explored during the Achievable Potential workshop. Consequently, it incorporates consideration of both market constraints and DSM program budget limitations, which are roughly consistent with current Union levels.

This scenario, therefore, provides a high level estimate of the level of natural gas savings that could be achieved by Union's residential customers over the nine-year period beginning in 2009 and ending in 2017, assuming present levels of program activity and a somewhat different mix of programs. It also provides Union's residential DSM program personnel with a view of the relative potential contribution of individual sub sectors, end uses, technologies and service regions.

Major Assumptions: Static Marketing Scenario

- All measures that pass the measure TRC screen are included
- Program spending levels are similar to current Union DSM activity, with a different mix of programs
- Participation rates are constrained by the market barriers noted in the workshop
- Participation rates for measures discussed in the workshop are employed directly and are shown in Exhibit 6.13. These measures are identified in the exhibit with a Workshop Reference #, and in the notes column. The 2017 participation rate and the

adoption curve shape (from those shown in Exhibit 6.6) are those chosen by the workshop participants.

- Participation rates for the remaining measures are extrapolated from the workshop results and/or consultant experience and are shown in Exhibit 6.13. These measures in the exhibit have no Workshop Reference #. The extrapolation method is noted.
- Fixed program costs (e.g., advertising, training workshops, contractor certification etc.,) and incentive costs are included for each measure. The levels selected for the scenario are summarized in Exhibit 6.14. In each case the values shown draw on the workshop results and recent Union DSM program experience.

Exhibit 6.13: Participation Rates for Static Marketing Scenario

Workshop Reference #	Upgrade Technology/Measures	Participation Rate 2017	Adoption Curve Shape	Notes
R1a	High-Performance Windows	70%	B	Workshop measure R1a, consultant experience
R1b	Super High-Performance Windows	3%	B	Workshop measure R1b
	Air Sealing and Insulation (Old Homes)	3%	B	Based on consultant experience
R8	Programmable Thermostats	70%	A	Workshop measure R8
	Solar Pre-Heated Make-Up Air	10%	B	Based on workshop measure R7
R6	Ultra Low-Flow Showerheads	75%	A	Workshop measure R6
R3	Efficient Dishwashers	100%	C	Workshop measure R3
	Efficient Clothes Washers	80%	C	Workshop measure R3, consultant experience
	DHW Temperature Reduction	40%	C	Based on consultant experience
	Hot Water Pipe Insulation	70%	A	Based on workshop measure R8
R4	DHW Recirculation (Metland D'Mand)	1%	B	Workshop measure R4
R5	Instantaneous Gas-Fired DHW	10%	C	Workshop measure R5
	High-Efficiency Fireplaces	20%	A	Based on consultant experience
	Swimming Pool Covers	20%	C	Based on consultant experience
R7	Solar Pool Heaters	10%	B	Workshop measure R7

Exhibit 6.14: Summary of Program Cost Assumptions – Static Marketing Scenario[136]

Upgrade Technology/Measures	Fixed Program Costs ($/yr.)	Measure Basis	Measure Cost ($)[A]	Incentive Level (% of cost)[B]	Payback After Incentive (yrs.)
High-Performance Windows	20,000	Incr.	500	50%	2.9
Super High-Performance Windows		Incr.	950	25%	6.1
Air Sealing and Insulation (Old Homes)		Full	2,000	10%	6.4
Programmable Thermostats	10,000	Full	65	30%	0.4
Solar Pre-Heated Make-Up Air	20,000	Full	1,300	10%	6.0
Ultra Low-Flow Showerheads	440,000	Full	15	100%	0.0
Hot Water Pipe Insulation		Full	1	100%	0.0
Efficient Dishwashers	20,000	Incr.	50	30%	0.9
Efficient Clothes Washers		Incr.	500	10%	3.1
DHW Temperature Reduction	20,000	Full	N/A	0%	0.0
DHW Recirculation (Metland D'Mand)	20,000	Full	500	10%	6.3
Tankless Gas-Fired DHW	20,000	Incr.	700	50%	3.0
High-Efficiency Fireplaces	20,000	Incr.	100	15%	2.8
Swimming Pool Covers	20,000	Full	1,200	8%	2.5
Solar Pool Heaters		Full	1,850	5%	1.6

[A] Where measure cost varies by region and/or housing type, the cost for existing single detached homes in the Southern service region is shown

[B] The percentage of the cost reflects whether a full or incremental cost measure is being considered

Results: Static Marketing Scenario

Under the conditions defined by the Static Marketing scenario, total Residential sector natural gas savings in 2017 are estimated to be approximately 261 million m^3/yr. This represents a saving of approximately 9%, relative to the Reference Case and is equal to approximately 39% of the savings identified in the Economic Potential Forecast. Further detail is provided in the following exhibits:

- Exhibit 6.15 shows total natural gas savings by service region and milestone year
- Exhibit 6.16 shows total natural gas savings by dwelling type and milestone year for the total Union Service Area
- Exhibit 6.17 shows total natural gas savings by end use and milestone year for the total Union Service Area
- Exhibit 6.18 shows annual natural gas savings for the year 2017 by technology, together with the estimated program costs and TRC benefits for the total Union Service Area. (Note: the values shown in Exhibit 6.11 are for the single year 2017 only; consequently, they do not add to the same values shown in the preceding exhibits.)

136 Fixed program costs and incentive levels were provided by Union, based on workshop results and current experience. Where fixed program costs apply to a bundle of measures, costs are distributed among the measures weighted by total savings potential. Salary and related overhead costs are not included in program cost estimates. Also, the incentive levels are capped at 100% of the indicated measure cost.

Exhibit 6.15: Natural Gas Savings by Service Region and Milestone Year, Static Marketing Scenario (1000 m^3/yr.)

Milestone Year	Southern Region	Northern Region	Total	% Savings Relative to Ref Case
	1000 m^3/yr.			
2012	103,267	27,745	131,012	4%
2017	207,545	53,856	261,401	9%
% Savings 2017 Re: Reference Case	9%	8%	9%	
% Savings 2017 Re: Total	79%	21%	100%	

Exhibit 6.16: Natural Gas Savings by Dwelling Type and Milestone Year for the Total Union Service Area, Static Marketing Scenario (1000 m^3/yr.)

Dwelling Type	Milestone Year		% Savings 2017	
	2012	2017	Re: Ref Case	Re: Total
	1000 m^3/yr.			
Single-Family Detached/ Duplex	121,436	240,922	9%	92%
Attached/Row Housing/Tris & Quads	9,496	20,321	9%	8%
Other	80	158	8%	0%
Total	131,012	261,401	9%	100%

Exhibit 6.17: Natural Gas Savings by End Use and Milestone Year for the Total Union Service Area, Static Marketing Scenario (1000 m^3/yr.)

End Use	Milestone Year		% Savings 2017	
	2012	2017	Re: Ref Case	Re: Total
	1000 m^3/yr.			
Space Heating	34,812	74,198	4%	28%
DHW	87,527	168,134	24%	64%
Fireplaces	291	776	1%	0%
Dryers	4,165	9,660	15%	4%
Pool Heaters	4,217	8,634	9%	3%
Total	131,012	261,401	9%	100%

Note: DHW savings include savings from reduced DHW consumption by efficient clothes washers and dishwashers.

Exhibit 6.18: Annual Natural Gas Savings by Technology for One Year of Program Activity (2017) for the Total Union Service Area, Static Marketing Scenario

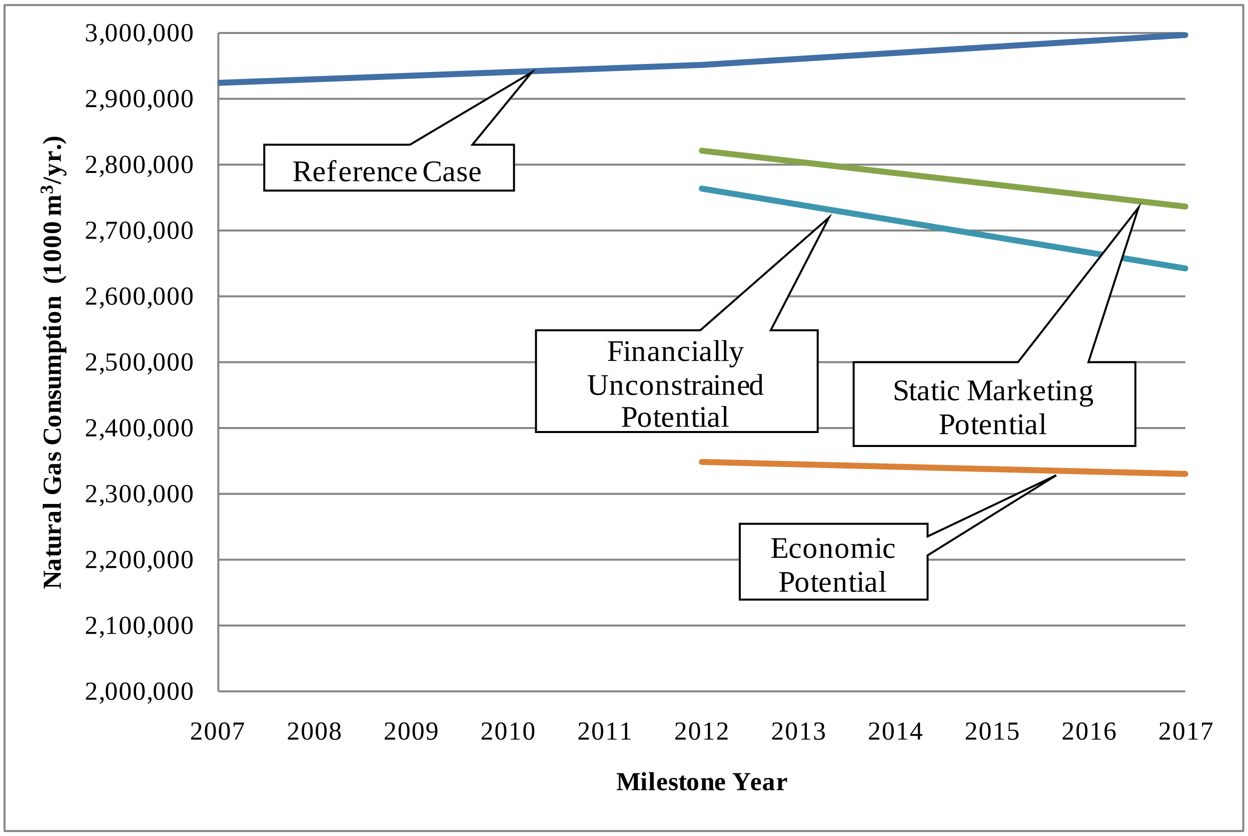
End Use	Technology	Static Marketing Potential, 2017		Program Costs, 2017 (thousands $)	Program Costs per Unit	
		Gas Savings (1000 m^3/yr.)	TRC Benefits (thousands $)		per Natural Gas Savings ($/$m^3$)	per TRC Benefits ($/$)
Space Heating	High-Performance Windows	1,215	2,351	2,081	$1.71	$0.88
Space Heating	Super High-Performance Windows	77	0	86	$1.12	*
Space Heating	Programmable Thermostats	6,062	22,942	561	$0.09	$0.02
Space Heating	Solar Pre-Heated Make-Up Air	531	156	207	$0.39	$1.32
Space Heating	Air Sealing and Insulation (Old Homes)	756	608	344	$0.46	$0.57
DHW	Ultra Low-Flow Showerheads	828	4,503	332	$0.40	$0.07
DHW	Efficient Dishwashers	306	949	83	$0.27	$0.09
DHW & Appliances	Efficient Clothes Washers	503	1,616	177	$0.35	$0.11
DHW	DHW Temperature Reduction	25	56	20	$0.81	$0.36
DHW	Hot Water Pipe Insulation	719	2,368	267	$0.37	$0.11
DHW	DHW Recirculation (Metland D'Mand)	83	26	60	$0.72	$2.34
DHW	Tankless Gas-Fired DHW	40	22	85	$2.14	$3.91
Fireplaces	High-Efficiency Fireplaces	78	111	42	$0.54	$0.37
Pools	Swimming Pool Covers	18	20	3	$0.15	$0.13
Pools	Solar Pool Heaters	1,293	3,712	85	$0.07	$0.02
	Weighted Average				$0.35	$0.11

* Super high-performance windows have a positive TRC with respect to the Reference Case, but not when compared to the high-performance windows. Therefore, the TRC benefits of the super windows are already included in the line above.
Note: Program costs = fixed program costs plus incentives.

6.7 SUMMARY AND INTERPRETATION OF RESULTS

Exhibit 6.19 provides a summary of the achievable natural gas savings under the Static Marketing and Financially Unconstrained scenarios presented in the preceding section. Results are shown relative to the Reference Case and Economic Potential Forecasts.

Exhibit 6.19: Achievable Potential versus Reference Case and Economic Potential Forecasts, for the Total Union Service Area



Further highlights are provided below.

The Financially Unconstrained Scenario

- Under the conditions defined by the Financially Unconstrained scenario, total Residential sector natural gas savings in 2017 are estimated to be approximately 357 million m^3/yr. This represents a saving of approximately 12% relative to the Reference Case and is equal to approximately 54% of the savings identified in the Economic Potential Forecast.

- The most significant opportunities for natural gas savings in this scenario are technologies that reduce space heating requirements. Air sealing in older homes is a particularly large opportunity in this scenario together with high-performance windows and programmable thermostats. Solar pool heaters are also a relatively large opportunity.

- Program costs per m^3 of natural gas savings in this scenario range widely by measure, from approximately $0.12 for solar pool heaters to almost $4.00 for tankless water heaters.

- Program costs per dollar of TRC benefit also show a wide range, from approximately $0.04 for solar pool heaters to almost $7.00 for tankless water heaters.

- Weighted averages for the whole group of measures show 2017 program costs of approximately $1.01/m^3 of natural gas savings and approximately $0.44/TRC dollar. These values are nearly five times higher than Union's current program results.[137]

The Static Marketing Scenario

- Under the conditions defined by the Static Marketing scenario, total Residential sector natural gas savings in 2017 are estimated to be approximately 261 million m^3/yr. This represents a saving of approximately 9%, relative to the Reference Case and is equal to approximately 39% of the savings identified in the Economic Potential Forecast.

- The most significant opportunities for natural gas savings are technologies that reduce space heating requirements, such as high-performance windows, programmable thermostats and air sealing in older homes. Solar pool heaters are also a relatively large opportunity.

- Program costs per m^3 of natural gas savings also range widely by measure in the Static Marketing scenario, from approximately $0.07 for solar pool heaters to over $2.00 for tankless water heaters.

- Program costs per dollar of TRC benefit show a similar wide range, from approximately $0.02 for solar pool heaters to almost $4.00 for tankless water heaters.

- Weighted averages for the whole group of measures included in the Static Marketing scenario show 2017 program costs of approximately $0.35/m^3 of natural gas savings and approximately $0.11/TRC dollar. These values are about 25% and 10% higher than Union's current program results, respectively.

Comparison of Scenarios

The distribution of savings potential changes significantly as the analysis moves from Economic Potential Scenario to the two achievable potential scenarios. The following observations may be made:

- Implementation of measures is spread out more evenly in the achievable scenarios. The "front loading" of savings in the Economic Potential scenario, because measures that pass at full cost are assumed to be implemented immediately, does not occur in the achievable scenarios, because market constraints are taken into account.

- There is no dramatic shift in the proportion of savings by region or by dwelling type when moving from one scenario to another.

- The savings by end use shifts substantially when moving from one scenario to another. In particular, space heating potential and pool heater potential account for a shrinking proportion of the overall savings as the analysis moves from Economic Potential to

[137] Union's audited results for its 2006 residential DSM programs show that program spending of $3,163,000 achieved natural gas savings of 11,375,000 m^3 and TRC net benefits of $31,614,000. Expressed as a ratio, one dollar of program spending generated approximately 3.6 m^3 (approximately $0.28/M^3) of annual natural gas savings and nearly $10 of TRC net benefits (approximately $0.10/TRC $).

Financially Unconstrained Potential and then to Static Marketing Scenario. In contrast, DHW measures assume an increasing relative importance. This is largely due to the assumptions about participation rates for the individual measures, arrived at during the achievable potential workshops.

- The relative importance of the different measures changes significantly from one scenario to another. Within the Economic Potential Scenario, the largest potential for natural gas savings in 2017 is contributed by Air Sealing & Insulation (Old Homes), Ultra Low-Flow Showerheads, Efficient Clothes Washers, and Programmable Thermostats.

  - Under the both of the achievable scenarios, the showerhead measure's contribution is reduced by two key factors: some consumers will be reluctant to install the new showerheads because of desired features only offered in higher flow fixtures; and, existing Union DSM programs have been aggressively promoting these showerheads, so the potential diminishes towards the end of the study period.

  - Under the two achievable scenarios, the clothes washer measure's contribution is reduced by two key factors: free ridership rates for these appliances are very high, as consumers adopt them for reasons other than the energy savings; and existing programs such as Energy Star are aggressively promoting the new clothes washers, so potential diminishes towards the end of the study period.

  - The air sealing and insulation measure in older homes is a relatively expensive measure and was judged to be very dependent on incentives and program activity; accordingly, it retains much of its relative importance under the Financially Unconstrained Achievable Potential, but its potential shrinks under the Static Marketing Scenario.

  - As some of the other significant measures shrink in importance from one scenario to the next, the programmable thermostats measure increases in importance.

7. CONCLUSIONS

This study has confirmed the existence of significant cost-effective DSM potential within Union's Residential sector customers.

Although the weighted average program cost values presented for both the Financially Unconstrained and the Static Marketing scenarios will vary depending on the specific composition of the future program portfolio, both scenarios show an evident trend towards higher future costs to achieve natural gas savings and TRC benefits.[138] This trend recognizes that savings from DSM programs tend to become more expensive with time as the most attractive measures gain greater market penetration and only the more challenging measures remain.[139]

In this specific case, one measure with which the Ontario gas utilities have had great success is the condensing residential furnace. Over half of the gas customers in Ontario now have high-efficiency condensing furnaces. Furthermore, the planned changes to the efficiency standards for gas furnaces will eliminate mid-efficiency furnaces from the marketplace after 2010. This change alone dramatically changes the economics of residential DSM programs in Union's Service Area.

7.1 ADDITIONAL OBSERVATIONS

In addition to the preceding conclusions, two additional observations warrant note as they may affect future program strategies. They include:

- ***Niche Markets Warrant Greater Program Focus:*** As the DSM market matures within Union's service area, niche or target markets are becoming increasingly important. For example, measures that may not pass the TRC test in a "typical" or "average" application often will pass in niche applications. Air sealing and insulation in older homes (build before 1980) is one example that was included in this study, because the available data permitted an estimate of the higher heat loss in these older homes. Similarly, additional domestic hot water measures may be feasible in homes with a larger number of occupants. For example, drain water heat recovery systems and DHW recirculation systems become more economically attractive with larger household sizes. These latter measures have not been included in the current results as suitable data were not available.

- ***Market Transformation Approaches Warrant Additional Consideration:*** There remains an additional untapped potential savings by from technically mature measures that do not currently pass the TRC screen. The largest share of these additional potential savings is from air sealing and envelope insulation in existing homes. These measures do not pass the TRC screen as currently defined. However, they provide non-energy benefits such as increased comfort and reduced noise that are not currently captured in the TRC calculation. Similarly, industry specialists emphasized that as insulation levels increase, proper air and moisture sealing is becoming increasingly essential to the long-term

138 Design of a DSM program portfolio is beyond the scope of this current study.

139 Over time, it is also expected that some relatively new technologies, such as tankless water heaters and high-performance windows, may become less expensive as they gain greater sales volumes.

structural integrity of Ontario's housing stock. This situation presents both an opportunity and a possible technical issue that may be better addressed through a market transformation approach.

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9. GLOSSARY

Achievable potential
The Achievable Potential is the proportion of the natural gas savings identified in the Economic Potential Forecast that could realistically be achieved within the study period. Achievable Potential recognizes that it is difficult to induce customers to purchase and install all of the efficiency technologies that meet the criteria defined by the Economic Potential Forecast.

Avoided cost
The unit cost of acquiring the next resource to meet demand, which is used as a measure for evaluating individual demand-side and supply-side options. In the context of this study “avoided cost” is the capital expenditure offset by Union Gas DSM activities (i.e., the cost of having to buy natural gas on the open market, contract for long-term supply, and/or build and run new storage/transmission facilities).

Base year
The Base Year is the year to which all potentials will be compared. It provides a detailed description of “where” and “how” natural gas is currently used in each sector. For this study, it is the calendar year 2007. The modelled base year energy use is calibrated against Union’s actual sales for 2007.

Benefit/cost ratio
The measure benefit/cost ratio indicates the relative attractiveness of the measures. A measure that has a benefit/cost ratio in excess of 1.0 has benefits which outweigh its costs. Similarly, a measure with a benefit/cost ratio that is well in excess of one (e.g., 3.0) means that it is very attractive. A measure with a benefit/cost ratio of less than 1.0 has costs which outweigh its benefits.

Building envelope
The material separation between the interior and the exterior environments of a building. The building envelope serves as the outer shell to protect the indoor environment as well as to facilitate its climate control.

Co-generation
The simultaneous production of electric or mechanical energy and useful heat energy from a single fuel source.

Combustion efficiency
The ratio of energy released during combustion to the potential chemical energy available in the fuel.

Demand-side management (DSM)
Actions that modify customer demand for natural gas and that can defer the need for additional new supply.

Discount rate
The interest rate used in calculating the present value of expected yearly benefits and costs.

Economic efficiency
Allocation of human and natural resources in a way that results in the greatest net economic benefit, regardless of how benefits and costs are distributed within society.

Economic potential forecast
The economic potential forecast is an estimate of the level of natural gas consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective from society's perspective. All of the energy-efficiency technologies and measures that have a positive measure TRC are incorporated into the economic potential forecast. These technologies and measures are applied at either natural stock turnover rates or at designated years for immediate application.

Effective measure life (EML)
The estimate median number of years that the measures installed under a program are still in place and operable. EML incorporates field conditions, obsolescence, building remodelling, renovation, demolition and occupancy changes.

Energy audit
An on-site inspection and cataloguing of energy using equipment/buildings, energy consumption and the related end-uses. The purpose is to provide information to the customer and the utility. Audits are useful for load research, for DSM program design and for identification of specific energy savings projects.

Energy conservation
Activities by energy users that result in a reduction of the energy used to provide services. Energy conservation can include a wide variety of behavioural or operational changes that result in energy savings. For the purpose of this study, only energy savings achieved through physical or hardware installations are considered.

Energy intensity
The ratio of energy consumed per application or end use. For example, gigajoules per square metre of heated office space per day, or gigajoules per tonne of aluminum produced. All else being equal, energy intensity increases as energy efficiency decreases.

Emerging technologies
New energy-conserving technologies that are not yet market-ready, but may be market-ready over next 5 to 10 years. This category includes technologies that could be accelerated into the market during that period through targeted financial or technical support.

End use
The final application or final use to which energy is applied. End use is often used interchangeably with energy service.

Energy savings
The savings that result from efficient technologies or activities. In this document, the term "energy" refers specifically to energy derived from natural gas unless otherwise noted.

Energy service
An amenity or service supplied jointly by energy and other components/equipment such as buildings and heating equipment. Examples of energy services include residential space heating, commercial cooking, aluminum smelting and public transit. The same energy service can frequently be supplied with different mixes of equipment and energy.

Energy use index (EUI)
End use energy consumption divided by a specific parameter of production (e.g., MJ/m^2., MJ/unit).

Environmental credit/environmental penalty
An increment or decrement to the cost of a resource or set of resources, to reflect the overall level of its/their environmental impact, relative to another resource or set of resources.

Financial incentive
Certain financial features in the utility's DSM programs designed to motivate customer participation. They may include features designed to reduce a customer's net cash outlay, pay-back period or cost of finance to participate.

Fuel share
The proportion of requirements for a specific service met using a certain fuel. For example, a natural gas fuel share of 90% for space heating in commercial large office sub sector implies that 90% of the sub sector floor space is heated using natural gas. Similarly, a 90% natural gas fuel share in single family detached homes means that 90% of the space heating requirements for that dwelling type are met by natural gas.

Gigajoule
One billion joules or one thousand megajoules.

Interactive effects
In the context of natural gas use, interactive effects refer to the increase in gas consumed by heating equipment required to offset a decrease in "waste" heat generated by more efficient electrical fixtures or appliances after retrofit or replacement.

Joule
The basic unit of energy. In physical terms, equal to the work required to move a mass of one Newton a distance of one metre.

Kilowatt (kW)
One thousand watts; the most common unit of measurement of electric power. (The amount of energy transferred at a rate of one kilowatt for one hour is equal to one kilowatt hour.)

Kilowatt hour (kWh)
The most common unit of measurement of electric energy. One kilowatt hour represents the power of one thousand watts for a period of one hour.

Load forecast
An estimate of expected natural gas requirements that have to be met by the utility in future years.

Load research
Research to disaggregate and analyze patterns of natural gas consumption by various subsectors and end-uses. Load Research supports the development of the load forecast and the design of demand-side management programs.

Measure total resource cost (TRC)
The Measure TRC is the net present value of energy savings that result from an investment in a energy efficiency measure. The Measure TRC is equal to its full or incremental capital cost (depending on application) plus any change (positive or negative) in the combined annual energy and operating & maintenance costs. This calculation includes among others, the following inputs: the avoided natural gas and electricity supply costs; the life of the measure; and the selected discount rate.

Megajoule
One million joules.

Natural conservation
The future change in energy intensity that is expected to occur in the absence of utility DSM programs.

Non-participant test (NPT)
A test measuring what happens to rates due to changes in utility revenues and operating costs caused by a program. Rates will go down if the avoided cost is greater than the sum of the revenue lost plus the program costs. This test indicates the direction and magnitude of the expected change in rate levels.

Rate
Generically refers to a utility's rate structure.

Rate structure
The formulae used by a utility to calculate charges for the use of natural gas or electricity.

Reference case forecast
An estimate of the expected level of natural gas consumption that would occur over the study period in the absence of any new utility DSM market interventions after 2008. It is the baseline against which the scenarios of energy savings are calculated. The Reference Case forecast incorporates an estimation of "natural conservation," namely, changes in end-use efficiency over the study period that are projected to occur in the absence of new market interventions by the utility.

Saturation
The portion of floor area that receives a specific energy service. For example, a saturation of 86% for space cooling in the Large Office sub sector means that 86% of the sub sector floor space is cooled (regardless of fuel used to provide that cooling).

Seasonal efficiency
The ratio of delivered useful energy relative to the input potential fuel energy determined over a full heating season (or year).

Sector
A group of customers having a common type of economic activity. Union Gas divides its customers into three principal sectors: Residential, Commercial and Industrial. Sectors are further divided into subsectors. For example, "Large Offices" is a sub sector of the Commercial sector.

Service area
The portion of the Province of Ontario that receives service from Union Gas. Union Gas' service area is spread across the Province of Ontario including northern, southwestern and southeastern cities and towns.

Service region
For the purposes of this study, the total Union Gas service area is divided into two service regions. They are the Northern Region and Southern Region.

Simple payback
The simple payback is generated to show the customer's financial perspective. Simple payback is a measure of the length of time required for the cumulative savings from a project to recover its initial investment cost and other accrued costs, without taking into account the time value of money.

Strategic conservation
Utility action to reduce the total natural gas demand. Strategic conservation is natural gas conservation induced by utility programs.

Strategic load growth
Utility action to increase (annual) total natural gas demand for specific end uses.

Sub sectors
A classification of customers within a sector by common features. Residential subsectors are by type of home (SFD, duplex, apartment, etc.). Commercial subsectors are generally by type of commercial service (office, retail, warehouse, etc.). Industrial subsectors are by product type (pulp and paper, solid wood products, chemicals, etc.).

Supply curves
A curve illustrating the amount of energy available at an appropriate screened price in ascending order of cost.

Total Resource Cost (TRC) Test
A test that compares the total costs of energy efficiency investments, including natural gas conservation programs, to the social cost of natural gas. Un-priced environmental and social costs may be accounted for by changing the cost of either the investment under consideration or the total cost of natural gas in such a way that relative un-priced impacts are reflected. It is used in designing and evaluating programs that are developed from the Energy Efficiency Potential study's results.

Utility cost
The total financial cost incurred by the utility to acquire energy resources. For DSM, the costs include all utility program costs, including incentive costs.

Watt
The basic unit of measurement of power.

Natural Gas
Energy Efficiency Potential

Residential Sector

–Appendices–

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Union Gas

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Resource Consultants Ltd.

APPENDIX A

Measure TRC Calculations

Customer Resource Prices

	Residential		
	Nat. Gas ($/m^3)	**Electricity ($/kWh)**	**Water ($/1000L)**
Northern Service Region	0.5400	0.0950	1.6750
Southern Service Region	0.4580	0.0980	1.6500

- Customer electricity rates are based on electricity rates charged by EnWin (utility which services Windsor) and North Bay Hydro (according to their websites, as of July 2008). Fixed customer charges are not included.

- Natural gas rates are approximate estimates based on Union Gas rates (as of July 1, 2008) in each service region and average natural gas consumption levels in each service region. Rates exclude current $17.00 monthly charge.

- Water rates based on water and wastewater rates in several municipalities in both service regions. A weighted average is obtained based on the populations in these municipalities and an assumed annual water consumption of 300,000 L. Fixed charges are not included.

GHG Adder

	Residential		
	Nat. Gas (m^3)	**Electricity (kWh)**	**Water (1000L)**
GHG Cost, 2008-2012 ($/tonne CO_2e)	15	15	15
GHG Cost, 2013+ ($/tonne CO_2e)	20	20	20
Emissions Coefficient (tonnes CO_2e/unit)	0.001903	0.000220	
GHG Adder, 2008-12 ($/unit)	0.0285	0.0033	0.0000
GHG Adder, 2013+ ($/unit)	0.0381	0.0044	0.0000

- Based on emission factors and Global Warming Potentials (GWPs) presented in Environment Canada; *National Inventory Report (1990-2005): Greenhouse Gas Sources and Sinks in Canada* , pgs. 23 and 583, April 2007.

- Electricity emissions coefficient based on Ontario emission factors presented in Environment Canada; *National Inventory Report (1990-2005): Greenhouse Gas Sources and Sinks in Canada* , pg. 521, April 2007.

Other Economic Parameters

Discount Rate 10.0%

High-Performance Windows (ENERGY STAR®)

Description: Replace 50% of existing windows with ENERGY STAR® windows (double-glazed, argon fill, low-e coating, insulating spacer, vinyl frame)

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.357	$0.540
Electricity ($/kWh)	$0.971	$0.095
Water ($/1000L)	$20.577	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	2,000	-	1,666	1,850	-	Incr.	$500	$0	30	135	150	-	$87	5.7	$0	$589	$146	$0	$234	1.47
2	**Attached (Existing)**	1,207	1,400	-	1,098	1,274	-	Incr.	$350	$0	30	109	126	-	$71	5.0	$0	$473	$122	$0	$246	1.70
3	**Single Detached (New)**	1,362	2,000	-	1,226	1,800	-	Incr.	$300	$0	30	136	200	-	$93	3.2	$0	$594	$194	$0	$488	2.63
4	**Attached (New)**	913	1,400	-	803	1,232	-	Incr.	$200	$0	30	110	168	-	$75	2.7	$0	$477	$163	$0	$440	3.20

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.357	$0.458
Electricity ($/kWh)	$0.971	$0.098
Water ($/1000L)	$20.577	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	2,000	-	1,862	1,860	-	Incr.	$500	$0	30	140	140	-	$89	5.6	$0	$611	$136	$0	$247	1.49
2	**Attached (Existing)**	1,677	1,400	-	1,559	1,302	-	Incr.	$350	$0	30	117	98	-	$73	4.8	$0	$511	$95	$0	$256	1.73
3	**Single Detached (New)**	1,471	2,000	-	1,338	1,820	-	Incr.	$300	$0	30	132	180	-	$89	3.4	$0	$577	$175	$0	$451	2.50
4	**Attached (New)**	1,232	1,400	-	1,121	1,274	-	Incr.	$200	$0	30	111	126	-	$72	2.8	$0	$483	$122	$0	$405	3.03

High-Performance Windows (ENERGY STAR®)

Description: Replace 50% of existing windows with ENERGY STAR® windows (double-glazed, argon fill, low-e coating, insulating spacer, vinyl frame)

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.357	$0.540
Electricity ($/kWh)	$0.971	$0.095
Water ($/1000L)	$20.577	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	2,000	-	1,666	1,850	-	Incr.	$500	$0	30	135	150	-	$87	5.7	$0	$589	$146	$0	$234	1.47
2	**Attached (Existing)**	1,207	1,400	-	1,098	1,274	-	Incr.	$350	$0	30	109	126	-	$71	5.0	$0	$473	$122	$0	$246	1.70
3	**Single Detached (New)**	1,362	2,000	-	1,226	1,800	-	Incr.	$300	$0	30	136	200	-	$93	3.2	$0	$594	$194	$0	$488	2.63
4	**Attached (New)**	913	1,400	-	803	1,232	-	Incr.	$200	$0	30	110	168	-	$75	2.7	$0	$477	$163	$0	$440	3.20

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.357	$0.458
Electricity ($/kWh)	$0.971	$0.098
Water ($/1000L)	$20.577	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	2,000	-	1,862	1,860	-	Incr.	$500	$0	30	140	140	-	$89	5.6	$0	$611	$136	$0	$247	1.49
2	**Attached (Existing)**	1,677	1,400	-	1,559	1,302	-	Incr.	$350	$0	30	117	98	-	$73	4.8	$0	$511	$95	$0	$256	1.73
3	**Single Detached (New)**	1,471	2,000	-	1,338	1,820	-	Incr.	$300	$0	30	132	180	-	$89	3.4	$0	$577	$175	$0	$451	2.50
4	**Attached (New)**	1,232	1,400	-	1,121	1,274	-	Incr.	$200	$0	30	111	126	-	$72	2.8	$0	$483	$122	$0	$405	3.03

Low-E Window Films

Description: Retrofit windows with low-e films

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.814	$0.540
Electricity ($/kWh)	$0.847	$0.095
Water ($/1000L)	$17.927	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	2,000	-	1,774	1,856	-	Full	$800	$0	20	27	144	-	$28	28.3	$0	$103	$122	$0	-$575	0.28
2	**Attached (Existing)**	1,207	1,400	-	1,189	1,280	-	Full	$500	$0	20	18	120	-	$21	23.6	$0	$69	$102	$0	-$329	0.34

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.814	$0.458
Electricity ($/kWh)	$0.847	$0.098
Water ($/1000L)	$17.927	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	2,000	-	1,972	1,856	-	Full	$800	$0	20	30	144	-	$30	26.8	$0	$115	$122	$0	-$564	0.30
2	**Attached (Existing)**	1,677	1,400	-	1,651	1,280	-	Full	$500	$0	20	25	120	-	$25	20.0	$0	$96	$102	$0	-$302	0.40

Air Sealing

Description: Improve air tightness of buildings (Air Changes per Hour, ACH@50Pa) by 25%

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m³)	$4.137	$0.540
Electricity ($/kWh)	$0.921	$0.095
Water ($/1000L)	$19.502	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	2,000	-	1,603	1,780	-	Full	$1,800	$20	25	198	220	-	$108	16.7	$182	$820	$203	$0	-$959	0.52
2	**Attached (Existing)**	1,207	1,400	-	1,074	1,246	-	Full	$1,400	$20	25	133	154	-	$66	21.1	$182	$549	$142	$0	-$890	0.44
3	**Single Detached (New)**	1,362	2,000	-	1,213	1,780	-	Full	$1,200	$20	25	150	220	-	$82	14.7	$182	$620	$203	$0	-$559	0.60
4	**Attached (New)**	913	1,400	-	812	1,246	-	Full	$1,000	$20	25	100	154	-	$49	20.5	$182	$415	$142	$0	-$624	0.47

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m³)	$4.137	$0.458
Electricity ($/kWh)	$0.921	$0.098
Water ($/1000L)	$19.502	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	2,000	-	1,782	1,780	-	Full	$1,800	$20	25	220	220	-	$120	15.0	$182	$911	$203	$0	-$868	0.56
2	**Attached (Existing)**	1,677	1,400	-	1,492	1,246	-	Full	$1,400	$20	25	184	154	-	$94	14.9	$182	$763	$142	$0	-$677	0.57
3	**Single Detached (New)**	1,471	2,000	-	1,309	1,780	-	Full	$1,200	$20	25	162	220	-	$88	13.6	$182	$669	$203	$0	-$510	0.63
4	**Attached (New)**	1,232	1,400	-	1,096	1,246	-	Full	$1,000	$20	25	135	154	-	$68	14.8	$182	$560	$142	$0	-$479	0.59

Attic Insulation

Description: Improve ceiling/attic insulation to RSI-7.0 (R-40)

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.357	$0.540
Electricity ($/kWh)	$0.971	$0.095
Water ($/1000L)	$20.577	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	2,000	-	1,711	1,900	-	Full	$600	$0	30	90	100	-	$58	10.3	$0	$392	$97	$0	-$111	0.82
2	**Attached (Existing)**	1,207	1,400	-	1,147	1,330	-	Full	$450	$0	30	60	70	-	$39	11.5	$0	$263	$68	$0	-$119	0.74

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.357	$0.458
Electricity ($/kWh)	$0.971	$0.098
Water ($/1000L)	$20.577	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	2,000	-	1,902	1,900	-	Full	$600	$0	30	100	100	-	$64	9.4	$0	$436	$97	$0	-$67	0.89
2	**Attached (Existing)**	1,677	1,400	-	1,593	1,330	-	Full	$450	$0	30	84	70	-	$52	8.7	$0	$365	$68	$0	-$17	0.96

Wall Insulation

Description: Improve wall insulation (non-foundation) to RSI-3.5 (R-20)

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m³)	$4.357	$0.540
Electricity ($/kWh)	$0.971	$0.095
Water ($/1000L)	$20.577	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	2,000	-	1,567	1,900	-	Incr.	$1,600	$0	30	234	100	-	$136	11.8	$0	$1,020	$97	$0	-$483	0.70
2	**Attached (Existing)**	1,207	1,400	-	1,050	1,330	-	Incr.	$1,200	$0	30	157	70	-	$91	13.1	$0	$684	$68	$0	-$448	0.63

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m³)	$4.357	$0.458
Electricity ($/kWh)	$0.971	$0.098
Water ($/1000L)	$20.577	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	2,000	-	1,742	1,900	-	Incr.	$1,600	$0	30	260	100	-	$150	10.7	$0	$1,134	$97	$0	-$369	0.77
2	**Attached (Existing)**	1,677	1,400	-	1,459	1,330	-	Incr.	$1,200	$0	30	218	70	-	$124	9.7	$0	$950	$68	$0	-$182	0.85

Foundation Insulation

Description: Improve foundation insulation to full-height RSI-4.0 (base case is 0.6m below grade insulation)

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.357	$0.540
Electricity ($/kWh)	$0.971	$0.095
Water ($/1000L)	$20.577	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	2,000	-	1,567	2,000	-	Incr.	$2,500	$0	30	234	-	-	$126	19.8	$0	$1,020	$0	$0	-$1,480	0.41
2	**Attached (Existing)**	1,207	1,400	-	1,050	1,400	-	Incr.	$2,000	$0	30	157	-	-	$85	23.6	$0	$684	$0	$0	-$1,316	0.34

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.357	$0.458
Electricity ($/kWh)	$0.971	$0.098
Water ($/1000L)	$20.577	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	2,000	-	1,742	2,000	-	Incr.	$2,500	$0	30	260	-	-	$141	17.8	$0	$1,134	$0	$0	-$1,366	0.45
2	**Attached (Existing)**	1,677	1,400	-	1,459	1,400	-	Incr.	$2,000	$0	30	218	-	-	$118	17.0	$0	$950	$0	$0	-$1,050	0.47

Crawl-Space Insulation

Description: Improve crawl-space insulation

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m³)	$4.357	$0.540
Electricity ($/kWh)	$0.971	$0.095
Water ($/1000L)	$20.577	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m³/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m³/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m³/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	2,000	-	1,711	1,900	-	Full	$600	$0	30	90	100	-	$58	10.3	$0	$392	$97	$0	-$111	0.82
2	**Attached (Existing)**	1,207	1,400	-	1,147	1,330	-	Full	$600	$0	30	60	70	-	$39	15.3	$0	$263	$68	$0	-$269	0.55

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m³)	$4.357	$0.458
Electricity ($/kWh)	$0.971	$0.098
Water ($/1000L)	$20.577	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m³/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m³/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m³/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	2,000	-	1,902	1,900	-	Full	$600	$0	30	100	100	-	$64	9.4	$0	$436	$97	$0	-$67	0.89
2	**Attached (Existing)**	1,677	1,400	-	1,593	1,330	-	Full	$600	$0	30	84	70	-	$52	11.6	$0	$365	$68	$0	-$167	0.72

Air Sealing and Insulation (Old Homes)

Description: Improve air tightness and insulation in the attic of old homes

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.357	$0.540
Electricity ($/kWh)	$0.971	$0.095
Water ($/1000L)	$20.577	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Old Existing)**	2,342	2,000	-	1,873	1,600	-	Full	$2,000	$10	30	468	400	-	$281	7.1	$94	$2,040	$388	$0	$335	1.16
2	**Attached (Old Existing)**	1,569	1,400	-	1,255	1,120	-	Full	$1,700	$10	30	314	280	-	$186	9.1	$94	$1,367	$272	$0	-$155	0.91

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.357	$0.458
Electricity ($/kWh)	$0.971	$0.098
Water ($/1000L)	$20.577	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Old Existing)**	2,603	2,000	-	2,082	1,600	-	Full	$2,000	$10	30	521	400	-	$309	6.5	$94	$2,268	$388	$0	$562	1.27
2	**Attached (Old Existing)**	2,180	1,400	-	1,744	1,120	-	Full	$1,700	$10	30	436	280	-	$252	6.7	$94	$1,899	$272	$0	$377	1.21

High-Performance New Homes

Description: Meeting R2000, EGH 80, LEED, or ENERGY STAR® standards for new homes

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.357	$0.540
Electricity ($/kWh)	$0.971	$0.095
Water ($/1000L)	$20.577	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (New)**	1,362	2,000	-	1,008	1,480	-	Incr.	$3,000	$0	30	354	520	-	$241	12.5	$0	$1,543	$505	$0	-$952	0.68
2	**Attached (New)**	913	1,400	-	675	1,036	-	Incr.	$3,000	$0	30	237	364	-	$163	18.4	$0	$1,034	$353	$0	-$1,613	0.46

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.357	$0.458
Electricity ($/kWh)	$0.971	$0.098
Water ($/1000L)	$20.577	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (New)**	1,471	2,000	-	1,088	1,480	-	Incr.	$3,000	$0	30	382	520	-	$256	11.7	$0	$1,666	$505	$0	-$829	0.72
2	**Attached (New)**	1,232	1,400	-	911	1,036	-	Incr.	$3,000	$0	30	320	364	-	$207	14.5	$0	$1,395	$353	$0	-$1,252	0.58

Under-Slab Insulation

Description: Installing under-slab insulation (RSI-2.0) in new homes

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.357	$0.540
Electricity ($/kWh)	$0.971	$0.095
Water ($/1000L)	$20.577	$1.675

Measure Description		Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	2,000	-	1,774	2,000	-	Incr.	$450	$0	30	27	-	-	$15	30.8	$0	$118	$0	$0	-$332	0.26
2	**Attached (Existing)**	1,207	1,400	-	1,189	1,400	-	Incr.	$450	$0	30	18	-	-	$10	46.0	$0	$79	$0	$0	-$371	0.18
3	**Single Detached (New)**	1,362	2,000	-	1,342	2,000	-	Incr.	$450	$0	30	20	-	-	$11	40.8	$0	$89	$0	$0	-$361	0.20
4	**Attached (New)**	913	1,400	-	899	1,400	-	Incr.	$450	$0	30	14	-	-	$7	60.9	$0	$60	$0	$0	-$390	0.13

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.357	$0.458
Electricity ($/kWh)	$0.971	$0.098
Water ($/1000L)	$20.577	$1.650

Measure Description		Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	2,000	-	1,972	2,000	-	Incr.	$450	$0	30	30	-	-	$16	27.7	$0	$131	$0	$0	-$319	0.29
2	**Attached (Existing)**	1,677	1,400	-	1,651	1,400	-	Incr.	$450	$0	30	25	-	-	$14	33.1	$0	$110	$0	$0	-$340	0.24
3	**Single Detached (New)**	1,471	2,000	-	1,449	2,000	-	Incr.	$450	$0	30	22	-	-	$12	37.8	$0	$96	$0	$0	-$354	0.21
4	**Attached (New)**	1,232	1,400	-	1,213	1,400	-	Incr.	$450	$0	30	18	-	-	$10	45.1	$0	$80	$0	$0	-$370	0.18

Condensing Furnaces

Description: Installing condensing furnaces with an average AFUE of 98% rather than a base case condensing furnaces with a 90% AFUE

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.645	$0.540
Electricity ($/kWh)	$0.808	$0.095
Water ($/1000L)	$17.108	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	-	-	1,693	-	-	Incr.	$1,500	$0	18	108	-	-	$58	25.7	$0	$394	$0	$0	-$1,106	0.26
2	**Attached (Existing)**	1,207	-	-	1,134	-	-	Incr.	$1,500	$0	18	72	-	-	$39	38.4	$0	$264	$0	$0	-$1,236	0.18

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.645	$0.458
Electricity ($/kWh)	$0.808	$0.098
Water ($/1000L)	$17.108	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	-	-	1,882	-	-	Incr.	$1,500	$0	18	120	-	-	$65	23.1	$0	$438	$0	$0	-$1,062	0.29
2	**Attached (Existing)**	1,677	-	-	1,576	-	-	Incr.	$1,500	$0	18	101	-	-	$54	27.6	$0	$367	$0	$0	-$1,133	0.24

Condensing Boilers

Description: Installing condensing boilers instead of mid-efficiency boilers

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.137	$0.540
Electricity ($/kWh)	$0.921	$0.095
Water ($/1000L)	$19.502	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	800	-	1,621	800	-	Incr.	$3,200	$0	25	180	-	-	$97	32.9	$0	$745	$0	$0	-$2,455	0.23
2	**Attached (Existing)**	1,207	400	-	1,086	400	-	Incr.	$3,200	$0	25	121	-	-	$65	49.1	$0	$499	$0	$0	-$2,701	0.16

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.137	$0.458
Electricity ($/kWh)	$0.921	$0.098
Water ($/1000L)	$19.502	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	800	-	1,802	800	-	Incr.	$3,200	$0	25	200	-	-	$108	29.6	$0	$828	$0	$0	-$2,372	0.26
2	**Attached (Existing)**	1,677	400	-	1,509	400	-	Incr.	$3,200	$0	25	168	-	-	$91	35.3	$0	$694	$0	$0	-$2,506	0.22

High-Efficiency HRVs

Description: Installing high-efficiency Heat Recovery Ventilators (HRVs) instead of standard efficiency models

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.336	$0.540
Electricity ($/kWh)	$0.738	$0.095
Water ($/1000L)	$15.618	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	800	-	1,684	800	-	Incr.	$650	$0	15	117	-	-	$63	10.3	$0	$391	$0	$0	-$259	0.60
2	**Attached (Existing)**	1,207	400	-	1,128	400	-	Incr.	$650	$0	15	78	-	-	$42	15.3	$0	$262	$0	$0	-$388	0.40
3	**Single Detached (New)**	1,362	800	-	1,274	800	-	Incr.	$650	$0	15	89	-	-	$48	13.6	$0	$295	$0	$0	-$355	0.45
4	**Attached (New)**	913	400	-	853	400	-	Incr.	$650	$0	15	59	-	-	$32	20.3	$0	$198	$0	$0	-$452	0.30

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.336	$0.458
Electricity ($/kWh)	$0.738	$0.098
Water ($/1000L)	$15.618	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	800	-	1,872	800	-	Incr.	$650	$0	15	130	-	-	$70	9.2	$0	$434	$0	$0	-$216	0.67
2	**Attached (Existing)**	1,677	400	-	1,568	400	-	Incr.	$650	$0	15	109	-	-	$59	11.0	$0	$364	$0	$0	-$286	0.56
3	**Single Detached (New)**	1,471	800	-	1,375	800	-	Incr.	$650	$0	15	96	-	-	$52	12.6	$0	$319	$0	$0	-$331	0.49
4	**Attached (New)**	1,232	400	-	1,151	400	-	Incr.	$650	$0	15	80	-	-	$43	15.0	$0	$267	$0	$0	-$383	0.41

Programmable Thermostats

Description: Installing programmable thermostats rather than or to replace manual thermostats

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.645	$0.540
Electricity ($/kWh)	$0.808	$0.095
Water ($/1000L)	$17.108	$1.675

Measure Description		Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	2,000	-	1,585	1,880	-	Full	$65	$0	18	216	120	-	$128	0.5	$0	$788	$97	$0	$820	13.61
2	**Attached (Existing)**	1,207	1,400	-	1,062	1,316	-	Full	$65	$0	18	145	84	-	$86	0.8	$0	$528	$68	$0	$531	9.16
3	**Single Detached (New)**	1,362	2,000	-	1,199	1,880	-	Incr.	$65	$0	18	163	120	-	$100	0.7	$0	$596	$97	$0	$628	10.66
4	**Attached (New)**	913	1,400	-	803	1,316	-	Incr.	$65	$0	18	110	84	-	$67	1.0	$0	$399	$68	$0	$402	7.19

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.645	$0.458
Electricity ($/kWh)	$0.808	$0.098
Water ($/1000L)	$17.108	$1.650

Measure Description		Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	2,000	-	1,762	1,880	-	Full	$65	$0	18	240	120	-	$141	0.5	$0	$876	$97	$0	$908	14.96
2	**Attached (Existing)**	1,677	1,400	-	1,475	1,316	-	Full	$65	$0	18	201	84	-	$117	0.6	$0	$733	$68	$0	$736	12.33
3	**Single Detached (New)**	1,471	2,000	-	1,294	1,880	-	Incr.	$65	$0	18	176	120	-	$107	0.6	$0	$643	$97	$0	$675	11.39
4	**Attached (New)**	1,232	1,400	-	1,084	1,316	-	Incr.	$65	$0	18	148	84	-	$88	0.7	$0	$539	$68	$0	$541	9.33

Integrated Heating & DHW

Description: Installing integrated heating and DHW systems (e.g. eKOCOMFORT, NY Thermal)

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.645	$0.540
Electricity ($/kWh)	$0.808	$0.095
Water ($/1000L)	$17.108	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,462	800	-	2,244	800	-	Incr.	$800	$0	18	218	-	-	$118	6.8	$0	$794	$0	$0	-$6	0.99
2	**Attached (Existing)**	1,679	400	-	1,523	400	-	Incr.	$800	$0	18	156	-	-	$84	9.5	$0	$568	$0	$0	-$232	0.71
3	**Single Detached (New)**	1,976	800	-	1,774	800	-	Incr.	$800	$0	18	203	-	-	$109	7.3	$0	$738	$0	$0	-$62	0.92
4	**Attached (New)**	1,352	400	-	1,207	400	-	Incr.	$800	$0	18	145	-	-	$78	10.2	$0	$529	$0	$0	-$271	0.66

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.645	$0.458
Electricity ($/kWh)	$0.808	$0.098
Water ($/1000L)	$17.108	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,652	800	-	2,438	800	-	Incr.	$800	$0	18	214	-	-	$116	6.9	$0	$782	$0	$0	-$18	0.98
2	**Attached (Existing)**	2,142	400	-	1,988	400	-	Incr.	$800	$0	18	154	-	-	$83	9.7	$0	$559	$0	$0	-$241	0.70
3	**Single Detached (New)**	2,041	800	-	1,853	800	-	Incr.	$800	$0	18	188	-	-	$102	7.9	$0	$686	$0	$0	-$114	0.86
4	**Attached (New)**	1,640	400	-	1,505	400	-	Incr.	$800	$0	18	135	-	-	$73	11.0	$0	$491	$0	$0	-$309	0.61

Gas-Fired Heat Pumps

Description: Installing gas fired heat pumps rather than mid-efficiency furnaces

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.137	$0.540
Electricity ($/kWh)	$0.921	$0.095
Water ($/1000L)	$19.502	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	800	-	1,441	800	-	Incr.	$4,000	$0	25	360	-	-	$195	20.6	$0	$1,491	$0	$0	-$2,509	0.37
2	**Attached (Existing)**	1,207	400	-	965	400	-	Incr.	$4,000	$0	25	241	-	-	$130	30.7	$0	$999	$0	$0	-$3,001	0.25
3	**Single Detached (New)**	1,362	800	-	1,090	800	-	Incr.	$4,000	$0	25	272	-	-	$147	27.2	$0	$1,127	$0	$0	-$2,873	0.28
4	**Attached (New)**	913	400	-	730	400	-	Incr.	$4,000	$0	25	183	-	-	$99	40.6	$0	$755	$0	$0	-$3,245	0.19

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.137	$0.458
Electricity ($/kWh)	$0.921	$0.098
Water ($/1000L)	$19.502	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	800	-	1,602	800	-	Incr.	$4,000	$0	25	400	-	-	$216	18.5	$0	$1,657	$0	$0	-$2,343	0.41
2	**Attached (Existing)**	1,677	400	-	1,341	400	-	Incr.	$4,000	$0	25	335	-	-	$181	22.1	$0	$1,387	$0	$0	-$2,613	0.35
3	**Single Detached (New)**	1,471	800	-	1,177	800	-	Incr.	$4,000	$0	25	294	-	-	$159	25.2	$0	$1,217	$0	$0	-$2,783	0.30
4	**Attached (New)**	1,232	400	-	985	400	-	Incr.	$4,000	$0	25	246	-	-	$133	30.1	$0	$1,019	$0	$0	-$2,981	0.25

Duct Sealing

Description: Professional sealing of furnace ducts

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.645	$0.540
Electricity ($/kWh)	$0.808	$0.095
Water ($/1000L)	$17.108	$1.675

Measure Description		Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	2,000	-	1,711	1,900	-	Full	$1,000	$0	18	90	100	-	$58	17.2	$0	$328	$81	$0	-$591	0.41
2	**Attached (Existing)**	1,207	1,400	-	1,147	1,330	-	Full	$1,000	$0	18	60	70	-	$39	25.5	$0	$220	$57	$0	-$724	0.28
3	**Single Detached (New)**	1,362	2,000	-	1,294	1,900	-	Full	$1,000	$0	18	68	100	-	$46	21.6	$0	$248	$81	$0	-$671	0.33
4	**Attached (New)**	913	1,400	-	867	1,330	-	Full	$1,000	$0	18	46	70	-	$31	32.0	$0	$166	$57	$0	-$777	0.22

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.645	$0.458
Electricity ($/kWh)	$0.808	$0.098
Water ($/1000L)	$17.108	$1.650

Measure Description		Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	2,000	-	1,902	1,900	-	Full	$1,000	$0	18	100	100	-	$64	15.7	$0	$365	$81	$0	-$554	0.45
2	**Attached (Existing)**	1,677	1,400	-	1,593	1,330	-	Full	$1,000	$0	18	84	70	-	$52	19.3	$0	$306	$57	$0	-$638	0.36
3	**Single Detached (New)**	1,471	2,000	-	1,397	1,900	-	Full	$1,000	$0	18	74	100	-	$49	20.3	$0	$268	$81	$0	-$651	0.35
4	**Attached (New)**	1,232	1,400	-	1,170	1,330	-	Full	$1,000	$0	18	62	70	-	$40	25.1	$0	$224	$57	$0	-$719	0.28

Furnace Tune-Ups

Description: Professional furnace tune-ups

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$1.053	$0.540
Electricity ($/kWh)	$0.221	$0.095
Water ($/1000L)	$4.692	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	800	-	1,765	784	-	Full	$100	$0	3	36	16	-	$21	4.8	$0	$38	$4	$0	-$59	0.41
2	**Attached (Existing)**	1,207	400	-	1,183	392	-	Full	$100	$0	3	24	8	-	$14	7.2	$0	$25	$2	$0	-$73	0.27

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$1.053	$0.458
Electricity ($/kWh)	$0.221	$0.098
Water ($/1000L)	$4.692	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	800	-	1,962	784	-	Full	$100	$0	3	40	16	-	$23	4.3	$0	$42	$4	$0	-$54	0.46
2	**Attached (Existing)**	1,677	400	-	1,643	392	-	Full	$100	$0	3	34	8	-	$19	5.3	$0	$35	$2	$0	-$63	0.37

High-Efficiency Fireplaces

Description: Installing high-efficiency natural gas fireplaces

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.336	$0.540
Electricity ($/kWh)	$0.738	$0.095
Water ($/1000L)	$15.618	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	278	-	-	223	-	-	Incr.	$100	$0	15	56	-	-	$30	3.3	$0	$186	$0	$0	$86	1.86
2	**Attached (Existing)**	199	-	-	159	-	-	Incr.	$100	$0	15	40	-	-	$22	4.6	$0	$133	$0	$0	$33	1.33
3	**Single Detached (New)**	203	-	-	163	-	-	Incr.	$100	$0	15	41	-	-	$22	4.6	$0	$136	$0	$0	$36	1.36
4	**Attached (New)**	145	-	-	116	-	-	Incr.	$100	$0	15	29	-	-	$16	6.4	$0	$97	$0	$0	-$3	0.97

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.336	$0.458
Electricity ($/kWh)	$0.738	$0.098
Water ($/1000L)	$15.618	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	309	-	-	248	-	-	Incr.	$100	$0	15	62	-	-	$33	3.0	$0	$206	$0	$0	$106	2.06
2	**Attached (Existing)**	221	-	-	177	-	-	Incr.	$100	$0	15	44	-	-	$24	4.2	$0	$148	$0	$0	$48	1.48
3	**Single Detached (New)**	226	-	-	181	-	-	Incr.	$100	$0	15	45	-	-	$24	4.1	$0	$151	$0	$0	$51	1.51
4	**Attached (New)**	162	-	-	129	-	-	Incr.	$100	$0	15	32	-	-	$17	5.7	$0	$108	$0	$0	$8	1.08

Solar Pre-Heated Make-Up Air

Description: Installing a solar pre-heated ventilation system (e.g. Solarwall, MatrixAir, UnitAir)

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.814	$0.540
Electricity ($/kWh)	$0.847	$0.095
Water ($/1000L)	$17.927	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	1,801	800	-	1,441	800	-	Full	$1,300	$0	20	360	-	-	$195	6.7	$0	$1,374	$0	$0	$74	1.06
2	**Attached (Existing)**	1,207	400	-	965	400	-	Full	$1,300	$0	20	241	-	-	$130	10.0	$0	$921	$0	$0	-$379	0.71
3	**Single Detached (New)**	1,362	800	-	1,090	800	-	Full	$1,300	$0	20	272	-	-	$147	8.8	$0	$1,039	$0	$0	-$261	0.80
4	**Attached (New)**	913	400	-	730	400	-	Full	$1,300	$0	20	183	-	-	$99	13.2	$0	$696	$0	$0	-$604	0.54

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.814	$0.458
Electricity ($/kWh)	$0.847	$0.098
Water ($/1000L)	$17.927	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,002	800	-	1,602	800	-	Full	$1,300	$0	20	400	-	-	$216	6.0	$0	$1,527	$0	$0	$227	1.17
2	**Attached (Existing)**	1,677	400	-	1,341	400	-	Full	$1,300	$0	20	335	-	-	$181	7.2	$0	$1,279	$0	$0	-$21	0.98
3	**Single Detached (New)**	1,471	800	-	1,177	800	-	Full	$1,300	$0	20	294	-	-	$159	8.2	$0	$1,122	$0	$0	-$178	0.86
4	**Attached (New)**	1,232	400	-	985	400	-	Full	$1,300	$0	20	246	-	-	$133	9.8	$0	$939	$0	$0	-$361	0.72

Ultra Low-Flow Showerheads

Description: Installing ultra low-flow showerheads (1.25 GPM) to replace or rather than an average of 2.5 GPM showerheads

Service Region: **Southern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$2.636	$0.540
Electricity ($/kWh)	$0.578	$0.095
Water ($/1000L)	$12.234	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	660	-	55,714	555	-	30,643	Full	$15	$0	10	106	-	25,071	$99	0.2	$0	$278	$0	$307	$570	39.01
2	**Attached (Existing)**	473	-	42,602	397	-	23,431	Full	$15	$0	10	76	-	19,171	$73	0.2	$0	$199	$0	$235	$419	28.92
3	**Single Detached (New)**	614	-	55,714	516	-	30,643	Full	$15	$0	10	98	-	25,071	$95	0.2	$0	$259	$0	$307	$551	37.71
4	**Attached (New)**	439	-	42,602	369	-	23,431	Full	$15	$0	10	70	-	19,171	$70	0.2	$0	$185	$0	$235	$405	27.99

Service Region: **Northern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$2.636	$0.458
Electricity ($/kWh)	$0.578	$0.098
Water ($/1000L)	$12.234	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	650	-	55,714	546	-	30,643	Full	$15	$0	10	104	-	25,071	$98	0.2	$0	$274	$0	$307	$566	38.72
2	**Attached (Existing)**	465	-	42,602	391	-	23,431	Full	$15	$0	10	74	-	19,171	$72	0.2	$0	$196	$0	$235	$416	28.71
3	**Single Detached (New)**	570	-	55,714	479	-	30,643	Full	$15	$0	10	91	-	25,071	$91	0.2	$0	$240	$0	$307	$532	36.48
4	**Attached (New)**	408	-	42,602	343	-	23,431	Full	$15	$0	10	65	-	19,171	$67	0.2	$0	$172	$0	$235	$392	27.11

Hot Water Pipe Insulation

Description: Installing hot water pipe insulation on exposed areas of piping

Service Region: **Southern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.347	$0.540
Electricity ($/kWh)	$0.738	$0.095
Water ($/1000L)	$15.618	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	660	-	-	640	-	-	Full	$1	$0	15	20	-	-	$11	0.1	$0	$66	$0	$0	$65	66.30
2	**Attached (Existing)**	473	-	-	458	-	-	Full	$1	$0	15	14	-	-	$8	0.1	$0	$47	$0	$0	$46	47.45

Service Region: **Northern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.347	$0.458
Electricity ($/kWh)	$0.738	$0.098
Water ($/1000L)	$15.618	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	650	-	-	630	-	-	Full	$1	$0	15	19	-	-	$11	0.1	$0	$65	$0	$0	$64	65.27
2	**Attached (Existing)**	465	-	-	451	-	-	Full	$1	$0	15	14	-	-	$8	0.1	$0	$47	$0	$0	$46	46.71

DHW Heat Traps

Description: Installing a hot water heat trap on the exit side of a hot water tank

Service Region: **Southern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$2.457	$0.540
Electricity ($/kWh)	$0.538	$0.095
Water ($/1000L)	$11.387	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	660	-	-	640	-	-	Incr.	$65	$0	9	20	-	-	$11	6.1	$0	$49	$0	$0	-$16	0.75
2	**Attached (Existing)**	473	-	-	458	-	-	Incr.	$65	$0	9	14	-	-	$8	8.5	$0	$35	$0	$0	-$30	0.54

Service Region: **Northern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$2.457	$0.458
Electricity ($/kWh)	$0.538	$0.098
Water ($/1000L)	$11.387	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	650	-	-	630	-	-	Incr.	$65	$0	9	19	-	-	$11	6.2	$0	$48	$0	$0	-$17	0.74
2	**Attached (Existing)**	465	-	-	451	-	-	Incr.	$65	$0	9	14	-	-	$8	8.6	$0	$34	$0	$0	-$31	0.53

DHW Temperature Reduction

Description: Reducing the set-point of DHW tanks from 60°C to 54°C

Service Region: **Southern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$2.264	$0.540
Electricity ($/kWh)	$0.495	$0.095
Water ($/1000L)	$10.473	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	660	-	-	644	-	-	Full	$0	$0	8	17	-	-	$9	0.0	$0	$37	$0	$0	$37	N/A
2	**Attached (Existing)**	473	-	-	461	-	-	Full	$0	$0	8	12	-	-	$6	0.0	$0	$27	$0	$0	$27	N/A

Service Region: **Northern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$2.264	$0.458
Electricity ($/kWh)	$0.495	$0.098
Water ($/1000L)	$10.473	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	650	-	-	634	-	-	Full	$0	$0	8	16	-	-	$9	0.0	$0	$37	$0	$0	$37	N/A
2	**Attached (Existing)**	465	-	-	454	-	-	Full	$0	$0	8	12	-	-	$6	0.0	$0	$26	$0	$0	$26	N/A

Condensing Water Heaters

Description: Installing condensing hot water heaters rather than conventional models

Service Region: **Southern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.095	$0.540
Electricity ($/kWh)	$0.681	$0.095
Water ($/1000L)	$14.417	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	660	-	-	449	-	-	Incr.	$1,150	$0	13	211	-	-	$114	10.1	$0	$654	$0	$0	-$496	0.57
2	**Attached (Existing)**	473	-	-	321	-	-	Incr.	$1,150	$0	13	151	-	-	$82	14.1	$0	$468	$0	$0	-$682	0.41
3	**Single Detached (New)**	614	-	-	418	-	-	Incr.	$1,150	$0	13	196	-	-	$106	10.8	$0	$608	$0	$0	-$542	0.53
4	**Attached (New)**	439	-	-	299	-	-	Incr.	$1,150	$0	13	141	-	-	$76	15.1	$0	$435	$0	$0	-$715	0.38

Service Region: **Northern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.095	$0.458
Electricity ($/kWh)	$0.681	$0.098
Water ($/1000L)	$14.417	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	650	-	-	442	-	-	Incr.	$1,150	$0	13	208	-	-	$112	10.2	$0	$644	$0	$0	-$506	0.56
2	**Attached (Existing)**	465	-	-	316	-	-	Incr.	$1,150	$0	13	149	-	-	$80	14.3	$0	$461	$0	$0	-$689	0.40
3	**Single Detached (New)**	570	-	-	388	-	-	Incr.	$1,150	$0	13	182	-	-	$99	11.7	$0	$565	$0	$0	-$585	0.49
4	**Attached (New)**	408	-	-	277	-	-	Incr.	$1,150	$0	13	131	-	-	$71	16.3	$0	$404	$0	$0	-$746	0.35

Tankless Gas-Fired DHW

Description: Installing in-line (tankless) gas-fired water heaters rather than conventional models

Service Region: **Southern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.829	$0.540
Electricity ($/kWh)	$0.847	$0.095
Water ($/1000L)	$17.927	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	660	-	-	442	-	-	Incr.	$700	$0	20	218	-	-	$118	5.9	$0	$834	$0	$0	$134	1.19
2	**Attached (Existing)**	473	-	-	317	-	-	Incr.	$700	$0	20	156	-	-	$84	8.3	$0	$597	$0	$0	-$103	0.85
3	**Single Detached (New)**	614	-	-	411	-	-	Incr.	$700	$0	20	203	-	-	$109	6.4	$0	$776	$0	$0	$76	1.11
4	**Attached (New)**	439	-	-	294	-	-	Incr.	$700	$0	20	145	-	-	$78	8.9	$0	$555	$0	$0	-$145	0.79

Service Region: **Northern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.829	$0.458
Electricity ($/kWh)	$0.847	$0.098
Water ($/1000L)	$17.927	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	650	-	-	435	-	-	Incr.	$700	$0	20	214	-	-	$116	6.0	$0	$821	$0	$0	$121	1.17
2	**Attached (Existing)**	465	-	-	312	-	-	Incr.	$700	$0	20	154	-	-	$83	8.4	$0	$588	$0	$0	-$112	0.84
3	**Single Detached (New)**	570	-	-	382	-	-	Incr.	$700	$0	20	188	-	-	$102	6.9	$0	$720	$0	$0	$20	1.03
4	**Attached (New)**	408	-	-	273	-	-	Incr.	$700	$0	20	135	-	-	$73	9.6	$0	$516	$0	$0	-$184	0.74

Waste Water Heat Recovery

Description: Installing wastewater heat recovery systems such as PowerPipe®

Service Region: **Southern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.829	$0.540
Electricity ($/kWh)	$0.847	$0.095
Water ($/1000L)	$17.927	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	660	-	-	561	-	-	Full	$900	$0	20	99	-	-	$53	16.8	$0	$379	$0	$0	-$521	0.42
2	**Attached (Existing)**	473	-	-	402	-	-	Full	$900	$0	20	71	-	-	$38	23.5	$0	$271	$0	$0	-$629	0.30
3	**Single Detached (New)**	614	-	-	522	-	-	Full	$700	$0	20	92	-	-	$50	14.1	$0	$353	$0	$0	-$347	0.50
4	**Attached (New)**	439	-	-	374	-	-	Full	$700	$0	20	66	-	-	$36	19.7	$0	$252	$0	$0	-$448	0.36

Service Region: **Northern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.829	$0.458
Electricity ($/kWh)	$0.847	$0.098
Water ($/1000L)	$17.927	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	650	-	-	552	-	-	Full	$900	$0	20	97	-	-	$53	17.1	$0	$373	$0	$0	-$527	0.41
2	**Attached (Existing)**	465	-	-	395	-	-	Full	$900	$0	20	70	-	-	$38	23.9	$0	$267	$0	$0	-$633	0.30
3	**Single Detached (New)**	570	-	-	485	-	-	Full	$700	$0	20	86	-	-	$46	15.2	$0	$327	$0	$0	-$373	0.47
4	**Attached (New)**	408	-	-	347	-	-	Full	$700	$0	20	61	-	-	$33	21.2	$0	$234	$0	$0	-$466	0.33

Solar DHW Systems

Description: Installing solar hot water systems to supplement conventional gas-fired models

Service Region:	**Southern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Free Rider Rate	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.137	$0.540
Electricity ($/kWh)	$0.921	$0.095
Water ($/1000L)	$19.502	$1.675

Measure Description		Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	660	-	-	264	-	-	Full	$7,000	$70	25	396	-	-	$144	48.6	$635	$1,639	$0	$0	-$5,996	0.21
2	**Attached (Existing)**	473	-	-	189	-	-	Full	$7,000	$70	25	284	-	-	$83	84.2	$635	$1,173	$0	$0	-$6,462	0.15
3	**Single Detached (New)**	614	-	-	246	-	-	Full	$7,000	$70	25	368	-	-	$129	54.3	$635	$1,524	$0	$0	-$6,111	0.20
4	**Attached (New)**	439	-	-	176	-	-	Full	$7,000	$70	25	264	-	-	$72	96.7	$635	$1,091	$0	$0	-$6,544	0.14

Service Region:	**Northern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Free Rider Rate	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.137	$0.458
Electricity ($/kWh)	$0.921	$0.098
Water ($/1000L)	$19.502	$1.650

Measure Description		Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	650	-	-	260	-	-	Full	$7,000	$70	25	390	-	-	$141	49.8	$635	$1,614	$0	$0	-$6,022	0.21
2	**Attached (Existing)**	465	-	-	186	-	-	Full	$7,000	$70	25	279	-	-	$81	86.7	$635	$1,155	$0	$0	-$6,481	0.15
3	**Single Detached (New)**	570	-	-	228	-	-	Full	$7,000	$70	25	342	-	-	$115	61.0	$635	$1,415	$0	$0	-$6,220	0.19
4	**Attached (New)**	408	-	-	163	-	-	Full	$7,000	$70	25	245	-	-	$62	112.5	$635	$1,013	$0	$0	-$6,622	0.13

DHW Recirculation Systems (e.g. Metlund D'MAND®)

Description: Installing DHW recirculation systems such as the Metlund D'MAND®

Service Region: **Southern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.658	$0.540
Electricity ($/kWh)	$0.808	$0.095
Water ($/1000L)	$17.108	$1.675

	Measure Description	Baseline Consumption Nat. Gas (m^3/yr.)	Baseline Consumption Elec. (kWh/yr.)	Baseline Consumption Water (L/yr.)	Upgrade Consumption Nat. Gas (m^3/yr.)	Upgrade Consumption Elec. (kWh/yr.)	Upgrade Consumption Water (L/yr.)	Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings Nat. Gas (m^3/yr.)	Annual Energy & Water Savings Elec. (kWh/yr.)	Annual Energy & Water Savings Water (L/yr.)	Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits Nat. Gas	Total Benefits Elec.	Total Benefits Water	Measure TRC ($)	Benefit/Cost Ratio
1	**Single Detached (Existing)**	660	-	55,714	555	-	46,800	Full	$500	$0	18	106	-	8,914	$72	6.9	$0	$386	$0	$153	$39	1.08
2	**Attached (Existing)**	473	-	42,602	397	-	35,786	Full	$500	$0	18	76	-	6,816	$52	9.6	$0	$277	$0	$117	-$107	0.79
3	**Single Detached (New)**	614	-	55,714	516	-	46,800	Full	$500	$0	18	98	-	8,914	$68	7.4	$0	$359	$0	$153	$12	1.02
4	**Attached (New)**	439	-	42,602	369	-	35,786	Full	$500	$0	18	70	-	6,816	$49	10.1	$0	$257	$0	$117	-$126	0.75

Service Region: **Northern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.658	$0.458
Electricity ($/kWh)	$0.808	$0.098
Water ($/1000L)	$17.108	$1.650

	Measure Description	Baseline Consumption Nat. Gas (m^3/yr.)	Baseline Consumption Elec. (kWh/yr.)	Baseline Consumption Water (L/yr.)	Upgrade Consumption Nat. Gas (m^3/yr.)	Upgrade Consumption Elec. (kWh/yr.)	Upgrade Consumption Water (L/yr.)	Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings Nat. Gas (m^3/yr.)	Annual Energy & Water Savings Elec. (kWh/yr.)	Annual Energy & Water Savings Water (L/yr.)	Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits Nat. Gas	Total Benefits Elec.	Total Benefits Water	Measure TRC ($)	Benefit/Cost Ratio
1	**Single Detached (Existing)**	650	-	55,714	546	-	46,800	Full	$500	$0	18	104	-	8,914	$71	7.0	$0	$380	$0	$153	$33	1.07
2	**Attached (Existing)**	465	-	42,602	391	-	35,786	Full	$500	$0	18	74	-	6,816	$52	9.7	$0	$272	$0	$117	-$111	0.78
3	**Single Detached (New)**	570	-	55,714	479	-	46,800	Full	$500	$0	18	91	-	8,914	$64	7.8	$0	$334	$0	$153	-$14	0.97
4	**Attached (New)**	408	-	42,602	343	-	35,786	Full	$500	$0	18	65	-	6,816	$47	10.7	$0	$239	$0	$117	-$145	0.71

High-Efficiency Gas Ranges

Description: Installing high-efficiency gas ranges rather than standard efficiency models

Service Region: **Southern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.829	$0.540
Electricity ($/kWh)	$0.847	$0.095
Water ($/1000L)	$17.927	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	122	-	-	98	-	-	Incr.	$650	$0	20	24	-	-	$13	49.2	$0	$94	$0	$0	-$556	0.14
2	**Attached (Existing)**	68	-	-	54	-	-	Incr.	$650	$0	20	14	-	-	$7	88.8	$0	$52	$0	$0	-$598	0.08
3	**Single Detached (New)**	120	-	-	96	-	-	Incr.	$650	$0	20	24	-	-	$13	50.0	$0	$92	$0	$0	-$558	0.14
4	**Attached (New)**	67	-	-	53	-	-	Incr.	$650	$0	20	13	-	-	$7	90.2	$0	$51	$0	$0	-$599	0.08

Service Region: **Northern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.829	$0.458
Electricity ($/kWh)	$0.847	$0.098
Water ($/1000L)	$17.927	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	115	-	-	92	-	-	Incr.	$650	$0	20	23	-	-	$12	52.4	$0	$88	$0	$0	-$562	0.14
2	**Attached (Existing)**	78	-	-	62	-	-	Incr.	$650	$0	20	16	-	-	$8	77.1	$0	$60	$0	$0	-$590	0.09
3	**Single Detached (New)**	113	-	-	90	-	-	Incr.	$650	$0	20	23	-	-	$12	53.2	$0	$87	$0	$0	-$563	0.13
4	**Attached (New)**	78	-	-	62	-	-	Incr.	$650	$0	20	16	-	-	$8	77.1	$0	$60	$0	$0	-$590	0.09

High-Efficiency Gas Dryers

Description: Installing high-efficiency gas dryers (with moisture sensors) rather than standard efficiency models

Service Region: **Southern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m³)	$3.095	$0.540
Electricity ($/kWh)	$0.681	$0.095
Water ($/1000L)	$14.417	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	131	-	-	124	-	-	Incr.	$50	$0	13	7	-	-	$4	14.2	$0	$20	$0	$0	-$30	0.40
2	**Attached (Existing)**	73	-	-	69	-	-	Incr.	$50	$0	13	4	-	-	$2	25.4	$0	$11	$0	$0	-$39	0.23
3	**Single Detached (New)**	128	-	-	122	-	-	Incr.	$50	$0	13	6	-	-	$3	14.4	$0	$20	$0	$0	-$30	0.40
4	**Attached (New)**	72	-	-	68	-	-	Incr.	$50	$0	13	4	-	-	$2	25.8	$0	$11	$0	$0	-$39	0.22

Service Region: **Northern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m³)	$3.095	$0.458
Electricity ($/kWh)	$0.681	$0.098
Water ($/1000L)	$14.417	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	128	-	-	122	-	-	Incr.	$50	$0	13	6	-	-	$3	14.4	$0	$20	$0	$0	-$30	0.40
2	**Attached (Existing)**	72	-	-	68	-	-	Incr.	$50	$0	13	4	-	-	$2	25.8	$0	$11	$0	$0	-$39	0.22
3	**Single Detached (New)**	126	-	-	120	-	-	Incr.	$50	$0	13	6	-	-	$3	14.7	$0	$20	$0	$0	-$30	0.39
4	**Attached (New)**	70	-	-	67	-	-	Incr.	$50	$0	13	4	-	-	$2	26.3	$0	$11	$0	$0	-$39	0.22

Efficient Dishwashers

Description: DHW savings from efficient dishwashers as compared to standard models

Service Region: **Southern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.095	$0.540
Electricity ($/kWh)	$0.681	$0.095
Water ($/1000L)	$14.417	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	660	75	5,083	598	44	2,999	Incr.	$50	$0	13	63	31	2,084	$40	1.2	$0	$194	$21	$30	$195	4.90
2	**Attached (Existing)**	473	58	4,614	428	34	2,722	Incr.	$50	$0	13	45	24	1,892	$30	1.7	$0	$139	$16	$27	$132	3.65
3	**Single Detached (New)**	614	75	5,083	556	44	2,999	Incr.	$50	$0	13	58	31	2,084	$38	1.3	$0	$181	$21	$30	$182	4.63
4	**Attached (New)**	439	58	4,614	398	34	2,722	Incr.	$50	$0	13	42	24	1,892	$28	1.8	$0	$129	$16	$27	$123	3.45

Service Region: **Northern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.095	$0.458
Electricity ($/kWh)	$0.681	$0.098
Water ($/1000L)	$14.417	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	650	75	5,083	588	44	2,999	Incr.	$50	$0	13	62	31	2,084	$40	1.3	$0	$191	$21	$30	$192	4.84
2	**Attached (Existing)**	465	58	4,614	421	34	2,722	Incr.	$50	$0	13	44	24	1,892	$29	1.7	$0	$137	$16	$27	$130	3.60
3	**Single Detached (New)**	570	75	5,083	516	44	2,999	Incr.	$50	$0	13	54	31	2,084	$36	1.4	$0	$168	$21	$30	$169	4.37
4	**Attached (New)**	408	58	4,614	369	34	2,722	Incr.	$50	$0	13	39	24	1,892	$26	1.9	$0	$120	$16	$27	$113	3.27

Efficient Clothes Washers

Description: DHW and dryer savings from efficient clothes washers as compared to standard models

Service Region: **Southern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.226	$0.540
Electricity ($/kWh)	$0.711	$0.095
Water ($/1000L)	$15.041	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	791	64	45,711	630	32	13,713	Incr.	$500	$0	14	161	32	31,998	$144	3.5	$0	$520	$23	$481	$524	2.05
2	**Attached (Existing)**	546	48	41,492	437	24	12,447	Incr.	$500	$0	14	108	24	29,044	$109	4.6	$0	$349	$17	$437	$303	1.61
3	**Single Detached (New)**	742	64	45,711	590	32	13,713	Incr.	$500	$0	14	152	32	31,998	$139	3.6	$0	$491	$23	$481	$495	1.99
4	**Attached (New)**	511	48	41,492	409	24	12,447	Incr.	$500	$0	14	102	24	29,044	$106	4.7	$0	$329	$17	$437	$283	1.57

Service Region: **Northern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.226	$0.458
Electricity ($/kWh)	$0.711	$0.098
Water ($/1000L)	$15.041	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	778	64	45,711	620	32	13,713	Incr.	$500	$0	14	159	32	31,998	$142	3.5	$0	$512	$23	$481	$516	2.03
2	**Attached (Existing)**	537	48	41,492	430	24	12,447	Incr.	$500	$0	14	107	24	29,044	$108	4.6	$0	$344	$17	$437	$298	1.60
3	**Single Detached (New)**	696	64	45,711	552	32	13,713	Incr.	$500	$0	14	144	32	31,998	$134	3.7	$0	$464	$23	$481	$468	1.94
4	**Attached (New)**	479	48	41,492	382	24	12,447	Incr.	$500	$0	14	96	24	29,044	$103	4.9	$0	$310	$17	$437	$264	1.53

Swimming Pool Covers

Description: Installing insulating swimming pool covers

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$2.630	$0.540
Electricity ($/kWh)	$0.578	$0.095
Water ($/1000L)	$12.234	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,012	-	-	1,207	-	-	Full	$1,200	$0	10	805	-	-	$435	2.8	$0	$2,116	$0	$0	$916	1.76
2	**Attached (Existing)**	1,440	-	-	864	-	-	Full	$1,200	$0	10	576	-	-	$311	3.9	$0	$1,515	$0	$0	$315	1.26
3	**Single Detached (New)**	1,929	-	-	1,157	-	-	Full	$1,200	$0	10	771	-	-	$417	2.9	$0	$2,028	$0	$0	$828	1.69
4	**Attached (New)**	1,380	-	-	828	-	-	Full	$1,200	$0	10	552	-	-	$298	4.0	$0	$1,452	$0	$0	$252	1.21

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$2.630	$0.458
Electricity ($/kWh)	$0.578	$0.098
Water ($/1000L)	$12.234	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,237	-	-	1,342	-	-	Full	$1,200	$0	10	895	-	-	$483	2.5	$0	$2,352	$0	$0	$1,152	1.96
2	**Attached (Existing)**	1,601	-	-	960	-	-	Full	$1,200	$0	10	640	-	-	$346	3.5	$0	$1,684	$0	$0	$484	1.40
3	**Single Detached (New)**	2,143	-	-	1,286	-	-	Full	$1,200	$0	10	857	-	-	$463	2.6	$0	$2,254	$0	$0	$1,054	1.88
4	**Attached (New)**	1,534	-	-	920	-	-	Full	$1,200	$0	10	614	-	-	$331	3.6	$0	$1,613	$0	$0	$413	1.34

High-Efficiency Pool Heaters

Description: Installing high-efficiency pool heaters rather than standard efficiency models

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.336	$0.540
Electricity ($/kWh)	$0.738	$0.095
Water ($/1000L)	$15.618	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,012	-	-	1,791	-	-	Incr.	$2,900	$0	15	221	-	-	$120	24.3	$0	$738	$0	$0	-$2,162	0.25
2	**Attached (Existing)**	1,440	-	-	1,282	-	-	Incr.	$2,900	$0	15	158	-	-	$86	33.9	$0	$528	$0	$0	-$2,372	0.18
3	**Single Detached (New)**	1,929	-	-	1,716	-	-	Incr.	$2,900	$0	15	212	-	-	$115	25.3	$0	$708	$0	$0	-$2,192	0.24
4	**Attached (New)**	1,380	-	-	1,228	-	-	Incr.	$2,900	$0	15	152	-	-	$82	35.4	$0	$506	$0	$0	-$2,394	0.17

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.336	$0.458
Electricity ($/kWh)	$0.738	$0.098
Water ($/1000L)	$15.618	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,237	-	-	1,990	-	-	Incr.	$2,900	$0	15	246	-	-	$133	21.8	$0	$821	$0	$0	-$2,079	0.28
2	**Attached (Existing)**	1,601	-	-	1,425	-	-	Incr.	$2,900	$0	15	176	-	-	$95	30.5	$0	$587	$0	$0	-$2,313	0.20
3	**Single Detached (New)**	2,143	-	-	1,907	-	-	Incr.	$2,900	$0	15	236	-	-	$127	22.8	$0	$786	$0	$0	-$2,114	0.27
4	**Attached (New)**	1,534	-	-	1,365	-	-	Incr.	$2,900	$0	15	169	-	-	$91	31.8	$0	$563	$0	$0	-$2,337	0.19

Solar Pool Heaters

Description: Installing solar pool heaters as a replacement to standard efficiency gas-fired pool heaters

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.814	$0.540
Electricity ($/kWh)	$0.847	$0.095
Water ($/1000L)	$17.927	$1.675

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,012	-	-	-	-	-	Full	$1,850	$0	20	2,012	-	-	$1,087	1.7	$0	$7,674	$0	$0	$5,824	4.15
2	**Attached (Existing)**	1,440	-	-	-	-	-	Full	$1,850	$0	20	1,440	-	-	$778	2.4	$0	$5,492	$0	$0	$3,642	2.97
3	**Single Detached (New)**	1,929	-	-	-	-	-	Full	$1,850	$0	20	1,929	-	-	$1,041	1.8	$0	$7,355	$0	$0	$5,505	3.98
4	**Attached (New)**	1,380	-	-	-	-	-	Full	$1,850	$0	20	1,380	-	-	$745	2.5	$0	$5,264	$0	$0	$3,414	2.85

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Free Rider Rate 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.814	$0.458
Electricity ($/kWh)	$0.847	$0.098
Water ($/1000L)	$17.927	$1.650

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost		Incr. O&M ($/yr.)	Measure Life (yrs.)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (yrs.)	NPV O&M Cost ($)	Total Benefits			Measure TRC ($)	Benefit/Cost Ratio
		Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)	Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)					Nat. Gas (m^3/yr.)	Elec. (kWh/yr.)	Water (L/yr.)				Nat. Gas	Elec.	Water		
1	**Single Detached (Existing)**	2,237	-	-	-	-	-	Full	$1,850	$0	20	2,237	-	-	$1,208	1.5	$0	$8,529	$0	$0	$6,679	4.61
2	**Attached (Existing)**	1,601	-	-	-	-	-	Full	$1,850	$0	20	1,601	-	-	$864	2.1	$0	$6,104	$0	$0	$4,254	3.30
3	**Single Detached (New)**	2,143	-	-	-	-	-	Full	$1,850	$0	20	2,143	-	-	$1,157	1.6	$0	$8,173	$0	$0	$6,323	4.42
4	**Attached (New)**	1,534	-	-	-	-	-	Full	$1,850	$0	20	1,534	-	-	$828	2.2	$0	$5,850	$0	$0	$4,000	3.16

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APPENDIX B

Achievable Potential Workshop - Opportunity Slides

R1: Efficient Windows

- **Technology:** Two levels of windows pass the economic screen
  - ENERGY STAR windows: ~RSI-0.5
  - Super windows (triple-glazed): RSI-1.0 to RSI-1.9
- **Target sub-sector:** Southern new detached (but passes in all new and existing)
- **Incremental costs:** ENERGY STAR: ~$200-$500/house
  Super windows: ~$400-$950/house
- **Savings:** ENERGY STAR: ~7-12% of HVAC energy
  Super windows: ~10-15% of HVAC energy
  - Percentage varies because of the rest of the house envelope; absolute savings are more consistent
- **Lifetime:** 30 years

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R1: Efficient Windows (cont'd...)

- **B/C ratio:** ENERGY STAR: 1.5-3.0
  Super windows: 1.0-2.3
- **Customer payback:** ENERGY STAR: 3-6 years
  Super windows: 4-8 years
- **Financial assessment:** Incremental basis
- **Eligible participants:** E-STAR: 13K by 2012; 17.5K by 2017
  Super: 39K by 2012; 78K by 2017
- ENERGY STAR potential declines with time as they become standard
- Super windows cost premium will likely fall as ENERGY STAR becomes standard
- Custom vs. tract builders – replacement market looks like custom home builder market?

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R2: Weatherization (Old Homes)

- **Technology:**
  - Several weatherization measures were evaluated.
  - In an average house (all vintages lumped together), few of them passed the economic screen.
  - Two were re-evaluated for leaky, older homes:
    - Attic insulation from RSI 1.8 (R-10) to RSI 5.3 (R-30)
    - Air sealing to reduce 9.1 ACH (@50 Pa) by 50% (professionally done, including blower door test)
- **Target sub-sector:** Southern detached homes at least 25 years old (maybe use high bills to pinpoint)
- **Full costs:** Attic insulation: ~$600
  Air sealing: ~$900 in detached
  ~$700 in attached

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R2: Weatherization (Old Homes) (cont'd...)

- **Savings:** Attic insulation: ~8% of HVAC energy
  Air sealing: ~14% of HVAC energy
- **Lifetime:** Attic insulation: 30 years; Air sealing: 25 years
- **B/C ratio:** Attic insulation: 1.0 to 1.7; Air sealing: 1.0 to 1.4
- **Customer payback**: Attic insulation: 5 to 8 years
  Air sealing: 5 to 7 years
- **Financial assessment:** Full cost basis
- **Eligible participants:**
  - Attic Insul: 162,000 existing homes by 2012; no additional by 2017
  - Air Sealing: 235,500 existing by 2012; no additional by 2017
- Approximately half of Ontario houses are over 25 years old – how many have had weatherization?

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R3: Dishwashers

- **Technology:**
  - ENERGY STAR threshold for dishwashers was changed in January 2007. Now 41% more efficient than standard dishwasher.
  - Savings of DHW energy, electricity (for motor and heat booster) and water
- **Target sub-sector:** Southern existing detached (but passes in all new and existing)
- **Incremental cost:** ~$50/dishwasher
- **Savings:** 41% of DHW used for dishwashing (just under 10% of DHW overall)
- **Lifetime:** 13 years

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R3: Dishwashers (cont'd...)

- **B/C ratio:** 3.5 to 5.0
- **Customer payback:** 1.3 to 2.0 years
- **Financial assessment:** Incremental basis
- **Eligible participants:** 218,000 dishwashers by 2012 (31%)
  436,000 dishwashers by 2017 (55%)
- Both minimum standards and ENERGY STAR targets tend to move up with time, though often with long lead times
- Revisions not likely until near end of study period

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R4: Water Recirculation Systems

- **Technology:**
  - Metlund D'MAND DHW recirculation systems reduce time waiting for hot water to reach tap by a factor of 4 or 5
  - Recirculate lukewarm water back to hot water tank (often through cold lines)
  - Install at point farthest from water heater
- **Target sub-sector:** Southern existing detached
- **Full cost:** $500 per dwelling
- **Savings:** 16% of DHW
- **B/C ratio:** 0.7 to 1.1
- **Customer payback:** 7.5 to 12 years

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R4: Water Recirculation Systems (cont'd…)

- **Financial assessment:** Full cost basis
- **Eligible participants:** 290,000 existing homes by 2012 (37%)
  263,000 existing homes by 2017 (33%)
- Also applies to new homes
  - Potentially lower cost if system is incorporated in design stage
  - System can also be made more effective if it uses dedicated lines to return water (rather than cold water lines) but this will result in higher costs

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R5: Tankless Water Heaters

- **Technology:**
  - Instantaneous (tankless) water heaters heat water on demand, eliminating standby losses associated with storage tanks
- **Target sub-sector:** Southern new detached
- **Incremental cost:** $700
  - Takes into account longer lifetime of tankless heaters and makes an assumption of market mature incremental cost
- **Savings:** 33% of DHW energy
- **Lifetime:** 20 years
- **B/C ratio:** 0.75 to 1.2
- **Customer payback:** 6.0 to 9.5 years

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R5: Tankless Water Heaters (cont'd...)

- **Financial assessment:** Incremental basis
- **Eligible participants:** 14,000 new homes by 2012 (32%)
  27,500 new homes by 2017 (31%)
- Also applies to existing homes
  - Potentially higher cost due to issues related to venting

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R6: Ultra Low-Flow Showerheads

- **Technology:**
  - Ultra low-flow showerheads consume 4.75 LPM (1.25 GPM) while traditional low flow models use 7.6-9.5 LPM (2.0-2.5 GPM)
- **Target sub-sector:** Southern existing detached
- **Full cost:** $15/household
- **Savings:** 16% of DHW energy (50% of shower DHW)
- **Lifetime:** 10 years
- **B/C ratio:** 27.0 to 39.0
- **Customer payback:** 0.2 years
- **Financial assessment:** Full cost basis
- **Eligible participants:** 730,000 existing homes by 2012; No additional homes by 2017

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Drain Water Heat Recovery

- Evaluated drain water heat recovery (DWHR)
  - Full cost: $900 in existing; $700 in new
  - Savings: ~15% of DHW energy
  - Based on these average assumptions, not close to meeting economic screen
- At current installed costs, technology is attractive in a subset of households with high water use:
  - Large families, long showers, small and large multi-res. buildings
- Measure is currently in Year 2 of Union's market transformation programming
  - Focused primarily in the new build market
- Expected to continue to be a market transformation activity for next planning cycle (2009)

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R7: Solar Pool Heaters

- **Technology:**
  - Generally employ unglazed solar collectors that are mounted on the roofs of houses
  - Much simpler than solar DHW systems, and thus, much more affordable
- **Target sub-sector:** Southern existing detached (but passes in all new and existing)
- **Full cost:** ~$1,850/dwelling with pool
- **Savings:** 100% of pool heating energy
- **Lifetime:** 20 years

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R7: Solar Pool Heaters (cont'd...)

- **B/C ratio:** 3.0 to 4.5
- **Customer payback:** 1.5 to 2.5 years
- **Financial assessment:** Full cost basis
- **Eligible participants:** 22,500 existing pools by 2012;
  24,000 existing pools by 2017

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R8: Programmable Thermostats

- **Technology:**
  - Allow for temperature setback during nights and unoccupied periods
  - Provide improved temperature setting accuracy
  - Important behavioural aspect associated with the use of p-stats
- **Target sub-sector:** Southern existing detached (but passes in all new and existing)
- **Incremental cost:** $65/thermostat
- **Savings:** 12% of space heating energy;
  6% of space cooling and ventilation energy

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R8: Programmable Thermostats (cont'd...)

- **B/C ratio:** 9.0 to 15.0
- **Customer payback:** 0.5 to 1.0 years
- **Financial assessment:** Full cost basis
- **Eligible participants:** 250,000 existing homes by 2012;
  No additional thermostats by 2017

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Natural Gas Energy Efficiency Potential

Commercial Sector

–Final Report–

Submitted to:

Union Gas

Submitted by:

Marbek Resource Consultants Ltd.

March 24, 2009

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Note to Reader

The primary economic data for this study was compiled during the period April to June of 2008. They represented the best available at the time. However, since that time, Canada and other global economies have entered a period of unprecedented economic uncertainty that may have significant impact on the results of this study, particularly in the short term. Three elements that affect this study's results are particularly impacted by these economic changes:

- Sector growth rates
- DSM Program participation rates that are used to determine the estimates of achievable potential
- Type of DSM investment

Sector Growth Rates

Key factors underlying Union's load forecast and the study's Reference Case such as gross domestic product (GDP), energy prices, commodity prices, currency values etc. are expected to change under the current conditions. The impact of these changes, at least in the short term, is expected to be reduced industrial output accompanied by reduced consumption of natural gas. At this time, it is impossible to predict either the extent or the duration of the economic downturn and its consequent impact on natural gas consumption.

DSM Program Participation Rates

The participation rates estimated during the Achievable Potential workshops do not explicitly take into account changes in industry outlook as a result of the economic downturn. In the short term, the expected impact would be lower discretionary investment and, hence, lower program participation rates than those presented in this report. As neither the extent nor the duration of the economic downturn is known at this time, it is not possible to estimate the total reduction in program participation rates over the full study period.

Type of DSM Investment

Many of the DSM investments included in this study's results pass the economic screen on a full cost basis and can be implemented at any time over the study period. This means that even if program participation rates are reduced in the short term, there remains the possibility of recapturing some of these opportunities in later portions of the study period. However, some of the DSM investment opportunities included in the study's results occur only when existing equipment is replaced at the end of its life. This means that if program participation rates are reduced in the short term, then the opportunity to implement the energy efficient model is lost until the equipment again comes up for replacement, which in most applications will be beyond the period covered by this study.

EXECUTIVE SUMMARY

❑ Background and Objectives

Union Gas Ltd. (Union) is a natural gas utility serving almost 1.3 customers in the residential, commercial and industrial markets. Union is a regulated utility with a Service area spread across the Province of Ontario including Northern, southwestern and southeastern cities and towns. Union distributes approximately 13.88 billion cubic metres (489.91 billion cubic feet) of natural gas to its customers annually.

Since 1997, Union has delivered demand side management (DSM) programs to its customers under a mandate from the provincial regulator, the Ontario Energy Board (OEB). Union offers DSM programs to all in-franchise customer rate classes and across all sectors and the DSM savings target and budget are determined through a rate proceeding with the OEB. Over the past eleven years Union has delivered approximately 614 million m^3 of natural gas savings and over $1 billion in net Total Resource Cost (TRC) benefits.

Union has been participating in a market of increasing DSM program maturity. This market is continually evolving in its engagement with energy efficiency through growing voluntary initiatives and more stringent codes and standards. In addition, changes in the economy have started to show signs of negatively impacting the commercial and industrial marketplace in Union's Service Area.

In the DSM Generic Proceeding held in 2006, Union committed to creating an updated Market Potential Study for input into the next DSM plan. This study will support the identification of potential energy savings for Union's next multi-year plan and be part of Union's regulatory filing in the next DSM rate case.

Union has initiated this current study within the context of the conditions noted above. When completed, the results of this natural gas Efficiency Potential Study will provide a foundation that Union can use to guide the development of its longer-term DSM strategy, including new measures and targets. More specifically, this includes support for Union's filing to the OEB regulatory application for the next multi-year DSM plan by:

- Estimating the achievable and economic potential for DSM measures across all applicable technologies, markets and sectors in Union's Service Area

- Giving shape to, and refining, ongoing energy-efficiency work by Union in order to develop its next multi-year DSM plan, and

- Provide information that is actionable and can be easily converted to plan and program development.

❑ Scope and Organization

This study covers a 10-year study period from 2007 to 2017 and addresses the Residential, Commercial and Industrial sectors. The 2007 calendar year was selected as the Base Year as this is the most recent year for which complete customer data are available.

The study addresses the full range of natural gas efficiency measures. Results are presented for the total Union Service Area and for two service regions: Southern and Northern. The Southern region of Union's system extends through Southwestern Ontario from Windsor to just west of Toronto. The Northern region of Union's system extends throughout Northern Ontario from the Manitoba border to the North Bay/Muskoka area and across Eastern Ontario from Port Hope to Cornwall. The study results are disaggregated by service region due to differences in building stock and weather conditions (heating degree days).

This report presents the results for Union's Commercial sector[1]

❑ Approach

The detailed end-use analysis of the Commercial sector was conducted using two linked modeling platforms: **CEEAM** (Commercial Energy and Emissions Analysis Model), Marbek's in-house commercial building stock energy-use simulation model, and **CSEEM** (Commercial Sector Energy End-use Model), a Marbek in-house spreadsheet-based macro model. The models are described in further detail in Section 1.

The major steps involved in the analysis are shown in Exhibit ES1 and are discussed in greater detail in Section 1. As illustrated in Exhibit ES1, the results of this study, and in particular the estimation of Achievable Potential,[2] support Union's on-going DSM program planning; however, it should be emphasized that the estimation of Achievable Potential is not synonymous with either the setting of specific targets or with detailed program design, which are beyond the scope of this study.

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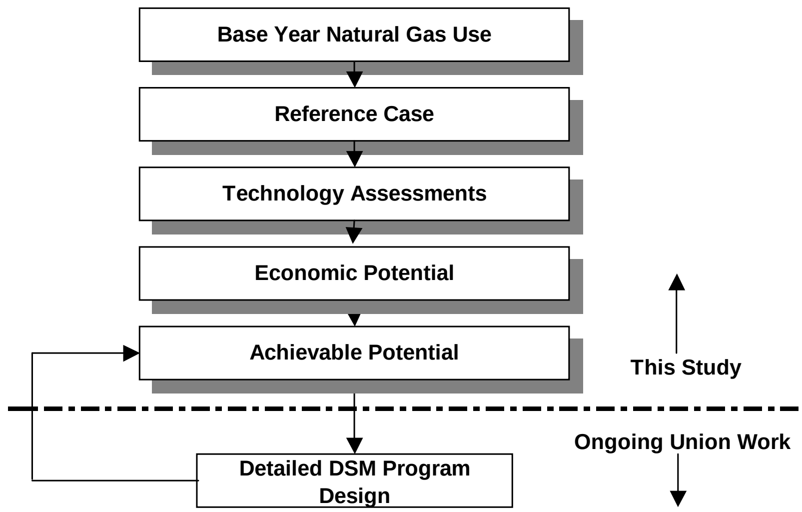
[1] The sub sectors Other Buildings and Other Contract Institutional Buildings are included in the total load but natural gas consumption was not modeled by end use in these sub sectors.

[2] The proportion of savings identified that could realistically be achieved within the study period, under various program spending and market conditions.

Exhibit ES1: Study Approach - Major Analytical Steps



❑ Overall Study Findings

As in any study of this type, the results presented in this report are based on a large number of important assumptions. Assumptions such as those related to the current penetration of energy-efficient technologies, the rate of future growth in the province's building stock and customer willingness to implement new efficiency measures are particularly influential. Wherever possible, the assumptions used in this study are consistent with those used by Union and are based on best available information, which in many cases includes the professional judgement of the consultant team, Union personnel and local experts. The reader should, therefore, use the results presented in this report as best available estimates; major assumptions, information sources and caveats are noted throughout the report.

The study findings confirm the existence of significant cost-effective DSM potential in Union's Commercial sector. Efficiency improvements within the Union service area would provide between 390 and 259 million m^3/yr. of natural gas savings by 2017 in, respectively, the Financially Unconstrained and the Static Marketing Achievable scenarios. The most significant Achievable Savings opportunities were actions that reduce space heating loads in existing buildings (e.g., building recommissioning, advanced Building Automation Systems, and space heating equipment upgrades), and actions that reduce water heating loads in existing buildings, including low flow fixtures and water heating equipment upgrades.

Although program costs for the Financially Unconstrained and the Static Marketing scenarios will vary depending on the specific composition of the future program portfolio, both scenarios show an evident trend towards higher future costs to achieve natural gas savings and TRC benefits.[3] This trend recognizes that savings from DSM programs tend to become more

[3] Design of a DSM program portfolio is beyond the scope of this current study.

expensive with time as the most attractive measures gain greater market penetration and only the more challenging measures remain.[4]

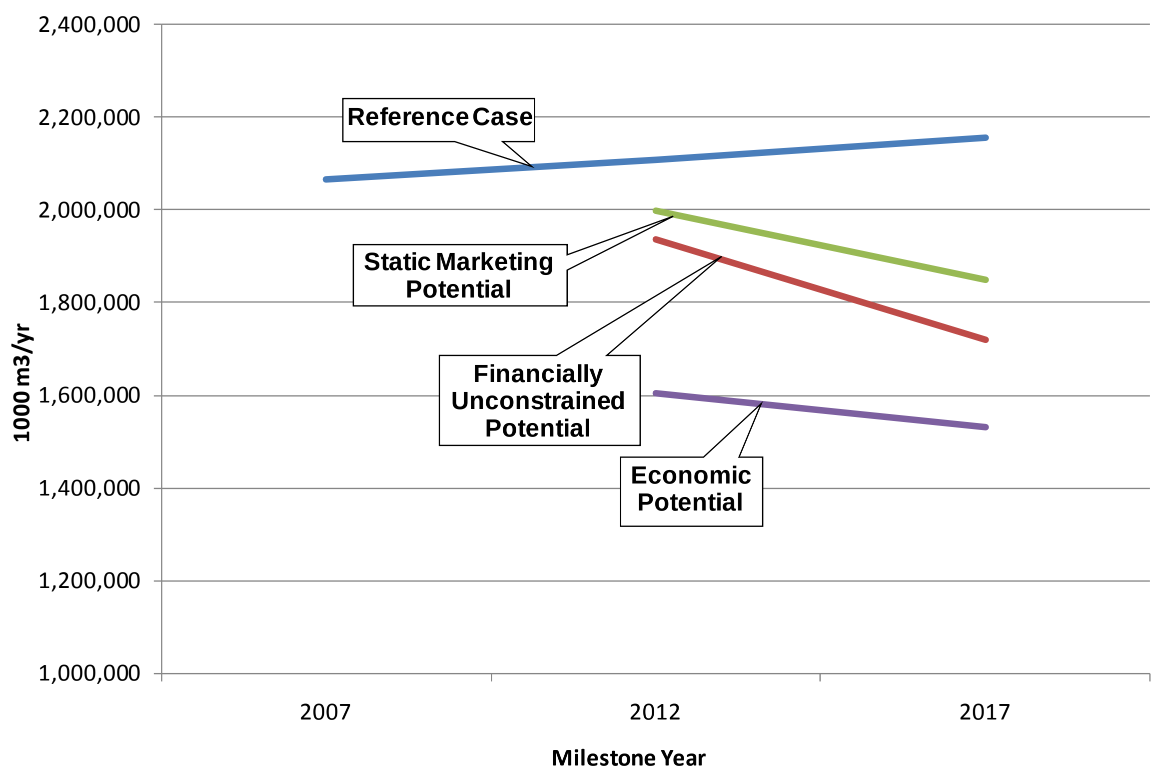
❑ Summary of Natural Gas Savings

A summary of the levels of annual natural gas consumption contained in each of the forecasts addressed by the study is presented by milestone year in Exhibits ES2 and ES3, and discussed briefly in the paragraphs below.

Exhibit ES2: Summary of Forecast Results for the Total Union Service Area – Annual Natural Gas Consumption, Commercial Sector (1000 m^3/yr.)

Annual Consumption (1000 m^3/yr.) Commercial Sector					Potential Savings (1000 m^3/yr.)		
Milestone Year	Reference Case	Economic	Achievable		Economic	Achievable	
			Unconstrained	Static		Unconstrained	Static
	(A)	(B)	(C)	(D)	(A-B)	(A-C)	(A-D)
2007	2,067,064						
2012	2,110,220	1,605,716	1,937,890	1,997,612	504,505	172,330	112,609
2017	2,157,072	1,531,696	1,720,144	1,851,019	625,376	390,076	259,202

Exhibit ES3: Graphic of Forecast Results for the Total Union Service Area – Annual Natural Gas Consumption, Commercial Sector (1000 m^3/yr.)



4 Over time, it is also expected that some relatively new technologies, such as tankless water heaters and super high-performance glazings, may become less expensive as they gain greater sales volumes.

Base Year Natural Gas Use

Exhibit ES4 shows that in the Base Year of 2007, Union's Commercial sector consumed about 2,067 million m^3 of natural gas.

Exhibit ES4: Base Year Natural Gas Use by End Use for the Total Union Service Area, Commercial Sector

Sub Sector	Space Heating	Water Heating	Cooking	Space Cooling	Other	Total
Large Office	99,744	7,774	324	185	11,716	119,743
Small Office	213,790	15,367	626	0	12,519	242,302
Retail	147,344	9,583	4,219	0	5,274	166,419
Large Hotel	7,649	4,766	643	0	919	13,978
Small Hotel/Motel	4,849	2,718	59	0	588	8,214
Contract Hospital	41,177	10,879	1,096	291	7,026	60,469
Hospital	18,650	3,762	489	70	1,361	24,332
Nursing Home	42,669	12,719	2,843	0	4,045	62,276
School	127,355	7,415	1,783	0	841	137,394
Contract University/College	58,582	10,173	2,868	617	7,170	79,409
University/College	12,355	1,837	444	118	846	15,600
Restaurant/Food Service	39,992	15,664	25,853	0	326	81,836
Warehouse	61,965	3,307	138	0	2,752	68,162
Contract Apartment	5,038	1,854	22	0	179	7,093
High-rise Apartment	120,369	40,913	522	0	4,176	165,980
Mid-rise Apartment	74,936	24,848	484	0	1,210	101,478
Other Buildings						391,810
Other Contract Institutional Buildings						320,568
Total	1,076,463	173,581	42,413	1,280	60,948	2,067,064

Note: Any difference in totals is due to rounding.

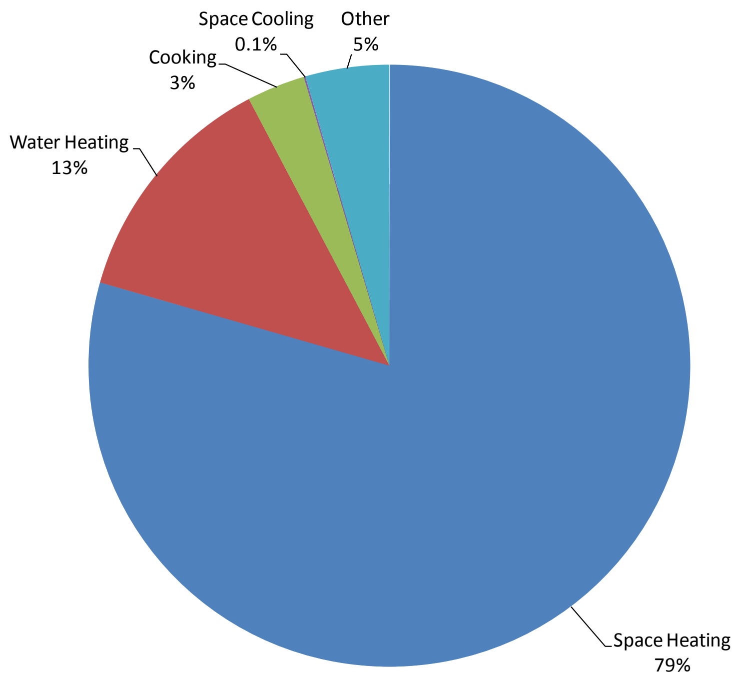


Exhibit ES4 also shows that space heating accounts for about 79% of total commercial natural gas use. Water heating accounts for about 13% of the total natural gas use, followed by cooking at 3%. The remaining 5% of natural gas consumption in the Commercial sector occurs in a variety of other applications, such as dehumidification, air reheat, steam distribution losses, laboratory equipment, laundry equipment and space cooling.

The sub sectors Other Buildings and Other Contract Institutional Buildings have the largest share of total gas consumption at 19% and 16% respectively. Among modelled sub sectors, Small Office accounts for 12% of total gas consumption, followed by Retail and High-rise Apartment at 8% each.

The Southern service region accounts for 77% of the commercial natural gas consumption in the total Union Service Area.

Reference Case

In the absence of new Union DSM initiatives, the study estimates that natural gas consumption in Union's Commercial sector will grow from 2,067 million m^3 in 2007 to about 2,157 million m^3 by 2017. This represents an overall growth of about 2.2 % in the period and compares very closely with Union's load forecast. Both this study and the Union load forecast include consideration of the impacts of "natural conservation."

Economic Potential Forecast

Under the conditions of the Economic Potential Forecast,[5] the study estimated that natural gas consumption in Union's Commercial sector would decline from the Base Year levels of 2,067 million m^3 to about 1,531 million m^3 by 2017. Annual savings relative to the Reference Case are 626 million m^3, or about 29%.

Achievable Potential

As noted above, the Achievable Potential is the proportion of the economic natural gas savings that could be realistically achieved within the study period under various program spending and marketing conditions.

Under the conditions defined by the Financially Unconstrained scenario, total Commercial sector natural gas savings in 2017 are estimated to be approximately 390 million m^3/yr. This represents a saving of approximately 18%, relative to the Reference Case and is equal to approximately 62% of the savings identified in the Economic Potential Forecast.

Under the conditions defined by the Static Marketing scenario, total Commercial sector natural gas savings in 2017 are estimated to be approximately 259 million m^3/yr. This represents a saving of approximately 12%, relative to the Reference Case and is equal to approximately 41% of the savings identified in the Economic Potential Forecast.

[5] The level of natural gas consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective. In this study, "cost effective" means that the technology upgrade passes the measure TRC test.

The most significant Achievable Savings opportunities were actions that reduce space heating loads in existing buildings (e.g., building recommissioning, advanced building automation systems, space heating equipment upgrades and heat recovery), and actions that reduce hot water loads in existing buildings, including low-flow fixtures and water heating equipment upgrades. Building recommissioning is a particularly large opportunity.

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List of Exhibits

1. INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

Union Gas Ltd. (Union) is a natural gas utility serving almost 1.3 customers in the commercial, commercial and industrial markets. Union is a regulated utility with a Service Area spread across the Province of Ontario including northern, southwestern and southeastern cities and towns. Union distributes approximately 13.88 billion cubic metres (489.91 billion cubic feet) of natural gas to its customers annually.

Since 1997, Union has delivered demand side management (DSM) programs to its customers under a mandate from the provincial regulator, the Ontario Energy Board (OEB). Union offers DSM programs to all in-franchise customer rate classes and across all sectors and the DSM savings target and budget are determined through a rate proceeding with the OEB. Over the past eleven years Union has delivered approximately 614 million m^3 of natural gas savings and over $1 billion in net Total Resource Cost (TRC) benefits.

Union has been participating in a market of increasing DSM program maturity. This market is continually evolving in its engagement with energy efficiency through growing voluntary initiatives and more stringent codes and standards. In addition, changes in the economy have started to show signs of negatively impacting the commercial and industrial marketplace in Union's Service Area.

In the DSM Generic Proceeding held in 2006, Union committed to creating an updated Market Potential Study for input into the next DSM plan. This study will support the identification of potential energy savings for Union's next multi-year plan and be part of Union's regulatory filing in the next DSM rate case.

Union has initiated this current study within the context of the conditions noted above. When completed, the results of this natural gas Efficiency Potential Study will provide a foundation that Union can use to guide the development of its longer-term DSM strategy, including new measures and targets. More specifically, this includes support for Union's filing to the OEB regulatory application for the next multi-year DSM plan by:

- Estimating the achievable and economic potential for DSM measures across all applicable technologies, markets and sectors in Union's Service Area
- Giving shape to, and refining, ongoing energy-efficiency work by Union in order to develop its next multi-year DSM plan, and
- Provide information that is actionable and can be easily converted to plan and program development.

1.2 STUDY SCOPE

The scope of this study is summarized below.

- **Sector Coverage:** The study addresses three sectors: Residential, Commercial[6] and Industrial.

- **Geographical Coverage**: The study results are presented for the total Union Service Area and for two service regions: Southern and Northern. The Southern region of Union's system extends through Southwestern Ontario from Windsor to just west of Toronto. The Northern region of Union's system extends throughout Northern Ontario from the Manitoba border to the North Bay/Muskoka area and across Eastern Ontario from Port Hope to Cornwall. The study results are further disaggregated by service region due to differences in building stock and weather conditions (heating degree days).

- **Study Period**: This study covers a 10-year period. The Base Year is the calendar year 2007, with milestone periods at five-year increments: 2012 and 2017. The Base Year of 2007 was selected as this was the most recent calendar year for which complete customer data were available.

- **Technologies:** The study addresses the full range of natural gas energy-efficiency measures (see Exhibit 1.1, overleaf).

1.2.1 Data Caveat

As in any study of this type, the results presented in this report are based on a large number of important assumptions. Assumptions such as those related to the current penetration of energy-efficient technologies, the rate of future growth in Union's industrial load and customer willingness to implement new energy-efficiency measures are particularly influential.

Wherever possible, the assumptions used in this study are consistent with those used by Union and are based on best available information, which in many cases includes the professional judgment of the consultant team, Union personnel and/or local experts. The reader should use the results presented in this report as best available estimates; major assumptions, information sources and caveats are noted throughout.

[6] Throughout this report the term "Commercial" also includes institutional sectors, such as schools, hospitals, etc., unless otherwise noted.

Exhibit 1.1: Commercial Energy-efficiency Technologies

Building Envelope: • High-Performance Glazings • Super High-Performance Glazings • Wall Insulation Upgrade • Roof Insulation Upgrade • Air Sealing • Air Curtains • Vinyl Strip Curtains • Fast-moving Doors • L-Shaped Vestibules • Turnstile Doors **Heating, Ventilating and Air-Conditioning:** • Condensing Boilers • Near-Condensing Boilers • Condensing Unit Heaters • High-Efficiency Rooftop Units • Condensing Rooftop Units • Absorption Heat Pumps • Steam Plant Efficiency Measures • HVLS De-stratification Fans • Heat Reflector Panels • Programmable Thermostats • Heat Recovery • Demand Controlled Ventilation • Demand Control Kitchen Ventilation • Furnace & Boiler Tune-ups • Condensing Furnaces • Infrared Heaters • Solar Preheated Make-up Air	**Domestic Hot Water:** • Condensing Water Heaters • Condensing Tank-Type Water Heaters • Tankless Water Heaters • Drainwater Heat Recovery • Low-Flow Faucet Aerators & Showerheads • Low-Flow Pre-Rinse Spray Valves • Solar Water Heating • Booster Water Heaters **Cooking:** • Efficient Griddles • Efficient Broilers • Efficient Ovens • ENERGY STAR® Fryers **Whole Building:** • Building Recommissioning • Advanced Building Automation Systems • High-Performance New Building Construction • Includes high-efficiency building envelopes, space heating & ventilation equipment, water heating equipment, food preparation equipment, whole building measures, LEED building criteria and specific technologies and practices such as multi-unit residential patio beam insulation, green roofs and cellular concrete.

1.3 DEFINITIONS[7]

This study employs numerous terms that are unique to analyses such as this one and consequently it is important to ensure that readers have a clear understanding of what each term means when applied to this study. Below is a brief description of some of the most important terms.

Base Year Natural Gas Use The Base Year is the starting point for the analysis. It provides a detailed description of "where" and "how" natural gas is currently used in the Commercial sector. The bottom up profile of energy use patterns and market shares of energy-using technologies was calibrated to actual Union customer sales data.

[7] A Glossary is provided in Section 9.

Reference Case Forecast The Reference Case is a projection of natural gas consumption to 2017, in the absence of any new Union DSM market interventions after 2008. It is the baseline against which the scenarios of energy savings are calculated. The Reference Case forecast incorporates an estimation of "natural conservation," namely, changes in end-use efficiency over the study period that are projected to occur in the absence of new market interventions by Union.

Measure Total Resource Cost The measure TRC calculates the net present value of natural gas, electricity and water savings that result from an investment in an efficiency technology or measure. The measure TRC is equal to its full or incremental capital cost (depending on application) plus any change (positive or negative) in the combined annual energy, water and equipment operating and maintenance (O&M) costs. This calculation includes, among others, the following inputs: the avoided natural gas, electricity and water supply costs, the life of the technology and the selected discount rate, which in this analysis has been set at 10%.

The measure TRC test is the primary determinant of whether a measure is included in the economic potential.

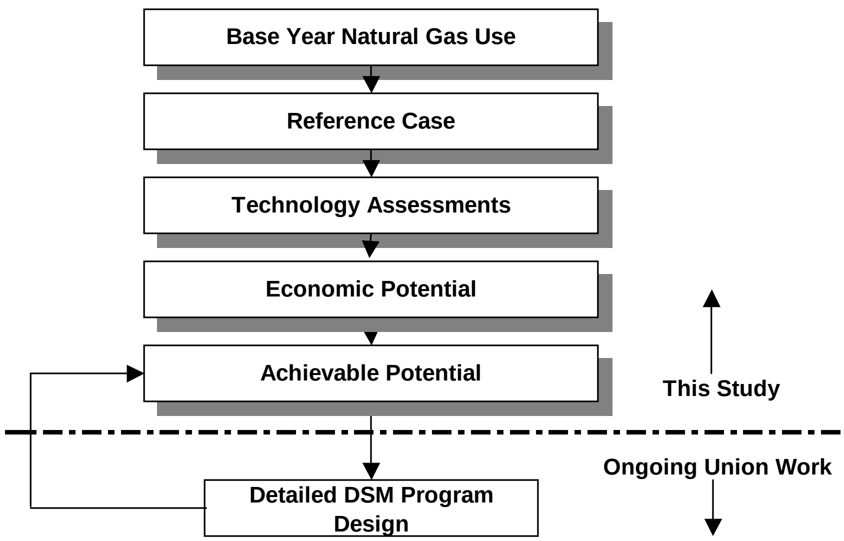
Economic Potential Forecast The Economic Potential Forecast is the level of natural gas consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective from Union's perspective. All of the energy-efficiency technologies and measures that have a positive measure TRC are incorporated into the Economic Potential Forecast. These technologies and measures are applied at either natural stock turnover rates or at designated years for immediate application.

Achievable Potential The Achievable Potential is the proportion of the natural gas savings identified in the Economic Potential Forecast that could realistically be achieved within the study period. Achievable Potential recognizes that it is difficult to induce customers to purchase and install all of the efficiency technologies that meet the criteria defined by the Economic Potential Forecast.

1.4 APPROACH

To meet the objectives outlined above, the study was conducted within an iterative process that involved a number of well-defined steps. At the completion of each step, the client reviewed the results and, as applicable, revisions were identified and incorporated into the interim results. The study then progressed to the next step. A summary of the steps is presented in Exhibit 1.2 and briefly discussed below.

Exhibit 1.2: Major Study Steps



Step 1: Develop Profile of Base Year Natural Gas Use

- Compile and analyze available data on Union's existing building stock, including both customer billing data and information from customer surveys, facility energy audits etc.
- Develop detailed technical descriptions of the existing building stock for each sub sector and service region
- Compile actual Union billing data
- Undertake computer simulations of energy use in each building sub sector and compare these with actual building billing and audit data
- Calibrate sector model results using actual Union billing data.
- The output of Step 1 forms Section 2 of this report.

Step 2: Develop Reference Case Forecast for the Study period

- Compile and analyze building design, equipment and operations data and develop detailed technical descriptions of the new building stock
- Develop computer simulations of energy use in each new building sub sector
- Compile data on forecast levels of building stock growth and "natural" changes in equipment efficiency levels and/or practices
- Define sector model inputs and create forecasts of energy use for each of the milestone years
- Compare sector model results with Union's forecast for the period.
- The output of Step 2 forms Section 3 of this report.

Step 3: Develop and Assess Energy-efficiency Upgrade Options

- Develop list of energy-efficiency measures in consultation with the client
- Compile detailed cost and performance data for each measure
- Assess the energy, WATER and economic impacts of implementing the energy-efficiency upgrade options in place of the baseline technologies employed in the Reference Case
- Determine the measure TRC for each upgrade option.

- The output of this task forms Section 4 of this report.

Step 4: Estimate Economic Energy Savings Potential

- Compile utility economic data on the forecast cost of new natural gas supply;
- Screen the identified energy-efficiency upgrade options from Step 3 against the utility economic data
- Identify the combinations of energy-efficiency upgrade options and building types where the measure TRC is positive
- Apply the economically attractive efficiency measures from Step 3 within the energy use simulation model developed previously for each building type
- Determine annual energy consumption in each building type when the economic efficiency measures are employed
- Compare the energy consumption levels when all economic efficiency measures are used with the Reference Case consumption levels and calculate the energy savings.
- The output of this task forms Section 5 of this report.

Step 5: Estimate Achievable Energy Savings Potential

- "Bundle" the energy saving opportunities identified in the Economic Potential Forecast into a set of Actions
- Create "Action Profiles" for each of the identified Actions that provide a "high-level" rationale and direction, including target technologies and sub-markets as well as key barriers and a broad intervention strategy
- Review historical achievable program results and prepare preliminary Action Assessment Worksheets
- Conduct Achievable Potential workshops involving utility and consultant team personnel, selected trade allies and technology and market experts to reach general agreement on a range of Achievable Potential based on different funding scenarios
- The output of this task forms Section 6 of this report.

1.5 ANALYTICAL MODELS

The detailed end-use analysis of the Commercial sector was conducted using two linked modeling platforms as follows:

- ***CEEAM*** (***C***ommercial ***E***nergy and ***E***missions ***A***nalysis ***M***odel), an in-house, simulation model, developed in conjunction with Natural Resources Canada for modeling energy use in commercial/institutional building stock.
- ***CSEEM (C***ommercial ***S***ector ***E***nergy ***E***nd-use ***M***odel), an in-house spreadsheet based macro model.

CEEAM is Marbek's in-house model used to develop commercial natural gas end-use intensities (EUIs) for each of the commercial and institutional building archetypes. CEEAM has been successfully employed in numerous studies for NRCan, several electric and natural gas utilities and international DSM projects, including the extensive national climate change analysis conducted for the Federal Buildings Table. CEEAM is a robust modeling platform and its results have been verified against actual end-use metered data for the cities of Ottawa and Toronto and against DOE-2.1E.

CEEAM has been developed specifically for applications such as this study. One of CEEAM's particular strengths is the capability to simulate energy performance not only in a given building but also in an entire stock of similar buildings (e.g., all Large Offices). In particular, it is capable of tracking the penetration of multiple technologies and combinations that are not possible in other simulation software, such as DOE 2.

CEEAM simulates the energy consumption for all natural gas end uses present in a given commercial building segment. CEEAM calculates energy use and emissions by end use and reports them in $MJ/m^2/yr.$ and kg eCO_2/m^2. Because CEEAM is a full modeling program, it calculates both building heating and cooling loads (internal and transmission), thus accounting for interactive effects such as the increase in heating use and decrease in cooling electricity use from lighting retrofits. CEEAM also uses equipment part load performance curves to accurately model the seasonal efficiency of heating and cooling plants.

The EUIs derived by CEEAM provide inputs into CSEEM (Marbek's in-house Commercial Sector Electricity End-use Model). As noted above, CSEEM is a spreadsheet-based macro model. It consists of two modules:

- A General Parameters module that contains general sector data (e.g., total building stock floor area per sub sector, growth rates, etc.)
- A Building Profile module that contains the EUI data for each of the selected building segments.

CSEEM combines the data from each of the modules and provides total natural gas use by service region, building sub sector and end use.

1.6 THIS REPORT

This report addresses the Commercial sector and provides a summary of the results to date. This report is presented in the following sections.

- Section 2 presents a profile of Base Year Natural Gas use in Union's Service Area, including a discussion of the major steps involved and the data sources employed.

- Section 3 presents the Commercial sector Reference Case for the study period 2007 to 2017.

- Section 4 provides a financial and economic assessment of the identified energy-efficiency measures.

- Section 5 presents the Commercial sector Economic Potential Forecast for the study period 2007 to 2017.

- Section 6 presents the estimated range of Achievable Potential for natural gas savings, under differing scenarios, for the study period 2007 to 2017.

- Section 7 presents the conclusions.

- Section 8 presents a listing of major references.
- Section 9 provides a glossary of commonly used terms.

2. BASE YEAR NATURAL GAS USE

2.1 INTRODUCTION

This section presents a description of natural gas use in Union's Commercial sector in the Base Year of 2007. Drawing on the best available data, this section presents total natural gas consumption in Union's Commercial sector, together with an estimate of how that consumption is distributed by service region, sub sector and end use.

The remainder of this section outlines the steps involved in preparing the profile of Base Year natural gas use and presents a summary of the results. The discussion is organized into the following subsections:

- Segmentation of Commercial Building Stock
- Segmentation of Union's Sales Data
- Development of Detailed Technical Profiles for Existing Buildings
- Derivation of Saturation and Fuel Share Data
- Summary of Base Year Natural Gas Use.

2.2 SEGMENTATION OF COMMERCIAL BUILDING STOCK

The first major task in developing the profile of Base Year natural gas use involved the segmentation of the commercial building stock into specific sub sectors. The choice of specific building sub sectors is driven by both data availability and the need to facilitate the subsequent analysis and modelling of potential energy-efficiency improvements. To facilitate the subsequent modelling and analysis of energy-efficiency opportunities, the selected building sub sectors need to be reasonably similar in terms of major design and operating considerations, such as building size, mechanical and electrical systems, annual operating hours, etc.

A summary of the Commercial sub sectors that are used in this study is provided in Exhibit 2.1.

Exhibit 2.1: Commercial Sub Sectors

- Large Office
- Small Office
- Retail
- Large Hotel
- Small Hotel/Motel
- Contract Hospital
- Hospital
- Nursing Home
- Contract University/College
- University/College
- School
- Restaurant/Food Service
- Warehouse
- Contract Apartment
- High-rise Apartment
- Mid-rise Apartment
- Other Buildings
- Other Contract Institutional Buildings

Selected additional information related to the sub sectors shown in Exhibit 2.1 is provided below.

Contract Sub sectors

These sub sectors include buildings served under contract agreements with Union including Hospitals, University/Colleges, Apartments and Other Contract Institutional Buildings. Included among the Other Contract Institutional Buildings sub sector are social service and correctional facilities.

Large and Small

Office and Hotel/Motel each have large and small sub sectors. The large sub sectors include buildings with an annual gas consumption of greater and 50,000 m^3; the small sub sectors include buildings with an annual gas consumption of less than 50,000 m^3.

Mid-rise and High-rise

The High-rise Apartment sub sector includes apartment and condominium buildings with an annual gas consumption of greater than 50,000 m^3. The Mid-rise Apartment sub sector includes apartment and condominium buildings with an annual gas consumption of less than 50,000 m^3.

Other Buildings

The Other Buildings sub sector includes all other buildings: recreational, religious, laundromats, gas stations/car washes and buildings classified in Union's customer database as other multi-family, other commercial and other institutional.

2.3 SEGMENTATION OF UNION CUSTOMER SALES DATA

Once agreement was reached on the selection and definition of the commercial sub sectors shown in Exhibit 2.1, Union compiled a summary of its total 2007 customer sales segmented into the selected sub sectors for each of the Southern and Northern service regions. The data were provided on both an annual and monthly basis.[8] A summary of the sales data mapping is provided below in Exhibit 2.2.

[8] Annual sales data were actual data and monthly sales data were derived using forecasting factors.

Exhibit 2.2: Sales Data Mapping

Study Sub sector	Union Sub sector Components
Large Office	Office Building >50,000 m^3 consumption
	Office Building Unit >50,000 m^3
Small Office	Office Building < 50,000 m^3
	Office Building Unit < 50,000 m^3
Retail	Retail Building
	Retail Plaza
	Retail Plaza Unit
Large Hotel	Hotel/Motel >50,000 m^3
Small Hotel/Motel	Hotel/Motel <50,000 m^3
Contract Hospital	Contract Institutional (Hospital Portion)
Hospital	Hospital Facility
Nursing Home	Senior/Nursing/Health Care
School	Education Primary/Secondary
	Permanent Daycare
Contract University/College	Contract Institutional (College/University Portion)
University/College	Education College/University
Restaurant/Food Service	Restaurant/Food Service
Warehouse	Warehouse Facility
Contract Apartment	Contract Apartment
High-rise Apartment	Apartment Building > 50,000 m^3
	Condominium Building > 50,000 m^3
	Apartment Unit > 50,000 m^3
Mid-rise Apartment	Apartment Building < 50,000 m^3
	Condominium Building < 50,000 m^3
	Apartment Unit < 50,000 m^3
Other Buildings	Commercial Other
	Recreation
	Religious
	Institutional Other
	Permanent Correctional Facility
	Commercial Laundromat
	Gas Station/Car Wash
	Multi-Family Other > 50,000 m^3
Other Contract Institutional Buildings	Other Contract Institutional Buildings

The actual sales data by sub sector provides the reference point for the calibration of the modelled results that were developed in subsequent steps of the analysis. This data was further disaggregated into its base and weather sensitive components to assist in the calibration. Base load factors for each sub sector were derived from Marbek's in-house database of end-use intensities for similar building types and service regions. This database is based on previous DSM project experience as well as several dozen commercial and institutional building audits. The database contains information on monthly gas sales data by for the Southern Ontario market at the sub sector level. Exhibit 2.3 presents a breakdown of the gas sales into base load and weather sensitive load components for each service region.

Exhibit 2.3: Natural Gas Sales by Component and Service Region[9]

Sub Sector	Southern service region				Northern service region			
	Total Sector Consumption (1000 m^3)	Estimated Base Load Proportion (%)	Base Load (1000 m3)	Weather Sensitive Load (1000 m3)	Total Sector Consumption (1000 m3)	Estimated Base Load Proportion (%)	Base Load (1000 m3)	Weather Sensitive Load (1000 m3)
Large Office	51,811	22%	11,398	40,413	67,931	21%	14,266	53,666
Small Office	90,394	14%	12,655	77,739	151,908	18%	27,343	124,565
Retail	150,327	14%	21,046	129,281	16,092	14%	2,253	13,839
Large Hotel	10,734	45%	4,830	5,904	3,243	45%	1,459	1,784
Small Hotel/Motel	5,854	50%	2,927	2,927	2,360	50%	1,180	1,180
Contract Hospital	53,461	40%	21,384	32,077	7,008	45%	3,154	3,855
Hospital	10,290	30%	3,087	7,203	14,042	40%	5,617	8,425
Nursing Home	41,142	38%	15,634	25,508	21,134	40%	8,454	12,681
School	87,245	7%	6,107	81,137	50,149	8%	4,012	46,137
Contract University/College	70,537	29%	20,456	50,081	8,872	29%	2,573	6,299
University/College	12,599	25%	3,150	9,449	3,001	30%	900	2,101
Restaurant/Food Service	71,838	60%	43,103	28,735	9,998	60%	5,999	3,999
Warehouse	64,300	8%	5,144	59,156	3,862	8%	309	3,553
Contract Apartment	7,093	29%	2,057	5,036	0	n/a	n/a	n/a
High-rise Apartment	149,737	27%	40,429	109,308	16,243	26%	4,223	12,020
Mid-rise Apartment	82,468	26%	21,442	61,027	19,010	25%	4,753	14,258
Other Buildings	340,457	20%	68,091	272,365	51,354	20%	10,271	41,083
Other Contract Institutional Buildings	295,028	20%	59,006	236,022	25,541	20%	5,108	20,433
Grand Total	1,595,315	24%	361,946	1,233,369	471,749	22%	101,873	369,876

2.4 FUEL SHARE DATA

The next step in the analysis involved an estimation of the gas fuel share[10] for space heating, water heating, space cooling and cooking. It is important to note that for the purposes of this study, the space heating end use includes the heating of make-up air and takes into account such factors as envelope losses and internal heat gains from electrical equipment. Various information sources were used to derive these estimates, including analysis of utility sales data, consultations with Union and local technical advisors, existing consultant team files of facility energy audits in Ontario facilities, reviews of previous Ontario sub sector specific analysis conducted by team members on behalf of a variety of clients and recent discussions with select building engineering practitioners. Unless specific data was available, natural gas fuel shares were assumed to be the same for the two regions.

Exhibit 2.4 presents the estimated fuel shares for each sub sector and service region.

9 There are no contract apartment customers in the Northern service region.

10 Refers to the percent of total load met by natural gas.

Exhibit 2.4: Natural Gas Fuel Share for Major End Uses by Sub Sector and Service Region (%)

Sub Sector	Southern service region			Northern service region		
	Space Heating	Water Heating	Cooking	Space Heating	Water Heating	Cooking
Large Office	90%	81%	20%	90%	81%	20%
Small Office	90%	81%	20%	90%	81%	20%
Retail	90%	66%	40%	90%	66%	40%
Large Hotel	65%	88%	50%	65%	88%	50%
Small Hotel/Motel	65%	85%	20%	65%	85%	20%
Contract Hospital	96%	82%	65%	96%	82%	65%
Hospital	96%	82%	65%	96%	82%	65%
Nursing Home	65%	90%	82%	65%	90%	82%
School	89%	77%	53%	89%	77%	53%
Contract University/College	83%	91%	70%	83%	91%	70%
University/College	83%	91%	70%	83%	91%	70%
Restaurant/Food Service	82%	82%	88%	82%	82%	88%
Warehouse	96%	64%	10%	96%	64%	10%
Contract Apartment	90%	79%	5%	n/a	n/a	n/a
High-rise Apartment	90%	79%	5%	90%	79%	5%
Mid-rise Apartment	90%	88%	10%	90%	88%	10%

2.5 DEVELOPMENT OF DETAILED TECHNICAL PROFILES FOR EXISTING BUILDINGS

The next step involved the development of detailed technical profiles for each of the major existing commercial building sub sectors described above.[11] Each profile contains detailed technical data on building envelope characteristics, hot water heating equipment, HVAC equipment, lighting systems, and cooking, plug and miscellaneous loads. The detailed technical profiles summarize the major data inputs that are used by Marbek's energy use simulation model to estimate natural gas use by sub sector and end use. It is important to note that Union sales data are based on customer accounts. For this reason, some accounts for mixed-use buildings are classified by their major use. For example, an office building with a ground floor retail store or restaurant would fall into one of the office sub sectors. These secondary uses are reflected in the sub sector technical profiles.

Development of the detailed building profiles was informed by existing consultant team files of facility energy audits in Ontario facilities, reviews of previous Ontario sub sector specific analysis conducted by team members on behalf of a variety of clients and recent discussions with select building engineering practitioners.

[11] Detailed building profiles were not constructed for the Other Buildings or Other Contract Institutional Buildings due to the wide variation of building types included in these sub sectors. Potential savings for the facilities included in these sub sectors will be estimated based on the results of the modelled sub sectors.

Separate building profiles were developed for each combination of sub sector and service region. Two representative weather regions were used as follows:

- Southern service region (London)
- Northern service region (North Bay)

A sample building profile summary for existing Large Offices in the Southern service region is presented in Exhibit 2.5. A complete set of detailed profiles for existing buildings are presented in Appendix A (Southern service region) and B (Northern service region).

Exhibit 2.5: Sample Building Profile Summary – Existing Large Office

Additional highlights are provided below related to each of the major Commercial sector natural gas end uses addressed by this study, namely:

- Space Heating
- Water Heating
- Cooking
- Space Cooling
- Other.

2.5.1 Space Heating

Model assumptions related to the distribution of natural gas space heating equipment are summarized in Exhibit 2.6.[12]

Exhibit 2.6: Space Heating Equipment Type - % of Natural Gas Heated Floor Area

Sub Sector	Southern service region		Northern service region	
	Boilers	Rooftop Units/ Other	Boilers	Rooftop Units/ Other
Large Office	50%	50%	50%	50%
Small Office	50%	50%	50%	50%
Retail	11%	89%	11%	89%
Large Hotel	80%	20%	80%	20%
Small Hotel/Motel	80%	20%	80%	20%
Contract Hospital	95%	5%	95%	5%
Hospital	95%	5%	95%	5%
Nursing Home	69%	31%	69%	31%
School	90%	10%	90%	10%
Contract University/College	76%	24%	76%	24%
University/College	76%	24%	76%	24%
Restaurant/Food Service	18%	82%	18%	82%
Warehouse	11%	89%	11%	89%
Contract Apartment	78%	22%	n/a	n/a
High-rise Apartment	78%	22%	78%	22%
Mid-rise Apartment	78%	22%	78%	22%

[12] Based on Marbek database and discussions with Union personnel.

2.5.2 Water Heating

Exhibit 2.7[13] presents the distribution of gas-fired water heating equipment between boilers and tank heaters that has been assumed in this study. The distributions are shown by sub sector and service region.

Exhibit 2.7: Existing Gas Water Heating Equipment Distribution - % of Floor Area Serviced by Gas-fired Water Heating

Sub Sector	Southern service region		Northern service region	
	Boilers	Tank Heaters	Boilers	Tank Heaters
Large Office	20%	80%	20%	80%
Small Office	5%	95%	5%	95%
Retail	3%	97%	3%	97%
Large Hotel	85%	15%	85%	15%
Small Hotel/Motel	74%	26%	74%	26%
Contract Hospital	87%	13%	87%	13%
Hospital	87%	13%	87%	13%
Nursing Home	76%	24%	76%	24%
School	40%	60%	40%	60%
Contract University/College	76%	24%	76%	24%
University/College	76%	24%	76%	24%
Restaurant/Food Service	17%	83%	17%	83%
Warehouse	9%	91%	9%	91%
Contract Apartment	30%	70%	n/a	n/a
High-rise Apartment	30%	70%	30%	70%
Mid-rise Apartment	20%	80%	20%	80%

13 Based on Marbek database and discussions with Union personnel.

2.5.3 Cooking

Exhibit 2.8[14] presents the natural gas cooking energy use intensities (EUIs) used in this study for each service region. These EUIs represent stock averages, which take into account the incidence of gas cooking equipment in each sub sector.

Exhibit 2.8: Gas Cooking EUIs (MJ/m^2.yr)

Sub Sector	Southern service region	Northern service region
Large Office	10	10
Small Office	10	10
Retail	40	40
Large Hotel	70	70
Small Hotel/Motel	30	30
Contract Hospital	60	60
Hospital	50	60
Nursing Home	60	60
School	20	20
Contract University/College	40	40
University/College	30	30
Restaurant/Food Service	900	900
Warehouse	10	10
Contract Apartment	50	n/a
High-rise Apartment	50	50
Mid-rise Apartment	40	40

2.5.4 Space Cooling

Natural gas space cooling represents a small proportion of the total space cooling end use as discussed in section 2.3. The gas-fired space cooling equipment present in the Union Service Area includes both gas engine-driven chillers and absorption chillers.

Exhibit 2.9 presents the estimates of space cooling saturation[15] and gas fuel share used in this study for each sub sector and service region.

[14] Based on Marbek database and discussions with Union personnel.

[15] Space cooling saturation refers to the percentage of the total floor space that is served by air conditioning equipment (both electricity and natural gas driven equipment).

Exhibit 2.9: Space Cooling Saturation and Fuel Share (% of Floor Space)

Sub Sector	Southern service region		Northern service region	
	Saturation	Natural Gas Fuel Share	Saturation	Natural Gas Fuel Share
Large Office	86%	1%	86%	0%
Small Office	86%	0%	86%	0%
Retail	85%	0%	85%	0%
Large Hotel	85%	0%	85%	0%
Small Hotel/Motel	85%	0%	85%	0%
Contract Hospital	75%	5%	75%	1%
Hospital	75%	5%	75%	1%
Nursing Home	60%	0%	60%	0%
School	15%	0%	15%	0%
Contract University/College	75%	4%	75%	1%
University/College	75%	4%	75%	1%
Restaurant/Food Service	85%	0%	85%	0%
Warehouse	10%	0%	10%	0%
Contract Apartment	40%	0%	n/a	n/a
High-rise Apartment	40%	0%	25%	0%
Mid-rise Apartment	40%	0%	25%	0%

2.5.5 Other Gas Uses

Natural gas use is used primarily for space heating, hot water heating, cooking and, to a lesser extent, space cooling. Other natural gas uses commonly found in commercial buildings include the following:

- Dehumidification
- Air reheat
- Steam distribution losses
- Sterilizers and other process loads
- Laboratory equipment
- Laundry equipment
- Fireplaces and patio heaters
- Pools and hot tubs.

Exhibit 2.10 presents the estimated EUIs for “other” gas uses, and their approximate percentages of total natural gas use for each sub sector and service region.

Exhibit 2.10: "Other" Natural Gas Use EUIs and % of Total Building Use

Sub Sector	Southern service region		Northern service region	
	Other EUI ($MJ/m^2.yr.$)	% of Total Natural Gas Use	Other EUI ($MJ/m^2.yr.$)	% of Total Natural Gas Use
Large Office	75	11%	70	9%
Small Office	40	6%	40	5%
Retail	20	3%	20	3%
Large Hotel	50	7%	50	6%
Small Hotel/Motel	60	8%	60	6%
Contract Hospital	250	12%	250	10%
Hospital	100	6%	100	5%
Nursing Home	70	7%	70	6%
School	5	1%	5	1%
Contract University/College	70	9%	70	8%
University/College	40	6%	40	5%
Restaurant/Food Service	10	0.4%	10	0.4%
Warehouse	20	4%	20	3%
Contract Apartment	20	3%	n/a	n/a
High-rise Apartment	20	3%	20	2%
Mid-rise Apartment	10	1%	10	1%

2.6 FLOOR SPACE ESTIMATES

The estimated floor area for each building sub sector was estimated by dividing the Union sales data by the whole building natural gas (energy) use intensity (EUI) that was generated by the CEEAM model using the input assumptions, as summarized in the preceding discussions. The general equation is shown below.

$$Floor\ area = \frac{Consumption}{(EUI_{heat})(FS_{heat}) + (EUI_{water\ htg})(FS_{water\ htg}) + (EUI_{cook})(FS_{cook}) + (EUI_{cool})(FS_{cool})(SAT_{cool}) + (EUI_{other})}$$

Where;

EUI is energy use intensity in $MJ/m^2.yr.$
FS is percent natural gas fuel share for the end use
SAT is percentage saturation for the end use

Exhibit 2.11: Base Year (2007) Estimated Floor Area by Sub Sector and Service Region (m^2)

Sub Sector	Southern service region	Northern service region	Total
Large Office	2,886,107	3,177,068	6,063,175
Small Office	4,933,040	6,783,010	11,716,050
Retail	9,112,392	800,307	9,912,699
Large Hotel	548,857	141,428	690,284
Small Hotel/Motel	284,703	83,181	367,883
Contract Hospital	951,177	105,241	1,056,418
Hospital	241,821	267,821	509,641
Nursing Home	1,512,124	656,390	2,168,514
School	4,291,254	2,019,322	6,310,576
Contract University/College	3,490,673	359,396	3,850,069
University/College	665,633	128,479	794,112
Restaurant/Food Service	1,096,109	130,800	1,226,909
Warehouse	4,965,853	208,694	5,174,547
Contract Apartment	336,230	0	336,230
High-rise Apartment	7,202,562	647,423	7,849,985
Mid-rise Apartment	3,804,397	741,767	4,546,164

2.7 SUMMARY OF BASE YEAR ENERGY USE

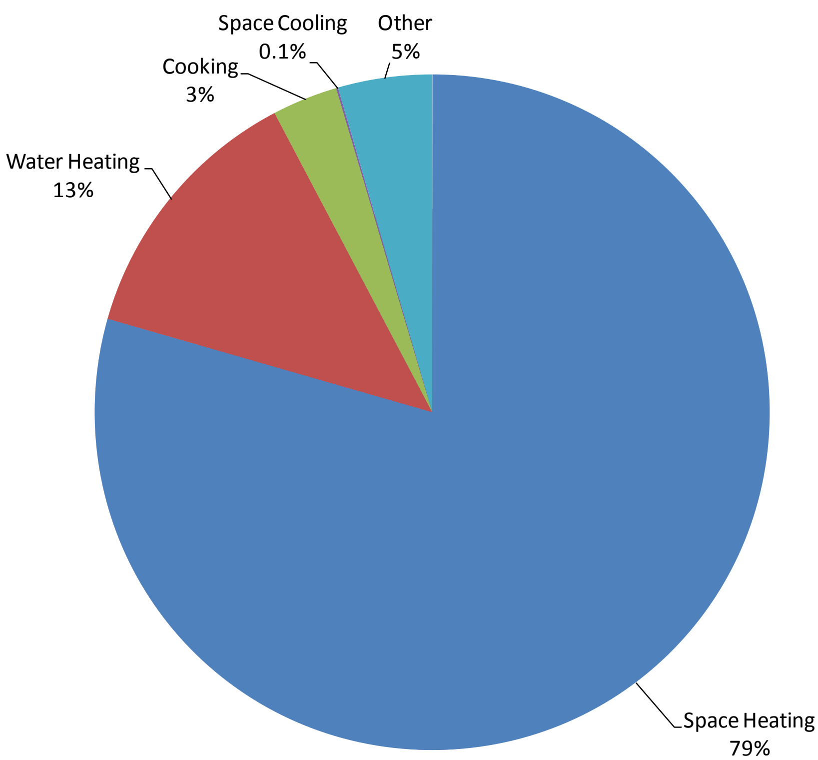
The summary of Base Year model results are presented in three separate Exhibits:

- Exhibit 2.12 presents the modelled results, broken out by sub sector and end use for the total Union Service Area. Note that the CSEEM model has been calibrated using the actual Union sales data in each service region. As a consequence, modelled results match the sales data exactly for each sub sector and service region.

- Exhibits 2.13 and 2.14 present the modelled results, broken out by sub sector and end use for the Southern and Northern service regions, respectively.

Exhibit 2.12: Base Year Results by Sub Sector and End Use – Total Service Region (1000 m^3/yr.)[16]

Sub Sector	Space Heating	Water Heating	Cooking	Space Cooling	Other	Total
Large Office	99,744	7,774	324	185	11,716	119,743
Small Office	213,790	15,367	626	0	12,519	242,302
Retail	147,344	9,583	4,219	0	5,274	166,419
Large Hotel	7,649	4,766	643	0	919	13,978
Small Hotel/Motel	4,849	2,718	59	0	588	8,214
Contract Hospital	41,177	10,879	1,096	291	7,026	60,469
Hospital	18,650	3,762	489	70	1,361	24,332
Nursing Home	42,669	12,719	2,843	0	4,045	62,276
School	127,355	7,415	1,783	0	841	137,394
Contract University/College	58,582	10,173	2,868	617	7,170	79,409
University/College	12,355	1,837	444	118	846	15,600
Restaurant/Food Service	39,992	15,664	25,853	0	326	81,836
Warehouse	61,965	3,307	138	0	2,752	68,162
Contract Apartment	5,038	1,854	22	0	179	7,093
High-rise Apartment	120,369	40,913	522	0	4,176	165,980
Mid-rise Apartment	74,936	24,848	484	0	1,210	101,478
Other Buildings						391,810
Other Contract Institutional Buildings						320,568
Total	1,076,463	173,581	42,413	1,280	60,948	2,067,064



[16] The pie charts in Exhibits 2.12, 2.13 and 2.14 present percentage of gas consumption by end use for modelled buildings only; the sub sectors Other Buildings and Other Contract Institutional Buildings are included in the total load, but not included in the respective pie charts.

Exhibit 2.13: Base Year Results by Sub Sector and End Use - Southern Service Region ($1000\ m^3$/yr.)

Sub Sector	Space Heating	Water Heating	Cooking	Space Cooling	Other	Total
Large Office	42,035	3,684	153	185	5,754	51,811
Small Office	78,448	6,438	262	0	5,245	90,394
Retail	132,804	8,803	3,876	0	4,844	150,327
Large Hotel	5,711	3,783	511	0	729	10,734
Small Hotel/Motel	3,255	2,100	45	0	454	5,854
Contract Hospital	36,081	9,787	986	286	6,321	53,461
Hospital	7,601	1,777	209	60	643	10,290
Nursing Home	27,505	8,846	1,978	0	2,814	41,142
School	80,437	5,028	1,209	0	570	87,245
Contract University/College	51,623	9,216	2,598	605	6,495	70,537
University/College	9,867	1,538	372	114	708	12,599
Restaurant/Food Service	34,490	13,981	23,076	0	291	71,838
Warehouse	58,355	3,173	132	0	2,640	64,300
Contract Apartment	5,038	1,854	22	0	179	7,093
High-rise Apartment	107,917	37,512	479	0	3,829	149,737
Mid-rise Apartment	60,288	20,765	405	0	1,011	82,468
Other Buildings						340,457
Other Contract Institutional Buildings						295,028
Total	741,454	138,286	36,312	1,251	42,528	1,595,315

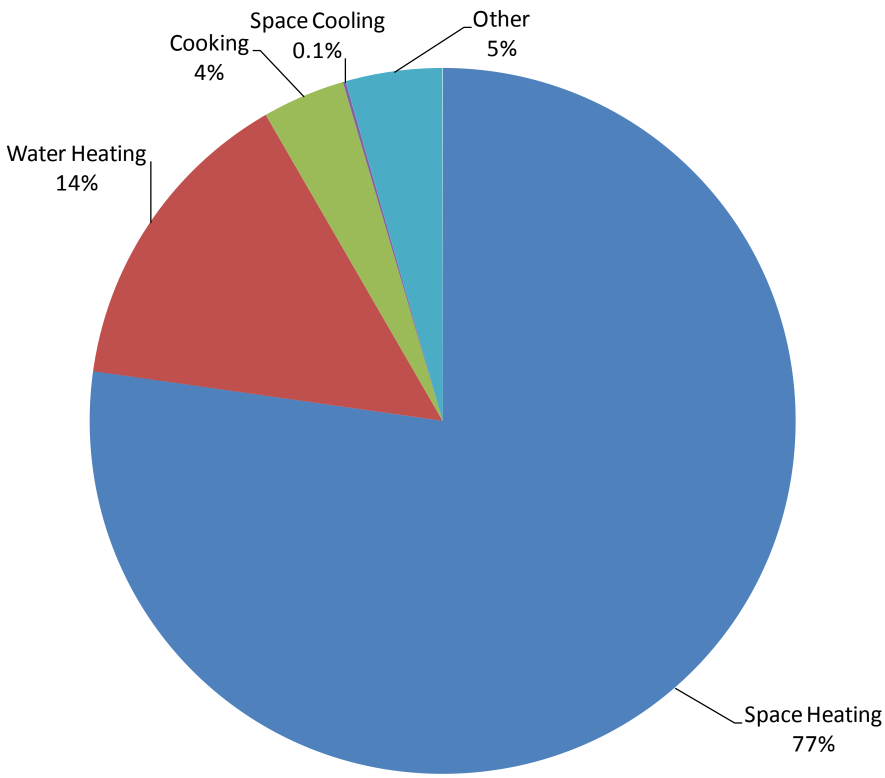
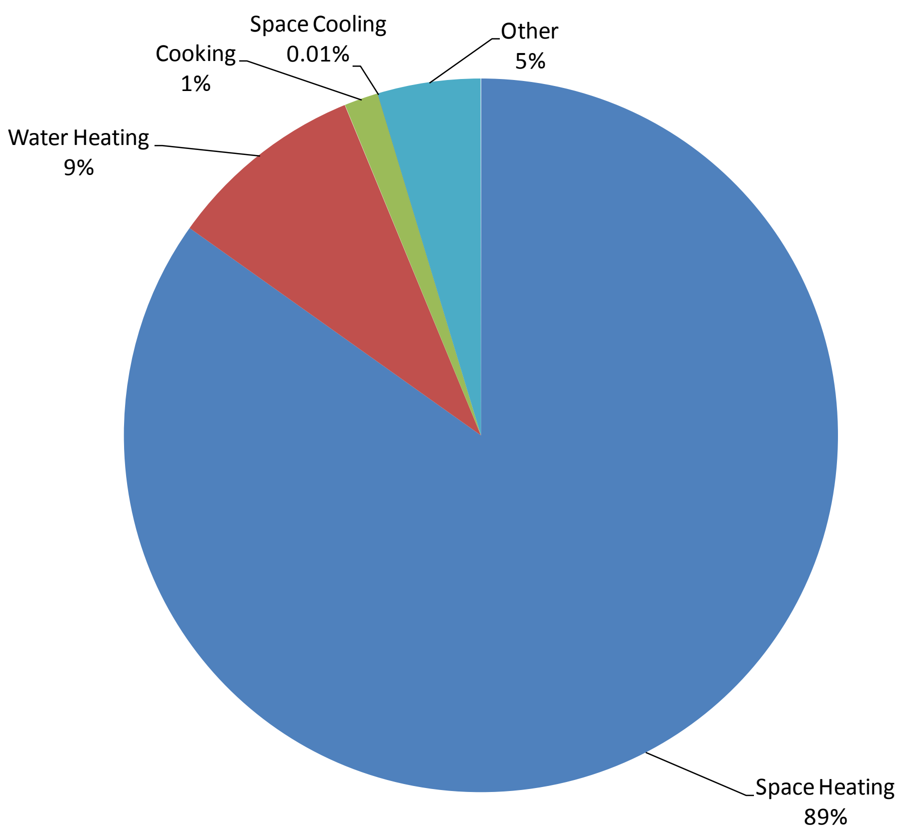


Exhibit 2.14: Base Year Results by Sub Sector and End Use - Northern Service Region (1000 m^3/yr.)

Sub Sector	Space Heating	Water Heating	Cooking	Space Cooling	Other	Total
Large Office	57,708	4,090	170	0	5,962	67,931
Small Office	135,342	8,929	364	0	7,274	151,908
Retail	14,540	780	343	0	429	16,092
Large Hotel	1,938	983	133	0	190	3,243
Small Hotel/Motel	1,594	619	13	0	134	2,360
Contract Hospital	5,096	1,092	110	4	705	7,008
Hospital	11,049	1,985	280	9	718	14,042
Nursing Home	15,164	3,873	866	0	1,232	21,134
School	46,918	2,386	574	0	271	50,149
Contract University/College	6,959	957	270	12	674	8,872
University/College	2,488	299	72	4	138	3,001
Restaurant/Food Service	5,503	1,683	2,777	0	35	9,998
Warehouse	3,610	134	6	0	112	3,862
High-rise Apartment	12,452	3,401	43	0	347	16,243
Mid-rise Apartment	14,648	4,083	80	0	199	19,010
Other Buildings						51,354
Other Contract Institutional Buildings						25,541
Total	335,009	35,295	6,101	30	18,420	471,749



2.7.1 Interpretation of Results

Highlights of the results shown in Exhibits 2.13 and 2.14 are as follows:

Sub Sector

In the Southern service region, the sub sectors Other Buildings and Other Contract Institutional Buildings have the largest share of total gas consumption at 21% and 18% respectively. Among modelled sub sectors, Retail buildings and High-rise Apartment buildings each make up 9% of total gas consumption, followed by Contract Hospital at 6%.

In the Northern service region, Small Office accounts for the largest share of total gas consumption at 32%, followed by Large Office at 14%, Other Buildings at 11% and Schools at 10%.

End Use

In the Southern service region, space heating accounts for the largest share of gas consumption at 77%, followed by water heating at 14% and other at 5%.

In the Northern service region, space heating also accounts for the largest share of gas consumption at 89%, followed by water heating at 9% and other at 5%.

3. REFERENCE CASE

3.1 INTRODUCTION

This section presents the Commercial sector Reference Case for the study period 2007 to 2017. The Reference Case estimates the expected level of natural gas consumption that would occur over the study period in the absence of new Union energy-efficiency initiatives. The Reference Case, therefore, provides the point of comparison for the subsequent calculation of energy savings opportunities associated with each of the subsequent scenarios that are assessed within this study.

The discussion is presented within the following subsections:

- Development of Detailed Profiles—New Buildings
- "Natural" Changes Affecting Natural Gas Consumption
- Expected Growth in Building Stock
- End-use Model Results.

3.2 DEVELOPMENT OF DETAILED PROFILES—NEW BUILDINGS

For the purposes of this study, any buildings built subsequent to the base year (2007) were considered "new buildings." The first task in building the Reference Case involved the development of detailed technical profiles that defined building envelope characteristics, HVAC, hot water, cooking equipment and electrical loads for the new buildings in each of the Commercial sub sectors. In each case, new building profiles were developed using CEEAM and the same approach described previously in the Base Year discussion.

A sample building profile summary for new Large Offices in the Southern service region is presented in Exhibit 3.1. It summarizes the major technical assumptions that have been used for new Large Offices in the development of the Reference Case. A complete set of detailed profiles for new buildings are presented in Appendix C (Southern service region) and D (Northern service region).

Exhibit 3.1: Sample New Building Profile Summary – New Large Office, Southern Service Region

Exhibit 3.2 highlights the resulting whole-building natural gas EUIs (as modeled in CEEAM) for each new commercial building segment. For reference purposes, it also shows whole-building EUIs for each of the existing building segments. In general, EUIs are lower for new buildings than for existing buildings.

General factors that lead to lower EUIs for new buildings as compared to existing buildings include the following:

- Improved thermal characteristics of building envelope systems including walls, roofs and windows
- Higher-efficiency heating systems, including improved controls and scheduling in some cases
- Higher-efficiency hot water heating systems and, in some cases, more efficient fixtures such as aerators and low-flow showerheads.

In general the following factors tend to lead to higher building EUIs in new buildings:

- Higher ventilation rates leading to an increase in space heating energy, especially in institutional buildings such as hospitals and nursing homes
- Higher gas shares for space heating and water heating in new buildings
- Lower internal heat gains due to improved lighting efficiencies.

In one case, University/College, the new building natural gas EUI is slightly larger than the corresponding existing building EUI. Reasons for this increase are noted below in Exhibit 3.2.

It should be noted that the Ontario Building Code (2006) is slated to require all new commercial and large residential construction to exceed the standards of the Model National Energy Code for Buildings by 25% starting in the year 2012. This change has been taken into account when constructing models for new buildings but has not been explicitly included. There remains considerable debate around this regulation among commercial builders, leaving implementation and enforcement uncertain. A brief discussion of the Ontario Building Code and other regulatory issues is included in section 3.3.7.

Exhibit 3.2: Comparison of Whole Building Gas EUIs – Southern Service Region (GJ/m^2/yr.)

Sub Sector	Existing Buildings	New Buildings	Comments
Large Office	585	475	New office buildings have higher efficiency HVAC and envelope systems, and signifigantly lower internal heat gains due to improved lighting efficiency. Overall, this results in a lower whole building gas EUI.
Small Office	643	631	New office buildings have higher efficiency HVAC and envelope systems, and signifigantly lower internal heat gains due to improved lighting efficiency. Overall, this results in a lower whole building gas EUI.
Retail	618	532	New retail buildings are typically "big box" stores, with higher efficiency HVAC and envelope systems. Overall, this results in a lower whole building gas EUI.
Large Hotel	743	697	New hotels are generally equipped with higher efficiency HVAC systems and envelopes. Overall, this results in a lower whole building gas EUI.
Small Hotel/Motel	763	667	New hotels generally are equipped with higher efficiency HVAC systems and envelopes. Overall, this results in a lower whole building gas EUI.
Contract Hospital	2,125	1,513	New hospital buildings are equipped with higher efficiency HVAC systems and envelopes. This is generally offset by higher ventilation rates compared to existing hostpitals. Overall, this results in a lower whole building gas EUI.
Hospital	1,618	1,516	
Nursing Home	1,034	1,001	New nursing homes are equipped with higher efficiency HVAC systems and envelopes. This is offset by higher ventilation rates, and increased space heating gas share compared to existing nursing homes. Overall, this results in a slightly lower gas EUI.
School	751	669	New schools are generally equipped with higher efficiency HVAC systems and envelopes. This is partially offset by higher space heating and water heating EUIs. Overall, this results in a lower whole building gas EUI.
Contract University/College	770	735	New university/college buildings have more efficient HVAC and envelope systems, but generally have higher ventilation rates and a higher gas fuel share for space heating, this may result in a higher whole building EUI.
University/College	730	735	
Restaurant/Food Service	2,474	2,342	New restaurant/food service buildings have more efficient HVAC systems and envelopes. This is offset by higher ventilation rates, and slightly increased space heating and water heating gas shares, resulting in a slightly lower gas EUI.
Warehouse	754	488	New warehouse buildings have higher efficiency HVAC and envelope systems, resulting in a lower whole building EUI.
Contract Apartment	799	713	New highrise apartment buildings have higher efficiency HVAC and envelope systems and slightly higher gas fuel shares for water heating, resulting in a lower whole building EUI.
High-rise Apartment	782	719	
Mid-rise Apartment	757	687	New midrise apartment buildings have higher efficiency HVAC and envelope systems and slightly higher gas fuel shares for water heating, resulting in a lower whole building EUI.

3.3 "NATURAL" CHANGES AFFECTING NATURAL GAS CONSUMPTION

The next task involved an estimation of expected "natural" changes[17] in natural gas consumption patterns over the study period. The following factors were considered:

- Improvements in equipment efficiency, including new energy performance standards
- Expected (naturally occurring) increased stock penetration of more efficient natural gas equipment
- Interactive effects on natural gas space heating resulting from changes in building electricity use.

A discussion of the expected "natural" changes follows. In each case, the discussion identifies the technical change, the major driver(s) and the assumed natural gas impact.

3.3.1 Space Heating

Natural gas boilers being installed in new buildings are assumed to be a mix of standard (75% seasonal efficiency), near condensing (80% seasonal efficiency) and condensing boilers (90% seasonal efficiency). A weighted seasonal boiler efficiency[18] for existing and new buildings, showing a general trend toward higher boiler efficiencies, is presented in Exhibit 3.3.[19]

[17] "Natural changes" refer to those changes that are expected in the absence of any post-2008 Union programming.

[18] Estimated seasonal efficiencies are based on the estimated floor space weighted mix of boiler technologies/vintages/and operating characteristics for both existing and new buildings. CEEAM uses building heating loads and estimated average seasonal efficiencies to calculate gas consumption.

[19] Based on Marbek database, previous studies in similar jurisdictions and discussion with Union personnel.

Exhibit 3.3: Natural Gas Space Heating: Estimated Seasonal Boiler Efficiency in Existing and New Buildings – Southern Service Region (%)

Sub Sector	Weighted Seasonal Boiler Efficeincy	
	Existing Buildings	New Buildings
Large Office	78%	80%
Small Office	77%	79%
Retail	78%	80%
Large Hotel	77%	79%
Small Hotel/Motel	76%	80%
Contract Hospital	80%	82%
Hospital	80%	82%
Nursing Home	78%	80%
School	81%	83%
Contract University/College	80%	81%
University/College	80%	81%
Restaurant/Food Service	77%	80%
Warehouse	79%	81%
Contract Apartment	77%	80%
High-rise Apartment	77%	80%
Mid-rise Apartment	78%	79%

Similar efficiency improvement trends are also assumed for other space heating equipment including rooftop units, unit heaters and furnaces.

As discussed in Exhibit 3.2, space heating EUIs in new buildings are also driven lower by improved building envelope characteristics. At the same time, however, space heating EUIs are being driven higher by increased ventilation rates (mitigated to some degree by increasing levels of air-to-air heat recovery) and reduced internal waste heat gains due improved electrical equipment efficiency (e.g., lighting).

In the case of existing buildings, similar factors to those discussed above are expected to affect space heating loads over the course of the study period. These changes will take place at the time of natural equipment turnover (i.e., for boilers or rooftop units) or when existing buildings are renovated (i.e., improvements to building envelopes). Internal heating gains are also expected to decrease due to efficient lighting retrofits. The net effect of these natural changes is assumed to be an improvement in existing building space heating EUIs of 3% over the study period.

3.3.2 Domestic Hot Water

Gas water heating equipment is assumed to be distributed in new buildings as shown in Exhibit 3.4.

Exhibit 3.4: Distribution of Gas DHW Equipment in New Buildings, by Type for the Southern Service Region (% of Floor Space)

Sub Sector	Boiler	Tank-type
Large Office	14%	86%
Small Office	5%	95%
Retail	3%	97%
Large Hotel	71%	29%
Small Hotel/Motel	47%	53%
Contract Hospital	88%	12%
Hospital	88%	12%
Nursing Home	76%	24%
School	16%	84%
Contract University/College	88%	12%
University/College	88%	12%
Restaurant/Food Service	12%	88%
Warehouse	9%	91%
Contract Apartment	34%	66%
High-rise Apartment	34%	66%
Mid-rise Apartment	28%	72%

In existing buildings, improvements in water heating equipment and a higher market penetration of condensing technologies at time of stock turnover is expected to lead to a 3% improvement in existing building water heating EUIs over the study period.

3.3.3 Commercial Cooking

Commercial cooking EUIs for new buildings were assumed to be equivalent to those in existing buildings. Although high-efficiency commercial cooking equipment is available in the marketplace, there are no federal or provincial energy-efficiency regulations for such equipment in place in Canada.[20] In the absence of such regulations or available research on temporal trends in cooking EUIs, and the inclination of restaurant and food service decision makers to rank energy performance low on the list of factors considered when purchasing equipment, commercial cooking EUIs are assumed to stay constant for the purposes of this study.

[20] ENERGY STAR® does prescribe voluntary efficiency standards for some equipment, including gas-fired fryers and steam cookers. See www.oee.nrcan.gc.ca/energystar.

3.3.4 Space Cooling

For space cooling, overall EUIs, and gas cooling technologies are assumed to be the same for new buildings as for existing buildings. Natural gas share is assumed to be lower for new buildings. The small size of the gas cooling market means that a mix of gas cooling technologies and gas share for space cooling in new buildings will be in large part dependent on individual builders and contractors.

3.3.5 Other

Because of the relatively small size of the “miscellaneous” end use, most components included were assumed to be the same in new buildings as in old buildings. In some cases, miscellaneous EUIs are lower in new buildings due to lower levels of air reheat in new building design.

3.3.6 Interactive Effects from Changes to Electrical End Uses

“Natural” changes also occur in the electrical end uses and are incorporated in the CEEAM sub sector models. The two most relevant electrical end uses for this study are:

- Lighting
- Plug loads.

Lighting

The continued replacement of T12 fluorescent lighting and electromagnetic ballasts with T8 fluorescent lamps and electronic ballasts in existing buildings is occurring because of decreasing prices, increasing public recognition of the savings and changing energy performance codes and standards. Similarly, the federal and provincial governments have announced a commitment to phase out incandescent lighting from the marketplace, beginning in 2012. Both of these lighting changes will result in reduced lighting loads and, hence, reduced internal heat gains. As lighting loads decrease, winter heating loads will tend to increase.

Plug Loads

The density and variety of office and other plug load equipment is increasing. However, the electricity use of many types of office equipment has been decreasing due to programs such as ENERGY STAR®. Previous studies performed on behalf of the electrical utilities BC Hydro and Newfoundland Power/Newfoundland and Labrador Hydro, have assumed a low to intermediate growth scenario in terms of overall plug load. An increase in plug loads will tend to decrease heating loads via increased internal heat gains.

The net impacts of these electrical trends are included in the results provided in Section 3.3.8.

3.3.7 Additional Considerations

As noted in section 3.2, the Ontario Building Code is slated to require institutional, commercial and large residential buildings to achieve an energy performance 25% better than the Model National Energy Code for Buildings (MNECB). This requirement has not been explicitly considered in the new building profiles used to construct this reference case, although the CEEAM models constructed for new buildings incorporate many of the characteristics that would be required to meet the standard of 25% below MNECB requirements.

Natural Resources Canada (NRCan) has proposed an amendment to Canada's energy-efficiency regulations that would require gas-fired unit heaters to have a minimum full load thermal efficiency of 80%.[21] This regulation will particularly affect space heating in the Warehouse sub sector.

No attempt has been made to explicitly incorporate the above considerations into this Reference Case, as the outcome of the proposal discussion is currently uncertain. However, these considerations will be addressed as part of the Achievable Potential presented in later sections of this report.

3.3.8 Net Impact on Natural Gas Use

A comparison of new and existing building natural gas EUIs for the two largest energy-consuming end uses, space heating and water heating, is provided in Exhibit 3.5. The EUIs shown in Exhibit 3.5 combine the affects of changes to fuel share and technology penetrations.

As illustrated in Exhibit 3.5, the general trend in most sub sectors is towards lower space and water heating EUIs among new buildings. The exceptions shown are due to the impacts of increased ventilation rates and/or increased natural gas fuel shares.

[21] See www.oee.nrcan.gc.ca/regulations/bulletin/gas-unit-heaters-aprilr007.cfm for details of the NRCan proposal. Unit heater standards contained in this proposal were originally scheduled to come into effect August 8, 2008 and, as of November 2008, were expected to come into force in the near future (personal communication, NRCan Office of Energy Efficiency Equipment Standards group).

Exhibit 3.5: Comparison of Space Heating and Water Heating Gas EUIs – Southern Service Region (MJ/m²/yr.)

Sub Sector	Space Heating		Water Heating	
	Existing Buildings	New Buildings	Existing Buildings	New Buildings
Large Office	458	382	48	50
Small Office	552	549	49	49
Retail	545	459	36	37
Large Hotel	399	350	259	262
Small Hotel/Motel	419	338	277	283
Contract Hospital	1438	1083	387	288
Hospital	1200	1086	276	288
Nursing Home	695	682	220	220
School	691	599	44	54
Contract University/College	566	599	99	84
University/College	576	600	87	84
Restaurant/Food Service	1192	1043	480	496
Warehouse	709	443	24	24
Contract Apartment	569	485	207	206
High-rise Apartment	564	491	196	206
Mid-rise Apartment	538	470	205	203

3.4 EXPECTED GROWTH IN BUILDING STOCK

The next step in developing the Reference Case involved the development and application of estimated levels of floor space growth in each building sub sector and service region over the study period. For the purposes of this study, growth rates were derived from data provided by Union's Load Forecasting Group[22]. Separate rates were derived for each combination of rate class and service region. Additionally, growth rates for the Office and Retail sub sectors were adjusted directionally upward on the advice of Union forecasting staff. Exhibit 3.6 summarizes the estimated annual growth rates.

[22] Floor space growth rates were derived using Union's most recent sales forecast. It is important to note that both future natural gas sales and building stock growth are heavily dependent on prevailing economic conditions.

Exhibit 3.6: Annual Building Stock Growth Rates by Building Segment and Service Region (%/Yr.)

Subsector	Southern service region		Northern service region	
	2007 to 2012	2012 to 2017	2007 to 2012	2012 to 2017
Large Office	1.3%	1.3%	2.0%	2.0%
Small Office	1.1%	1.1%	1.0%	1.0%
Retail	1.2%	1.2%	1.9%	1.9%
Large Hotel	0.5%	0.5%	0.8%	0.8%
Small Hotel/Motel	0.5%	0.5%	0.8%	0.8%
Contract Hospital	0.7%	0.7%	1.1%	1.1%
Hospital	0.5%	0.5%	0.8%	0.8%
Nursing Home	0.5%	0.5%	0.8%	0.8%
School	0.6%	0.6%	1.0%	1.0%
Contract University/College	0.5%	0.5%	0.7%	0.7%
University/College	0.4%	0.4%	0.7%	0.7%
Restaurant/Food Service	0.5%	0.5%	0.8%	0.8%
Warehouse	0.5%	0.5%	0.8%	0.8%
Contract Apartment	0.6%	0.6%	0.9%	0.9%
High-rise Apartment	0.6%	0.6%	0.9%	0.9%
Mid-rise Apartment	0.6%	0.6%	1.0%	1.0%

3.5 END-USE MODEL RESULTS

The Reference Case results are presented in three exhibits:

- Exhibit 3.7 presents the model results for the total Union Service Area, with the results broken out by sub sector, end use and milestone year.
- Exhibits 3.8 and 3.9 present the same results for the Southern and Northern service regions respectively.

Exhibit 3.7: Reference Case for Annual Natural Gas Consumption for Total Union Service Area (1000 m^3/yr.)

Sub Sector	Milestone Year	Total	Space Heating	Water Heating	Cooking	Space Cooling	Other
Large Office	2007	119,743	99,744	7,774	324	185	11,716
	2012	126,391	105,187	8,370	366	185	12,283
	2017	133,820	111,289	9,032	413	185	12,902
Small Office	2007	242,302	213,790	15,367	626	0	12,519
	2012	249,172	219,539	15,945	675	0	13,013
	2017	256,584	225,759	16,565	727	0	13,533
Retail	2007	166,419	147,344	9,583	4,219	0	5,274
	2012	172,286	152,113	10,066	4,492	0	5,615
	2017	178,704	157,351	10,590	4,784	0	5,979
Large Hotel	2007	13,978	7,649	4,766	643	0	919
	2012	14,157	7,711	4,837	663	0	947
	2017	14,349	7,779	4,912	683	0	975
Small Hotel/Motel	2007	8,214	4,849	2,718	59	0	588
	2012	8,309	4,892	2,758	60	0	599
	2017	8,411	4,938	2,800	62	0	611
Contract Hospital	2007	60,469	41,177	10,879	1,096	291	7,026
	2012	61,200	41,634	11,009	1,129	300	7,128
	2017	61,988	42,130	11,150	1,163	310	7,234
Hospital	2007	24,332	18,650	3,762	489	70	1,361
	2012	24,737	18,915	3,839	504	73	1,407
	2017	25,169	19,199	3,919	519	77	1,454
Nursing Home	2007	62,276	42,669	12,719	2,843	0	4,045
	2012	63,202	43,248	12,889	2,924	0	4,141
	2017	64,181	43,865	13,070	3,007	0	4,239
School	2007	137,394	127,355	7,415	1,783	0	841
	2012	139,543	129,176	7,645	1,850	0	872
	2017	141,863	131,150	7,889	1,919	0	905
Contract University/College	2007	79,409	58,582	10,173	2,868	617	7,170
	2012	80,358	59,339	10,235	2,921	617	7,246
	2017	81,358	60,139	10,302	2,976	617	7,324
University/College	2007	15,600	12,355	1,837	444	118	846
	2012	15,792	12,506	1,853	455	118	861
	2017	15,995	12,665	1,869	466	118	876
Restaurant/Food Service	2007	81,836	39,992	15,664	25,853	0	326
	2012	83,081	40,369	15,851	26,527	0	335
	2017	84,383	40,772	16,049	27,218	0	344
Warehouse	2007	68,162	61,965	3,307	138	0	2,752
	2012	68,831	62,517	3,346	141	0	2,827
	2017	69,546	63,111	3,387	145	0	2,903
Contract Apartment	2007	7,093	5,038	1,854	22	0	179
	2012	7,156	5,068	1,881	23	0	184
	2017	7,223	5,101	1,910	24	0	190
High-rise Apartment	2007	165,980	120,369	40,913	522	0	4,176
	2012	167,681	121,218	41,620	538	0	4,305
	2017	169,513	122,153	42,369	555	0	4,437
Mid-rise Apartment	2007	101,478	74,936	24,848	484	0	1,210
	2012	102,600	75,548	25,301	500	0	1,251
	2017	103,815	76,222	25,782	517	0	1,293
Other Buildings	2007	391,810					
	2012	399,311					
	2017	407,437					
Other Contract Institutional Buildings	2007	320,568					
	2012	326,411					
	2017	332,733					
Total	2007	2,067,064	1,076,463	173,581	42,413	1,280	60,948
	2012	2,110,220	1,098,979	177,443	43,769	1,293	63,013
	2017	2,157,072	1,123,622	181,594	45,178	1,307	65,200

Exhibit 3.8: Reference Case for Annual Natural Gas Consumption for Southern Service Region (1000 m^3/yr.)

Sub Sector	Milestone Year	Total	Space Heating	Water Heating	Cooking	Space Cooling	Other
Large Office	2007	51,811	42,035	3,684	153	185	5,754
	2012	53,552	43,351	3,888	169	185	5,960
	2017	55,456	44,797	4,109	185	185	6,180
Small Office	2007	90,394	78,448	6,438	262	0	5,245
	2012	93,354	80,892	6,709	285	0	5,469
	2017	96,556	83,541	7,000	308	0	5,706
Retail	2007	150,327	132,804	8,803	3,876	0	4,844
	2012	155,243	136,761	9,223	4,115	0	5,144
	2017	160,595	141,086	9,676	4,370	0	5,463
Large Hotel	2007	10,734	5,711	3,783	511	0	729
	2012	10,843	5,741	3,829	524	0	749
	2017	10,959	5,774	3,878	538	0	769
Small Hotel/Motel	2007	5,854	3,255	2,100	45	0	454
	2012	5,911	3,280	2,123	47	0	462
	2017	5,971	3,307	2,147	48	0	470
Contract Hospital	2007	53,461	36,081	9,787	986	286	6,321
	2012	54,025	36,419	9,889	1,014	295	6,407
	2017	54,632	36,787	10,000	1,043	303	6,497
Hospital	2007	10,290	7,601	1,777	209	60	643
	2012	10,390	7,656	1,799	214	62	659
	2017	10,497	7,716	1,821	220	64	677
Nursing Home	2007	41,142	27,505	8,846	1,978	0	2,814
	2012	41,560	27,746	8,927	2,025	0	2,862
	2017	42,001	28,002	9,013	2,074	0	2,912
School	2007	87,245	80,437	5,028	1,209	0	570
	2012	88,005	81,022	5,148	1,247	0	588
	2017	88,831	81,663	5,274	1,287	0	607
Contract University/College	2007	70,537	51,623	9,216	2,598	605	6,495
	2012	71,276	52,205	9,262	2,644	605	6,561
	2017	72,054	52,818	9,312	2,691	605	6,628
University/College	2007	12,599	9,867	1,538	372	114	708
	2012	12,723	9,962	1,548	380	114	719
	2017	12,853	10,061	1,558	388	114	731
Restaurant/Food Service	2007	71,838	34,490	13,981	23,076	0	291
	2012	72,793	34,727	14,126	23,642	0	299
	2017	73,790	34,982	14,280	24,222	0	306
Warehouse	2007	64,300	58,355	3,173	132	0	2,640
	2012	64,883	58,829	3,208	135	0	2,710
	2017	65,506	59,339	3,246	139	0	2,782
Contract Apartment	2007	7,093	5,038	1,854	22	0	179
	2012	7,156	5,068	1,881	23	0	184
	2017	7,223	5,101	1,910	24	0	190
High-rise Apartment	2007	149,737	107,917	37,512	479	0	3,829
	2012	151,062	108,522	38,105	493	0	3,942
	2017	152,489	109,193	38,732	507	0	4,057
Mid-rise Apartment	2007	82,468	60,288	20,765	405	0	1,011
	2012	83,184	60,641	21,083	417	0	1,042
	2017	83,958	61,033	21,421	430	0	1,074
Other Buildings	2007	340,457					
	2012	346,178					
	2017	352,354					
Other Contract Institutional Buildings	2007	295,028					
	2012	299,986					
	2017	305,337					
Total	2007	1,595,315	741,454	138,286	36,312	1,251	42,528
	2012	1,622,124	752,820	140,747	37,375	1,261	43,758
	2017	1,651,062	765,201	143,377	38,474	1,271	45,048

Exhibit 3.9: Reference Case for Annual Natural Gas Consumption for Northern Service Region (1000 m^3/yr.)

Sub Sector	Milestone Year	Total	Space Heating	Water Heating	Cooking	Space Cooling	Other
Large Office	2007	67,931	57,708	4,090	170	0	5,962
	2012	72,839	61,836	4,482	197	0	6,323
	2017	78,365	66,492	4,923	227	0	6,722
Small Office	2007	151,908	135,342	8,929	364	0	7,274
	2012	155,818	138,648	9,236	391	0	7,544
	2017	160,028	142,217	9,565	419	0	7,827
Retail	2007	16,092	14,540	780	343	0	429
	2012	17,043	15,352	843	377	0	471
	2017	18,109	16,265	913	414	0	517
Large Hotel	2007	3,243	1,938	983	133	0	190
	2012	3,314	1,970	1,008	138	0	198
	2017	3,389	2,005	1,034	144	0	206
Small Hotel/Motel	2007	2,360	1,594	619	13	0	134
	2012	2,398	1,612	635	14	0	137
	2017	2,439	1,632	652	14	0	141
Contract Hospital	2007	7,008	5,096	1,092	110	4	705
	2012	7,175	5,214	1,120	115	5	721
	2017	7,356	5,343	1,150	120	7	737
Hospital	2007	14,042	11,049	1,985	280	9	718
	2012	14,347	11,258	2,040	290	11	747
	2017	14,672	11,483	2,098	299	14	778
Nursing Home	2007	21,134	15,164	3,873	866	0	1,232
	2012	21,642	15,502	3,962	899	0	1,279
	2017	22,180	15,862	4,057	933	0	1,327
School	2007	50,149	46,918	2,386	574	0	271
	2012	51,538	48,154	2,497	602	0	284
	2017	53,032	49,487	2,615	632	0	298
Contract University/College	2007	8,872	6,959	957	270	12	674
	2012	9,082	7,135	973	277	12	685
	2017	9,304	7,321	990	285	12	696
University/College	2007	3,001	2,488	299	72	4	138
	2012	3,070	2,544	305	75	4	141
	2017	3,142	2,604	311	77	4	145
Restaurant/Food Service	2007	9,998	5,503	1,683	2,777	0	35
	2012	10,288	5,642	1,725	2,885	0	36
	2017	10,593	5,790	1,769	2,996	0	38
Warehouse	2007	3,862	3,610	134	6	0	112
	2012	3,948	3,688	138	6	0	117
	2017	4,041	3,771	142	6	0	121
High-rise Apartment	2007	16,243	12,452	3,401	43	0	347
	2012	16,620	12,696	3,515	45	0	363
	2017	17,024	12,960	3,637	48	0	380
Mid-rise Apartment	2007	19,010	14,648	4,083	80	0	199
	2012	19,417	14,907	4,217	83	0	209
	2017	19,857	15,189	4,361	87	0	219
Other Buildings	2007	51,354					
	2012	53,133					
	2017	55,083					
Other Contract Institutional Buildings	2007	25,541					
	2012	26,426					
	2017	27,396					
Total	2007	471,749	335,009	35,295	6,101	30	18,420
	2012	488,096	346,159	36,696	6,394	33	19,255
	2017	506,009	358,422	38,217	6,704	36	20,153

3.5.1 Comparison with Union Load Forecast

The Reference Case presented in Exhibits 3.7 through 3.9 is closely aligned with the Union commercial forecast for both total sales volume as well as sales volume by service region. Union has provided a consumption forecast for the years 2008-2012. This reference case has been calibrated to Union's forecast sales growth rates (in the absence of DSM programming) to 2012. A constant growth rate to 2017 is assumed.

For the Total Union Service Area, the 2008-2012 Union volume forecast shows an overall sales increase of approximately 1.7%. Pro-rating this growth over a five-year period gives an increase of 2.1%. The Reference Case shown in Exhibit 3.7 gives a 2.1% increase from 2007-2012 and a further 2.2% increase from 2012-2017.

In the Southern service region, the pro-rated five-year Union volume forecast shows an overall sales increase of 1.8%. The Reference Case shown in Exhibit 3.8 gives a 1.7% increase from 2007-2012 and a further 1.8% increase from 2012-2017.

In the Northern service region, the pro-rated five-year Union volume forecast (2008-2012) shows an overall sales increase of 3.6%. The Reference Case shown in Exhibit 3.9 gives a 3.5% increase from 2007-2012 and a further 3.7% increase from 2012-2017.

4. ENERGY-EFFICIENCY MEASURES

4.1 INTRODUCTION

This section identifies and assesses the financial and economic attractiveness of the selected energy-efficiency measures for the Commercial sector. The discussion is organized and presented as follows:

- Methodology
- Summary of energy-Efficiency Results
- Description of energy-Efficiency Technologies and Measures.

4.2 METHODOLOGY

The following steps were employed to assess the energy-efficiency measures:

- Select candidate energy-efficiency measures
- Establish technical performance for each option within a range of applicable load sizes and/or service region conditions (e.g., degree days or full load-equivalent hours)
- Establish the capital, installation and operating costs for each option
- Calculate the simple payback from the customer's perspective
- Calculate the measure total resource cost (TRC)
- Calculate the benefit/cost ratio.

A brief discussion of each step is outlined below.

Step 1 Select Candidate Measures

The candidate measures were selected in close collaboration with Union personnel based on a combination of a literature review and the previous experience of both the consultants and Union personnel. The selected measures are all considered to be technically proven and commercially available, even if only at an early stage of market entry. Technology costs, which will be addressed in this section, were not a factor in this initial selection of candidate technologies.

Step 2 Establish Technical Performance

Information on the performance improvements provided by each measure was compiled from available secondary sources, including the experience and on-going research work of study team members. As applicable, the energy impacts of the measures are reported for both natural gas and electricity. Where available, technical performance inputs have been drawn from data provided by Union Gas, specifically July 2008 DSM input assumptions.

Step 3 Establish Capital, Installation and Operating Costs for Each Measure

Information on the cost of implementing each measure was also compiled from secondary sources, including the experience and on-going research work of study team members. As applicable, both the incremental and full costs were estimated for each measure. Where available, cost inputs have been drawn from data provided by Union Gas, specifically July 2008 DSM input assumptions.

The incremental cost is applicable when a measure is installed in a new facility, or at the time of equipment turnover in an existing facility. In this case, incremental cost is defined as the difference between the energy-efficiency measure and the "baseline" technology. The full cost is applicable when an operating piece of equipment is replaced with a more efficient model prior to the end of its useful life.

In both cases, the costs and savings are annualized, based on the number of years of equipment life and the discount rate. The costs incorporate applicable changes in annual O&M costs and all costs are expressed in constant (2008) dollars.

Step 4 Calculate Simple Payback

The simple payback is generated to show the customer's financial perspective. Simple payback is "a measure of the length of time required for the cumulative savings from a project to recover its initial investment cost and other accrued costs, without taking into account the time value of money. The simple payback period is usually measured from the service date of the project."[23] The cost of the measure (incremental or full, as appropriate) is divided by the expected annual savings. The answer is given in years**.**

The following equation illustrates how this calculation is applied to a situation where an upgrade has a higher upfront cost than the baseline technology, but lower ongoing operating costs:

$$\text{Payback}_{\text{(years)}} = (\text{CostUpgr} - \text{CostBase})/(\text{AnnBase} - \text{AnnUpgr})$$

where:

CostUpgr	= initial capital cost of the upgrade measure ($)
CostBase	= initial capital cost of the baseline measure ($)
AnnUpgr	= ongoing operating cost of the upgrade ($/yr.)
AnnBase	= ongoing operating savings of the base ($/yr.)

Step 5 Calculate the Measure TRC

The measure TRC calculates the net present value of energy and water savings that result from an investment in an efficiency measure. The measure TRC is equal to its full or incremental capital cost (depending on application) plus any change (positive or negative) in the combined annual energy, water and equipment O&M costs. This calculation includes, among others, the following inputs: the avoided natural gas, electricity and water supply costs, the life of the technology and the selected discount rate, which in this analysis has been set at 10%.

[23] Sieglinde K. Fuller and Stephen R. Petersen. *Life Cycle Costing Manual for the Federal Energy Management Program.* National Institute of Standards and Technology Handbook 135, 1995 Edition, Washington, DC.

A technology or measure with a positive TRC value is included in subsequent phases of the analysis, which consists of the economic and Achievable Potential scenarios. A measure with a negative TRC value is not economically attractive and is therefore not included in subsequent stages of the analysis.

It should be noted that the measure TRC provides an initial screen of the technical options. Considerations such as program delivery costs, incentives, etc., are incorporated in later detailed program design stages, which are beyond the scope of this study.

Step 6 Calculate Benefit/Cost Ratio

The measure benefit/cost ratio indicates the relative attractiveness of the measures. A measure that has a benefit/cost ratio in excess of 1.0 means that the measure's benefits outweigh its costs; it is, therefore, included in subsequent stages of the analysis. Similarly, a measure with a benefit/cost ratio that is well in excess of one (e.g., 3.0) means that it is very attractive. A measure with a benefit/cost ratio of less than 1.0 means that its costs outweigh its benefits and, hence, is not included in subsequent stages of the analysis.

4.2.1 Energy Costs

The financial and economic results that are presented in this section are based on the following:

- Avoided supply cost of natural gas
- Avoided supply cost of electricity
- Customer energy prices.

A brief discussion of each is provided below.

Avoided Supply Cost of Natural Gas

Natural gas avoided supply costs were provided by Union. The data provided were segmented into base load and weather-sensitive rates and their resulting NPVs (net present values). The rates were forecast for a 30-year time span. The avoided supply costs also incorporate a GHG adder that accounts for carbon dioxide emissions resulting from natural gas consumption. A cost of \$15/tonne CO_2e (per tonne of CO_2 equivalent) is employed until 2012 and the price is increased to \$20 /tonne CO_2e starting in 2013. An emissions coefficient of 0.001903 tonnes CO_2e/m^3 (1903 g CO_2e/m^3) is used in this analysis.[24] The resulting avoided supply costs for natural gas are shown in Exhibit 4.1.

[24] Based on emission factors and Global Warming Potentials (GWPs) presented in Environment Canada, National Inventory Report (1990-2005): Greenhouse Gas Sources and Sinks in Canada, p. 23 and 583, April 2007.

Exhibit 4.1: Natural Gas – Avoided Supply Costs

Year	Base load		Weather Sensitive	
	Gas Rates ($/m^3)	NPV ($/m^3)	Gas Rates ($/m^3)	NPV ($/m^3)
1	0.39898	0.39898	0.40143	0.40143
2	0.38189	0.74614	0.38823	0.75436
3	0.36510	1.04787	0.36231	1.05378
4	0.37148	1.32698	0.36864	1.33075
5	0.37799	1.58515	0.37510	1.58694
6	0.39425	1.82995	0.39130	1.82991
7	0.40101	2.05631	0.39800	2.05457
8	0.40790	2.26562	0.40483	2.26231
9	0.41492	2.45919	0.41179	2.45442
10	0.42207	2.63818	0.41889	2.63207
11	0.42936	2.80372	0.42611	2.79635
12	0.43678	2.95681	0.43348	2.94828
13	0.44435	3.09839	0.44098	3.08879
14	0.45206	3.22934	0.44863	3.21874
15	0.45992	3.35045	0.45642	3.33893
16	0.46793	3.46247	0.46436	3.45010
17	0.47608	3.56608	0.47245	3.55292
18	0.48440	3.66191	0.48070	3.64802
19	0.49287	3.75056	0.48910	3.73599
20	0.50150	3.83256	0.49766	3.81736
21	0.51030	3.90841	0.50639	3.89263
22	0.51927	3.97858	0.51528	3.96226
23	0.52840	4.04349	0.52433	4.02668
24	0.53771	4.10354	0.53357	4.08626
25	0.54719	4.15910	0.54297	4.14139
26	0.55686	4.21049	0.55256	4.19239
27	0.56671	4.25804	0.56232	4.23957
28	0.57674	4.30204	0.57228	4.28322
29	0.58697	4.34274	0.58242	4.32361
30	0.59739	4.38040	0.59275	4.36098

Avoided Supply Cost of Electricity and Water

The avoided supply costs of electricity and water used in this analysis were also provided by Union and are shown in Exhibit 4.2. The electricity costs also include a GHG adder to account for average carbon dioxide emissions from electricity production in Ontario. A method similar to that described for the natural gas avoided costs was used. An emissions coefficient of 0.000220 tonnes CO_2e/kWh (220 g CO_2e/kWh) is used in this analysis.[25]

[25] Based on Ontario emission factors presented in Environment Canada, National Inventory Report (1990-2005): Greenhouse Gas Sources and Sinks in Canada, p. 521, April 2007.

As the same electricity avoided cost value was used for both service regions, no attempt was made to generate distinct service region values in this study.

Exhibit 4.2: Water and Electricity – Avoided Supply Costs

Year	Water Rates		Electricity Rates	
	Rates ($/1000 L)	NPV ($/1000 L)	Rates ($/kWh)	NPV ($/kWh)
1	1.68504	1.68504	0.08032	0.08032
2	1.71705	3.24599	0.08177	0.15465
3	1.74967	4.69200	0.08324	0.22345
4	1.78292	6.03154	0.08474	0.28712
5	1.81679	7.27243	0.08627	0.34604
6	1.85131	8.42195	0.08922	0.40144
7	1.88649	9.48682	0.09081	0.45271
8	1.92233	10.47328	0.09243	0.50014
9	1.95886	11.38710	0.09408	0.54403
10	1.99607	12.23363	0.09577	0.58464
11	2.03400	13.01783	0.09748	0.62223
12	2.07265	13.74428	0.09923	0.65701
13	2.11203	14.41723	0.10101	0.68919
14	2.15215	15.04064	0.10282	0.71897
15	2.19304	15.61813	0.10467	0.74654
16	2.23471	16.15311	0.10655	0.77204
17	2.27717	16.64869	0.10847	0.79565
18	2.32044	17.10777	0.11042	0.81750
19	2.36453	17.53305	0.11242	0.83772
20	2.40945	17.92702	0.11445	0.85643
21	2.45523	18.29197	0.11652	0.87375
22	2.50188	18.63005	0.11862	0.88978
23	2.54942	18.94324	0.12077	0.90461
24	2.59786	19.23336	0.12296	0.91835
25	2.64722	19.50212	0.12519	0.93106
26	2.69751	19.75109	0.12747	0.94282
27	2.74877	19.98173	0.12978	0.95371
28	2.80099	20.19538	0.13214	0.96379
29	2.85421	20.39330	0.13455	0.97312
30	2.90844	20.57665	0.13700	0.98176

1 kWh=3.6 MJ; 1 GJ=1000 MJ

Customer Resource Prices

The customer resource prices used in this analysis are presented in Exhibit 4.3. These values are used in the calculation of customer payback periods that are presented in later sections of this report. In the case of both electricity and natural gas, the prices shown are based on July 2008 rate schedules; in the case of electricity, prices incorporate both energy and demand charges.

Exhibit 4.3: Customer Resource Prices

	Nat. Gas[26] ($/m^3)	Electricity[27] ($/kWh)	Water[28] ($/1000L)
Northern service region	0.466	0.103	2.25
Southern service region	0.441	0.111	3.05

1kWh=3.6 MJ; 1 GJ=1000 MJ

4.3 SUMMARY OF ENERGY-EFFICIENCY SCREENING RESULTS

A summary of the screening results for the energy-efficiency options is presented in Exhibit 4.4. Due to the number of measures assessed, the following exhibits only show results for those options that pass the TRC screen. Analysis of all measures, including those options that did not pass the economic screen, is contained in Appendix E.

[26] Natural gas rates are approximate estimates based on Union rates (as of July 25, 2008) in each service region and average natural gas consumption levels in each service region.

[27] Customer electricity rates are based on electricity rates charged by EnWin (utility which services London) and North Bay Hydro (according to their websites, as of July 2008). Delivery charge is estimated based on monthly average peak demand of 250 kW.

[28] Water rates based on resource rates in London (South) and North Bay (North) and an approximate annual water consumption of 8,000 m^3.

Exhibit 4.4: Summary of Measure TRC Screening Results Commercial Sector Energy-efficiency Options – Average Operating Conditions

Measure Name	Target Market			Simple Payback (Yrs)	B/C Ratio
	Sub Sector(s)	Vintage	Full/ Incr		
High-Performance Glazings	All	E	I	5.7	1.73
Super High-Performance Glazings	All	E	I	16.9	0.58
Wall Insulation	All	E	I	30.6	0.28
Roof Insulation	All	E	I	7.6	1.14
Air Sealing	All	E	F	3.8	1.10
Air Curtains	All	E	F	1.2	6.33
Vinyl Strip Curtains	All	E	F	2.7	1.32
Fast Moving Doors	All	E	I	53.1	0.11
L-Shaped Vestibule	All	E	I	0.0	N/A
Turnstile Doors	All	E	I	14.9	0.63
Condensing Boiler - Baseline: Standard Boiler - 1,500 FLE hours	All	E	I	5.3	1.78
Condensing Boiler - Baseline: Near-condensing - 1,500 FLE hours	All	E	I	8.1	1.17
Near-Condensing Boiler - Baseline: Standard Boiler - 1,500 FLE hours	All	E	I	1.9	4.86
Condensing Unit heater - Baseline: Standard efficiency - 1,500 FLE hours	All	E	I	2.4	3.54
High Efficiency Rooftop Unit - Baseline: Standard efficiency - 1,500 FLE hours	All	E	I	2.2	3.89
Condensing Rooftop Unit - Baseline: Standard efficiency - 1,500 FLE hours	All	E	I	5.2	1.68
Gas Absorption Heat Pump - Baseline: standard efficiency boiler - 1,500 FLE hours	All	E	I	2.9	2.64
Steam Plant Efficiency Measures	All	E	F	1.2	4.97
HVLS De-stratification Fans	All	E	F	2.8	2.61
Heat Reflector Panels	All	E	F	3.5	2.40
Programmable Thermostats	All	E	F	2.4	3.13
Demand Controlled Ventilation	All	E	F	1.7	3.36
Demand Control Kitchen Ventilation	All	E	F	2.1	4.05
Heat Recovery	All	E	I	3.4	2.20
Furnace Boiler Tune Ups	All	E	F	1.7	0.98
Condensing Furnace	All	E	I	2.6	3.21
Infrared Heaters	All	E	I	2.0	4.38
Solar Preheated Make-up Air	All	E	F	12.3	0.70
Condensing Water Heater - baseline: standard efficiency - 1,000 FLE hours	All	E	I	4.1	2.26
Condensing Storage Water Heater - baseline: standard efficiency - 1,000 FLE hours	All	E	I	3.4	2.26
Tankless Water Heater - baseline: standard efficiency - 1,000 FLE hours	All	E	I	6.0	1.44
Drainwater Heat Recovery - 10 minute shower, 3 times per day	All	E	I	9.9	0.88
Low-Flow Faucet Aerators - 3 min/day	All	E	F	0.4	14.17
Low-Flow Showerheads - 10 min/day	All	E	F	0.2	20.04
Pre-Rinse Spray Valve - 40 min/day	All	E	F	0.2	13.79
Solar Weater Heating System - baseline: standard efficiency - 1,000 FLE hours	All	E	F	20.7	0.42
Booster Water Heater - 800 FLE hours	All	E	I	7.6	1.14
Commercial Cooking - High-Efficiency Griddle	All	E	I	5.4	1.11
Commercial Cooking - High-Efficiency Broiler	All	E	I	0.5	11.16
Commercial Cooking - High-Efficiency Oven	All	E	I	8.3	0.72
Commercial Cooking - High-Efficiency Fryer	All	E	I	4.0	1.51
Building Recommissioning	All	E	F	0.9	3.63
Advanced Building Automation Systems	All	E	F	3.4	1.58
High-Performance New Construction - 25% more efficient	All	N	I	4.7	1.85
High-Performance New Construction - 40% more efficient	All	N	I	4.8	1.80

4.4 DESCRIPTION OF ENERGY-EFFICIENCY TECHNOLOGIES AND MEASURES

This sub section provides a brief description of each of the energy-efficiency technologies and measures that are included in this study, as listed in Exhibit 4.5.

Exhibit 4.5: Energy-efficiency Technologies and Measures - Commercial Sector

Building Envelope: • High-Performance Glazings • Super High-Performance Glazings • Wall Insulation Upgrade • Roof Insulation Upgrade • Air Sealing • Air Curtains • Vinyl Strip Curtains • Fast-Moving Doors • L-Shaped Vestibules • Turnstile Doors **Heating, Ventilating and Air-Conditioning:** • Condensing Boilers • Near-Condensing Boilers • Condensing Unit Heaters • High-Efficiency Rooftop Units • Condensing Rooftop Units • Absorption Heat Pumps • Steam Plant Efficiency Measures • HVLS De-stratification Fans • Heat Reflector Panels • Programmable Thermostats • Heat Recovery • Demand Controlled Ventilation • Demand Control Kitchen Ventilation • Furnace & Boiler Tune-ups • Condensing Furnaces • Infrared Heaters • Solar Preheated Make-up Air	**Domestic Hot Water:** • Condensing Water Heaters • Condensing Tank-Type Water Heaters • Tankless Water Heaters • Drainwater Heat Recovery • Low-Flow Faucet Aerators & Showerheads • Low-Flow Pre-Rinse Spray Valves • Solar Water Heating • Booster Water Heaters **Cooking:** • Efficient Griddles • Efficient Broilers • Efficient Ovens • ENERGY STAR® Fryers **Whole Building:** • Building Recommissioning • Advanced Building Automation Systems • High-Performance New Building Construction • Includes high-efficiency building envelopes, space heating and ventilation equipment, water heating equipment, food preparation equipment, whole building measures, LEED building criteria and specific technologies and practices such as multi-unit residential patio beam insulation, green roofs and cellular concrete.

The discussion is organized and presented in the following sub sections:

- Building envelope
- Heating, ventilating and air-conditioning
- Domestic hot water
- Cooking
- Whole building.

Each option is discussed below, with a brief description of the measure, savings relative to the baseline, typical installed costs, applicability and co-benefits. Where applicable, measures have been evaluated over a range of typical operating conditions. Detailed cost and performance data are provided in Appendix E.

4.4.1 Building Envelope

This study considered ten building envelope upgrade measures:

- High-Performance Glazings
- Super High-Performance Glazings
- Wall Insulation Upgrade
- Roof Insulation Upgrade
- Air Sealing
- Air Curtains
- Vinyl Strip Curtains
- Fast-Moving Doors
- L-Shaped Vestibules
- Turnstile Doors.

An overview of each upgrade measure is presented below.

High-Performance Glazings

High-performance glazings refer to a variety of technologies that can be used alone or in combination to provide an array of benefits, including lower energy costs, enhanced daylighting opportunities, reduced heating and cooling loads and more comfortable spaces. They incorporate one or more of the following:

- Double or triple glazing with a sealed insulating glass unit
- Low-E glass
- Inert gas such as argon or krypton in the sealed unit
- Low conductivity or "warm edge" spacer bars
- Insulated frames and sashes.

When combined these features will create windows with U-values of 0.32 Btu/hr.ft^2.^{o}F[29] or lower. In general, glazing upgrade opportunities are most attractive in sub sectors with high typical window/wall ratios, such as office buildings.

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	\$5/ft^2 (of glazing area) incremental cost
Savings	10% of space heating energy
Useful Life	30 years

[29] Maximum ENERGY STAR® qualifying U-value for windows in the Union service territory.

This measure involves upgrading to a glazing system with an overall U-value of 0.32 Btu/hr.ft^2.^oF. It is applicable to both existing buildings (at end of window life cycle) and new construction. The baseline is a standard double-glazed window with an overall U-value of 0.46 Btu/hr.ft^2.^oF. The incremental cost is $5 per square foot of window area,[30] the savings are 10%[31] of space heating energy and the service life is 30 years.[32]

Super High-Performance Glazings

Super high-performance glazing systems such as High Insulation Technology (HIT) windows consist of low-E coated films suspended inside an insulating glass unit. These units can be incorporated into both window and curtain wall systems. One example is the Visionwall window and curtain wall system manufactured by Visionwall Corporation,[33] which has thermal resistance R-values ranging from 3 to 7 hr.ft^2.^oF/Btu, low shading coefficients and high visible light transmission. In addition to superior insulating performance and lower energy costs, the co-benefits include enhanced comfort, noise reduction, elimination of perimeter heating and reduced HVAC equipment costs.

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$12.50/$ft^2$ (of glazing area) incremental cost
Savings	15% of space heating energy
Useful Life	30 years

This measure involves upgrading glazing to a high-performance glazing system with an overall U-value of 0.2 Btu/hr.ft^2.^oF (R-5). It is applicable to both existing buildings (at end of window life cycle) and new construction. The baseline is an office building with standard double glazing with an overall U-value of 0.46 Btu/hr.ft^2.^oF (R-2.2). The incremental cost is $12.50[34] per square foot of glazing area, the savings are 15%[35] of space heating energy and the service life is 30 years.[36]

30 ACEEE.

31 CEEAM simulations.

32 BC Hydro QA Standard.

33 www.visionwall.com.

34 Marbek database of technology costs.

35 CEEAM simulation of office building.

36 BC Hydro QA Standard.

Wall Insulation Upgrade

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$1.38/ft^2 (floor area) incremental cost
Savings	9% of space heating energy
Useful Life	20 years

Various insulating materials and methods can be used to upgrade wall insulation, including applying rigid polystyrene board to the exterior of a building or installing fiberglass batts between interior wall studs. In addition to superior insulating performance and lower energy costs, the co-benefits include enhanced comfort, noise reduction and reduced HVAC equipment costs.

This measure involves upgrading wall insulation to R-24. It is applicable to both existing buildings (at time of renovations) and new construction. The baseline is a retail building with R-12 wall insulation. The incremental cost is $1.38[37] per square foot of floor area, the savings are 9%[38] of space heating energy and the service life is 20 years.[39]

Roof Insulation Upgrade

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$1/ft^2 (roof area) incremental cost
Savings	20% of heating energy
Useful Life	20 years

Upgrading insulation on a built-up roofing system typically involves adding additional layers of rigid insulation at the time of re-roofing. In addition to superior insulating performance and lower energy costs, the co-benefits include enhanced comfort, noise reduction and reduced HVAC equipment costs.

This measure involves upgrading roof insulation to R-22. It is applicable to both existing buildings (at time of re-roofing) and new construction. The baseline is a retail building with R-12 roof insulation. The incremental cost is $1 per square foot of roof area,[40] the savings are up 20%[41] of heating energy (depending on building geometry) and the service life is 20 years.[42]

[37] Marbek database.

[38] CEEAM simulation.

[39] BC Hydro QA Standard.

[40] Marbek database.

[41] CEEAM simulation.

[42] BC Hydro QA Standard.

Air Sealing

Air leakage control involves the identification and sealing of air leakage paths within the building envelope. Many of the leaks are obvious breaks in the air barrier system, such as through and around doors and windows and mechanical penetrations. Other air leaks are more difficult to identify including the wall/roof interface, plumbing stacks and elevator shafts that can channel air directly from the ground floor to the penthouse. Air sealing typically involves the systematic effort of applying insulating foam, caulking and weather stripping to improve the integrity of the building envelope system and control the stack effect. Suitable applications include other facilities with poorly maintained envelopes and high-rise buildings. Blocking air leaks brings many benefits, such as increased comfort, reduced heat loss, protection of the building structure and reduction of noise and dust from outdoors.

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$0.10/ft^2 full cost
Savings	5% of space heating energy
Useful Life	6 years

This measure involves controlling air leakage in a building, including applying insulating foam, caulking and weather –stripping, and performing "blower door" tests where appropriate. It is applicable to both existing buildings and new construction. The baseline is a high-rise office building with a poor envelope. The cost is $0.10/ft^2 per square foot,[43] the savings are 5% of space heating energy[44] and the service life is six years.[45]

Air Curtains

Air curtain systems use a fan to generate a laminar airflow across an open doorway. This mass flow of air acts as a barrier, reducing outside air infiltration by approximately 90%, thus preventing unwanted heat transfer both at the building envelope and between rooms within the building. Typical applications include entrances to retail buildings, overhead garage doors, loading docks and refrigerated rooms. The co-benefits include protecting employees from adverse environmental conditions such as cold drafts and dust.

Measure Profile	
Applicable Building Types	Retail, Warehouse, Garage
Vintage	Existing & new
Costs	$2,500 per double door full cost
Savings	85% of heat loss through door
Useful Life	15 years

[43] Marbek database.

[44] CEEAM simulation.

[45] BC Hydro QA Standard.

This measure involves the installation of an air curtain to a double door entrance. It is applicable to both existing buildings and new construction. The baseline is a retail store with a double door entrance that is open for four hours per day. The cost is $2,500[46] per double door, the savings are 85%[47] of heat loss through the door and the service life is estimated to be 15 years.[48]

Vinyl Strip Curtains

Measure Profile	
Applicable Building Types	All
Vintage	Existing & new
Costs	Full cost of $420 per 8’ x 8’ door
Savings	60% of energy use associated with air infiltration through open doors
Useful Life	5 years

Vinyl strip doors act as a physical barrier to air infiltration, reducing outside air infiltration through the open doorway by an estimated 60%. This prevents unwanted heat transfer at the building envelope or between rooms within the building. Typical applications include loading docks and refrigerated rooms.

This measure involves the installation of a vinyl strip curtain on a standard sized (8’ x 8’) loading dock. It is applicable to both existing buildings and new construction. The baseline is a loading dock door with no additional treatment, which is open one hour per day. The full cost is $420 per door[49], the savings are 60% over the baseline[50] and the service life is estimated to be 5 years.[51]

High-Speed Doors

Measure Profile	
Applicable Building Types	All
Vintage	Existing & new
Costs	Incremental cost of $20,500 per 16’ x16’ door
Savings	87% of energy loss associated with air infiltration during door opening and closing
Useful Life	10 years

High-speed doors reduce unwanted heat transfer at the building envelope or between rooms within the building by minimizing the amount of time that doors are left open.

[46] Enbridge Gas Distribution DSM input assumptions.

[47] Marbek estimated for the effectiveness of Enershield MCS-72 air curtain.

[48] Enbridge Gas Distribution DSM input assumptions.

[49] Supplier information and RS Means.

[50] Marbek estimate.

[51] Marbek estimate.

Typical applications include overhead garage doors, and loading docks. Co-benefits include reduced likelihood of damage due to collisions, as high-speed doors are generally composed of flexible materials such as PVC or rubber, as opposed to standard overhead doors that are made of steel or aluminum.

This measure involves the installation of a high-speed overhead door in place of a standard overhead door. It is applicable to both existing buildings and new construction. The baseline is a standard speed overhead door. The full cost is $36,500 for a 16' x 16' door ($20,500 incremental cost over a standard, electrically operated rolling steel door[52]), savings are 87% over the baseline[53] and the service life is estimated to be 10 years.[54] Electric loads are assumed to be equivalent for both the baseline and the upgrade.

L-Shaped Vestibules

Measure Profile	
Applicable Building Types	All
Vintage	Existing & new
Costs	No incremental cost, estimated full cost of approximately $7,000 for a 50 ft^2 vestibule
Savings	20% compared to losses due to infiltration through a "straight" vestibule
Useful Life	25 years

L-shaped vestibules reduce unwanted heat transfer at the building envelope by minimizing mass transfer of outside air to the inside of the building and vice-versa. Typical applications include Retail buildings, Office buildings and Restaurants. Co-benefits include increased occupant comfort as a result of reduced drafts.

This measure involves upgrading a standard vestibule (in which the doors are aligned) with an L-shaped vestibule to reduce the penetration of air into the building. It is applicable to both existing buildings and new construction. The baseline is a standard vestibule in which the doors are aligned. The installed cost is estimated to be $7,040,[55] savings are estimated at 20% over the baseline[56] and the service life is estimated to be 25 years.[57]

[52] Personal communication, Bryan Crombeen, V.P.: Edwards Door Systems Ltd., London, ON.

[53] Savings based on assumed reduction in "open door" time. See Allocca, et. al (2003) and Appendix E for full calculation.

[54] Marbek estimate.

[55] RS Means Assemblies.

[56] Marbek estimate.

[57] BC Hydro QA Standard.

Turnstile Doors

Measure Profile	
Applicable Building Types	All
Vintage	Existing & new
Costs	Incremental cost of $6725
Savings	89% of energy lost due to infiltration when compared to a set of two standard doors
Useful Life	25 years

Turnstile doors reduce unwanted heat transfer at the building envelope by minimizing the amount of time that doors are left open, thus minimizing mass transfer of outside air to the inside of the building. Typical applications include high traffic exterior doorways such as those found in airports, shopping malls and large office buildings. The co-benefits include increased occupant comfort as a result of reduced drafts.

This measure involves the installation of a turnstile door in place of two standard swinging doors. It is applicable to both existing buildings and new construction. The baseline is two standard balanced doors. The installed cost is $19,675 door ($6,725 incremental cost), [58] savings are 89% over the baseline[59] and the service life is estimated to be 25 years.[60]

4.4.2 Heating, Ventilating and Air Conditioning

This study considered 17 heating, ventilating and air conditioning upgrade measures:

- Condensing Boilers
- Near-Condensing Boilers
- Condensing Unit Heaters
- High-Efficiency Rooftop Units
- Condensing Rooftop Units
- Absorption Heat Pumps
- Steam Plant Efficiency
- HVLS De-stratification Fans
- Heat Reflector Panels
- Programmable Thermostats
- Heat Recovery
- Demand Controlled Ventilation
- Demand Controlled Kitchen Ventilation
- Furnace/Boiler Tune-ups
- Condensing Furnaces
- Infrared Heaters
- Solar Preheated Make-up Air

[58] RS Means Assemblies.

[59] Savings based on assumed reduction in “open door” time. See Allocca, et. al (2003) and Appendix E for full calculation.

[60] BC Hydro QA Standard.

As applicable, the measures were evaluated at low, medium, and high hours of operation to reflect the range of commercial building types and climate regions found in the Union Service Area. Where available, cost and savings inputs have been drawn from data provided by Union Gas. An overview of each upgrade measure is presented below.

Condensing Boilers

Condensing boilers feature additional advanced heat exchanger designs and materials that extract more heat from the flue gases before they are exhausted. The temperature of the flue gases is reduced to the point where the water vapour produced during combustion condenses back into liquid form, releasing the latent heat, which improves energy efficiency. With 12% of the energy of a gas-fired boiler in the form of latent heat, this represents a significant energy savings potential. However, if the return water temperature to the boiler is above 60°C, condensation will not occur and savings will not be realized. This is particularly relevant to existing buildings that are typically designed with higher return water temperatures. The benefits of condensing boilers include superior performance, reduced operating costs through lower natural gas expenditures and fewer greenhouse gas emissions.

The analysis considered two baseline scenarios: standard efficiency boilers and near-condensing boilers. In both cases, the upgrade is applicable to existing buildings (at time of boiler replacement) and new construction, and the estimated service life is 25 years.[61] Note that this study assumes both baselines are present in all sub sectors (See appendices A and B).

<u>Standard Efficiency to Condensing</u>

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$17/MBH incremental cost
Savings	14% of space heating energy
Useful Life	25 years

This measure involves upgrading to a high-efficiency condensing boiler with a thermal efficiency of 94% and a seasonal efficiency of 88%. The baseline is a standard efficiency boiler with a thermal efficiency of 80% and a seasonal efficiency of 76%.[62] The incremental cost is approximately $17 per MBH[63] and the savings are estimated to be 14% of space heating energy.

[61] Union Gas 2007-2009 DSM Plan, Appendix A, ASHRAE Applications Handbook – 2003, Chapter 36, Table 3.

[62] Union Gas 2007-2009 DSM Plan, Appendix A.

[63] Marbek database.

<u>Near-Condensing to Condensing</u>

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$14/MBH incremental cost
Savings	8% of space heating energy
Useful Life	25 years

This measure involves upgrading to a high-efficiency condensing boiler with a thermal efficiency of 94% and a seasonal efficiency of 88%. The baseline is a near-condensing boiler with a thermal efficiency of 85% and a seasonal efficiency of 81%.[64] The incremental cost is approximately $14 per MBH,[65] and the savings are estimated to be 8% of space heating energy.

Near-Condensing Boilers

Near-condensing boilers offer superior heat exchange design and improved combustion technologies over standard efficiency units and generally have thermal efficiencies in the range of 85% to 88% without condensing. The benefits of near-condensing boilers include reduced operating costs through lower natural gas expenditures and fewer greenhouse gas emissions.

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$3/MBH incremental cost
Savings	6% of space heating energy
Useful Life	25 years

This measure involves upgrading to a high-efficiency near-condensing boiler with a thermal efficiency of 85% and a seasonal efficiency of 81%. It is applicable to existing buildings (at time of boiler replacement) and new construction. The baseline is a standard efficiency boiler with a thermal efficiency of 80% and a seasonal efficiency of 76%. The incremental cost is approximately $3 per MBH,[66] the savings are estimated to be 6% of space heating energy and the service life is 25 years.[67]

Condensing Unit Heaters

High-efficiency condensing unit heaters feature a secondary heat exchanger to capture the latent heat in the exhaust air stream, separated combustion and a thermal efficiency of

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[64] Terasen Gas DSM Potential Study 2004.

[65] Marbek database.

[66] Marbek database.

[67] Union Gas 2007-2009 DSM Plan, Appendix A, ASHRAE Applications Handbook – 2003, Chapter 36, Table 3.

up to 93%.[68] Typical applications include open high bay spaces such as warehouses, garages and industrial facilities. Conventional unit heaters generally have gravity vents and power vents and thermal efficiencies in the range of 76% to 83%.[69] The seasonal efficiency of gravity-vented units can be as low as 64%[70] when off-cycle losses and heated air exiting the building through the draft hood are taken in to consideration. The benefits of condensing unit heaters include superior performance, reduced operating costs through lower natural gas expenditures and fewer greenhouse gas emissions.

Measure Profile	
Applicable Building Types	Warehouse
Vintage	Existing and new
Costs	$8/MBH incremental cost
Savings	11% of space heating energy
Useful Life	20 years

This measure involves upgrading to a high-efficiency condensing unit heater with a thermal efficiency of 91%[71] and a seasonal efficiency of 89%.[72] It is applicable to existing buildings (at time of unit heater replacement) and new construction. The baseline is a conventional unit heater with a thermal efficiency of 80% and a seasonal efficiency of 79%.[73] The incremental cost is approximately $8 per MBH,[74] the savings are estimated to be 11% of space heating energy and the service life is 20 years.[75]

High-Efficiency Rooftop Units

High-efficiency rooftop units employ high-efficiency heat exchangers and modulating burners that can achieve part-load efficiencies as high as 86%.[76] High-efficiency rooftop units are able to maintain their steady state efficiencies by avoiding “on-off” cycling. They operate their heating sections continuously and modulate the heating output to match heating requirements. In contrast, standard gas-fired rooftop units generally have single or two-stage burners[77] and seasonal efficiencies of 73%. The benefits of high-efficiency rooftop units include better temperature control and the capability to maintain high comfort levels in multiple zones.

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68 Reznor Model UEAS.

69 ACEEE.

70 NRCan.

71 Reznor Model UEAS 180.

72 Marbek estimate.

73 Based on NRCan’s proposed amendment to Canada’s Energy Efficiency Regulations.

74 RS Means Mechanical Cost Data 2007 and Reznor.

75 Union Gas 2007-2009 DSM Plan, Appendix A.

76 Personal communication with Engineered Air.

77 Union’s current high-efficiency rooftop unit measure inputs assume a minimum two-stage burner.

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$5/MBH incremental cost
Savings	9% of space heating energy
Useful Life	20 years

This measure involves upgrading to a high-efficiency gas-fired rooftop unit with a fully modulating burner and a seasonal efficiency of 80%. It is applicable to existing buildings (at time of rooftop unit replacement) and new construction. The baseline is a standard rooftop unit with a seasonal efficiency of 73%. The incremental cost is approximately $5 per MBH,[78] the savings are estimated to be 9% of heating energy and the service life is 20 years.[79]

Condensing Rooftop Units

Condensing rooftop units are the most energy-efficient rooftop units on the market with thermal efficiencies in the range of 89% to 97%.[80] They include a secondary heat exchanger to extract the latent heat in the products of combustion. One of the challenges of this technology is providing a condensate drain system and a method of condensate freeze protection. The benefits of condensing rooftop units include reduced operating costs through lower natural gas expenditures and fewer greenhouse gas emissions.

Two suppliers of condensing rooftop units are Engineered Air and Custom Mechanical Equipment.

Engineered Air has recently developed a condensing rooftop unit with an efficiency of 90% to 94%.[81] The company is presently looking for sites to test the product in the field.

Custom Mechanical Equipment of Oklahoma manufactures custom-order high-efficiency packaged multi-zone units equipped with Lennox condensing furnaces (94.3 AFUE).

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$25/MBH incremental cost
Savings	19% of space heating energy
Useful Life	20 years

This measure involves upgrading to a condensing gas-fired rooftop unit with a seasonal efficiency of 92%. It is applicable to existing buildings (at time of rooftop unit

[78] RS Means Mechanical Cost Data 2007.

[79] Union Gas 2007-2009 DSM Plan, Appendix A.

[80] ACEEE.

[81] Personal communication with Engineered Air.

replacement) and new construction. The baseline is a standard rooftop unit with a seasonal efficiency of 73%. The incremental cost is $25 per MBH,[82] the savings are estimated to be 19% of heating energy and the service life is 20 years.[83]

Gas Absorption Heat Pumps

Gas-fired absorption heat pumps (GAHP) are high-efficiency packaged heat pumps that use a water-ammonia absorption cycle to provide cooling and high-efficiency heating up to 126%.[84] The system uses outside air for heat rejection in the cooling mode and outside air as a heat source in the heating mode. Manufactured by Robur Corporation, they are available in several configurations including air-source, water source and heating only.

The GAHP-AR reversible air-source heat pump provides 120 MBH heating output at 140°F water temperature and an external ambient temperature as low as -20°F. In cooling mode, the unit has a capacity of 4.5 tons and is capable of providing chilled water as low as 38°F. However, one of the limitations is that the unit has a lower cooling efficiency than the standard electric vapour-compression cycle. The benefits of GAHPs include low electrical power requirements, modularity and outdoor installation.

Measure Profile	
Applicable Building Types	Small commercial, Multi-family
Vintage	Existing and new
Costs	$17/MBH incremental cost
Savings	25% of heating energy
Useful Life	15 years

For this analysis, we choose the Robur GAHP-A (heating only) air-source heat pump because it has the best chance for economic success given the low cooling efficiency of the reversible heat pump, and its ability to be combined with traditional boilers to improve overall heating efficiency. The GAHP-A has a seasonal efficiency of 105%[85] and is suitable for medium temperature applications up to 140 °F in small commercial buildings including fan coil systems, radiant in-floor systems and domestic hot water systems. It is applicable to existing buildings (at time of boiler replacement) and new construction. The baseline is a standard efficiency boiler with a thermal efficiency of 80% and a seasonal efficiency of 76%. The incremental cost is approximately $17 per MBH,[86] the savings are 24% of heating energy and the service life is 15 years.[87]

[82] RS Means and Personal communication with Engineered Air.

[83] Union Gas 2007-2009 DSM Plan, Appendix A.

[84] Robur GAHP-AR.

[85] GazMetro InformaTECH Vol 22, Number 2, June 2008.

[86] Marbek estimate and personal communication with D-B Cooling Systems Inc.

[87] BC Hydro QA Standard.

Steam Plant Efficiency Measures

Steam plant efficiency measures generally include combustion efficiency improvements, heat recovery, steam distribution and condensate return improvements, and equipment O&M improvements. The results of Enbridge Gas Distribution's Steam Plan Performance Test and Audit program show a potential of 13.7% natural gas savings with an average payback of 1.2 years.[88]

Measure Profile	
Applicable Building Types	Institutional including Hospital & University
Vintage	Existing and new
Costs	Average of 1.2 year payback
Savings	13.7% of heating energy
Useful Life	10 years

This measure involves the application of steam plant efficiency measures in large institutional buildings such as hospitals and universities. Since not all measures are applicable in any given project, the average results of the Enbridge program outlined above will be used in this analysis. The measures are applicable to both existing and new steam-heated buildings and the useful life is estimated to be an average of 10 years.

HVLS De-stratification Fans

High volume low speed (HVLS) de-stratification fans use large blades turning at low speeds to counter air stratification in facilities with high ceilings such as warehouses, retail stores and sports facilities. The proper application of HVLS fans can virtually eliminate stratification by gently driving the ceiling air downward and properly mixing the air to eliminate hot and cold spots. This results in reduced heat losses through the walls and roof during the heating season. In summer, the HVLS fan's breeze can lower the effective temperature of a space, allowing the cooling setpoint to be raised. The co-benefits include improved occupant comfort and indoor air quality.

Measure Profile	
Applicable Building Types	Warehouse and Retail
Vintage	Existing and new
Costs	$7,090/fan full cost
Savings	18% of space heating energy
Useful Life	15 years

This measure involves the installation of 24 ft. diameter HVLS fans. It is applicable to both new and existing buildings with high ceilings. The baseline is a high-ceiling warehouse with no ceiling fans. The installed cost is $7,090 per fan, the savings are 18% of the space heating energy[89] and the service life is 15 years.[90]

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[88] The Enbridge Steam Saver Program Update To Year-End 2005, March 1, 2006.

[89] Analysis and assumptions based on *Energy Savings Associated with De-stratification Fans in Buildings With High Ceilings* (Draft), Caneta Research Inc., October 2007.

[90] Enbridge Gas Distribution DSM input assumptions.

Heat Reflector Panels

Heat reflector panels provide a low-E surface used to reflect infrared heat. This heat would normally be absorbed by walls situated behind radiators and partially lost to the outside through conduction. A layer of still air is also trapped behind the panels, reducing conductive heat losses through the wall.

Measure Profile	
Applicable Building Types	Older commercial buildings hot water or steam radiators/convectors
Vintage	Existing
Costs	$25/radiator full cost
Savings	3% of space heating energy
Useful Life	18 years

This measure involves the installation of heat reflector panels behind radiators in a commercial building. It is applicable to older existing buildings. The baseline is a radiator located against a standard wall. The full installed cost is estimated to be $25/unit,[91] savings are 3% of space heating energy[92] and the service life is estimated to be 18 years.[93] It should be noted that savings would likely be significantly reduced if this measure were installed in newer, better insulated buildings, as a portion of the savings are a result of increased thermal insulation provided by the panels.

Air-To-Air Heat Recovery

Energy recovery ventilators (ERV) and heat recovery ventilators (HRV) are air-to-air heat exchangers used to exchange the energy contained in normally exhausted building air with incoming outdoor ventilation air in commercial HVAC systems. HRVs recover the heat energy in the exhaust air, and transfer it to fresh air as it enters the building. ERVs also transfer the humidity level of the exhaust air to the intake air. HRVs and ERVs can capture between 70% and 80%[94] of the energy in air that is exiting the building. HRVs and ERVs can be stand-alone devices that operate independently, they can be built-in or they can be added to existing HVAC systems. It should be noted that Ontario's Building Code requires heat recovery ventilators in some instances where outdoor air is introduced at high volumes. Such systems are typical of modern health care buildings.[95] The co-benefits of air-to-air heat recovery include improved indoor air quality and reduced total HVAC equipment capacity.

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[91] Manufacturer information: www.novitherm.com.

[92] Union estimate.

[93] Enbridge Gas Distribution DSM input assumptions.

[94] www.uniongas.com.

[95] The Ontario Building Code requires heat recovery ventilators where:

"the quantity of the outdoor air supplied to the air duct distribution system is,

(a) more than 1 400 L/s, and

(b) more than 70% of the supply air quantity of the system."

See Government of Ontario. *Ontario Regulation 350/06 Building Code*. 2006.

Measure Profile	
Applicable Building Types	All
Vintage	Existing & new
Costs	$2.17/cfm incremental cost
Savings	50% of ventilation heating energy
Useful Life	15 years

This measure involves installing air-to-air heat recovery equipment to preheat make-up air in a commercial building. It is applicable to both existing buildings (at time of make-up air unit replacement) and new construction. The baseline is no heat recovery. The cost is $2.17 per cfm,[96] the savings are 50% of ventilation heating energy use[97] and the service life is 15 years.[98]

Programmable Thermostats

The use of programmable thermostats with packaged HVAC equipment provides improved control, scheduling and setpoint reset capability. The co-benefits include reduced maintenance and longer service life.

Measure Profile	
Applicable Building Types	Small Commercial
Vintage	Existing & new
Costs	$275/thermostat full cost
Savings	10% of space heating energy
Useful Life	15 years

This measure involves upgrading standard thermostats with programmable thermostats and scheduling the operation of the equipment based on occupancy requirements. It is applicable to both existing buildings and new construction and the baseline is a small commercial building with packaged rooftop units and standard thermostats. The full cost is estimated to be $275 per thermostat,[99] the savings are 10% of space heating energy use[100] and the service life is 15 years.[101]

Demand Controlled Ventilation

Demand controlled ventilation (DCV) uses CO_2 sensors to supply outdoor air (OA) based on the actual building occupancy, while preserving indoor air quality. Energy is saved because lower volumes of OA are introduced during periods of low occupancy. In

[96] RS Means Mechanical cost data.

[97] Marbek estimate.

[98] Union Gas 2007-2009 DSM Plan, Appendix A and BC Hydro QA Standard.

[99] Union estimate.

[100] CEEAM simulation.

[101] Personal communication, Union Gas / Enbridge DSM input assumptions.

practice, volumes of OA can often be reduced by as much as 50% in buildings with variable occupancy patterns. For most commercial buildings this reduction translates into a 10% savings in space heating energy use.

Measure Profile	
Applicable Building Types	All
Vintage	Existing & new
Costs	$1,500/air handling system full cost
Savings	10% of space heating energy
Useful Life	15 years

This measure involves upgrading standard ventilation controls with DCV. It is applicable to both existing buildings and new construction. The baseline is a large office building with standard ventilation controls. The cost is estimated to be $1,500 per air handling system,[102] the savings are 10% of space heating energy use[103] and the service life is 15 years.[104]

Demand Control Kitchen Ventilation

Commercial kitchen exhaust systems and associated makeup air systems continue to be designed and operated as constant volume ventilation systems, without the ability to respond to variations in cooking equipment usage. The application of a demand control kitchen ventilation (DCKV) system can achieve reductions in exhaust (and makeup) airflow when appliances are not being used to capacity. In a typical configuration, the DCKV system controls the speed of the exhaust fans and make-up air fan through variable frequency drives (VFDs) based on feedback from an infrared beam in the hood and temperature sensors located in the exhaust ducts. A 2004 DCKV pilot project in a Boston Pizza outlet showed an average 30% reduction in make-up air and a 2.1-year simple payback.[105]

Measure Profile	
Applicable Building Types	Food Service Operations
Vintage	Existing & new
Costs	$1.50/cfm full cost
Savings	30% of ventilation heating energy
Useful Life	20 years

This measure involves upgrading a standard kitchen ventilation system DCKV. It is applicable to both existing buildings and new construction. The baseline is a constant volume ventilation system. The cost is estimated to be $1.50 per cfm, the savings are approximately 30% of ventilation heating energy and the service life is 20 years.[106]

[102] Supplier information and RS Means.

[103] CEEAM simulation.

[104] BC Hydro QA Standard for building automation system.

[105] Evaluation of a Kitchen Ventilation Demand Control System Installed in a Boston Pizza, Fisher-Nickel, Inc, December 2004.

[106] Union Gas 2007-2009 DSM Plan, Appendix A.

Furnace/Boiler Tune-ups

Gas-fired equipment tune-ups involve inspecting the venting system, mechanical parts, filters (as applicable) and the interior of the combustion chamber. The burners are also generally removed and cleaned and the carbon monoxide level of the flue gas is assessed to ensure that the appliance is burning as cleanly as possible. Other checks include burner adjustments, testing the heat exchanger for carbon monoxide leaks, checking and adjusting all controls, setpoint adjustment, inspecting wiring and thermocouples, and making repair recommendations. For boiler systems, tune-ups may include a full combustion analysis. The benefits include improved efficiency, extending the lifetime of the equipment and improved safety and comfort.

Measure Profile	
Applicable Building Types	All
Vintage	Existing & new
Costs	$500/unit full cost
Savings	5% of space heating energy
Useful Life	2 years

This measure involves tuning up gas-fired appliances as part of a regular maintenance plan. It is applicable to both existing buildings and new construction. The baseline is a retail building with gas-fired rooftop units. The cost is estimated to be $500 per appliance,[107] the savings are 5% of space heating energy use[108] and the service life is two years.[109]

Condensing Furnaces

Condensing gas furnaces are the most energy-efficient furnaces available, with seasonal efficiencies between 89% and 97%, compared with AFUEs of about 60% for old furnaces and of 78% to 84% for standard efficiency units[110]. Most have burners similar to conventional furnaces, with draft supplied by an induced draft fan. Additional heat exchange surfaces made of corrosion-resistant materials (usually stainless steel) extract most of the heat remaining in the combustion by-products before they are exhausted. In this condensing heat exchange section, the combustion gases are cooled to a point where the water vapour condenses, thus releasing additional heat for space heating. The benefits of condensing unit heaters include superior performance, reduced operating costs through lower natural gas expenditures and fewer greenhouse gas emissions.

[107] Marbek estimate.

[108] Marbek estimate.

[109] Marbek estimate.

[110] Office of Energy Efficiency, Natural Resources Canada.

Measure Profile	
Applicable Building Types	Small Commercial
Vintage	Existing and new
Costs	$6/MBH incremental cost
Savings	15% of space heating energy
Useful Life	18 years

This measure involves upgrading to a high-efficiency condensing furnace with an AFUE of 94%. It is applicable to existing small commercial buildings (at time of furnace replacement) and new construction. The baseline is a standard furnace with an AFUE of 80%. The incremental cost is approximately $6 per MBH,[111] the savings are 15% of space heating energy and the service life is 18 years.[112]

Infrared Heaters

Infrared heating systems heat objects (including people) directly by radiant heat. The absorbed heat then warms the surrounding air. By comparison, a conventional forced air heating system heats the air and then circulates it so it can warm objects and people in the space. Since infrared heating heats objects directly, the ambient air temperature can be maintained at a lower temperature resulting in lower heat losses through building envelope.

Infrared heaters are categorized by high and low intensity. Tube-style heaters are usually low intensity; wall mounted heaters with ceramic refractory are high intensity. Tube heaters burn gas inside a long tube, creating radiant heat from the tube surface. A polished reflector directs the radiant heat down to the floor. Tube heaters start at 20,000 Btu/hr and have an efficiency of approximately 80%.[113] Typical applications include high ceiling and open spaces such as warehouses, garages, and recreation facilities. The co-benefits include improved comfort and quiet operation.

Measure Profile	
Applicable Building Types	Warehouse, Garage, Recreation Facility
Vintage	Existing and new
Costs	$3/MBH incremental cost
Savings	12% of space heating energy
Useful Life	20 years

This measure involves upgrading to an infrared heating system and maintaining a lower ambient air temperature in the space. It is applicable to existing buildings (at time of heater replacement) and new construction. The baseline is a standard unit heater with efficiency of 80%. The incremental cost is $3 per MBH,[114] the savings are 12%[115] of space heating energy and the service life is 20 years.[116]

[111] Supplier information and RS Means.

[112] ASHRAE, Union Gas Updated input assumptions (July 2008).

[113] Union Gas.

[114] RS Means Mechanical Cost Data 2007.

Solar Preheated Make-Up Air

A preheat solar air system uses solar energy to preheat outside air before it is introduced into a facility. In a typical system, a dark metal cladding mounted on the south-facing wall is used as a heat exchanger. Sunlight hitting the cladding heats the air, which is then drawn through thousands of small perforations into a narrow space between the wall and the building. The heated air rises up to a canopy plenum where it is drawn into the building or make-up air units for further heating and distribution. Typical applications include buildings with large south-facing exposures and a requirement for make-up air including warehouses, garages, multi-unit residential buildings, schools and central heating plants. The co-benefits include comfortable work environment, reduced air stratification and improved R-value of clad wall.

Measure Profile	
Applicable Building Types	Warehouse, Garage, Schools
Vintage	Existing and new
Costs	$40/ft^2 (of cladding)
Savings	18% of ventilation heating energy
Useful Life	20 years

This measure involves upgrading to a solar preheat make-up air system. It is applicable to existing buildings and new construction. The baseline is a standard make-up air unit with an efficiency of 80%. The cost is $40 per square foot of cladding,[117] the savings are estimated to be 18% of ventilation heating energy[118] and the service life is 20 years.[119]

4.4.3 Domestic Hot Water

The evaluation of domestic hot water (DHW) efficiency measures involved a study of the following gas-fired domestic hot water heating equipment:

- Condensing Water Heaters
- Condensing Storage Water Heaters
- Tankless Hot Water Heaters
- Drainwater Heat Recovery
- Low-flow Faucet Aerators and Showerheads
- Low-flow Pre-Rinse Spray Valves
- Solar Water Heating
- Booster Water Heaters

As applicable, measures were evaluated at low, medium, and high equivalent full-load hours to reflect the range of operation and loads commonly found in commercial

[115] Based on CEEAM simulation.

[116] Union updated input assumptions (July 2008).

[117] Marbek review of Renewable Energy Deployment Initiative (REDI) applications.

[118] RETScreen simulation.

[119] Marbek estimate.

buildings. In general, measures have been evaluated against a specific baseline to obtain a typical percentage savings as opposed to an absolute "per installation" savings. An overview of each upgrade measure is presented below.

Condensing Water Heaters

Condensing water heaters offer superior heat exchange design and improved combustion technologies over standard efficiency heaters resulting in thermal efficiencies up to 98%.[120] Its features include a separate storage tank, stainless steel heat exchanger, direct-vent sealed combustion and fully modulating combustion. Suitable applications include facilities with large hot water loads such as hotels, nursing homes and apartment buildings. The benefits of condensing water heaters include superior performance, reduced operating costs through lower natural gas expenditures and flexible venting.

Measure Profile	
Applicable Building Types	Hospitality, Health Care, & Multi-family
Vintage	Existing and new
Costs	$17/MBH incremental cost
Savings	22% of heating energy
Useful Life	24 years

This measure involves upgrading to a high-efficiency condensing water heater with a seasonal efficiency of 90%. It is applicable to existing buildings (at time of heater replacement) and new construction. The baseline is a standard water heater with a thermal efficiency of 80% and a seasonal efficiency of 70%. The incremental cost is approximately $17 per MBH,[121] the savings are estimated to be 22% of heating energy and the service life is 24 years.[122]

Condensing Storage Water Heaters

Condensing tank-type water heaters offer superior heat exchange design and improved combustion technologies over standard efficiency units resulting in thermal efficiencies up to 98%.[123] The heaters feature an integral storage tank, direct-vent sealed combustion, power burner and a multi-pass flue system. Suitable applications include all Commercial sub-sectors with medium to high hot water loads. The benefits of condensing water heaters include superior performance, reduced operating costs through lower natural gas expenditures and venting flexibility.

[120] Lochinvar Armor.

[121] RS Means Mechanical Cost Data 2007.

[122] BC Hydro QA Standard.

[123] Lochinvar Turbo Charger.

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$13/MBH incremental cost
Savings	22% of heating energy
Useful Life	15 years

This measure involves upgrading to a high-efficiency condensing water heater with a seasonal efficiency of 90%. It is applicable to existing buildings (at time of heater replacement) and new construction. The baseline is a standard water heater with a thermal efficiency of 80% and a seasonal efficiency of 70%. The incremental cost is approximately $13 per MBH,[124] the savings are estimated to be 22% of heating energy under average operating conditions / duty cycle and the service life is 15 years.[125]

Tankless Water Heaters

Tankless water heaters heat water on demand, eliminating hot water storage. The gas burner is activated by the flow of water whenever a hot water valve is opened. They do not have standby losses (incurred by continuous use of energy to maintain water in a tank to a set temperature) and can be installed at a point-of-use or can replace conventional tank water heaters. Suitable applications include small and commercial buildings with medium to high hot water loads including restaurants, motels, laundries and car washes. Installation in areas with hard water lead to increased maintenance requirements for tankless water heaters due to heat exchanger fouling.

The efficiency of tankless water heaters depends on the water heater's characteristics and on the temperature of the water being heated. Operating efficiencies can be as high as 95% but are more typically in the 80% range. The gas requirements for tankless water heaters are much larger than for storage water heaters (2 to 4 times), so they may require larger gas lines and vents than conventional water heaters. The benefits of tankless water heaters include modularity, no standby losses and small space requirements.

Measure Profile	
Applicable Building Types	Small Commercial
Vintage	Existing and new
Costs	$15/MBH incremental cost
Savings	14% of heating energy
Useful Life	20 years

This measure involves upgrading a standard tank-type heater to tankless water heaters with a thermal efficiency of 82%.[126] It is applicable to existing buildings (at time of heater replacement) and new construction. The baseline is a standard water heater with a

[124] RS Means Mechanical Cost Data 2007.

[125] Union Gas Demand Side Management 2006 Evaluation Report.

[126] Takagi TM1.

thermal efficiency of 80% and a seasonal efficiency of 70%.[127] The incremental cost is approximately $15 per MBH,[128] the savings are estimated to be 14% of heating energy under average operating conditions / duty cycle and the service life is 20 years.[129]

Drainwater Heat Recovery

Drainwater heat recovery systems capture energy from warm wastewater and transfer it to cold make-up water at efficiencies up to 71%.[130] The technology consists of a shell-and-tube heat exchanger installed in a drainpipe. Typical applications include showers, dishwashers and laundries that have sustained levels of hot wastewater. Examples of this technology include the GFX system, which was originally developed with a grant from the U.S. Department of Energy and is currently manufactured by Doucette Industries, and the Powerpipe, manufactured by RenewABILITY Energy Inc.

Measure Profile	
Applicable Building Types	Apartments, Hotels, Kitchens, Laundries, Gyms
Vintage	Existing and new
Costs	$900/unit incremental cost
Savings	48% of shower water heating energy
Useful Life	20 years

This measure involves upgrading a hotel shower with a drainwater heat recovery system. It is applicable to existing buildings (at time of major plumbing renovations) and new construction. The baseline is a standard plumbing system with no heat recovery. The incremental cost is $900[131] per unit, the savings are 48%[132] of shower heating energy and the service life is estimated to be 20 years.[133]

Low-Flow Faucet Aerators and Showerheads

Low-flow faucet aerators lower the water flow to 0.5 to 2 gallons per minute (gpm) by introducing air into the water stream. The aerators create a fine water spray with a screen that is inserted in the faucet head. Low-flow showerheads use the same principle to achieve flow rates in the range of 1.5 to 2.2 gpm.

[127] Standing losses (and therefore seasonal efficiency) of a tank-type heater are heavily dependent on usage patterns. 70% has been taken as a sector-wide average.

[128] RS Means and supplier information.

[129] BC Hydro QA Standard.

[130] GFX dishwasher case study.

[131] RenewABILITY Energy Inc.

[132] Natural Resources Canada, Sustainable Buildings and Communities, *Drain Water Heat Recovery Characterization and Modeling*, July 19, 2007.

[133] Marbek estimate.

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$5/faucet & $20/head
Savings	50% of hot water heating energy
Useful Life	10 years

This measure involves upgrading faucet aerators and showerheads with equivalent water efficiency units. It is applicable to existing buildings and new construction, with particular relevance to multi-unit residential buildings and hotels/motels. The baseline is a standard showerhead with a flow rate of 2.5 gpm and a standard faucet aerator with a flow rate of 2 gpm. The costs are $5 per faucet and $20 per showerhead,[134] the savings are 50% of hot water heating energy and the service life is 10 years.[135]

Low-Flow Pre-Rinse Spray Valves

Pre-rinse spray valves (also called a spray nozzle or spray head) are used by restaurant, cafeteria and kitchen workers to remove food from plates and other dishes prior to loading them in the dishwasher. New energy- and water-efficient valves utilize a "knife-edge" spray rather than a traditional "shower-type" spray to better focus the available energy and remove the food particles more efficiently. A traditional spray valve uses up to 5.0 gpm[136] of hot water, while efficient models use 1.6 gpm or less. The co-benefits include improved cleaning efficiency and performance.

Measure Profile	
Applicable Building Types	Food Service Operations
Vintage	Existing and new
Costs	$100/valve full cost
Savings	60% of hot water heating energy
Useful Life	5 years

This measure involves upgrading a standard pre-rinse spray valve with an equivalent water efficient 1.2 gpm spray valve. The technology is applicable to existing buildings and new construction with food service operations. The baseline is a standard spray valve with a flow rate of 2.7 gpm. The cost is $100 per valve, the savings are 60% of hot water heating energy and the service life is 5 years.[137]

Solar Water Heating Systems

Solar water heating systems use the energy of the sun to heat water. The primary components of a solar water heating system are a solar collector, a heat transfer fluid and

[134] Personal communication with Water Conservation Company Ltd.

[135] BC Hydro QA Standard.

[136] CEE Commercial Kitchens Initiative – Program Guidance on Pre-Rinse Spray Valves.

[137] Analysis and assumptions based on Region of Waterloo Pre-Rinse Spray Valve Pilot Study, Veritec Consulting Inc., January 2005.

a storage tank. Due to Canada's colder climate and the higher likelihood of freezing, active closed-loop systems are generally used. These systems use a pump to circulate a non-freezing heat transfer fluid through the collectors and then through a heat exchanger so that the thermal energy can be transferred to the water. Since solar heating systems are only able to partially offset hot water heating requirements, a conventional water heating system is generally used in conjunction with it to provide supplementary heat as required. A solar system is typically able to displace 20% of the total hot water energy use.

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$9,000 per system
Savings	20% of hot water heating energy
Useful Life	15 years

This measure involves upgrading a standard hot heating system with a solar heating system. It is applicable to existing buildings and new construction. The baseline is a standard 100-gallon water heater with a thermal efficiency of 80% and a seasonal efficiency of 70%. The cost is approximately $9,000[138] per system, the savings are estimated to be 20% of hot water heating energy[139] and the service life is 15 years.[140]

Booster Water Heaters

Booster water heaters are used in applications requiring water temperatures above 140^{o}F including dishwashers, which typically require water up to 180^{o}F. Several technologies are commonly used including tank-type water heaters, tankless water heaters and small under-counter hot water boilers.

Measure Profile	
Applicable Building Types	Food Services
Vintage	Existing and new
Costs	$16/MBH incremental cost
Savings	16% of heating energy
Useful Life	15 years

This measure involves upgrading a standard tank-type booster heater to a tankless booster water heater with a thermal efficiency of 82%.[141] It is applicable to existing buildings with food services (at time of heater replacement) and new construction. The baseline is a standard water heater with a thermal efficiency of 80% and a seasonal efficiency of 70%.

138 RS Means Mechanical Cost Data 2007.

139 Marbek estimate.

140 Marbek estimate based on measure life for standard tank water heaters.

141 Takagi.

The incremental cost is approximately $16 per MBH,[142] the savings are estimated to be 16% of heating energy and the service life is 20 years.[143]

4.4.4 Cooking

This study considered four cooking appliance upgrade measures, primarily applicable in the Restaurant/Food Service sub sector:

- Efficient Gas Griddles
- Efficient Gas Broilers
- Efficient Gas Ovens
- ENERGY STAR® Fryers.

With the exception of broilers, food service appliances are generally evaluated in terms of "cooking efficiency," the ratio of energy added to food to the energy supplied to the appliance during cooking. Because broilers are not generally thermostatically controlled, and idling energy input rates are generally similar to energy input rates while cooking, cooking energy efficiency measured over the time span of a cooking event is less relevant. For this study, broilers are evaluated based on average hourly energy use using a standard duty cycle.

In general, measures have been evaluated against a specific baseline to obtain a typical percentage savings as opposed to an absolute "per installation" savings. An overview of each upgrade measure is presented below.

Efficient Gas Griddles

Standard griddles use approximately 86,100 kBtu (approximately 2,400 m^3 natural gas) per year and have efficiency levels that range from 25% to 45%. As with most commercial cooking appliances, a significant portion of griddle energy is lost during idling, as griddles are generally turned on all day and kept at cooking temperatures. A recent study estimated average griddle idling losses of 15 kBtu per hour.[144] Various new technologies, such as improved thermostat accuracy and control, infrared burners and enclosed heat pipes that connect the heat source directly to the griddle plate, have been developed. Under ideal operating conditions, these innovations can improve griddle cooking efficiency to levels above 45%, while reducing idling losses.

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$1,150/unit incremental cost
Savings	20% compared with standard gas griddle
Useful Life	10 years

[142] RS Means and supplier information.

[143] BC Hydro QA Standard.

[144] *Commercial Cooking Appliance Technology Assessment*. Prepared for the Food Service Technology Center (FSTC) by Don Fisher, 2002.

This measure involves upgrading to an efficient gas griddle with a cooking efficiency of 40% at the time of stock turnover. The baseline is a standard gas griddle with a cooking efficiency of 32%.[145] The incremental cost is approximately $1,150 per unit,[146] measure savings are estimated to be 20% compared to the baseline and the service life is 10 years.[147]

Efficient Gas Broilers

Depending on the type, broilers use approximately 115,000 kBtu to 210,000 kBtu (approximately 3,200 m^3 to 5,900 m^3 gas) per year. They tend to have high energy use, low efficiency levels and are often one of the most expensive appliances to operate in a commercial kitchen.[148] Past broiler efficiency strategies have dealt with methods of reducing the input energy when the broiler is idle; however, none have proven to be commercially successful. In addition, the distinctive flavour and appearance of broiled food is often desirable and consequently, switching to other, more efficient cooking methods is typically not a viable option.

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$200/unit incremental cost
Savings	19% compared with standard gas broiler
Useful Life	10 years

This measure involves upgrading to an efficient gas broiler with an average gas use of 69 MJ/hr at the time of stock turnover. The baseline is a standard gas griddle with an average gas use of 85 MJ/hr.[149] In general, commercial broiler prices vary based on non-energy features and are not directly related to the unit's energy efficiency. This study assumes the most efficient units have a small incremental cost ($200) over baseline models.[150] Measure savings are estimated to be 19% and the service life of a commercial broiler is estimated to be 10 years.[151]

Efficient Gas Ovens

Standard gas ovens use approximately 62,400 kBtu (approximately 1,750 m^3 gas) per year and have efficiency levels that range from 30% to 40%.[152] Various technologies, such as improved insulation, infrared burners and improved air circulation have been

[145] U.S. EPA ENERGYSTAR Commercial food service equipment best practice tools. www.energystar.gov/index.cfm?c=commercial_food_service.commercial_food_service.

[146] U.S. EPA ENERGYSTAR.

[147] Marbek estimate,

[148] Fisher, 2002.

[149] U.S. EPA ENERGY STAR® Commercial food service equipment best practice tools.

[150] U.S. EPA ENERGY STAR®.

[151] U.S. EPA ENERGY STAR®.

[152] Fisher, 2002.

developed to improve both cooking characteristics and oven efficiency. Combination ovens, which include steam injection, claim efficiencies of up to 60%.[153]

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$1,500/unit incremental cost
Savings	25% compared with standard gas oven
Useful Life	10 years

This measure involves upgrading to an efficient gas oven with a cooking efficiency of 45% at the time of stock turnover. The baseline is a standard gas oven with a cooking efficiency of 35%.[154] The incremental cost is approximately $1,500 per unit,[155] measure savings are estimated to be 25% compared to the baseline and the service life is 10 years.[156]

ENERGY STAR® Gas Fryers

Standard gas fryers have efficiencies in the range of 25% to 50% and use approximately 74,900 kBtu (approximately 2,100 m^3 natural gas) per year.[157] Various new technologies, such as infrared burners, powered burners, recirculation tubes and fry pot insulation, have been developed that improve fryer efficiency to roughly 50% to 65%.

Infrared (IR) burners employ a fine honeycomb matrix to evenly disperse the fuel/air mixture across the burner surface. Combustion takes place close to the burner surface, causing it to become red hot and emit infrared radiation to the surrounding heat-transfer-tube walls. IR burners currently represent 5% to 10% of the gas fryers in the marketplace.[158]

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$1,100/unit incremental cost
Savings	30% compared with standard gas fryer
Useful Life	10 years

This measure involves upgrading to an ENERGY STAR® fryer with a cooking efficiency of 50% at time of stock turnover. The baseline is a standard fryer with an efficiency of 35%. Incremental cost is estimated at $1,100[159] and savings are 30%

[153] U.S. EPA ENERGY STAR®.

[154] Fisher, 2002.

[155] Fisher, 2002.

[156] Marbek estimate.

[157] Fisher, 2002.

[158] Fisher, 2002.

[159] U.S. EPA ENERGY STAR®.

compared to the baseline technology. The service life of a fryer is estimated to be 10 years.[160]

4.4.5 Whole Building

This study considered three whole building upgrade measures:

- Building Recommissioning
- Advanced Building Automation Systems
- High-Performance New Construction.

An overview of each upgrade measure is presented below.

Building Recommissioning

Retrocommissioning is the process of applying building commissioning procedures to an existing building in operation. This process ensures that the previously commissioned systems are still maintained and operated in accordance with the original design intent. It is also an opportunity to optimize operations beyond the intent of the original designers using the experience of operating the building as a guide. The U.S. Green Building Council (USGBC) recognized the importance of retrocommissioning by awarding it an innovation point in its Leadership for Energy and Environmental Design (LEED) for existing buildings (LEED-EB) ratings system.

The cost and energy savings of retrocommissioning depends on a building's complexity; studies indicate, however, that the process is cost effective. In 2004, Lawrence Berkeley National Laboratory (LBNL) compiled and synthesized extensive published and unpublished data from building commissioning projects undertaken across the U.S., establishing the largest available collection of standardized information on commissioning experience. The results showed the median cost of retrocommissioning was $0.27 per square foot, yielding whole-building energy savings of 15% and payback times of 0.7 years.[161] Other benefits of the process included improved IAQ, greater asset values, higher worker productivity and increased equipment life.

Measure Profile	
Applicable Building Types	All
Vintage	Existing
Costs	$0.35/ft^2 full cost
Savings	15% of whole building energy use
Useful Life	5 years

This measure involves applying the retrocommissioning process to an existing building. The baseline is a typical large office building. The cost is estimated to be $0.35/ft^2,[162] the savings are 15% of whole-building energy use[163] and the service life is 5 years.[164]

[160] U.S. EPA ENERGY STAR®.

[161] The Cost-effectiveness of Commercial Buildings Commissioning, LBNL, December 2004.

[162] The Cost-effectiveness of Commercial Buildings Commissioning, LBNL, December 2004.

Advanced Building Automation Systems

Advanced building automation systems (BAS) are able to automatically detect anomalies in building operations and can automate building diagnostics as well. These systems typically take data on how energy systems are performing in a building, analyze them using logic and physical modeling to detect deviations from expected performance and use built-in logic to suggest the cause of the deviation.[165] In addition, advanced BAS have improved predictive, self-tuning control algorithms that help to minimize the need for bypass or override of the BAS. Energy savings generally result from re-instituting equipment scheduling, expanded control to lighting and VAV boxes, instituting integrated control strategies and improving self-tuning diagnostics.

Measure Profile	
Applicable Building Types	All
Vintage	Existing
Costs	Full cost of $0.90/ft^2$
Savings	10% of total energy use
Useful Life	10 years

This measure involves installing an advanced BAS or upgrading an existing BAS with an advanced BAS. It is applicable to existing buildings. The baseline is a typical large commercial building. The cost is estimated to be $0.90/ft^2$, the savings are 10% of total building energy use and the service life is 10 years.[166]

High-Performance New Building Construction

High-performance new building construction refers to new high-efficiency buildings that are designed using the integrated design process. Through the application and integration of energy-efficiency technologies and design approaches, high-efficiency buildings that use this process can achieve substantial improvements over conventional new buildings. The co-benefits include lower operations and maintenance costs and enhanced occupant productivity and health.

Baseline new construction is assumed to follow the energy requirements of the Ontario Building Code 2006.

Two energy-efficiency upgrade options were evaluated for new construction:

- New Commercial Building – 25% more efficient than current standards
- New Commercial Building – 40% more efficient than current standards.

[163] Marbek database.

[164] Marbek estimate.

[165] E Source E News. *Automated Building Diagnostics: Improving Electricity Performance and Occupant Comfort*. ER-01. November 18, 2001.

[166] Marbek estimates.

New Commercial Building – 25% More Efficient than Current Standards

A new commercial building that is 25% more efficient than current design practice is achievable using an integrated design approach (IDA). The IDA approach to new building design is predicated on a systematic application of energy measures to all end uses at the design stage. This includes targeting the building envelope, lighting, fans and pumps and, finally, the heating and cooling plants.

Measure Profile	
Applicable Building Types	All
Vintage	New
Costs	$2.5/ft^2$ incremental cost
Savings	25%
Useful Life	25 years

This measure involves designing a new commercial building that is 25% more efficient than current design practice. The baseline is a building designed to the energy requirements in the Ontario Building Code 2006 (OBC). The incremental cost is estimated to be $2.50/ft^2, the savings are 25% of total building energy use and the service life is 25 years.[167]

New Commercial Building – 40% More Efficient than Current Standards

A new commercial building that is 40% more efficient than current design practice will require a very high-performance design, equivalent to the energy performance of a LEED Gold building. This requires a full IDA that takes advantage of costs trade-offs from equipment downsizing. The design will require the most energy-efficient technologies, extremely efficient lighting designs and heating/cooling plants with very high part-load efficiencies.

Measure Profile	
Applicable Building Types	All
Vintage	New
Costs	$4.50/ft^2 incremental cost
Savings	40%
Useful Life	25 years

This measure involves designing a new commercial building that is 40% more efficient than current design practice. The baseline is a building designed to the energy requirements in the OBC. The incremental cost is estimated to be $4.50/ft^2, the savings are 40% of total building energy use and the service life is 25 years.[168]

[167] The Costs and Financial Benefits of Green Buildings: A Report to California's Sustainable Building Task Force, October 2003.

[168] The Costs and Financial Benefits of Green Buildings: A Report to California's Sustainable Building Task Force, October 2003.

5 ECONOMIC POTENTIAL FORECAST

5.1 INTRODUCTION

This section presents the Commercial sector Economic Potential Forecast for the study period (2007 to 2017). The Economic Potential Forecast estimates the level of natural gas consumption that would occur if all building systems and equipment were upgraded to the level that is cost effective. In this study, "cost effective" means that the technology upgrade passes the measure TRC test, as discussed in Section 4.

The discussion in this section is organized into the following subsections:

- Major Modelling Tasks
- Technologies Included in Economic Potential Forecast
- Presentation of Results
- Interpretation of Results.

5.2 MAJOR MODELLING TASKS

By comparing the results of the Commercial sector Economic Potential Forecast with the Reference Case, it is possible to determine the aggregate level of potential natural gas savings within the Commercial sector, as well as identify which specific building segments, vintages and end uses provide the most significant savings opportunities.

To develop the Commercial sector Economic Potential Forecast, the following tasks were completed:

- The measure TRC results for each of the energy-efficiency upgrades presented in Exhibit 4.4 were reviewed.

- Technology upgrades that had positive measure TRC results were selected for inclusion either on a "full cost" or "incremental" basis. Technical upgrades passing the measure TRC test on a "full cost" basis were implemented in the first forecast year. Those upgrades that only passed the measure TRC test on an "incremental" basis were introduced as the existing stock reached the end of its useful life. If more than one cost-effective measure existed for the same end-use application, the study selected the most energy-efficient one.

- Energy use within each of the building segments was modelled with the same energy models that were used to generate the Reference Case. However, for this forecast, the remaining standard efficiency technologies included in the Reference Case forecast were replaced with the most efficient "technology upgrade option" that passed the measure TRC test.

- When more than one upgrade option was applied to a given end use, the first measure selected was the one that reduced the energy load. For example, measures to reduce the overall water heating load (e.g., low-flow showerheads and faucet aerators) would be applied before a high-efficiency water heater or boiler.

5.3 TECHNOLOGIES INCLUDED IN ECONOMIC POTENTIAL FORECAST

Exhibit 5.1 provides a listing of the technologies selected for inclusion in this forecast. In each case, the exhibit shows the following:

- End use affected
- Upgrade option(s) selected
- Sub sector(s) to which the upgrade options were applied
- Rate at which the upgrade options were introduced into the stock.

Exhibit 5.1: Technologies Included in Economic Potential

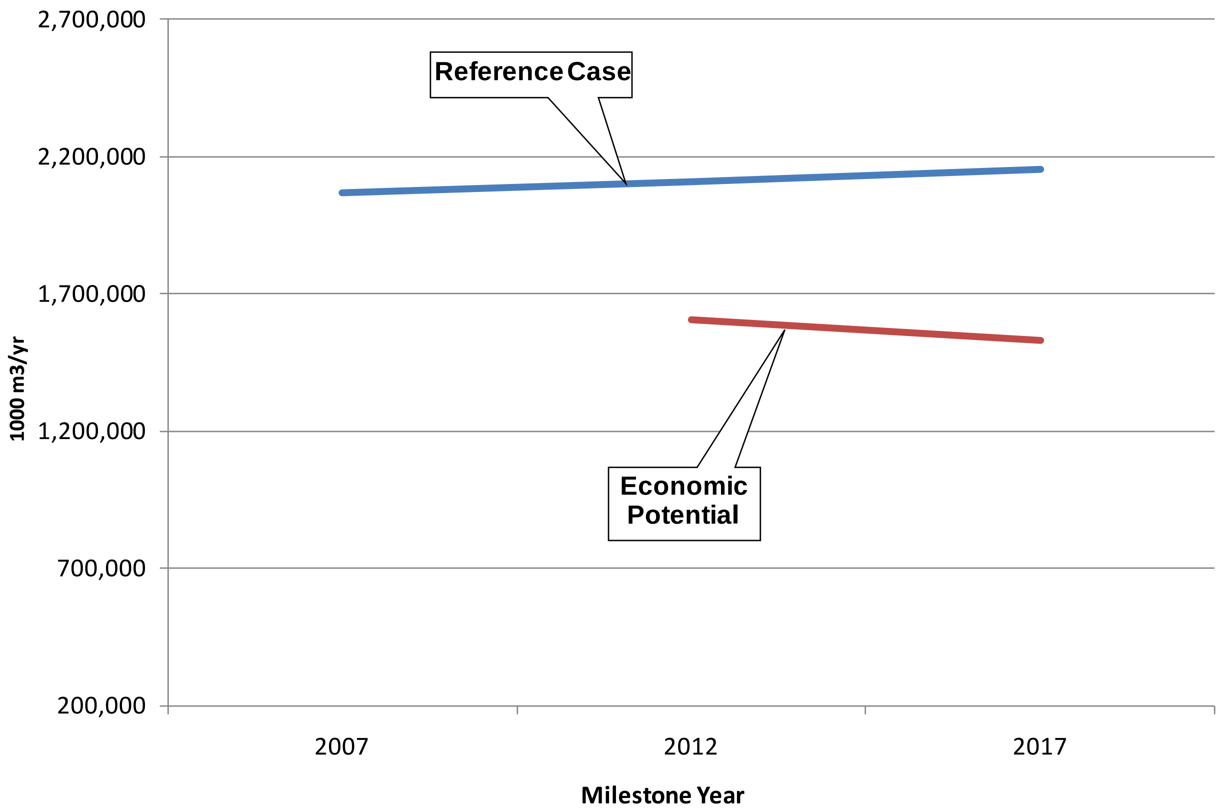
End Use	Upgrade Option	Applicability of Upgrade Options by Sub Sector	Rate of Stock Introduction
Space Heating	High-performance glazing	All existing	At rate of replacement
	Roof insulation	All existing	At rate re-roofing
	Air sealing	All existing	Immediate
	Air curtains	Existing Retail, Warehouse	Immediate
	Demand controlled ventilation	Existing School, Small Office, Large Office,	Immediate
	Demand controlled kitchen ventilation	Existing Restaurant	Immediate
	Air-to-air heat recovery	Existing Warehouse, University/College, Contract University/College, Small Hotel, Retail, Mid-rise Apartment, Nursing Home, Large Hotel, Hospital, Contract Hospital, High-Rise Apartment, Contract Apartment	Immediate
	Building Recommisioning	All Existing	Immediate
	De-stratification fans	Existing Warehouse	Immediate
	Steam plant measures	Existing Contract Hospital, Hospital, Contract University/College, University/College	Immediate
	Heat reflector panels	Existing Contract Apartment, High-rise Apartment, Mid-rise Apartment	Immediate
	Condensing boilers	All Existing	At rate of replacement
	Condensing unit heaters	Existing Warehouse	At rate of replacement
	Condensing rooftop units	All Existing	At rate of replacement
	Condensing furnace	Existing Small Office, Retail	At rate of replacement
DHW	Faucet aerators and low-flow showerheads	All Existing	Immediate
	Pre-rinse spray valve	Existing Restaurant	Immediate
	Condensing water heater	All Existing	At rate of replacement
	Condensing storage water heater	All Existing	At rate of replacement

End Use	Upgrade Option	Applicability of Upgrade Options by Sub Sector	Rate of Stock Introduction
Cooking	Efficient gas broiler	All Existing	At rate of replacement
	Efficient gas griddle	All Existing	At rate of replacement
	ENERGY STAR® gas fryer	All Existing	At rate of replacement
Space Cooling	Building recommissioning	Existing Hospital, Contract Hospital, University/College, Contract University/College, Large Office	Immediate
Other	Building recommissioning	All Existing	Immediate
New Construction	High-performance new construction – 40% more efficient	All New	At rate of new building construction

5.4 PRESENTATION OF RESULTS

Exhibit 5.2 compares the Reference Case and Economic Potential Forecast levels of energy consumption in the Commercial sector. As illustrated, under the Reference Case Commercial sector natural gas consumption would grow from the Base Year level of approximately 2,067,000,000 m^3/yr. to 2,157,000,000 m^3/yr. by 2017. This contrasts with the Economic Potential Forecast in which natural gas consumption would decrease to approximately 1,532,000,000 m^3/yr., a difference of approximately 625,000,000 m^3/yr., or 29% by 2017.

Exhibit 5.2: Reference Case versus Economic Potential - Natural Gas Consumption for the Total Union Service Area (1000 m^3/yr.)



5.4.1 Natural Gas Savings

Further detail on the total potential natural gas savings provided by the Economic Potential Forecast is provided in the following exhibits:

- Exhibits 5.3, 5.4 and 5.5 present results by end use and milestone year for the total Union Service Area in both tabular and graphic forms.
- Exhibits 5.6, 5.7 and 5.8 present results by end use and milestone year for the Southern service region in both tabular and graphic forms.
- Exhibits 5.9, 5.10 and 5.11 present results by end use and milestone year for the Northern service region in both tabular and graphic forms.
- Exhibit 5.12 and 5.13 present the results in 2017 by sub sector and end use for the Southern and Northern service regions, respectively.
- Exhibit 5.14 and 5.15 present the results in 2017 disaggregated by sub sector and building vintage for the Southern and Northern service regions, respectively.

Exhibit 5.3: Natural Gas Savings by End Use and Milestone Year, Total Union Gas Service Area – Economic Potential (1000 m^3/yr.)

Sub Sector	Milestone Year	Total	Space Heating	Water Heating	Cooking	Space Cooling	Other
Large Office	2012	34,602	29,280	3,049	27	26	2,220
	2017	41,908	35,243	3,787	60	26	2,792
Small Office	2012	66,873	60,052	4,440	49	0	2,332
	2017	83,975	75,182	5,798	105	0	2,890
Retail	2012	42,912	37,795	3,753	325	0	1,039
	2017	56,780	50,118	4,633	693	0	1,336
Large Hotel	2012	3,761	1,944	1,600	48	0	169
	2017	4,656	2,581	1,769	99	0	207
Small Hotel/Motel	2012	1,912	1,137	665	4	0	105
	2017	2,411	1,490	785	9	0	127
Contract Hospital	2012	14,857	10,169	3,480	82	45	1,081
	2017	17,250	12,174	3,697	169	49	1,161
Hospital	2012	6,306	4,823	1,216	36	11	220
	2017	7,572	5,934	1,304	75	13	246
Nursing Home	2012	15,544	10,346	4,265	212	0	721
	2017	19,765	13,755	4,708	436	0	867
School	2012	35,800	32,846	2,670	134	0	150
	2017	41,184	37,612	3,113	278	0	181
Contract University/College	2012	20,771	16,085	3,247	212	88	1,140
	2017	25,246	20,030	3,439	431	88	1,258
University/College	2012	4,163	3,388	588	33	17	137
	2017	5,078	4,216	624	67	17	153
Restaurant/Food Service	2012	19,927	12,366	5,580	1,921	0	59
	2017	24,606	14,149	6,442	3,942	0	72
Warehouse	2012	18,695	17,272	904	10	0	508
	2017	22,960	21,172	1,142	21	0	625
Contract Apartment	2012	2,016	1,326	656	2	0	33
	2017	2,500	1,704	753	3	0	40
High-rise Apartment	2012	47,062	31,744	14,516	39	0	764
	2017	58,550	40,819	16,717	80	0	934
Mid-rise Apartment	2012	28,096	18,907	8,932	36	0	221
	2017	35,004	24,276	10,382	75	0	270
Other Buildings	2012	78,359					
	2017	96,855					
Other Contract Institutional Buildings	2012	62,847					
	2017	79,076					
Total	2012	504,505	289,480	59,563	3,170	188	10,898
	2017	625,376	360,454	69,094	6,544	193	13,160

Exhibit 5.4: 2017 Natural Gas Savings by End Use, Total Union Gas Service Area – Economic Potential (1000 m^3/yr.)

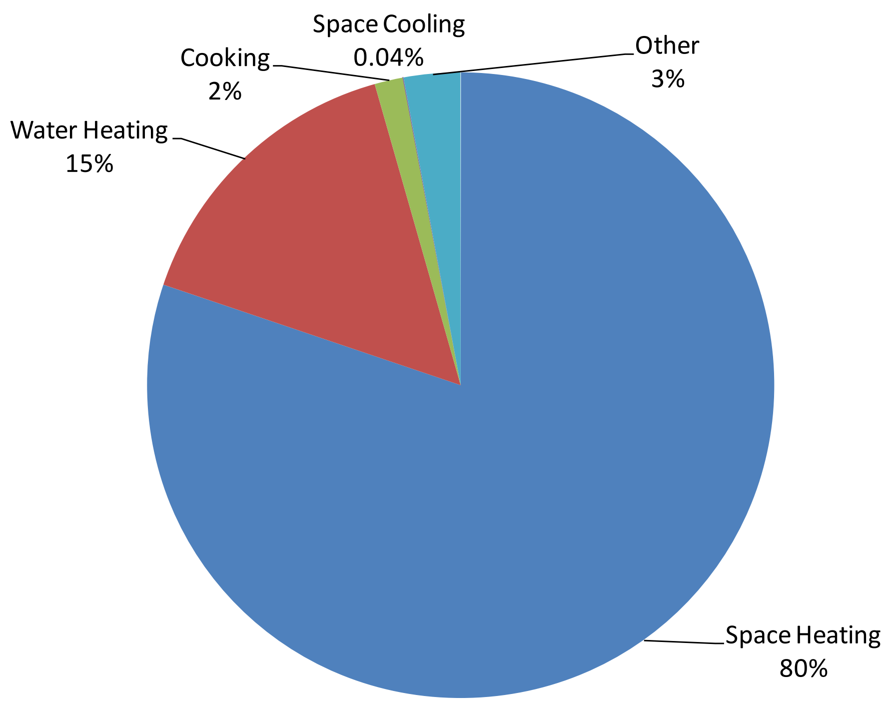


Exhibit 5.5: 2017 Natural Gas Savings by Sub sector, Total Union Gas Service Area – Economic Potential (1000 m^3/yr.)

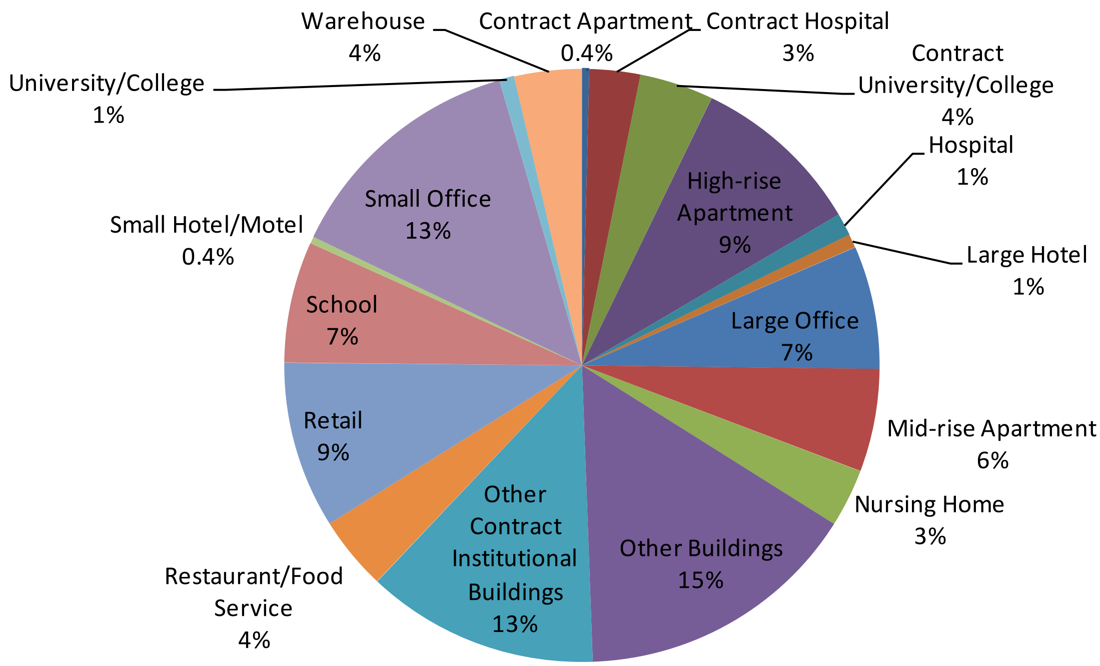


Exhibit 5.6: Natural Gas Savings by End use and Milestone Year, Southern Service Region – Economic Potential (1000 m^3/yr.)

Sub Sector	Milestone Year	Total	Space Heating	Water Heating	Cooking	Space Cooling	Other
Large Office	2012	14,454	11,948	1,406	12	26	1,061
	2017	17,082	14,011	1,709	27	26	1,309
Small Office	2012	25,048	22,169	1,875	21	0	984
	2017	31,597	27,868	2,459	45	0	1,225
Retail	2012	38,611	33,928	3,436	298	0	949
	2017	50,956	44,877	4,230	633	0	1,215
Large Hotel	2012	2,881	1,445	1,265	38	0	133
	2017	3,547	1,913	1,394	78	0	162
Small Hotel/Motel	2012	1,356	762	510	3	0	81
	2017	1,700	997	599	7	0	98
Contract Hospital	2012	13,099	8,886	3,125	73	44	970
	2017	15,169	10,616	3,314	151	48	1,041
Hospital	2012	2,640	1,944	569	16	9	102
	2017	3,133	2,375	604	32	10	112
Nursing Home	2012	10,209	6,616	2,951	147	0	494
	2017	12,889	8,757	3,243	300	0	588
School	2012	22,503	20,519	1,793	90	0	101
	2017	25,667	23,287	2,074	186	0	120
Contract University/College	2012	18,386	14,140	2,937	191	86	1,031
	2017	22,299	17,579	3,107	390	86	1,137
University/College	2012	3,345	2,696	491	28	16	114
	2017	4,066	3,346	520	56	16	128
Restaurant/Food Service	2012	17,366	10,629	4,972	1,712	0	53
	2017	21,435	12,130	5,732	3,508	0	64
Warehouse	2012	17,611	16,248	867	10	0	487
	2017	21,612	19,900	1,094	20	0	598
Contract Apartment	2012	2,016	1,326	656	2	0	33
	2017	2,500	1,704	753	3	0	40
High-rise Apartment	2012	42,418	28,397	13,287	36	0	698
	2017	52,673	36,467	15,281	73	0	852
Mid-rise Apartment	2012	22,809	15,156	7,440	30	0	184
	2017	28,327	19,415	8,627	62	0	223
Other Buildings	2012	67,771					
	2017	83,707					
Other Contract Institutional Buildings	2012	57,758					
	2017	72,537					
Total	2012	380,280	196,810	47,579	2,707	182	7,474
	2017	470,896	245,243	54,740	5,573	186	8,911

Exhibit 5.7: 2017 Natural Gas Savings by End Use, Southern Service Region – Economic Potential (1000 m^3/yr.)

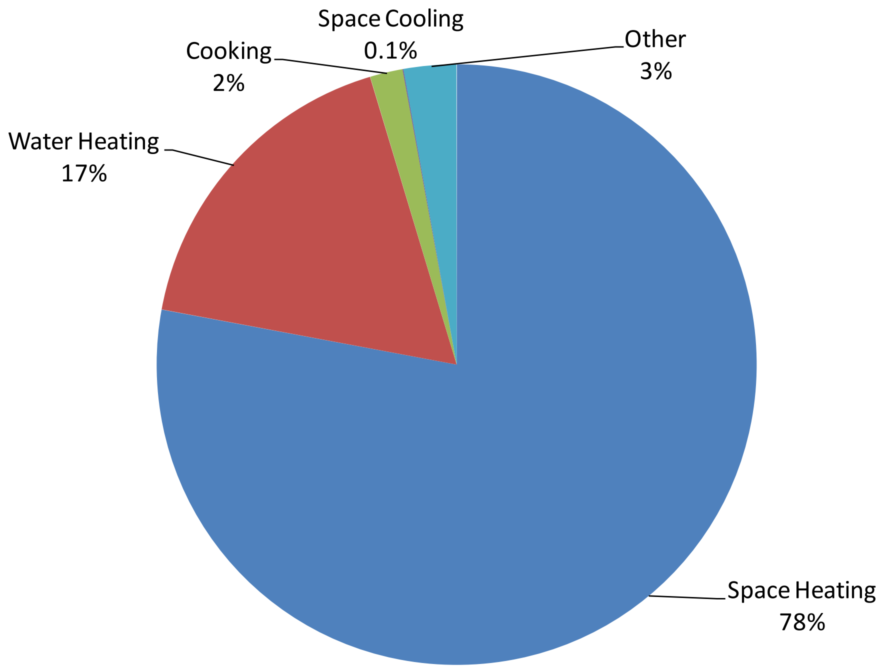


Exhibit 5.8: 2017 Natural Gas Savings by Sub sector, Southern Service Region – Economic Potential (1000 m^3/yr.)

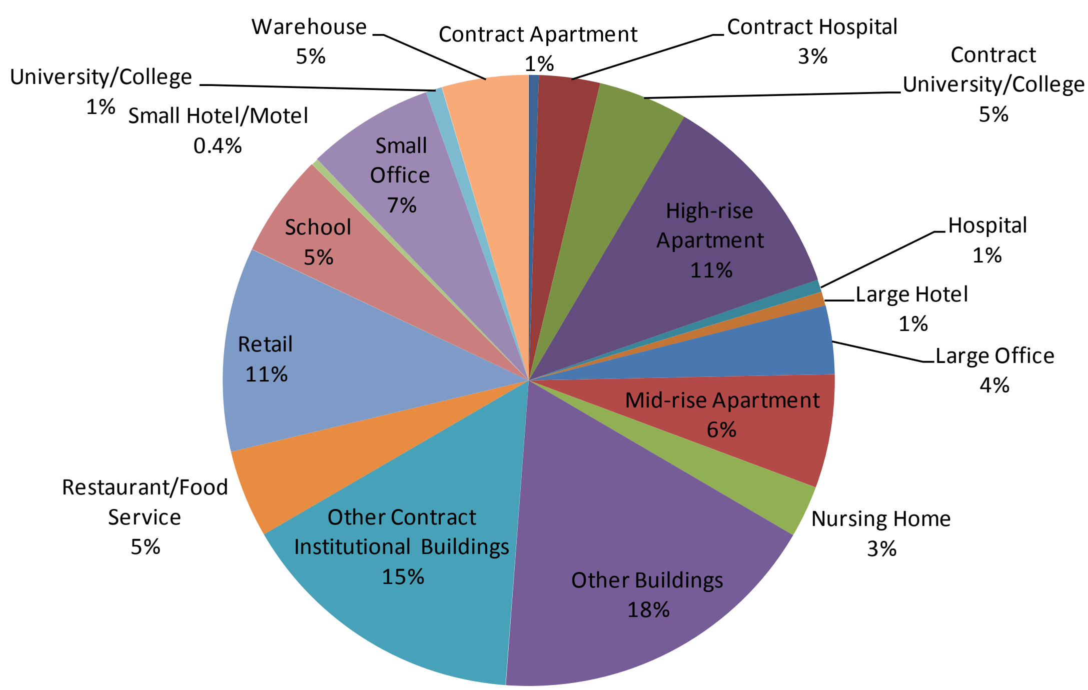


Exhibit 5.9: Natural Gas Savings by End use and Milestone Year, Northern Service Region – Economic Potential (1000 m^3/yr.)

Sub Sector	Milestone Year	Total	Space Heating	Water Heating	Cooking	Space Cooling	Other
Large Office	2012	20,148	17,332	1,644	14	0	1,159
	2017	24,826	21,232	2,078	33	0	1,483
Small Office	2012	41,825	37,883	2,566	28	0	1,348
	2017	52,379	47,314	3,339	61	0	1,664
Retail	2012	4,301	3,866	317	27	0	90
	2017	5,824	5,241	403	60	0	121
Large Hotel	2012	880	499	335	10	0	36
	2017	1,108	668	375	21	0	45
Small Hotel/Motel	2012	556	375	155	1	0	24
	2017	711	493	186	2	0	30
Contract Hospital	2012	1,758	1,283	355	8	1	110
	2017	2,081	1,558	383	17	2	121
Hospital	2012	3,667	2,878	648	21	2	118
	2017	4,440	3,559	700	43	3	134
Nursing Home	2012	5,335	3,730	1,314	65	0	227
	2017	6,876	4,998	1,464	135	0	279
School	2012	13,298	12,327	878	44	0	50
	2017	15,517	14,325	1,040	92	0	61
Contract University/College	2012	2,385	1,945	309	20	2	109
	2017	2,946	2,450	332	41	2	121
University/College	2012	819	693	97	5	1	23
	2017	1,012	870	104	11	1	26
Restaurant/Food Service	2012	2,560	1,736	608	209	0	7
	2017	3,171	2,019	710	434	0	8
Warehouse	2012	1,084	1,025	38	0	0	21
	2017	1,347	1,271	48	1	0	27
High-rise Apartment	2012	4,644	3,346	1,229	3	0	66
	2017	5,876	4,352	1,436	7	0	82
Mid-rise Apartment	2012	5,287	3,752	1,492	6	0	38
	2017	6,677	4,861	1,756	13	0	47
Other Buildings	2012	10,588					
	2017	13,148					
Other Contract Institutional Buildings	2012	5,090					
	2017	6,539					
Total	2012	124,225	92,670	11,984	463	5	3,424
	2017	154,480	115,211	14,355	971	7	4,249

Exhibit 5.10: 2017 Natural Gas Savings by End Use, Northern Service Region – Economic Potential (1000 m^3/yr.)

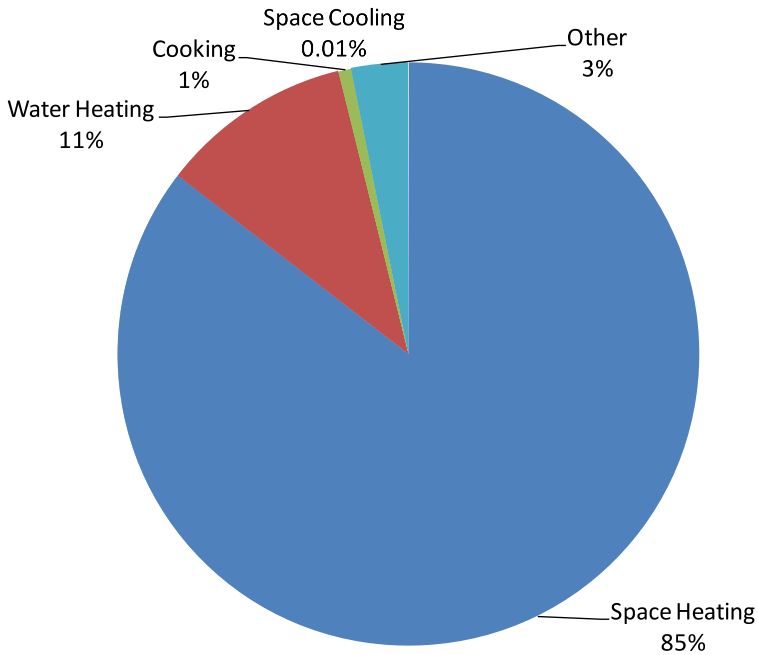


Exhibit 5.11: 2017 Natural Gas Savings by Sub sector, Northern Service Region – Economic Potential (1000 m^3/yr.)

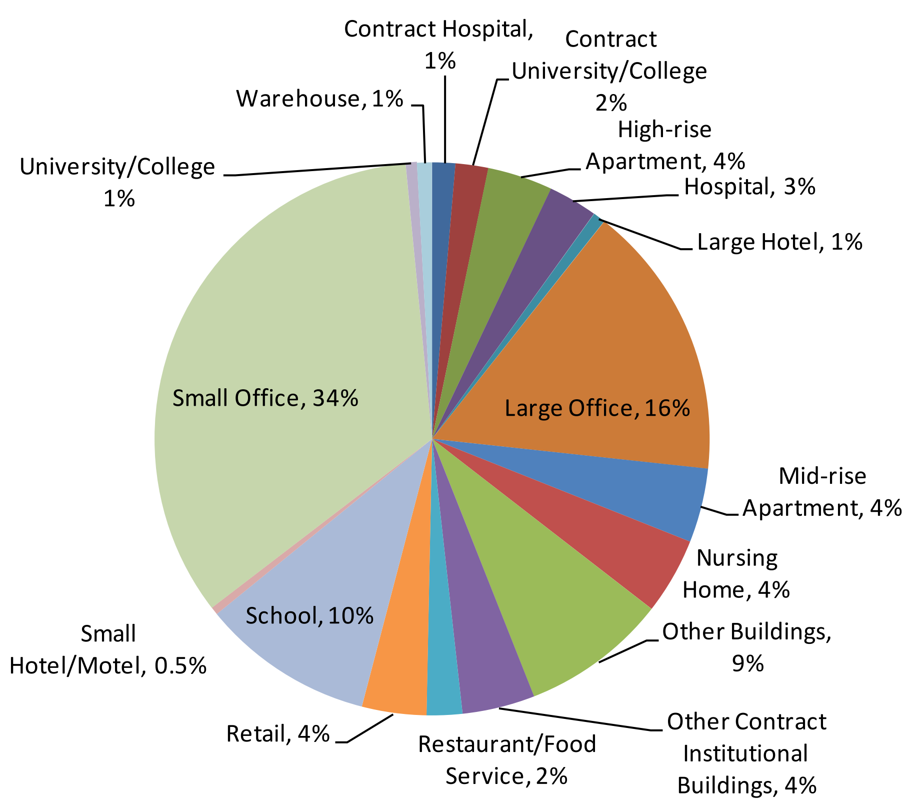


Exhibit 5.12: Natural Gas Savings by Sub Sector and End Use, Southern Service Region, 2017 (1000 m^3/yr.)

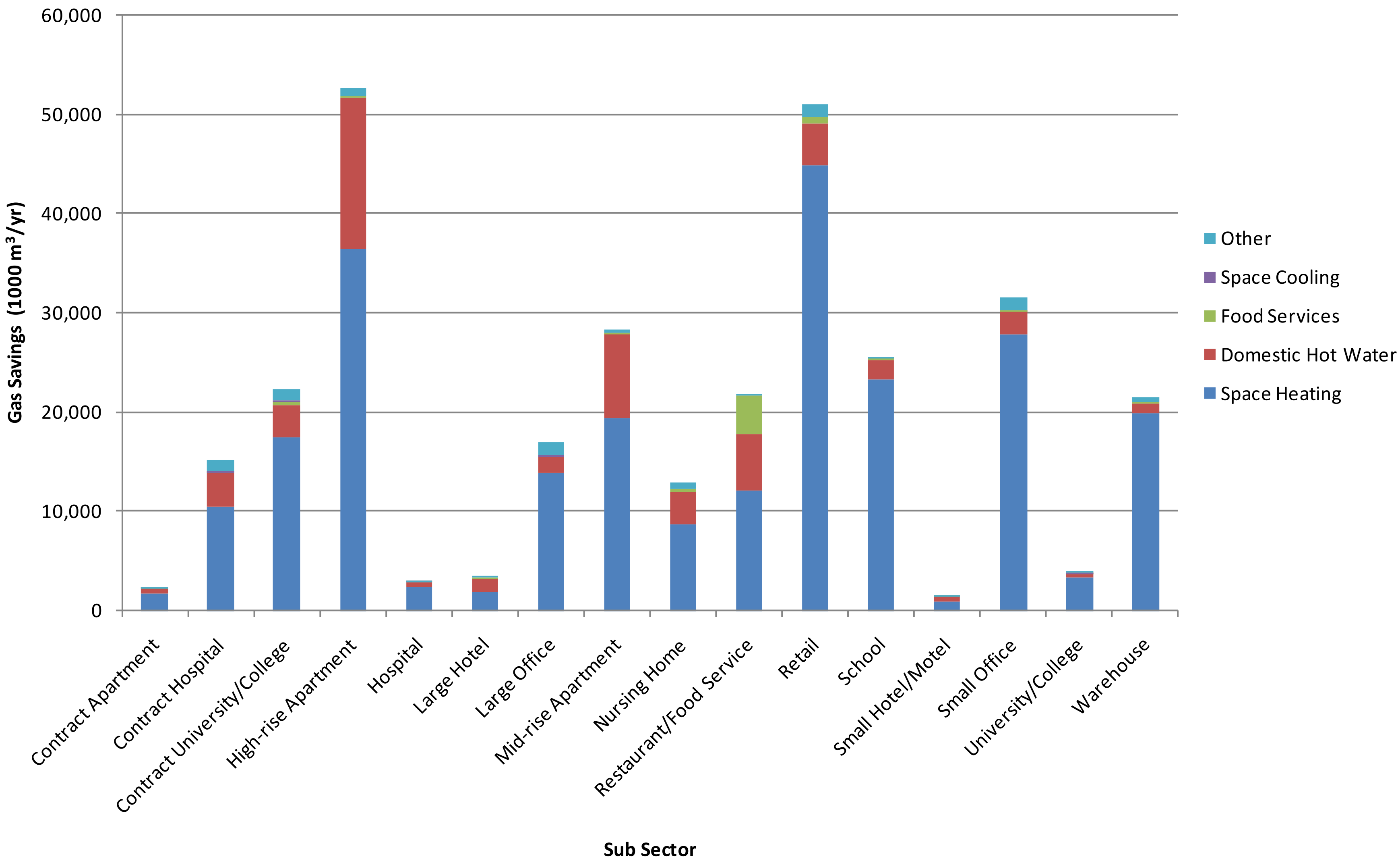


Exhibit 5.13: Natural Gas Savings by Sub Sector and End Use, Northern Service Region, 2017 (1000 m³/yr.)

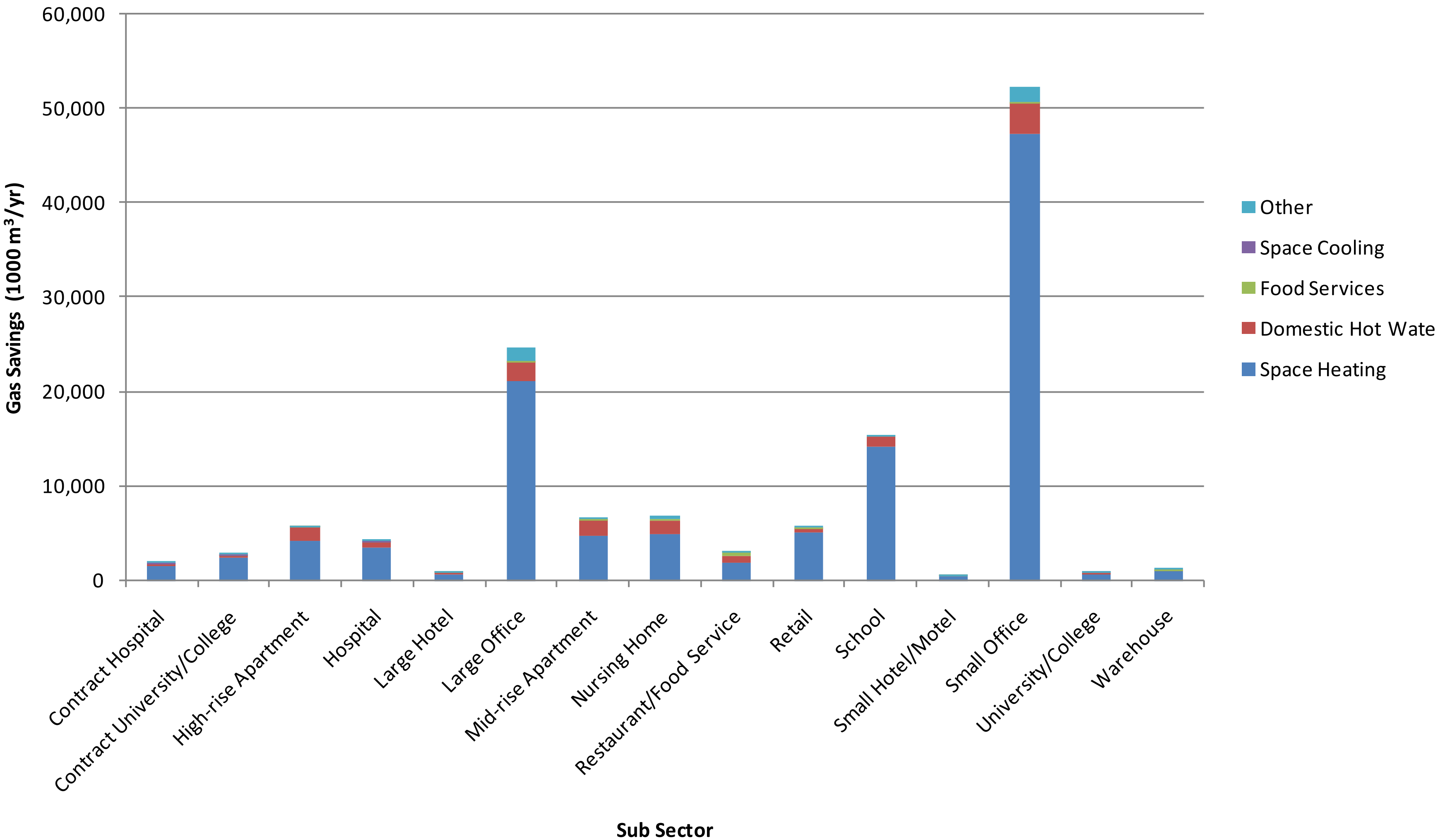


Exhibit 5.14: Natural Gas Savings by Sub Sector and Building Vintage, Southern Service Region, 2017 (1000 m^3/yr.)

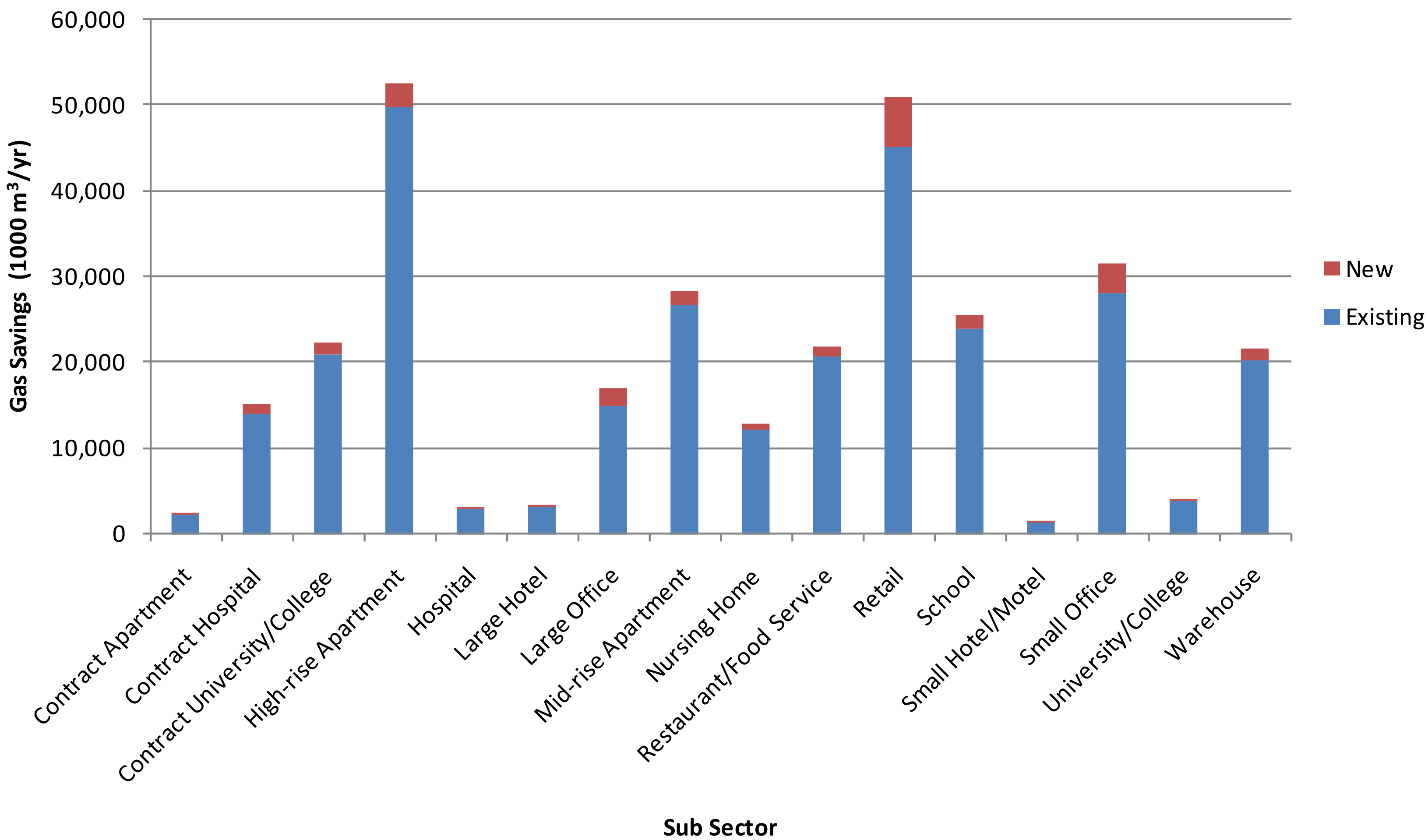
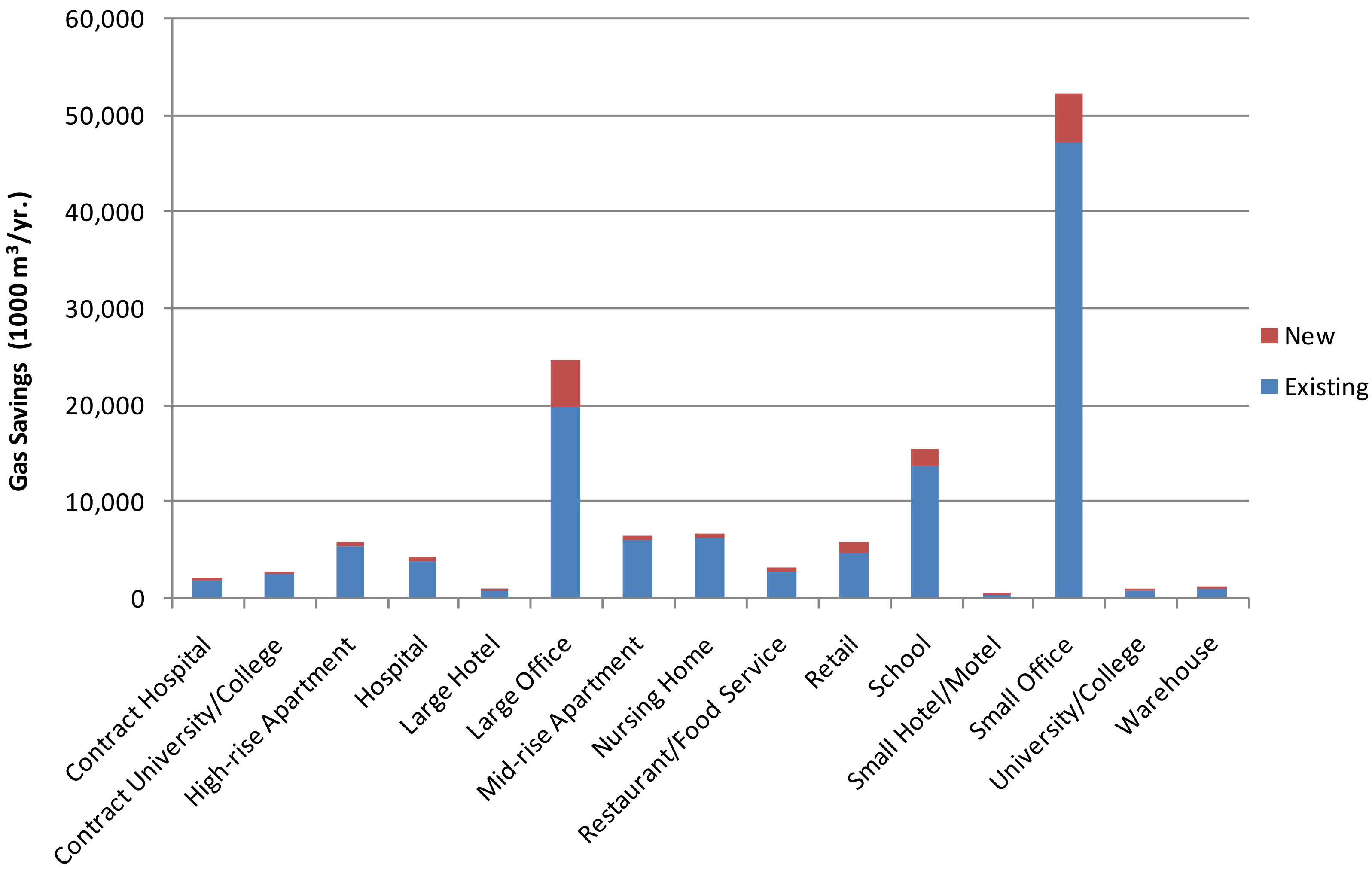


Exhibit 5.15: Natural Gas Savings by Sub Sector and Building Vintage, Northern Service Region, 2017 (1000 m^3/yr.)



5.5 INTERPRETATION OF RESULTS

Highlights of the results presented in the preceding exhibits are summarized below.

Savings by Service Region

The Southern service region represents slightly more than 75% of the identified savings in 2017. This is to be expected given the large number of customers in this service region.

Savings by Milestone Year

Approximately 80% of the identified economic potential savings in 2017 were identified as economically feasible by 2012. This is because a number of measures are cost effective at full cost, i.e., it is economically attractive to implement them before the equipment they affect or replace has reached the end of its useful life. Under the Economic Potential Forecast, they would therefore be implemented right away. The other factor that causes 2012 savings to look relatively large as a proportion of 2017 is the natural conservation expected in the Commercial sector over the course of the study. Savings are calculated based on the expected difference between the Reference Case forecast (which includes savings from natural conservation) and the Economic Potential Forecast. As naturally occurring savings gradually increase, they erode some of the economic potential.

Savings by Sub Sector

Among modelled sub sectors in the Southern service region, High-rise Apartment buildings and Retail buildings have the highest portion of identified savings (approximately 11% each).

In the Northern service region, the Small Office sub sector accounts for nearly 34% of identified savings, followed by Large Office (16%). Other Buildings[169] make up 10%.

Savings by End Use

Space heating measures account for approximately 78% of the total identified energy savings in the Southern service region and 85% in the Northern service region. Water heating measures account for approximately 17% and 11% of savings in the Southern and Northern service region, respectively.

5.5.1 Caveats on Interpretation of Results

A systems approach was used to model the energy impacts of the efficiency upgrades presented in the preceding section. In the absence of a systems approach, there would be double counting of savings and an accurate assessment of the total contribution of the energy-efficient upgrades would not be possible.

[169] Recreational buildings, religious buildings, gas stations, laundromats, and buildings classified as “other commercial”, “other institutional” and “other multifamily” in Union’s customer database.

For example, a condensing boiler reduces space heating natural gas use, as does the installation of new energy-efficient glazings. On its own, each measure will reduce overall space heating energy use. However, the two savings are not additive. The order in which some upgrades are introduced is also important. In this study, the approach has been to select and model the impact of measures that reduce the load for a given end use (e.g., roof insulation or glazing upgrades that reduce the space heating load) and then to introduce measures that meet the remaining load more efficiently (e.g., a high-efficiency space heating system).

The above approach means that where there is interaction between measures that affect the same end use, the savings for those individual measures are reduced. As appropriate, this issue is addressed in the Achievable Potential section of this report.

6. ACHIEVABLE POTENTIAL FORECAST

6.1 INTRODUCTION

This section presents the Commercial sector Achievable Potential natural gas savings for the study period (2007 to 2017). The Achievable Potential is defined as the proportion of the gross savings identified in the Economic Potential Forecast that could realistically be achieved within the study period.

The discussion is organized into the following sub sections:

- Description of Achievable Potential
- Approach to the Estimation of Achievable Potential
- Achievable Potential Workshop Organization
- Achievable Potential Workshop Results
- Achievable Potential DSM Investment Scenario Results
- Summary and Interpretation of Results.

6.2 DESCRIPTION OF ACHIEVABLE POTENTIAL

Achievable Potential recognizes that it is difficult to induce all customers to purchase and install all of the energy-efficiency measures that meet the criteria defined by the Economic Potential Forecast presented in the preceding section.

Exhibit 6.1 presents an illustration of the level of natural gas consumption that is estimated in Achievable Potential scenarios. As illustrated in Exhibit 6.1, reductions in natural gas consumption under Achievable Potential are "banded" by the two forecasts presented in previous sections, namely the Reference Case and the Economic Potential Forecast.

Exhibit 6.1: Illustration of Achievable Potential versus Reference Case and Economic Potential Forecasts

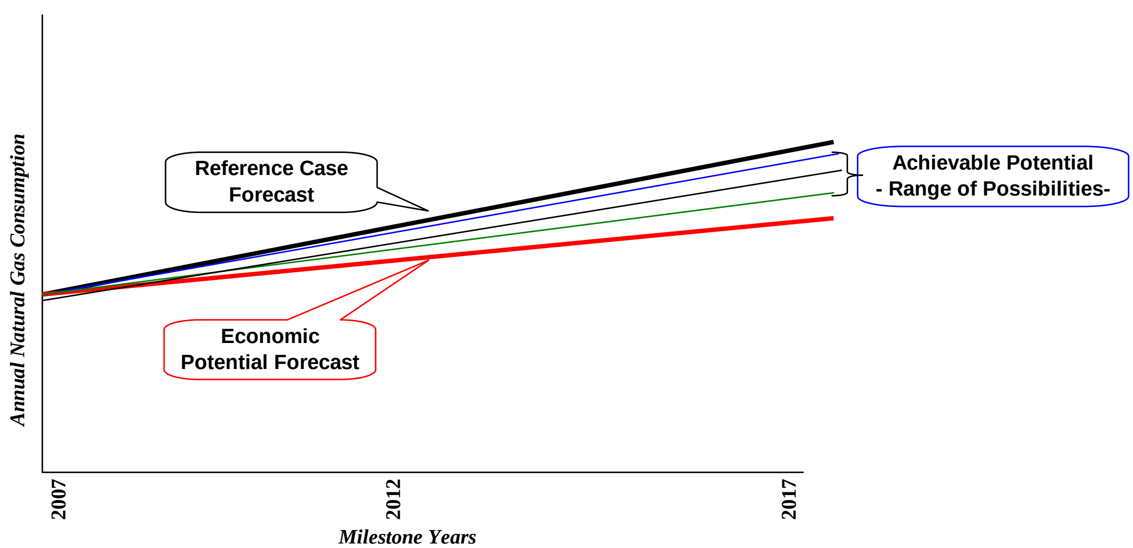


Exhibit 6.1 shows that future natural gas consumption under the Reference Case is greater than in any of the Achievable Potential forecasts. This is because the Reference Case represents a "worst case" situation in which there are no additional utility market interventions and hence no additional natural gas savings beyond those that occur "naturally."

Exhibit 6.1 also shows that future natural gas consumption under the Achievable Potential is greater than in the Economic Potential Forecast. This is because the Economic Potential Forecast assumes that efficient new technologies fully penetrate the market as soon as it is cost effective to do so. However, the Achievable Potential recognizes that under "real world" conditions, the rate at which customers are likely to implement energy-efficiency measures will be influenced by market constraints and, as a result, implementation will occur more slowly than under the assumptions employed in the Economic Potential Forecast. Exhibit 6.2 illustrates some of the types of market constraints that often affect customer implementation of energy-efficiency measures.

Exhibit 6.2: Illustration of "Typical" Market Constraints Affecting Energy-efficiency (EE) Implementation

Category	Barrier
Price Signals	• No monetization of externalities • Tax and subsidies that affect the playing field between EE and the fuels being displaced
Customer EE Awareness	• Awareness that EE opportunities and products exist • Awareness of benefits – cost and co-benefits • Customers' technical ability to assess the options.
Product and Service Availability	• Local or national product availability • Existence of a viable infrastructure of trade allies • Vendor or trade ally awareness of the efficiency options and their understanding of the technical issues
Financing of EE Measures	• Access to appropriate financing • Size of required EE investment vs. asset base • Payback Ratio – Actual vs. Required
Transaction Costs	• Level of effort/hassle required to become informed, select products, choose contractor(s) and install
Perceived Risk/Reward	• Level of perceived risk that the EE product may not perform as promised • Level of positive external/personal recognition for "doing the right thing" by installing the EE measure(s)
Split Incentive/Motivation	• Level to which the incentives of the agent charged with purchasing the EE are aligned with those of the person(s) that would benefit
Regulatory	• Codes or standards that prohibit implementation of innovative EE technologies • Level of EE performance that is required in codes or standards

The Achievable Potential scenarios shown in Exhibit 6.1 are presented as a range. This recognizes not only that any estimate of Achievable Potential over a 10-year period is necessarily subject to uncertainty but also that there are different types and levels of potential DSM program intervention. Government and utility DSM program experience throughout North America has shown that energy-efficiency market barriers can be addressed and customer willingness to accept and purchase energy-efficient products can be positively influenced by a variety of DSM market intervention strategies, such as those noted below in Exhibit 6.3.

The same body of DSM program experience also recognizes that there are limits to the scope of influence of any utility. It recognizes that some markets or sub markets may be so price sensitive or constrained by market barriers beyond the influence of utility DSM programs that they will only fully act if forced to by legal or other legislative means. It also recognizes that there are practical constraints related to the pace that existing inefficient equipment can be replaced by new, more efficient models or that existing building stock can be retrofitted to new energy performance levels. In addition, the design and implementation of DSM market interventions, such as those noted in Exhibit 6.3, require staff and financial resources. In "real world" conditions these resources are also subject to constraints.

Exhibit 6.3: "Illustration" of Potential DSM Market Intervention Strategies[170]

Strategy Type	Description
Alliances	• Vertical integration of market between upstream and downstream market actors (i.e., forming a relationship between contractors and suppliers)
Audit	• An assessment of a building's energy efficiency made by a trained inspector
Contractor Certification	• An assurance that a given contractor is knowledgeable about the product or service, verified through training and/or testing
Demonstration	• Providing demonstration of the use/performance of energy-efficient technologies to market actors
Design Assistance	• Providing recommendations on building or product design
Financing	• Providing loans to finance the acquisition of a product or service
Financial Incentives (and Rebates)	• Per measure dollars provided to market participants (generally either end users or distribution channel members) to encourage energy conservation measure installation
Information	• Passive provision of information to market participants
Linking Vendors & Customers	• Providing customer contacts to contractors, or contractor/vendor contacts to customers
Non-financial Incentives	• Products, changes in procedures or administrative consolidation to encourage product or service provision
Promotion	• Active advertising and information made available to the market
Sales Training	• Providing sales, marketing and/or technical training about products or services to individuals responsible for selling it
Standards, Labelling	• Setting specific standard levels for energy efficient technologies • Labelling these technologies accurately for easy consumer/contractor recognition
Technical Information	• Provision of technical information on energy-efficient products or services
Technical Support	• Providing answer to technical questions from market actors about energy-efficient products/services after installation
Technical Training	• Providing training to trade allies so that they better understand new or existing practices or procedures
Testing Protocols & Standards	• Standardization of testing protocols for installation and repair
Third Party Verification	• Inspection and verification provided by an unbiased party on the results of an inspection to insure correct product or service performance

Source: American Council for an Energy Efficient Economy (ACEEE) Proceedings: 2001.

[170] As in the preceding Exhibit, the strategies shown in Exhibit 6.3 are not necessarily exhaustive; rather, they illustrate the types of options that may be available to DSM program planners.

6.3 APPROACH TO THE ESTIMATION OF ACHIEVABLE POTENTIAL

Consistent with the description outlined above, this study approached the estimation of Achievable Potential by preparing a number of future scenarios, each representing differing assumptions related to the level of DSM program investment over the study period.

In consultation with Union personnel, the study identified two Achievable Potential scenarios to be assessed in this final stage of the study.[171] They are:

- A financially unconstrained DSM investment scenario
- A financially constrained DSM investment scenario based on the maintenance of historic Union DSM program funding levels.

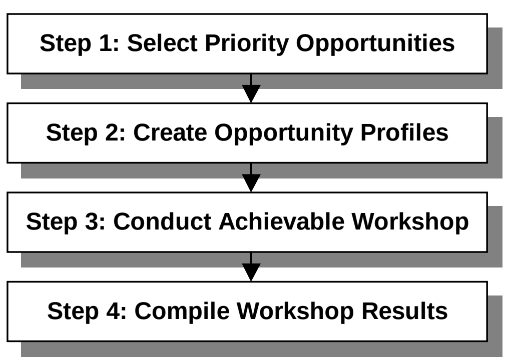
Development of the assumptions employed in each of the above scenarios was based on a combination of Union's own DSM program experience and the results of a one-day workshop involving Union DSM personnel, trade allies and consultant team members.

The workshop results were particularly valuable in generating the DSM investment scenarios; consequently, a brief description of the workshop organization and results is provided in the following sections.

6.4 ACHIEVABLE POTENTIAL WORKSHOP ORGANIZATION

The design and implementation of the Achievable Potential workshop was organized into four steps. A schematic showing the major steps is shown in Exhibit 6.4 and each step is briefly discussed below.

Exhibit 6.4: Approach to Achievable Potential Workshop



[171] It should be emphasized that the estimation of Achievable Potential scenarios is not synonymous with either the setting of specific program targets or with program design. While both are closely linked to the discussion of Achievable Potential, they involve more detailed analysis that is beyond the scope of this study.

Step 1: Select Priority Opportunities

The first step was to review the energy saving opportunities identified in the Economic Potential Forecast and to select a set of those opportunities for discussion in the Achievable Potential workshop. The amount of time available in the workshop for the discussion of energy-efficiency opportunities was limited. Consequently, the number of opportunities selected for discussion was limited to eight, which prior experience had shown to be about the maximum allowable within the available timeframe.

Exhibit 6.5 shows the eight energy-efficiency measures selected. Selection of the opportunities was based on a qualitative application of criteria that were intended to ensure that the workshop discussions would include:

- Technologies and measures that represent a significant share of the potential energy savings identified in the Economic Potential Forecast
- Review of conditions in a variety of sub markets
- Inclusion of new products or markets where little prior DSM experience existed.

Exhibit 6.5: Commercial Sector Opportunity Areas

Opportunity Area	Title	Approximate% of Economic Savings Potential
C1	Roof Insulation	4%
C2	Heat Recovery Ventilators	8%
C3	ENERGY STAR® Fryers	1%
C4	Condensing and Near-Condensing Boilers	5%
C5	Condensing and High-Efficiency Rooftop Units	4%
C6	Recomissioning & Advanced BAS	35%
C7	Condensing Storage Water Heaters	2%
C8	Advanced New Commercial Construction	9%
	Total	68%

Step 2: Create Opportunity Profiles

Brief profiles were prepared for each Opportunity selected in Step 1. The profiles, which were used to introduce the workshop discussion of each Opportunity, provided the following information:

- **Technology description,** e.g., retrofit of existing boilers to condensing models
- **Sub sector and service region,** e.g., existing Large Office Southern service region
- **Selection of a "Typical" application** for discussion purposes

- **Financial and economic indicators for the "Typical" application,** e.g., installed cost, useful life, annual energy savings simple payback, benefit/cost ratio, basis of assessment (incremental versus full cost)

- **Eligible participants** in each milestone period.[172]

Copies of the Opportunity Profile slides are provided in Appendix F.

Step 3: Conduct Achievable Potential Workshop

A one-day Commercial sector Achievable Potential workshop was held on September 25, 2008. Workshop participants consisted of core members of the consultant team, Union DSM personnel and local trade allies. Together, the participants represented a wide range of expertise and experience related to both the DSM technologies and the markets that were discussed during the workshop.

Following a brief consultant presentation that summarized the study result to date, the workshop provided a structured assessment of each of the selected Opportunities. The assessment of each Opportunity began with a brief consultant presentation, as outlined in Step 2 above. The majority of each assessment consisted of a facilitated discussion of the key elements affecting successful promotion and implementation of the DSM Opportunity. More specifically:

- What are the major constraints/challenges constraining customer adoption of the identified energy-efficiency opportunities?
  - How big is the "won't" portion of market for this Opportunity?

- Preferred strategies and potential partners for addressing the identified constraints (high level only)
  - Key criteria that determine customers' willingness to proceed
  - Key potential channel partners
  - Optimum intervention strategies, e.g., push, pull, combination
  - How sensitive is this Opportunity to incentive levels?

Following discussion of market constraints and potential intervention strategies, participants' views on potential participation rates were recorded. The achievable results were recorded as a band of possibilities. To facilitate workshop discussion, two "high level" DSM program scenarios were defined:

- **The Aggressive Marketing scenario,** which assumes both an aggressive program approach and a very supportive context, e.g., healthy economy, very strong public commitment to climate change mitigation, etc. The results of this component of the discussion provided particularly valuable input into the estimation of the Financially Unconstrained Scenario.

[172] For the purposes of the workshop, eligible participants were defined as: total population (e.g., existing Large Office buildings) minus those that have already installed the enegy-efficiency measure (e.g., 10% of building stock) or, due to technical constraints "can't" install the energy-efficient measure (e.g., 5% of building stock).

- **The Static Marketing scenario,** which assumes that market interest and customer commitment to energy-efficiency and sustainable environmental practices remain approximately as current. Similarly, federal, provincial and municipal government energy-efficiency and GHG mitigation efforts remain similar to the present. The results of this component of the discussion provided a valuable second reference point for the estimation of participation rates in the Static Marketing Scenario.

Exhibit 6.6 lists the steps employed in developing the estimated participation rates.

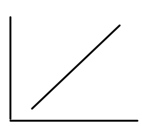
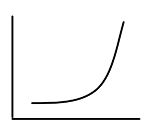
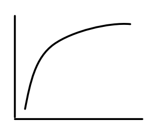
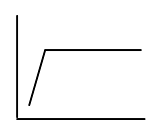
Exhibit 6.6: Workshop Process for Estimating Participation Rates

The participation rate for the Aggressive Marketing scenario in 2017 was estimated.

The shape of the adoption curve was selected for the Aggressive Marketing scenario. Rather than seek consensus on the specific values to be employed in each of the intervening years, workshop participants selected one of four curve shapes that best matched their view of the appropriate "ramp-up" rate for each Opportunity (see below).

This process was repeated for the Static Marketing scenario.

Once participation rates had been established for the specific technology, sub sector and service region selected for the Opportunity discussion, workshop participants provided guidelines to the consultants for extrapolating the discussion results to the other sub sectors and service regions included in the Opportunity, but not discussed in detail during the workshop

Curve A	Curve B	Curve C	Curve D
			

Curve A represents a steady increase in the expected participation rate over the 10-year study period.

Curve B represents a relatively slow participation rate during the first half of the 10-year study period followed by a rapid growth in participation during the second half of the 10-year study period.

Curve C represents a rapid initial participation rate followed by a relatively slow growth in participation during the remainder of the 10-year study period.

Curve D represents a very rapid initial participation rate that results in virtual full saturation of the applicable market during the first milestone period of the 10-year study period.

Step 4: Compile Workshop Results

This step involved aggregating the results of the eight Opportunities discussed during the workshop and extrapolating the results of the remaining Opportunities that were identified in the Economic Potential Forecast but not discussed during the workshop.

6.5 ACHIEVABLE POTENTIAL WORKSHOP RESULTS

The following discussion provides a summary of the workshop results for each of the Commercial sector Opportunities noted previously in Exhibit 6.5. In each case, the following information is provided:

- Brief description of the Opportunity and the specific “typical” application selected for the workshop discussion
- Highlights from the workshop discussions related to:
  - Constraints and challenges
  - Potential strategies and partners
  - Incentive sensitivity
- Summary of the estimated participation rates under the Aggressive and Static Marketing scenarios for the selected sub sector
  - Shape of adoption curve selected by the workshop participants
- Summary of major assumptions employed by the consultants for extrapolating the workshop results to other sub sectors.

6.5.1 C1 – Roof Insulation

- **Description**

This measure involves upgrading roof insulation to R-22 at time of re-roofing. Cost is estimated at $\$1/ft^2$ (incremental). The measure has a useful life of 20 years and associated savings of up to 20% of space heating energy (depending on building characteristics). The Small Office sub sector was the subject of detailed discussion for this Opportunity.

- **Discussion Highlights**

Constraints & Challenges

- Workshop participants felt that increasing roof insulation at the time of re-roofing is often not done due to lack of knowledge on the part of building owners and that replacing insulation at the same levels is often the default option for both roofing contractors and building owners. Participants also noted that the engineering community sometimes fails to consider energy savings due to increased insulation levels.

- Participants identified the incremental cost of increasing roof insulation as a significant barrier as building owners often evaluate contractor quotations on the basis of first cost. Presentation of costs on a lifetime basis, which would make clear the overall benefit, may have the potential to increase participation rates.

- Participants also felt that the split incentive, present in cases when owners of buildings are not responsible for energy costs, presents a significant barrier because the incremental cost of increasing roof insulation is borne by the owner, but the tenant realizes the benefits. Many participants noted that building owners who are not tenants are not attracted to these types of measures because of higher first costs.

Potential Strategies and Partners

- Participants estimated that up to 80% of roofing jobs for small commercial buildings do not involve an engineer or consultant, with the possible exception of properties owned by major management companies. This would suggest that alliances with roofing contractors may be an appropriate program delivery strategy for small commercial buildings. Involvement (and possibly third-party verification) by Union may lend credibility to contractors making energy savings claims. Several other organizations could play a similar verification role, including Enbridge Gas, Natural Resources Canada, the Ontario Power Authority and the Ontario Association of Architects.

- Possible allies include the Canadian Roofing Contractors Association, leading roofing contractors and engineering associations (such as Consulting Engineers of Ontario and Professional Engineers of Ontario).

Incentive Sensitivity

- Participant felt that program participation would be very sensitive to incentive level and that incentives would need to be well publicized and understood to achieve high participation.

- ❑ **Participation Rates – Small Office, Southern Service Region**

Workshop participants concluded that, under the conditions represented by the Aggressive Marketing scenario, participation rates of 80% of eligible customers could be achieved in Small Office buildings in the Southern service region in the year 2017. Workshop participants mentioned adoption curves A and B as the possible best fits with the pace of participation in the intervening years from 2007 to 2017 under the Aggressive Marketing scenario, and ultimately suggested a “flattened” curve B as the most likely adoption curve.

Under the more modest market conditions represented by the Static Marketing scenario, participation rates of 20% could be achieved in Small Office buildings in the Southern service region by 2017. Workshop participants agreed that a “flattened” curve B again represented the best fit with the pace of participation in the intervening years from 2007 to 2017 under this scenario.

- **Participation Rates - Remaining Regions & Sub Sectors**

Workshop participants felt that participation rates would be similar to the above values in all other sub sectors in the Southern service region. It was felt that participation rates in the Northern service region would be slightly higher than those for the Southern service region, based primarily on better paybacks in areas with higher heating demands.

The preceding results were used as a reference point for estimating participation rates related to high-performance glazings in all sub sectors.

6.5.2 C2 – Air-to-Air Heat Recovery

- **Description**

This measure involves installing air-to-air heat recovery equipment to pre-heat make-up air at the time of equipment replacement. Cost is estimated at $2.17/cfm (incremental). The measure has a useful life of 15 years and associated savings of 50% of ventilation air heating energy. The High-rise Apartment sub sector was the subject of detailed discussion for this Opportunity.

- **Discussion Highlights**

Constraints & Challenges

- Workshop participants noted that air-to-air heat recovery is being installed in energy-efficient new buildings but not in all new construction. Some workshop participants associated with the consulting engineering community felt that there were few economical applications for air-to-air heat recovery in existing High-rise Apartment buildings because incompatible intake/exhaust locations are common.

- By contrast, other participants felt that a significant Opportunity exists in several sub sectors, including Restaurants, Schools, University/College, Hospitals and Nursing Homes. A number of niche applications were also suggested, including laboratories and buildings housing swimming pools.

- As an illustration, one participant noted that in his portfolio of approximately 50 Restaurants, about half have been retrofitted with air-to-air heat recovery equipment in the last three years. These installations are realizing average paybacks of less than two years.

- Some participants noted possible regulatory issues, including various municipal building code requirements, especially in Hospitals, Nursing Homes and apartment buildings.

- Even in attractive technical and economical applications, there have often been disincentives, including increased equipment O&M (especially in restaurants, where there can be high grease content in exhaust stream).

- It was suggested that participation rates would be sensitive to both incentive levels and educational activities. Although the measure may be economically attractive in the absence of incentives, education (e.g., case studies and information from utilities and the engineering community) could be used to provide credibility, increase customer awareness and encourage customers to take on projects.

Potential Strategies and Partners

- Participants viewed the conceptual simplicity of the technology as a positive driver for customer participation.

- Education, in the form of case studies and information from utilities and the engineering community, can be used to provide credibility and increase customer awareness.

- Participants suggested that two delivery channels cover most of the market: the consulting engineering community and large mechanical contractors. Other possible trade allies include large HVAC suppliers.

Incentive Sensitivity

- It was suggested that participation rates would be sensitive to both incentive levels and educational activities. Although this measure may be economically attractive in the absence of incentives, educational activities could be used to provide credibility, increase customer awareness and encourage customers to take on projects.

- **Participation Rates – High-rise Apartment, Southern Service Region**

Workshop participants concluded that, under the conditions represented by the Aggressive Marketing scenario, participation by 80% of eligible customers could be achieved in High-rise Apartment buildings in the Southern service region in the year 2017. Workshop participants agreed that adoption curve B represented the best fit with the estimated pace of participation in the intervening years from 2007 to 2017 under this scenario.

Under the Static Marketing scenario, participation rates of 50% could be achieved in this sub sector. Workshop participants again felt that adoption curve B represented the best fit with the pace of participation in the intervening years from 2007 to 2017.

- **Participation Rates - Remaining Regions & Sub Sectors**

Workshop participants felt that participation rates would be similar in other sub sectors in the Southern service region, while all sub sectors in the Northern service region would have directionally higher participation rates due to improved paybacks in areas with higher heating demands.

The preceding results were used as a reference point for estimating participation rates related to demand controlled ventilation and demand controlled kitchen ventilation.

6.5.3 C3 - ENERGY STAR® Fryers

- **Description**

This measure involves upgrading to an ENERGY STAR® fryer at time of equipment replacement. Cost is estimated at $1,100/unit (incremental). The measure has a useful life of 10 years and has associated savings of 30% over a standard fryer. The Restaurant / Food Service sub sector was the subject of detailed discussion for this Opportunity.

- **Discussion Highlights**

Constraints & Challenges

- Participants noted that there is some penetration of this type of technology in larger restaurant chains. In some quick service restaurants, fryers may comprise half of cooking energy use, making this measure especially attractive. Even given this, cooking equipment efficiency is often a low priority, partly due to perceived high transaction costs.

- Participants felt that first cost is especially important for restaurants. In many cases, even a short payback may not be attractive where restaurants are concerned as many restaurants have very short operating lifetimes.

- Although energy costs are becoming a larger share of overall operating costs, participants felt that restaurant management may not have “caught up” and are not fully aware of this situation.

- Some participants felt that the publicly operated buildings sector (i.e., hospitals, nursing homes, and cafeterias in government buildings) would likely find this measure more attractive than the privately run buildings sector.

Potential Strategies and Partners

- Given that this is often not a primary concern to restaurant operators, it was suggested that an appropriate approach might be for Union to reduce transaction costs by handling delivery and installation in a similar manner to the existing pre-rinse spray valve program. The customer would be required to purchase the equipment and provide Union with a list of locations for delivery/installation.

- Equipment suppliers and manufacturers would be key trade allies for this type of scenario; regardless of program type, another important ally would be the large restaurant chains. It was estimated that there is one individual responsible for purchasing for every 80 quick service restaurants in Ontario.

- Participants again felt that Union could lend credibility to a program by way of promotion and that, for restaurants, individual priorities are a more appropriate program strategy than a bundled "energy management" approach.

Incentive Sensitivity

- Participants felt that this Opportunity was incentive sensitive. Given that energy efficiency is not often a primary concern to restaurant operators, an incentive would likely be required to "get the attention" of those making purchasing decisions.

- **Participation Rates – Restaurant / Food Service, Southern Service Region**

Workshop participants concluded that under the conditions represented by the Aggressive Marketing scenario, participation of 80% of eligible customers could be achieved in Restaurants in the Southern service region in the year 2017. Workshop participants agreed that adoption curve A represented the best fit with the estimated pace of participation in the intervening years from 2007 to 2017 under this scenario.

Under the Static Marketing scenario, participation rates of 55% could be achieved in this sub sector. Workshop participants again felt that adoption curve A represented the best fit with the pace of participation in the intervening years from 2007 to 2017.

- **Participation Rates - Remaining Regions & Sub Sectors**

Workshop participants felt that participation rates would be similar in all other sub sectors in the Southern service region, with the exception of Hospitals, where rates were expected to be higher as a result of government purchasing patterns. Participants felt that Northern service region sub sectors would have similar participation rates to those in the Southern service region.

The preceding results were used as a reference point for estimating participation rates related to high-efficiency broilers and griddles.

6.5.4 C4 – Condensing and Near-Condensing Boilers

- **Description**

This Opportunity addressed two technologies. The measure involves upgrading a standard atmospheric boiler to a condensing or near-condensing boiler at the time of equipment replacement. Workshop participants were asked to estimate participation rates for the installation of condensing boilers and were also asked to estimate the portion of customers who did not install condensing boilers but who would instead install near-condensing boilers.

Cost is estimated at $17/MBH and $3/MBH (incremental) for condensing and near-condensing boilers respectively. The measure has a useful life of 25 years and has associated savings of 14% and 6% of space heating energy for condensing and near-condensing boilers, respectively. The Large Office sub sector was the subject of detailed discussion for this Opportunity.

- **Discussion Highlights**

Constraints & Challenges

- Workshop participants discussed several constraints related to condensing boiler technology. These included technical barriers such as the need for low return water temperature (which can be incompatible with some heating loops, especially those employing radiators and baseboards as opposed to fan coils), lower applicability in buildings with constant heating loads (such as multi-unit residential buildings) and added complexity in terms of maintenance for condensing boilers.

- Higher first cost was also cited as a barrier to the financing and uptake of both condensing and near-condensing boilers, even given the attractive payback associated with these technologies.

- Some participants felt that the extra capital cost associated with condensing boilers (as opposed to near-condensing) may not be warranted, as actual savings would be comparable in some configurations.

- Other participants noted that condensing boilers are being installed at present, especially in public buildings.

Potential Strategies and Partners

- Several participants supported custom programs as opposed to prescriptive boiler programs. A custom approach would allow for condensing boilers to be installed where appropriate, and near-condensing boilers where they are more applicable. Some participants felt that prescriptive programs could lead to DSM funds being spent inappropriately, e.g., installing condensing boilers when improving control systems could improve energy efficiency more cost effectively.

- Union personnel suggested that for this Opportunity, the Aggressive Marketing scenario might represent a custom program comparable to the existing Enbridge Gas program in Ontario (in which incentives are based on savings achieved), while the Static Marketing scenario might represent a more prescriptive approach.

- Participants noted that case studies and other technical information would be a useful tool for decision makers. They also suggested that under proper market conditions, entire boiler systems may be replaced, but that low incentives may mean that only single boilers are replaced. Participants from the consulting engineering community estimated that more than half of boiler replacements are presently being completed without engineering work being done.

- Participants felt that the supplier capacity and service support capability needed to expand boiler programming is presently in place.

Incentive Sensitivity

- Workshop attendees agreed that participation in any boiler program would be very incentive sensitive.

- **Participation Rates – Large Office, Southern Service Region**

Participants concluded that, for condensing boilers under the Aggressive Marketing scenario, participation by 30% of eligible customers could be achieved in Large Office buildings in the Southern service region in 2017. Of the remaining customers, 60% could upgrade to a near-condensing boiler under this scenario.

Under the Static Marketing scenario, participation by 15% of eligible customers could be achieved for condensing boilers in the same sub sector and timeframe. Of the remaining customers, 50% could upgrade to a near-condensing boiler under this scenario.

For both scenarios, workshop participants agreed that adoption curve A represented the best fit with the estimated pace of participation in the intervening years from 2007 to 2017.

- **Participation Rates – Remaining Regions & Sub Sectors**

Workshop participants felt that participation rates would be similar in other sub sectors in the Southern service region, with the exception of Schools, which were expected to have higher participation rates based on the experience of workshop participants. Sub sectors in the Northern service region were expected to have similar participation rates, with improved paybacks in areas with higher heating demands balanced against a slightly less mature market in this region.

The preceding results were used as a reference point for estimating participation rates related to other space heating equipment, including condensing unit heaters and condensing furnaces.

6.5.5 C5 – Condensing and High-efficiency Rooftop Units

- **Description**

Similar to Opportunity C4, this Opportunity addressed two technologies. The measure involves upgrading a standard rooftop unit to a condensing or high-efficiency rooftop unit (RTU) at the time of equipment replacement. Workshop participants were asked to estimate participation rates for the installation of condensing RTUs and were also asked to estimate the portion of customers who did not install condensing RTUs but who would instead install high-efficiency RTUs.

Cost is estimated at $25/MBH and $5/MBH (incremental) for condensing and high-efficiency RTUs respectively. The measure has a useful life of 15 years and has associated savings of 19% and 9% of space heating energy for condensing and high-efficiency RTUs respectively. The Retail sub sector was the subject of detailed discussion for this Opportunity.

As condensing rooftop units are at a very early stage of market availability, workshop attendees concluded that participation by 2017 would likely be relatively low and that participation rates would be contingent on a number of difficult to estimate factors (discussed below). Workshop participants decided to discuss this Opportunity but did not estimate rates of participation for condensing rooftop units.

- **Discussion Highlights**

Constraints & Challenges

- Some workshop participants felt that, as a product new to the marketplace, condensing rooftop units may have technical issues and that improvements may come slowly because there are only a few small equipment manufacturers involved. It was felt that this technology would, at best, see a very slow increase in market penetration.

- Some participants felt that customers could demand a solution if market conditions warranted, although it was felt that these market conditions do not exist at present. The example of residential condensing furnaces was cited, in which market share in the Union Service Area increased from near zero to a significant portion of homes over the 10-year period between 1980 and 1990.

- To the best of participants' knowledge, only two small manufacturers are developing condensing rooftop units at present. Instead, most manufacturers are focusing on improving cooling efficiencies of packaged rooftop units. This is driven by demand from the U.S. It was also noted that high-efficiency modulating rooftop units are only available from most manufacturers as custom builds for sizes less than 20 tons.

- Participants felt that this technology is likely to be seen in new construction before it is implemented as a retrofit.

- It was noted that in a more mature market scenario, savings from condensing rooftop units would be more widely applicable than for condensing and near-condensing boilers (discussed in Opportunity C4).

Potential Strategies and Partners

- Participants felt that a condensing rooftop unit program would need to focus on market transformation. Potential strategies could include demonstrations and provision of technical information.

Incentive Sensitivity

- Participants felt that a condensing rooftop unit program would need to focus on market transformation, not simply incentives.

As workshop attendees did not estimate participation rates for this Opportunity, participation rates from Opportunity C4 were taken into account when estimating participation for high efficiency rooftop units, while condensing rooftop units were not included in either the Aggressive or Static Marketing scenarios.

6.5.6 C6 – Recommissioning and Advanced BAS

- **Description**

This measure involves applying the retrocommissioning process to an existing building and/or installing an advanced building automation system (BAS). Workshop participants were asked to estimate participation rates for both building recommissioning and the installation of advanced BAS. Cost is estimated at $0.35/ft^{2}and $0.90/ft^2 for recommissioning and advanced BAS respectively. The measures have a useful life of five and 10 years, and associated savings of 15 and 10% of space heating, cooling and "other gas use" for recommissioning and advanced BAS, respectively. The Large Office sub sector was the subject of detailed discussion for this Opportunity.

- **Discussion Highlights**

Constraints & Challenges

- Some workshop participants raised concerns regarding interoperability issues related to advanced BAS and existing BAS due either to the age of the existing system or the proprietary software embodied in existing systems. It was estimated that this might affect up to 50% of the existing stock to some degree.

- Participants noted that a large portion of savings associated with advanced BAS and controls are dependent on operator training and knowledge as well as monitoring and upkeep. Union could play a role in ensuring education is available, emphasizing the importance of maintenance/maintenance agreements, and providing credibility/verification of suppliers' claims.

- With respect to recommissioning, the primary barrier discussed was a lack of qualified service providers, as providers must be knowledgeable about several building systems. The requirement for this broad expertise also has the potential to increase costs.

- Participants noted that jurisdictions that have certification programs are further ahead than Ontario in terms of the availability of service providers and promoting recommissioning. Contractor certification was cited as a potential driver for increased rates of recommissioning.

- Participants suggested that it is difficult to attribute savings due to recommissioning and that interveners and regulators often prefer hard technologies to operational measures or measures requiring evaluation.

Potential Strategies and Partners

- Participants noted that BAS could allow for central monitoring with a dedicated staff for monitoring/maintenance. This often puts decision making into the hands of more qualified individuals at companies that are large enough to provide a dedicated resource.

- It was suggested that Union's role in promoting recommissioning could include identifying and publicizing qualified individuals/firms and providing training opportunities.

- It was noted that another Ontario utility presently has a monitoring and assessment program in place for recommissioning (in which energy consumption is tracked for 12 months and an incentive is provided for savings over the time period). Union personnel suggested that the Aggressive Marketing scenario could involve some type of monitoring and evaluation process to allow for savings verification.

- It was suggested that if a qualified consultant was to make recommendations, an incentive could be provided to those who provide proof that these recommendations have been acted upon.

Incentive Sensitivity

- Participants felt that although advanced BAS and recommissioning provided an attractive payback in the absence of any incentive, participation rates for both would be incentive sensitive.

- **Participation Rates – Retail, Southern Service Region**

With respect to advanced BAS, under the Aggressive Marketing scenario, workshop participants estimated that participation by 95% of eligible customers could be achieved in Large Office buildings in the Southern service region in 2017. Under the Static Marketing scenario, participants estimated that participation rates of 75% could be achieved. Curve A was suggested as the most likely pattern of market uptake for both scenarios.

With respect to recommissioning, under the Aggressive Marketing scenario, workshop participants estimated that participation by 75% of eligible customers could be achieved in Large Office buildings in the Southern service region in 2017. Under the Static Marketing scenario, participants estimated that participation rates of 50% could be achieved. Curve A was suggested as the most likely pattern of market uptake for both scenarios.

- **Participation Rates - Remaining Regions & Sub Sectors**

Workshop participants felt that participation rates would be directionally higher in High-rise Apartments in the Southern service region, and lower in several sub sectors, including Small Office, Retail, Small Hotel/Motel, Restaurant and Mid-rise Apartment. It was felt that participation would be similar in the Northern service region.

The preceding results were used as a reference point for estimating participation rates related to other low-cost/short payback measures, including air sealing, steam plant efficiency measures, low-flow faucet aerators, low-flow showerheads and low flow pre-rinse spray valves. These discussions also informed the estimation of participation rates for other measures that may be included in the recommissioning of a building, including air curtains, de-stratification fans and heat reflector panels.

6.5.7 C7 – Condensing Storage Water Heaters

- **Description**

This measure involves upgrading from a standard water heater to a condensing water heater at the time of equipment turnover. Cost is estimated at $13/MBH. The measure has a useful life 15 years and associated savings of 24% of water heating energy. The High-rise Apartment sub sector was the subject of detailed discussion for this Opportunity.

- **Discussion Highlights**

Constraints & Challenges

- Participants noted that while condensing water heaters are presently being installed in some retrofit situations, contractors continue to drive market uptake. As customer awareness of energy-efficient options is often low, in many cases it was felt that the default option is to replace equipment at the end of its service life with a similar technology.

Potential Strategies and Partners

- Mechanical contractors were identified as a key trade allies.

- Equipment availability/supply was not identified an issue although access to maintenance or installation contractors may be a limiting factor in some parts of the Union Service Area.

- Participants felt that an alliance with manufacturers would be beneficial.

Incentive Sensitivity

- Participants felt that both building owners and contractors would need to be incented to achieve high participation rates

- **Participation Rates – High-rise Apartment, Southern Service Region**

Workshop participants concluded that, under the conditions represented by the Aggressive Marketing scenario, participation by 80% of eligible customers could be achieved in High-rise Apartment buildings in the Southern service region in the year 2017. Workshop participants agreed that adoption curve A represented the best fit with the estimated pace of participation in the intervening years from 2007 to 2017 under this scenario.

Under the Static Marketing scenario, participation rates of 40% could be achieved in this sub sector. Workshop participants again felt that adoption curve A represented the best fit with the pace of participation in the intervening years from 2007 to 2017.

- **Participation Rates - Remaining Regions & Sub Sectors**

Workshop participants felt that participation rates would vary among other sub sectors in the Southern service region, with Large Office, Small Office and Retail buildings having directionally lower participation rates, and Large Hotel, Restaurants and University/Colleges having directionally higher participation. It was felt that the Northern service region would have similar participation rates.

The preceding results were used as a reference point for estimating participation rates related to condensing water heaters.

6.5.8 C8 – Advanced New Building Construction

- **Description**

Similar to opportunities C4 and C5, this Opportunity addressed two measures: 1) New buildings – 40% more efficient and 2) New buildings – 25% more efficient. Workshop participants were asked to estimate participation rates for the construction of new buildings 40% more energy efficient than current practice. Participants were also asked to estimate the portion of new buildings not built to the 40% more efficient standard that would instead be built to a 25% more efficient standard.

Cost is estimated at \$4.50/ft^2 and \$2.50/ ft^2 (incremental) for 40% and 25% more efficient construction, respectively. The measure has a useful life of 25 years and has associated savings of 40% and 25% of energy use respectively. The Large Office sub sector was the subject of detailed discussion for this Opportunity.

❑ Discussion Highlights

Constraints & Challenges

- The primary barrier discussed was higher first cost. This was seen as an especially difficult barrier to overcome for buildings that are not owner occupied, creating a split incentive. Perceived risk of under-performing buildings and the difficulty in quantifying savings were also cited as potential barriers.

Potential Strategies and Partners

- Several drivers were noted for various sub sectors. Participants noted that government owned buildings are increasingly being built to LEED standards, which are generally associated with significant energy savings. Other participants noted that schools are generally being designed for high efficiency, but not necessarily LEED accreditation, and that privately built buildings have been less attracted to LEED accreditation. Some participants felt that LEED standards could act as a barrier to the construction of energy-efficient buildings in some cases because the incremental cost of LEED buildings is often increased as a result of non-energy related design aspects.

Incentive Sensitivity

- Union personnel noted that the Ontario Power Authority's High Performance New Construction (HPNC) program is presently providing incentives for energy-efficient new construction. Union's role may be to identify natural gas specific applications and ensure that incentives match those for electric efficiency. Prospective partners for new building programming would be the same as those for HPNC.

❑ Participation Rates – Large Office, Southern Service Region

Participants concluded that for New Buildings – 40% more efficient under the Aggressive Marketing scenario, participation by 20% of eligible buildings could be achieved for Large Office buildings in the Southern service region in 2017. Of the remaining buildings, 80% could be built to a 25% more efficient standard under this scenario.

Under the Static Marketing scenario, workshop participants felt that no additional Large Office buildings would be built to a 40% more efficient standard by 2017; instead, it was estimated that 50% new Large Office buildings would be built to a 25% more efficient standard under this scenario.

For both scenarios, workshop participants agreed that adoption curve B represented the best fit with the estimated pace of participation in the intervening years from 2007 to 2017.

- **Participation Rates - Remaining Regions & Sub Sectors**

Workshop participants felt that participation rates would vary among other sub sectors in the Southern service region, with Small Office, Small Hotel/Motel, Restaurants, Warehouses and Mid-rise Apartment buildings having directionally lower participation rates, and institutional buildings including Hospitals, Schools and Universities/Colleges having directionally higher participation. It was felt that the Northern service region would have similar participation rates.

6.5.9 Extrapolated Participation Rates for Remaining Opportunities

As noted previously, the workshop results were used as a reference point. This knowledge was combined with follow-up discussions with some of the workshop participants and consultant experience to estimate participation rates for the remaining energy-efficiency opportunities contained in the Economic Potential Forecast.

Exhibits 6.7 and 6.14 provide a summary of the estimated participation rates for the Aggressive and Static Marketing scenarios, both for the Opportunities discussed above and for the remaining energy-efficiency opportunities. Each exhibit contains:

- Workshop reference numbers, corresponding to the order of the Opportunities discussed in the workshop
- All of the measures that passed the economic screen and were included in the Economic Potential Forecast
- The participation rates for eligible households by 2017 and the most likely adoption curves to represent participation rates in the intervening years
- Notes that illustrate sources and rationale used by the consultant team when estimating the participation rates shown.

6.6 ACHIEVABLE POTENTIAL RESULTS

Consistent with the description presented earlier in this section, the Achievable Potential results are presented as a range, which is defined by the following two scenarios:

- A Financially Unconstrained scenario, in which potential is limited by market constraints but not by program budget

- A Static Marketing scenario, in which potential is limited by market constraints as well as DSM program budgets that are approximately similar to current Union levels (although the specific programs and technologies addressed would not necessarily be the same).

The results of each scenario are presented below.

6.6.1 Financially Unconstrained DSM Investment Scenario

The financially unconstrained scenario provides an overview of the level of potential natural gas savings that could be achieved if a comprehensive portfolio of DSM programs was launched without any constraint on the availability of program funding. This scenario is based largely on the results of the Aggressive Marketing scenario that was explored during the Achievable Potential workshop.

Although the results of this scenario are not constrained by program funding, the results incorporate consideration of the market constraints identified during the workshop (see Exhibit 6.2), such as product and service availability, customer transaction costs, etc.

This scenario, therefore, provides a high level estimate of the upper level of natural gas savings that could be achieved by Union's commercial customers over the nine-year period beginning in 2009 and ending in 2017. It also provides Union's commercial DSM program personnel with a view of the relative potential contribution of individual sub sectors, end uses, technologies and service regions.

Major Assumptions: Financially Unconstrained Scenario

Major assumptions included within this scenario include:

- All measures that pass the measure TRC screen are included
- No program financial limit is set, except that all measures must continue to pass the measure TRC screen
- Participation rates are constrained by the market barriers noted in the workshop
- Participation rates for measures discussed in the workshop are employed directly and are shown in Exhibit 6.7
- Participation rates for the remaining measures are extrapolated from the workshop results and/or consultant experience and are shown in Exhibit 6.7
- Fixed program costs (e.g., advertising, training workshops, contractor certification, etc.) and incentive costs are included for each measure. The levels selected for the scenario are summarized in Exhibit 6.8. In each case, the values shown draw on the workshop results and recent Union DSM program experience.

Exhibit 6.7: Participation Rates for Financially Unconstrained Scenario

Workshop Reference #	Measure Name	Participation Rate in 2017 *(% of eligible)*	Adoption Curve Shape	Notes
	High-Performance Glazings	80%	A/B	Based on workshop measure C1
C1	Roof Insulation	80%	A/B	Workshop measure C1
	Air Sealing	50%	A	Based on workshop measure C6, consultant experience
	Air Curtains	50%	A	Based on workshop measure C6, consultant experience
C4	Condensing Boilers	30%	A	Workshop measure C4
C4	Near-Condensing Boilers	60%	A	Workshop measure C4
	Condensing Unit Heaters	30%	A	Based on workshop measure C4
C5	High-Efficiency Rooftop Units	60%	A	Based on workshop measure C4
	Steam Plant Efficiency Measures	85%	A	Based on workshop measure C6
	HVLS De-stratification Fans	85%	A	Based on workshop measure C6
	Heat Reflector Panels	85%	A	Based on workshop measure C6
	Demand Controlled Ventilation	80%	B	Based on workshop measure C2
	Demand Control Kitchen Ventilation	80%	B	Based on workshop measure C2
C2	Heat Recovery	80%	B	Workshop measure C2
	Condensing Furnaces	30%	A	Based on workshop measure C4
	Condensing Water Heaters	80%	A	Based on workshop measure C7
C7	Condensing Storage Water Heaters	80%	A	Workshop measure C7
	Low-Flow Faucet Aerators	85%	A	Based on workshop measure C6, consultant experience
	Low-Flow Showerheads	85%	A	Based on workshop measure C6, consultant experience
	Pre-Rinse Spray Valves	85%	A	Based on workshop measure C6, consultant experience
	High-Efficiency Griddles	80%	A	Based on workshop measure C3
	High-Efficiency Broilers	80%	A	Based on workshop measure C3
C3	ENERGY STAR® Fryers	80%	A	Workshop measure C3
C6	Building Recommissioning	75%	A	Workshop measure C6
C6	Advanced Building Automation Systems	95%	A	Workshop measure C6
C8	High-Performance New Construction - 25% more efficient	80%	B	Workshop measure C8
C8	High-Performance New Construction - 40% more efficient	20%	B	Workshop measure C8

Exhibit 6.8: Summary of Program Cost Assumptions – Financially Unconstrained Scenario[173]

Measure Name	Fixed Program Costs ($/yr)	Incentive Amount	Incentive Basis	Payback After Incentive (yrs.)	Notes
High-Performance Glazings	37,500	$0.10	per m^3 saved	5.5	Max. incentive $25K
Roof Insulation	37,500	$0.10	per m^3 saved	7.4	Max. incentive $25K
Air Sealing	5,000	$750	per unit	3.3	
Air Curtains	12,000	$1,000	per unit	0.7	
Condensing Boiler - Baseline: Standard Boiler	10,000	$3,000	per unit	4.4	
Condensing Boiler - Baseline: Near-condensing	10,000	$3,000	per unit	6.4	
Near-Condensing Boiler - Baseline: Standard Boiler	10,000	$2,941	per unit	0.0	Capped at 100% of incremental cost
Condensing Unit heater	10,000	$2,000	per unit	1.3	
High-Efficiency Rooftop Unit - Baseline: Standard Efficiency	10,000	$1,000	per unit	1.0	
Condensing Rooftop Unit - Baseline: Standard Efficiency	10,000	$2,159	per unit	4.0	Assume same incentive/ m^3 as HE rooftops
Steam Plant Efficiency Measures	12,000	65%	% of cost	0.4	Max. incentive $12K
HVLS De-stratification Fans	12,000	$1,200	per unit	2.7	
Heat Reflector Panels	15,000	100%	% of installed cost	0.0	
Demand Controlled Ventilation	15,000	$1,800	per unit	1.2	
Demand Control Kitchen Ventilation	25,000	$1,800	per unit	1.3	
Heat Recovery	15,000	$500	per unit	2.4	
Condensing Furnace	10,000	$600	per unit	0.0	Capped at 100% of incremental cost
Condensing Water Heater - Baseline: Standard Efficiency	12,000	$750	per unit	2.9	
Condensing Storage Water Heater - Baseline: Standard Efficiency	12,000	$750	per unit	2.1	
Low-Flow Faucet Aerators - 3 min/day	12,500	100%	% of installed cost	0.0	
Low-Flow Showerheads - 10 min/day	12,500	100%	% of installed cost	0.0	
Pre-Rinse Spray Valve - 40 min/day	25,000	100%	% of installed cost	0.0	
Commercial Cooking - High-Efficiency Griddle	10,000	$1,000	per unit	0.7	
Commercial Cooking - High-Efficiency Broiler	10,000	$200	per unit	0.0	Capped at 100% of incremental cost
Commercial Cooking - ENERGY STAR® Fryer	10,000	$1,000	per unit	0.4	
Building Recommissioning	25,000	$0.10	per m^3 saved	0.8	
Advanced Building Automation Systems	25,000	$0.10	per m^3 saved	3.4	
High-Performance New Construction - 25% More Efficient	30,000	$0.10	per m^3 saved	4.6	
High-Performance New Construction - 40% More Efficient	30,000	$0.10	per m^3 saved	4.7	

173 Fixed program costs and incentive levels were provided by Union based on workshop results and current experience.

Results: Financially Unconstrained Scenario

Under the conditions defined by this scenario, total Commercial sector natural gas savings in 2017 are estimated to be approximately 390 million m^3/yr. This represents a saving of approximately 18%, relative to the Reference Case, and is equal to approximately 62% of the savings identified in the Economic Potential Forecast. Further detail is provided in the following exhibits:

- Exhibit 6.9 shows total natural gas savings by service region and milestone year
- Exhibit 6.10 shows total natural gas savings by sub sector end use and milestone year for the total Union Service Area
- Exhibit 6.11 shows total natural gas savings by sub sector, end use and milestone year for the Southern service region
- Exhibit 6.12 shows total natural gas savings by sub sector, end use and milestone year for the Northern service region
- Exhibit 6.13 shows annual natural gas savings for the year 2017 by measure bundle, together with the estimated program costs and TRC benefits for the total Union Service Area. (**Note**: the values shown in Exhibit 6.13 are for the single year 2017 only; consequently, they do not add to the same values shown in the preceding exhibits),

Exhibit 6.9: Natural Gas Savings by Service Region and Milestone Year, Financially Unconstrained Scenario (1000 m^3/yr.)

Milestone Year	Southern Region	Northern Region	Total	% Savings Relative to Ref Case
	(1000 m^3/year)			
2012	130,457	41,873	172,330	8%
2017	293,429	96,647	390,076	18%
% Savings 2017 Re: Reference Case	18%	19%	18%	
% Savings 2017 Re: Total	75%	25%	100%	

Exhibit 6.10: Natural Gas Savings by End use and Milestone Year, Total Union Service Area – Financially Unconstrained Scenario (1000 m^3/yr.)

Sub Sector	Milestone Year	Total	Space Heating	Water Heating	Cooking	Space Cooling	Other
Large Office	2012	12,360	10,438	1,112	5	11	793
	2017	27,806	23,671	2,371	24	22	1,718
Small Office	2012	21,141	18,950	1,421	10	0	760
	2017	49,949	45,065	3,204	42	0	1,638
Retail	2012	13,298	11,651	1,250	65	0	331
	2017	31,154	27,456	2,684	277	0	737
Large Hotel	2012	1,359	642	646	10	0	61
	2017	2,995	1,506	1,319	40	0	130
Small Hotel/Motel	2012	618	350	232	1	0	35
	2017	1,392	820	494	4	0	74
Contract Hospital	2012	5,686	3,776	1,431	17	19	443
	2017	12,076	8,206	2,863	71	38	899
Hospital	2012	2,344	1,748	496	8	5	88
	2017	5,113	3,894	995	32	10	182
Nursing Home	2012	5,445	3,416	1,721	42	0	266
	2017	12,270	8,027	3,508	174	0	561
School	2012	13,096	11,977	1,036	27	0	56
	2017	29,197	26,805	2,162	111	0	119
Contract University/College	2012	7,623	5,746	1,342	42	38	455
	2017	16,689	12,827	2,687	172	75	928
University/College	2012	1,522	1,212	242	7	7	54
	2017	3,344	2,705	486	27	14	111
Restaurant/Food Service	2012	6,433	4,003	2,026	384	0	20
	2017	15,375	9,454	4,302	1,577	0	42
Warehouse	2012	6,836	6,319	332	2	0	183
	2017	14,782	13,652	734	8	0	388
Contract Apartment	2012	790	494	282	0	0	13
	2017	1,716	1,105	583	1	0	27
High-rise Apartment	2012	18,379	11,831	6,237	8	0	303
	2017	40,022	26,466	12,883	32	0	640
Mid-rise Apartment	2012	7,054	5,857	1,116	7	0	73
	2017	16,519	13,420	2,913	30	0	156
Other Buildings	2012	26,818					
	2017	60,386					
Other Contract Institutional Buildings	2012	21,530					
	2017	49,291					
Total	2012	172,330	98,412	20,922	635	79	3,934
	2017	390,076	225,078	44,190	2,622	159	8,350

Exhibit 6.11: Natural Gas Savings by End use and Milestone Year, Southern Service Region – Financially Unconstrained Scenario (1000 m^3/yr.)

Sub Sector	Milestone Year	Total	Space Heating	Water Heating	Cooking	Space Cooling	Other
Large Office	2012	5,202	4,281	523	2	11	384
	2017	11,511	9,550	1,106	11	22	822
Small Office	2012	7,806	6,886	597	4	0	320
	2017	18,428	16,371	1,348	18	0	691
Retail	2012	11,983	10,473	1,147	60	0	303
	2017	28,006	24,620	2,461	253	0	672
Large Hotel	2012	1,045	477	512	8	0	48
	2017	2,294	1,115	1,045	31	0	103
Small Hotel/Motel	2012	441	234	179	1	0	27
	2017	988	547	380	3	0	57
Contract Hospital	2012	5,020	3,302	1,287	15	18	398
	2017	10,640	7,160	2,573	63	37	807
Hospital	2012	987	705	234	3	4	41
	2017	2,130	1,557	468	13	8	85
Nursing Home	2012	3,595	2,187	1,195	29	0	184
	2017	8,045	5,106	2,434	120	0	385
School	2012	8,218	7,462	701	18	0	38
	2017	18,206	16,593	1,459	75	0	80
Contract University/College	2012	6,755	5,053	1,215	38	37	412
	2017	14,758	11,257	2,433	156	73	840
University/College	2012	1,225	965	203	6	7	45
	2017	2,682	2,146	406	22	14	93
Restaurant/Food Service	2012	5,596	3,429	1,807	342	0	17
	2017	13,362	8,085	3,836	1,403	0	37
Warehouse	2012	6,443	5,947	319	2	0	175
	2017	13,921	12,838	704	8	0	371
Contract Apartment	2012	790	494	282	0	0	13
	2017	1,716	1,105	583	1	0	27
High-rise Apartment	2012	16,591	10,590	5,716	7	0	278
	2017	36,070	23,652	11,803	29	0	586
Mid-rise Apartment	2012	5,695	4,698	930	6	0	61
	2017	13,313	10,734	2,424	25	0	130
Other Buildings	2012	23,249					
	2017	52,160					
Other Contract Institutional Buildings	2012	19,814					
	2017	45,200					
Total	2012	130,457	67,183	16,847	542	77	2,744
	2017	293,429	152,434	35,464	2,233	155	5,784

Exhibit 6.12: Natural Gas Savings by End use and Milestone Year, Northern Service Region – Financially Unconstrained Scenario (1000 m^3/yr.)

Sub Sector	Milestone Year	Total	Space Heating	Water Heating	Cooking	Space Cooling	Other
Large Office	2012	7,158	6,158	589	3	0	409
	2017	16,294	14,121	1,264	13	0	896
Small Office	2012	13,335	12,064	824	6	0	441
	2017	31,521	28,694	1,856	24	0	947
Retail	2012	1,315	1,178	103	5	0	28
	2017	3,148	2,836	224	24	0	64
Large Hotel	2012	313	165	134	2	0	13
	2017	701	391	274	8	0	28
Small Hotel/Motel	2012	177	116	53	0	0	8
	2017	404	272	114	1	0	17
Contract Hospital	2012	665	474	144	2	0	45
	2017	1,436	1,046	290	7	1	92
Hospital	2012	1,356	1,042	262	4	1	47
	2017	2,983	2,337	528	18	2	98
Nursing Home	2012	1,850	1,230	525	13	0	82
	2017	4,226	2,921	1,074	54	0	176
School	2012	4,877	4,515	335	9	0	18
	2017	10,992	10,212	703	37	0	39
Contract University/College	2012	868	693	127	4	1	43
	2017	1,931	1,570	254	17	1	88
University/College	2012	297	247	40	1	0	9
	2017	663	559	80	4	1	19
Restaurant/Food Service	2012	836	574	218	42	0	2
	2017	2,013	1,369	466	174	0	5
Warehouse	2012	394	372	14	0	0	8
	2017	861	814	30	0	0	16
High-rise Apartment	2012	1,788	1,241	521	1	0	26
	2017	3,952	2,814	1,080	3	0	55
Mid-rise Apartment	2012	1,358	1,159	186	1	0	12
	2017	3,206	2,685	489	5	0	27
Other Buildings	2012	3,569					
	2017	8,226					
Other Contract Institutional Buildings	2012	1,716					
	2017	4,091					
Total	2012	41,873	31,229	4,075	93	2	1,189
	2017	96,647	72,644	8,726	390	5	2,566

Exhibit 6.13: Annual Natural Gas Savings and Estimated Program Costs by Major Measure Type for One Year of Program Activity (2017) - Total Union Service Area, Financially Unconstrained Scenario

Measure Bundle	Financially Unconstrained Potential 2017		Program Costs, 2017 (1000 $)	Program Costs per Unit	
	Gas Savings (1000 m^3/yr.)	TRC Benefits (1000 $)		per Natural Gas Savings ($/$m^3$)	per TRC Benefits ($/$)
Efficient Food Service Equipment	365	511	408	$1.12	$0.80
Space Heating - Envelope measures (Conductive)	3,928	5,504	468	$0.12	$0.08
Space Heating - Envelope measures - Air Sealing	2,444	3,019	567	$0.23	$0.19
Space Heating / Other - Recommissioning	18,833	68,725	2,405	$0.13	$0.03
Space Heating - Ventilation Measures - Heat Recovery	9,306	20,342	6,916	$0.74	$0.34
Space Heating - Equipment	2,010	4,576	954	$0.47	$0.21
DHW - Conservation Measures	5,094	22,422	1,449	$0.28	$0.06
DHW - Equipment Measures	892	1,745	520	$0.58	$0.30
New construction - 40% Better	3,368	26,981	367	$0.11	$0.01
Weighted Average				$0.30	$0.09

6.6.2 Static Marketing Scenario

The Static Marketing scenario is based largely on the results of the scenario explored during the Achievable Potential workshop. Consequently, it incorporates consideration of both market constraints and DSM program budget limitations, which are roughly consistent with current Union levels.

This scenario, therefore, provides a high level estimate of the level of natural gas savings that could be achieved by Union's commercial customers over the nine-year period beginning in 2009 and ending in 2017, assuming present levels of program activity and a somewhat different mix of programs. It also provides Union's commercial DSM program personnel with a view of the relative potential contribution of individual sub sectors, end uses, technologies and service regions.

Major Assumptions: Static Marketing Scenario

Major assumptions included within this scenario include:

- All measures that pass the measure TRC screen are included
- No program financial limit is set, except that all measures must continue to pass the measure TRC screen
- Participation rates are constrained by the market barriers noted in the workshop
- Participation rates for measures discussed in the workshop are employed directly and are shown in Exhibit 6.14
- Participation rates for the remaining measures are extrapolated from the workshop results and/or consultant experience and are shown in Exhibit 6.14.
- Fixed program costs (e.g., advertising, training workshops, contractor certification, etc.) and incentive costs are included for each measure. The levels selected for the scenario are summarized in Exhibit 6.15. In each case, the values shown draw on the workshop results and recent Union DSM program experience.

Exhibit 6.14: Participation Rates for Static Marketing Scenario

Workshop Reference #	Measure Name	Participation Rate in 2017 *(% of eligible)*	Adoption Curve Shape	Notes
	High-Performance Glazings	20%	A/B	Based on workshop measure C1
C1	Roof Insulation	20%	A/B	Workshop measure C1
	Air Sealing	35%	A	Based on workshop measure C6, consultant experience
	Air Curtains	35%	A	Based on workshop measure C6, consultant experience
C4	Condensing Boilers	15%	A	Workshop measure C4
C4	Near-Condensing Boilers	50%	A	Workshop measure C4
	Condensing Unit Heaters	15%	A	Based on workshop measure C4
C5	High-Efficiency Rooftop Units	50%	A	Based on workshop measure C4
	Steam Plant Efficiency Measures	63%	A	Based on workshop measure C6
	HVLS De-stratification Fans	63%	A	Based on workshop measure C6
	Heat Reflector Panels	63%	A	Based on workshop measure C6
	Demand Controlled Ventilation	50%	B	Based on workshop measure C2
	Demand Control Kitchen Ventilation	50%	B	Based on workshop measure C2
C2	Heat Recovery	50%	B	Workshop measure C2
	Condensing Furnaces	15%	A	Based on workshop measure C4
	Condensing Water Heaters	40%	A	Based on workshop measure C7
C7	Condensing Storage Water Heaters	40%	A	Workshop measure C7
	Low-Flow Faucet Aerators	63%	A	Based on workshop measure C6, consultant experience
	Low-Flow Showerheads	63%	A	Based on workshop measure C6, consultant experience
	Pre-Rinse Spray Valves	63%	A	Based on workshop measure C6, consultant experience
	High-Efficiency Griddles	55%	A	Based on workshop measure C3
	High-Efficiency Broilers	55%	A	Based on workshop measure C3
C3	ENERGY STAR® Fryer	55%	A	Workshop measure C3
C6	Building Recommissioning	50%	A	Workshop measure C6
C6	Advanced Building Automation Systems	75%	A	Workshop measure C6
C8	High-Performance New Construction - 25% more efficient	50%	B	Workshop measure C8
C8	High-Performance New Construction - 40% more efficient	0%	B	Workshop measure C8

Exhibit 6.15: Summary of Program Cost Assumptions – Static Marketing Scenario[174]

Measure Name	Fixed Program Costs ($/yr)	Incentive Amount	Incentive Basis	Payback After Incentive (yrs.)	Notes
High-Performance Glazings	25,000	$0.05	per m^3 saved	5.6	Max. incentive $15K
Roof Insulation	25,000	$0.05	per m^3 saved	7.5	Max. incentive $15K
Air Sealing	3,000	$500	per unit	3.4	
Air Curtains	7,500	$750	per unit	0.8	
Condensing Boiler - Baseline: Standard Boiler	7,500	$2,000	per unit	4.7	
Condensing Boiler - Baseline: Near-condensing	7,500	$2,000	per unit	7.0	
Near-Condensing Boiler - Baseline: Standard Boiler	7,500	$2,000	per unit	0.6	
Condensing Unit heater	7,500	$1,500	per unit	1.7	
High-Efficiency Rooftop Unit - Baseline: Standard Efficiency	7,500	$500	per unit	1.6	
Condensing Rooftop Unit - Baseline: Standard Efficiency	7,500	$1,079	per unit	4.6	Assume same incentive/ m^3 as HE rooftops
Steam Plant Efficiency Measures	8,000	50%	% of cost	0.6	Max. incentive $6K
HVLS De-stratification Fans	8,000	$1,000	per unit	2.7	
Heat Reflector Panels	10,000	100%	% of installed cost	0.0	
Demand Controlled Ventilation	8,000	$1,500	per unit	1.3	
Demand Control Kitchen Ventilation	15,000	$1,500	per unit	1.4	
Heat Recovery	8,000	$250	per unit	2.9	
Condensing Furnace	7,500	$600	per unit	0.0	Capped at 100% of incremental cost
Condensing Water Heater - Baseline: Standard Efficiency	8,000	$500	per unit	3.3	
Condensing Storage Water Heater - Baseline: Standard Efficiency	8,000	$500	per unit	2.5	
Low-Flow Faucet Aerators - 3 min/day	10,000	100%	% of installed cost	0.0	
Low-Flow Showerheads - 10 min/day	10,000	100%	% of installed cost	0.0	
Pre-Rinse Spray Valve - 40 min/day	20,000	100%	% of installed cost	0.0	
Commercial Cooking - High-Efficiency Griddle	5,000	$500	per unit	3.1	
Commercial Cooking - High-Efficiency Broiler	5,000	$200	per unit	0.0	Capped at 100% of incremental cost
Commercial Cooking - ENERGY STAR® Fryer	5,000	$500	per unit	2.2	
Building Recommissioning	15,000	$0.05	per m^3 saved	0.9	
Advanced Building Automation Systems	15,000	$0.05	per m^3 saved	3.4	
High-Performance New Construction - 25% More Efficient	20,000	$0.05	per m^3 saved	4.6	
High-Performance New Construction - 40% More Efficient	20,000	$0.05	per m^3 saved	4.8	

174 Fixed program costs and incentive levels were provided by Union, based on workshop results and current experience.

Results: Static Marketing Scenario

Under the conditions defined by this scenario, total Commercial sector natural gas savings in 2017 are estimated to be approximately 259 million m^3/yr. This represents a saving of approximately 12%, relative to the Reference Case, and is equal to approximately 42% of the savings identified in the Economic Potential Forecast. Further detail is provided in the following exhibits:

- Exhibit 6.16 shows total natural gas savings by service region and milestone year
- Exhibit 6.17 shows total natural gas savings by sub sector, end use and milestone year for the total Union Service Area
- Exhibit 6.18 shows total natural gas savings by sub sector, end use and milestone year for the Southern service region.
- Exhibit 6.19 shows total natural gas savings by sub sector, end use and milestone year for the Northern service region.
- Exhibit 6.20 shows annual natural gas savings for the year 2017 by measure bundle, together with the estimated program costs and TRC benefits for the total Union Service Area. (**Note**: the values shown in Exhibit 6.20 are for the single year 2017 only; consequently, they do not add to the same values shown in the preceding exhibits).

Exhibit 6.16: Natural Gas Savings by Service Region and Milestone Year, Static Marketing Scenario (1000 m^3/yr.)

Milestone Year	Southern Region	Northern Region	Total	% Savings Relative to Ref Case
	(1000 m^3/yr.)			
2012	85,860	26,749	112,609	5%
2017	195,892	63,310	259,202	12%
% Savings 2017 Re: Reference Case	12%	13%	12%	
% Savings 2017 Re: Total	76%	24%	100%	

Exhibit 6.17: Natural Gas Savings by End use and Milestone Year, Total Union Service Area – Static Marketing Scenario (1000 m^3/yr.)

Sub Sector	Milestone Year	Total	Space Heating	Water Heating	Cooking	Space Cooling	Other
Large Office	2012	7,654	6,288	794	4	8	560
	2017	18,156	15,146	1,737	17	17	1,240
Small Office	2012	13,124	11,583	992	7	0	542
	2017	31,680	28,199	2,253	29	0	1,199
Retail	2012	8,398	7,237	885	46	0	231
	2017	19,194	16,540	1,938	194	0	522
Large Hotel	2012	924	412	461	7	0	44
	2017	2,058	971	963	28	0	96
Small Hotel/Motel	2012	417	227	164	1	0	25
	2017	926	514	354	3	0	56
Contract Hospital	2012	3,939	2,570	1,028	12	13	316
	2017	8,494	5,650	2,110	49	27	657
Hospital	2012	1,605	1,178	357	5	3	62
	2017	3,542	2,648	735	22	7	130
Nursing Home	2012	3,675	2,227	1,226	30	0	192
	2017	8,353	5,259	2,556	122	0	417
School	2012	8,301	7,506	736	19	0	40
	2017	19,554	17,820	1,570	78	0	86
Contract University/College	2012	5,166	3,820	962	30	27	327
	2017	11,444	8,605	1,974	121	55	688
University/College	2012	1,028	806	174	5	5	39
	2017	2,284	1,816	357	19	11	82
Restaurant/Food Service	2012	4,134	2,430	1,421	269	0	14
	2017	10,465	6,275	3,055	1,104	0	31
Warehouse	2012	4,493	4,129	231	1	0	132
	2017	9,907	9,099	512	6	0	290
Contract Apartment	2012	534	324	200	0	0	9
	2017	1,174	731	421	1	0	20
High-rise Apartment	2012	12,396	7,754	4,419	5	0	218
	2017	27,309	17,502	9,311	22	0	473
Mid-rise Apartment	2012	5,105	3,891	1,156	5	0	52
	2017	11,597	8,791	2,670	21	0	115
Other Buildings	2012	17,581					
	2017	40,210					
Other Contract Institutional Buildings	2012	14,136					
	2017	32,855					
Total	2012	112,609	62,381	15,205	445	57	2,803
	2017	259,202	145,566	32,515	1,836	116	6,103

Exhibit 6.18: Natural Gas Savings by End use and Milestone Year, Southern Service Region – Static Marketing Scenario (1000 m^3/yr.)

Sub Sector	Milestone Year	Total	Space Heating	Water Heating	Cooking	Space Cooling	Other
Large Office	2012	3,271	2,614	372	2	8	274
	2017	7,638	6,205	806	8	17	603
Small Office	2012	4,862	4,215	417	3	0	227
	2017	11,698	10,231	950	13	0	505
Retail	2012	7,582	6,517	812	42	0	212
	2017	17,297	14,866	1,775	177	0	479
Large Hotel	2012	713	307	365	5	0	35
	2017	1,582	721	763	22	0	76
Small Hotel/Motel	2012	298	152	126	0	0	20
	2017	661	344	272	2	0	43
Contract Hospital	2012	3,482	2,250	924	11	13	284
	2017	7,496	4,939	1,896	44	27	591
Hospital	2012	680	478	168	2	3	29
	2017	1,487	1,066	345	9	6	61
Nursing Home	2012	2,437	1,431	852	21	0	133
	2017	5,505	3,361	1,771	84	0	288
School	2012	5,242	4,705	497	13	0	27
	2017	12,265	11,098	1,057	52	0	58
Contract University/College	2012	4,585	3,364	871	27	27	297
	2017	10,137	7,564	1,787	109	54	623
University/College	2012	829	643	145	4	5	32
	2017	1,837	1,444	298	16	10	68
Restaurant/Food Service	2012	3,606	2,086	1,267	240	0	13
	2017	9,108	5,375	2,723	982	0	28
Warehouse	2012	4,236	3,887	221	1	0	127
	2017	9,336	8,562	491	6	0	278
Contract Apartment	2012	534	324	200	0	0	9
	2017	1,174	731	421	1	0	20
High-rise Apartment	2012	11,201	6,947	4,049	5	0	199
	2017	24,643	15,660	8,528	21	0	434
Mid-rise Apartment	2012	3,960	3,127	785	4	0	44
	2017	9,031	7,051	1,867	17	0	96
Other Buildings	2012	15,301					
	2017	34,822					
Other Contract Institutional Buildings	2012	13,041					
	2017	30,175					
Total	2012	85,860	43,049	12,072	380	55	1,962
	2017	195,892	99,217	25,750	1,563	113	4,252

Exhibit 6.19: Natural Gas Savings by End use and Milestone Year, Northern Service Region – Static Marketing Scenario (1000 m^3/yr.)

Sub Sector	Milestone Year	Total	Space Heating	Water Heating	Cooking	Space Cooling	Other
Large Office	2012	4,383	3,674	422	2	0	286
	2017	10,518	8,942	931	9	0	637
Small Office	2012	8,262	7,369	575	4	0	315
	2017	19,982	17,968	1,303	17	0	694
Retail	2012	816	720	73	4	0	19
	2017	1,897	1,674	163	17	0	44
Large Hotel	2012	211	105	96	1	0	9
	2017	477	250	201	6	0	20
Small Hotel/Motel	2012	118	75	38	0	0	6
	2017	265	170	82	1	0	13
Contract Hospital	2012	457	320	104	1	0	32
	2017	998	712	214	5	1	66
Hospital	2012	925	700	189	3	0	33
	2017	2,055	1,582	390	13	1	69
Nursing Home	2012	1,238	796	375	9	0	59
	2017	2,848	1,897	784	38	0	128
School	2012	3,058	2,801	239	6	0	13
	2017	7,289	6,722	513	26	0	28
Contract University/College	2012	582	457	91	3	1	31
	2017	1,307	1,042	187	12	1	65
University/College	2012	199	163	28	1	0	6
	2017	447	372	59	3	0	13
Restaurant/Food Service	2012	528	343	154	29	0	2
	2017	1,356	900	332	122	0	3
Warehouse	2012	257	242	9	0	0	5
	2017	571	537	21	0	0	12
High-rise Apartment	2012	1,195	807	370	0	0	18
	2017	2,666	1,841	783	2	0	40
Mid-rise Apartment	2012	1,145	764	372	1	0	9
	2017	2,565	1,740	802	4	0	19
Other Buildings	2012	2,280					
	2017	5,388					
Other Contract Institutional Buildings	2012	1,096					
	2017	2,680					
Total	2012	26,749	19,333	3,133	65	1	841
	2017	63,310	46,348	6,766	273	3	1,851

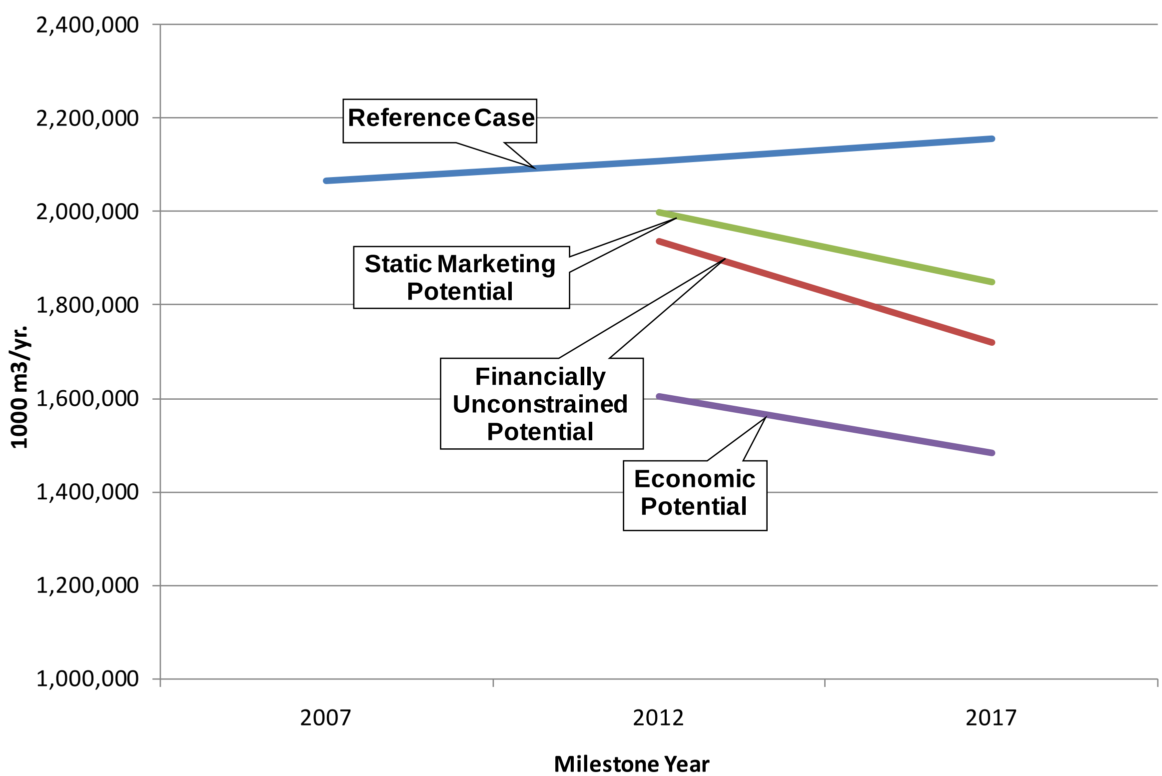
Exhibit 6.20: Annual Natural Gas Savings and Estimated Program Costs by Major Measure Type for One Year of Program Activity (2017) - Total Union Service Area, Static Marketing Scenario

Measure Bundle	Static Marketing Potential 2017		Program Costs, 2017 (1000 $)	Program Costs per Unit	
	Gas Savings (1000 m^3/yr.)	TRC Benefits (1000 $)		per Natural Gas Savings ($/$m^3$)	per TRC Benefits ($/$)
Efficient Food Service Equipment	255	363	163	$0.64	$0.45
Space Heating - Envelope measures (Conductive)	952	1,303	98	$0.10	$0.07
Space Heating - Envelope measures - Air Sealing	1,020	1,257	171	$0.17	$0.14
Space Heating / Other - Recommissioning	14,276	52,103	1,058	$0.07	$0.02
Space Heating - Ventilation Measures - Heat Recovery	5,932	12,971	3,492	$0.59	$0.27
Space Heating - Equipment	1,528	3,480	430	$0.28	$0.12
DHW - Conservation Measures	3,888	17,117	1,104	$0.28	$0.06
DHW - Equipment Measures	473	922	191	$0.40	$0.21
New construction - 40% Better	1,293	10,350	85	$0.07	$0.01
Weighted Average				$0.23	$0.07

6.7 SUMMARY AND INTERPRETATION OF RESULTS

Exhibit 6.21 provides a summary of the achievable natural gas savings under the Static Marketing and Financially Unconstrained scenarios presented in the preceding section. Results are shown relative to the Reference Case and Economic Potential Forecasts.

Exhibit 6.21: Achievable Potential, Reference Case and Economic Potential Forecasts for the Total Union Service Area



Further highlights are provided below.

The Financially Unconstrained Scenario

- Under the conditions defined by this scenario, total Commercial sector natural gas savings in 2017 are estimated to be approximately 390 million m^3/yr. This represents a saving of approximately 18%, relative to the Reference Case, and is equal to approximately 62% of the savings identified in the Economic Potential Forecast.

- The most significant opportunities for natural gas savings in this scenario are technologies that reduce space heating requirements. Approximately 80% of savings identified in this scenario come from the space heating end use; approximately 16% come from the water heating end use. Building recommissioning and advanced BAS systems are, however, a particularly large opportunity in this scenario.

- Program costs per m^3 of natural gas savings in this scenario range widely by measure, from approximately $0.11 for efficient new construction measures to over $1.00 for efficient food service equipment measures.

- Program costs per dollar of TRC benefit also show a wide range, from approximately $0.01 for efficient new construction measures to $0.80 for air efficient food service equipment measures.

- Weighted averages for the whole group of measures show 2017 program costs of approximately $0.30/$m^3$ of natural gas savings and approximately $0.09/TRC dollar. These values are approximately 110% and 50% higher, respectively, than Union's current program results.[175]

The Static Marketing Scenario

- Under the conditions defined by this scenario, total Commercial sector natural gas savings in 2017 are estimated to be approximately 259 million m^3/yr. This represents a saving of approximately 12%, relative to the Reference Case, and is equal to approximately 42% of the savings identified in the Economic Potential Forecast.

- The most significant opportunities for natural gas savings in this scenario are technologies that reduce space heating requirements. Approximately 78% of savings identified in this scenario come from the space heating end use; approximately 17% come from the water heating end use. Again, building recommissioning and advanced BAS systems are a particularly large opportunity in this scenario.

- Program costs per m^3 of natural gas savings in this scenario range widely by measure, from approximately $0.07 for efficient new construction measures to $0.64 for efficient food service equipment measures.

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[175] Union's audited results for its 2006 commercial DSM programs show that program spending of $3,090,000 achieved natural gas savings of 22,053,000 m^3 and TRC net benefits of $53,319,000. Expressed as a ratio, one dollar of program spending generated approximately 7.1 m^3 (approximately $0.14/$m^3$) of annual natural gas savings and over $17 of TRC net benefits (approximately $0.06/TRC $).

- Program costs per dollar of TRC benefit also show a wide range, from approximately $0.01 for efficient new construction measures to $0.45 for air efficient food service equipment measures.

- Weighted averages for the whole group of measures included in this scenario show 2017 program costs of approximately $0.23/m^3 of natural gas savings and approximately $0.07/TRC dollar. These values are approximately 65% and 20% higher, respectively, than Union's current program results.

Comparison of Scenarios

Changes in the distribution of savings potential can be detected as the analysis moves from Economic Potential Scenario to the two achievable potential scenarios. The following observations may be made:

- Implementation of measures is spread out more evenly in the achievable scenarios. In the Economic Potential scenario savings are "front loaded" because measures that pass at full cost are assumed to be implemented immediately. This does not occur to the same extent in the achievable scenarios because measure uptake ramps up slowly, taking into account market constraints.

- Savings by end use shift slightly when moving from one scenario to another. In particular, Space Heating potential accounts for a slightly smaller proportion of the overall savings as the analysis moves from Economic Potential to Financially Unconstrained Potential and then to Static Marketing Scenario. In contrast, Water Heating measures increase slightly relative importance. This is largely due to the assumptions about participation rates for the individual measures, arrived at during the achievable potential workshop.

- There is no dramatic shift in the proportion of savings by region moving from one scenario to another.

- A slight variation is observed with respect to the various subsectors when moving from one scenario to another. This is primarily due to two factors:

    - Participation rates in the more homogenous sub sectors, sub sectors with larger average building sizes, and those sub sectors with high levels of public ownership were generally estimated to be higher during the achievable potential workshop. These sub sectors therefore tended to have slightly higher proportion of the overall savings as the analysis moves from Economic Potential to Financially Unconstrained Potential and then to Static Marketing Scenario.

    - Sub sectors whose Water Heating gas consumption is higher than average (i.e. apartment buildings and hotels) tended to have a slightly higher proportion of the overall savings as the analysis moves from Economic Potential to Financially Unconstrained Potential and then to Static Marketing Scenario.

- The relative importance of the different measure types changes significantly from one scenario to another. Within the Economic Potential Scenario, the largest potential for natural gas savings in 2017 is contributed by Recommissioning & Advanced BAS, Hot Water Conservation and Efficient New Construction. These measure categories make up 35%, 11%, and 9% of savings respectively.

- For measures that pass the TRC screen on an incremental cost basis, low participation rates in early milestone years create a significant "lost opportunity." This is particularly relevant to the replacement of equipment with a very long life (i.e. space heating equipment), building renovations such as envelope improvements, and new building construction.

    - Due largely to this phenomenon, the contribution of those measures introduced immediately (i.e. full cost measures) become relatively more important under the both of the achievable scenarios.

    - In the unconstrained scenario, the two largest full cost measure types (Recommissioning and Hot Water Conservation) increase in importance, while the largest full cost measure (Efficient New Construction) decreases in relative importance. These measure categories make up 48%, 13%, and 5% of unconstrained savings respectively.

    - In the static marketing scenario, the trend is more pronounced. Recommissioning, Hot Water Conservation and Efficient New Construction make up 55%, 15%, and 3% of savings respectively.

7. CONCLUSIONS

This study has confirmed the existence of significant cost-effective DSM potential within all sub sectors of Union's Commercial sector.

Although the weighted average program cost values presented for both the Financially Unconstrained and Static Marketing scenarios will vary depending on the specific composition of the future program portfolio, both scenarios show an evident trend towards higher future costs to achieve natural gas savings and TRC benefits.[176] This trend recognizes that savings from DSM programs tend to become more expensive with time as the most attractive measures gain greater market penetration and only the more challenging measures remain.[177]

7.1 ADDITIONAL OBSERVATIONS

In addition to the preceding conclusions, three additional observations warrant note as they may affect future program strategies. They include:

- ***Rate of measure implementation has a large effect on overall savings:*** For measures that pass the TRC screen on an incremental cost basis, low participation rates in early milestone years create a significant "lost opportunity." This is particularly relevant to the replacement of equipment with a very long life (i.e. space heating equipment), building renovations such as envelope improvements, and new building construction. The gap between Economic Potential and Achievable Potential savings presented in this study is due in large part to this significant lost opportunity that occurs in early milestone years.

- ***Savings arising from full cost measures may be delayed without eroding overall potential:*** This is a corollary of the above point, and most pertinent to the discussion of the largest opportunity identified in this study, recommissioning. As recommissioning passes the TRC screen at full cost, eligible buildings which are not recommissioned remain as future opportunities, while incremental cost opportunities which are not exploited represent lost opportunities. This may be especially relevant to programming strategy during periods of economic downturn, when building owners and managers may be less likely to implement measures despite an attractive payback.

- ***Market transformation approaches warrant additional consideration:*** There are a number of technically mature measures that do not currently pass the TRC screen. The largest share of these additional potential savings are from air sealing and envelope upgrades, including wall insulation and more energy efficient glazing measures in existing buildings. These measures do not pass the TRC screen as currently defined. However, they provide non-energy benefits such as increased comfort and reduced noise that are not currently captured in the TRC calculation. In addition, industry specialists emphasized that some emerging technologies, such as solar preheated make-up air may be better addressed in a market transformation context. They provide "soft" benefits, such

[176] Design of a DSM program portfolio is beyond the scope of this current study.

[177] Over time, it is also expected that some relatively new technologies may become less expensive as they gain greater sales volumes.

as visible contribution to corporate greening goals, which are not included in the TRC calculation.

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9. GLOSSARY

achievable potential
The Achievable Potential is the proportion of the natural gas savings identified in the Economic Potential Forecast that could realistically be achieved within the study period. Achievable Potential recognizes that it is difficult to induce customers to purchase and install all of the efficiency technologies that meet the criteria defined by the Economic Potential Forecast.

avoided cost
The unit cost of acquiring the next resource to meet demand, which is used as a measure for evaluating individual demand-side and supply-side options. In the context of this study "avoided cost" is the capital expenditure offset by Union Gas DSM activities (i.e., the cost of having to buy natural gas on the open market, contract for long-term supply, and/or build and run new storage/transmission facilities).

base year
The Base Year is the year to which all potentials will be compared. It provides a detailed description of "where" and "how" natural gas is currently used in each sector. For this study, it is the calendar year 2007. The modelled base year energy use is calibrated against Union's actual sales for 2007.

benefit/cost ratio
The measure benefit/cost ratio indicates the relative attractiveness of the measures. A measure that has a benefit/cost ratio in excess of 1.0 has benefits which outweigh its costs. Similarly, a measure with a benefit/cost ratio that is well in excess of one (e.g., 3.0) means that it is very attractive. A measure with a benefit/cost ratio of less than 1.0 has costs which outweigh its benefits.

building envelope
The material separation between the interior and the exterior environments of a building. The building envelope serves as the outer shell to protect the indoor environment as well as to facilitate its climate control.

co-generation
The simultaneous production of electric or mechanical energy and useful heat energy from a single fuel source.

combustion efficiency
The ratio of energy released during combustion to the potential chemical energy available in the fuel.

demand-side management (DSM)
Actions that modify customer demand for natural gas and that can defer the need for additional new supply.

discount rate
The interest rate used in calculating the present value of expected yearly benefits and costs.

economic efficiency
Allocation of human and natural resources in a way that results in the greatest net economic benefit, regardless of how benefits and costs are distributed within society.

economic potential forecast
The economic potential forecast is an estimate of the level of natural gas consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective from society's perspective. All of the energy-efficiency technologies and measures that have a positive measure TRC are incorporated into the economic potential forecast. These technologies and measures are applied at either natural stock turnover rates or at designated years for immediate application.

effective measure life (EML)
The estimate median number of years that the measures installed under a program are still in place and operable. EML incorporates field conditions, obsolescence, building remodelling, renovation, demolition and occupancy changes.

energy audit
An on-site inspection and cataloguing of energy using equipment/buildings, energy consumption and the related end-uses. The purpose is to provide information to the customer and the utility. Audits are useful for load research, for DSM program design and for identification of specific energy savings projects.

energy conservation
Activities by energy users that result in a reduction of the energy used to provide services. Energy conservation can include a wide variety of behavioural or operational changes that result in energy savings. For the purpose of this study, only energy savings achieved through physical or hardware installations are considered.

energy intensity
The ratio of energy consumed per application or end use. For example, gigajoules per square metre of heated office space per day, or gigajoules per tonne of aluminum produced. All else being equal, energy intensity increases as energy efficiency decreases.

emerging technologies
New energy-conserving technologies that are not yet market-ready, but may be market-ready over next 5 to 10 years. This category includes technologies that could be accelerated into the market during that period through targeted financial or technical support.

end use
The final application or final use to which energy is applied. End use is often used interchangeably with energy service.

energy savings
The savings that result from efficient technologies or activities. In this document, the term "energy" refers specifically to energy derived from natural gas unless otherwise noted.

energy service
An amenity or service supplied jointly by energy and other components/equipment such as buildings and heating equipment. Examples of energy services include residential space heating, commercial cooking, aluminum smelting and public transit. The same energy service can frequently be supplied with different mixes of equipment and energy.

energy use index (EUI)
End use energy consumption divided by a specific parameter of production (e.g., MJ/m^2., MJ/unit).

environmental credit/environmental penalty
An increment or decrement to the cost of a resource or set of resources, to reflect the overall level of its/their environmental impact, relative to another resource or set of resources.

financial incentive
Certain financial features in the utility's DSM programs designed to motivate customer participation. They may include features designed to reduce a customer's net cash outlay, pay-back period or cost of finance to participate.

fuel share
The proportion of requirements for a specific service met using a certain fuel. For example, a natural gas fuel share of 90% for space heating in commercial large office sub sector implies that 90% of the sub sector floor space is heated using natural gas. Similarly, a 90% natural gas fuel share in single family detached homes means that 90% of the space heating requirements for that dwelling type are met by natural gas.

gigajoule
One billion joules or one thousand megajoules.

interactive effects
In the context of natural gas use, interactive effects refer to the increase in gas consumed by heating equipment required to offset a decrease in "waste" heat generated by more efficient electrical fixtures or appliances after retrofit or replacement.

joule
The basic unit of energy. In physical terms, equal to the work required to move a mass of one Newton a distance of one metre.

kilowatt (kW)
One thousand watts; the most common unit of measurement of electric power. (The amount of energy transferred at a rate of one kilowatt for one hour is equal to one kilowatt hour.)

kilowatt hour (kWh)
The most common unit of measurement of electric energy. One kilowatt hour represents the power of one thousand watts for a period of one hour.

load forecast
An estimate of expected natural gas requirements that have to be met by the utility in future years.

load research
Research to disaggregate and analyze patterns of natural gas consumption by various sub sectors and end-uses. Load Research supports the development of the load forecast and the design of demand-side management programs.

measure total resource cost (TRC)
The Measure TRC is the net present value of energy savings that result from an investment in a energy efficiency measure. The Measure TRC is equal to its full or incremental capital cost (depending on application) plus any change (positive or negative) in the combined annual energy and operating & maintenance costs. This calculation includes among others, the following inputs: the avoided natural gas and electricity supply costs; the life of the measure; and the selected discount rate.

megajoule
One million joules.

natural conservation
The future change in energy intensity that is expected to occur in the absence of utility DSM programs.

non-participant test (NPT)
A test measuring what happens to rates due to changes in utility revenues and operating costs caused by a program. Rates will go down if the avoided cost is greater than the sum of the revenue lost plus the program costs. This test indicates the direction and magnitude of the expected change in rate levels.

rate
Generically refers to a utility's rate structure.

rate structure
The formulae used by a utility to calculate charges for the use of natural gas or electricity.

reference case forecast
An estimate of the expected level of natural gas consumption that would occur over the study period in the absence of any new utility DSM market interventions after 2008. It is the baseline against which the scenarios of energy savings are calculated. The Reference Case forecast incorporates an estimation of "natural conservation," namely, changes in end-use efficiency over the study period that are projected to occur in the absence of new market interventions by the utility.

saturation
The portion of floor area that receives a specific energy service. For example, a saturation of 86% for space cooling in the Large Office sub sector means that 86% of the sub sector floor space is cooled (regardless of fuel used to provide that cooling).

seasonal efficiency
The ratio of delivered useful energy relative to the input potential fuel energy determined over a full heating season (or year).

sector
A group of customers having a common type of economic activity. Union Gas divides its customers into three principal sectors: Residential, Commercial and Industrial. Sectors are further divided into sub sectors. For example, “Large Offices” is a sub sector of the Commercial sector.

service area
The portion of the Province of Ontario that receives service from Union Gas. Union Gas’ service area is spread across the Province of Ontario including northern, southwestern and southeastern cities and towns.

service region
For the purposes of this study, the total Union Gas service area is divided into two service regions. They are the Northern Region and Southern Region.

simple payback
The simple payback is generated to show the customer’s financial perspective. Simple payback is a measure of the length of time required for the cumulative savings from a project to recover its initial investment cost and other accrued costs, without taking into account the time value of money.

strategic conservation
Utility action to reduce the total natural gas demand. Strategic conservation is natural gas conservation induced by utility programs.

strategic load growth
Utility action to increase (annual) total natural gas demand for specific end uses.

sub sectors
A classification of customers within a sector by common features. Residential sub sectors are by type of home (SFD, duplex, apartment, etc.). Commercial sub sectors are generally by type of commercial service (office, retail, warehouse, etc.). Industrial sub sectors are by product type (pulp and paper, solid wood products, chemicals, etc.).

supply curves
A curve illustrating the amount of energy available at an appropriate screened price in ascending order of cost.

Total Resource Cost (TRC) Test
A test that compares the total costs of energy efficiency investments, including natural gas conservation programs, to the social cost of natural gas. Un-priced environmental and social costs may be accounted for by changing the cost of either the investment under consideration or the total cost of natural gas in such a way that relative un-priced impacts are reflected. It is used in designing and evaluating programs that are developed from the Energy Efficiency Potential study’s results.

utility cost
The total financial cost incurred by the utility to acquire energy resources. For DSM, the costs include all utility program costs, including incentive costs.

watt
The basic unit of measurement of power.

Natural Gas
Energy Efficiency Potential

Commercial Sector

–Appendices–

Submitted to:

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APPENDIX A

Existing Building Profiles - Southern Region

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COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Office	**> 50,000 m3**		**Southern Franchise**
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.77 W/m².°C	0.14 Btu/hr.ft² .°F	Typical Building Size	8,000 m²	86,080 ft²
Roof U value (W/m².°C)	0.53 W/m².°C	0.09 Btu/hr.ft² .°F	Typical Footprint (m²)	2,000 m²	21,520 ft²
Glazing U value (W/m².°C)	3.04 W/m².°C	0.53 Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	1.5	
			Percent Conditioned Space	100%	
			Percent Conditioned Space Defined as Exterior Zone	36%	
Window/Wall Ratio (WIWAR) (%)	0.35				
Shading Coefficient (SC)	0.52		Typical # Stories	4	
			Floor to Floor Height (m)	3.7 m	12.0 ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	25%		5%		65%		5%		100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	26 m²/person	280 ft²/person	%OA 27.66%
Occupancy Schedule Occ. Period	90%		
Occupancy Schedule Unocc. Period			
Fresh Air Requirements or Outside Air	26 L/s.person	55 CFM/person	

Fresh Air Control Type *(enter a 1, 2 or 3) 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.5 L/s.m² 0.10 CFM/ft²; 50% operation (%)

Sizing Factor	1.26	
Total Air Circulation or Design Air Flow	3.62 L/s.m²	0.71 CFM/ft²
Infiltration Rate	0.30 L/s.m²	0.06 CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)	L/s.m²	CFM/ft²
Operation occupied period	50%	
Operation unoccupied period	50%	

Economizer

	Enthalpy Based	Dry-Bulb Based	Total
Incidence of Use	50%	50%	100%
Switchover Point	KJ/kg.	18 °C	
	Btu/lbm	64.4 °F	

Summary of Design Parameters		
Peak Design Cooling Load	2,685,134	
Peak Zone Sensible Load	1,045,502	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	48,637	
Total air circulation or Design air	3.62	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	14	°C	57.2	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	21	°C	69.8	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Office	> 50,000 m3		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	520 Lux	48.3	ft-candles
Floor Fraction (GLFF)	0.85		
Connected Load	15.7 W/m²	1.5	W/ft²
Occ. Period(Hrs./yr.)	2900		
Unocc. Period(Hrs./yr.)	5860		
Usage During Occupied Period	95%		
Usage During Unoccupied Period	25%		
Fixture Cleaning:			
Incidence of Practice			
Interval	years		
Relamping Strategy & Incidence of Practice	Group	Spot	

Light Level (Lux)	300	500	700	1000				Total
% Distribution	20%	50%	30%					100%
Weighted Average								**520**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	3%	2%	35%		60%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	5.2
	MJ/m².yr	203

ARCHITECTURAL LIGHTING

Light Level	430 Lux	40.0	ft-candles
Floor Fraction (ALFF)	0.15		
Connected Load	14.2 W/m²	1.3	W/ft²
Occ. Period(Hrs./yr.)	3600		
Unocc. Period(Hrs./yr.)	5160		
Usage During Occupied Period	100%		
Usage During Unoccupied Period	25%		
Fixture Cleaning:			
Incidence of Practice			
Interval	years		
Relamping Strategy & Incidence of Practice	Group	Spot	

Light Level (Lux)	300	500	700	1000				Total
% Distribution	35%	65%						100%
Weighted Average								**430**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%	30%		60%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	1.0
	MJ/m².yr	37

OTHER (HIGH BAY) LIGHTING

Light Level	300.00 Lux	27.9	ft-candles
Floor Fraction (HBLFF)			
Connected Load	0.0 W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000		
Unocc. Period(Hrs./yr.)	4760		
Usage During Occupied Period	0%		
Usage During Unoccupied Period	100%		
Fixture Cleaning:			
Incidence of Practice			
Interval	years		
Relamping Strategy & Incidence of Practice	Group	Spot	

Floor fraction check: should = 1.00 — 1.00

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 15.51 W/m²

EUI TOTAL	kWh/ft².yr	6
	MJ/m².yr	241

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.9	0.9	0.15	0.1	0.06	
Connected Load	1.9 W/m²	1.8 W/m²	0.6 W/m²	0.8 W/m²	0.5 W/m²	1.5 W/m²
	0.2 W/ft²	0.2 W/ft²	0.05 W/ft²	0.07 W/ft²	0.05 W/ft²	0.14 W/ft²
Diversity Occupied Period	80%	80%	80%	80%	100%	80%
Diversity Unoccupied Period	50%	50%	50%	50%	100%	50%
Operation Occ. Period (hrs./year)	2000	2000	2000	2000	2000	2500
Operation Unocc. Period (hrs./year)	6760	6760	6760	6760	6760	6260

Total end-use load (occupied period)	5.7 W/m²	0.5 W/ft²
Total end-use load (unocc. period)	3.8 W/m²	0.3 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	66%	

Computer Equipment	EUI	kWh/ft².yr	2.73
		MJ/m².yr	105.68
Plug Loads	EUI	kWh/ft².yr	0.72
		MJ/m².yr	27.70

FOOD SERVICE EQUIPMENT

Provide description below:

Gas Fuel Share: 20.0% Electricity Fuel Share: 80.0%

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	0.3	EUI	kWh/ft².yr	0.3
	MJ/m².yr	10.0		MJ/m².yr	10.0

REFRIGERATION

Provide description below:

EUI	kWh/ft².yr	0.1
	MJ/m².yr	5.0

MISCELLANEOUS

EUI	kWh/ft².yr	1.9
	MJ/m².yr	75

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Large Office** **Baseline**
SIZE: **> 50,000 m3**
VINTAGE:
REGION: **Southern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	20%	24%	1%		45%		10%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	41.7	W/m²	13.2	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	346	MJ/m².yr	8.9	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 10.0% Gas Fuel Share 90.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	8.9
MJ/m².yr	346

Natural Gas EUI	
kWh/ft².yr	13.1
MJ/m².yr	509

Market Composite EUI	
kWh/ft².yr	12.7
MJ/m².yr	493

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorption	Engine	
System Present (%)	25.0%	25.0%			49.0%	1.0%		100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	98	W/m²	31	Btu/hr.ft²	385	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	284.6	MJ/m².yr	7.3	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 86.0%

Electric Fuel Share 99.0% Gas Fuel Share 1.0%

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	2.4
MJ/m².yr	94

Natural Gas EUI	
kWh/ft².yr	7.1
MJ/m².yr	276

Market Composite EUI	
kWh/ft².yr	2.5
MJ/m².yr	96

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	15%		64%	1%	1%
Eff./COP	75%		65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	81%	19%	100%
Blended Efficiency	0.67	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 40.0

Wetting Use Percentage 50%

All Electric EUI	
kWh/ft².yr	1.1
MJ/m².yr	44

All Natural Gas EUI	
kWh/ft².yr	1.5
MJ/m².yr	59

Market Composite EUI	
kWh/ft².yr	1.5
MJ/m².yr	56.4

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Office	**> 50,000 m3**		**Southern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.6	L/s.m²	0.71	CFM/ft²
System Static Pressure CAV	750	Pa	3.0	wg
System Static Pressure VAV	750	Pa	3.0	wg
Fan Efficiency	55%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	5.8	W/m²	0.54	W/ft²
Fan Design Load VAV	5.8	W/m²	0.54	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	30%	70%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	75%	25%	75%	25%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.04	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.3	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	2.17	W/m²	0.20	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.005	L/s.m²	0.008	U.S. gpm/ft²
Pump Head Pressure	120	kPa	40	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.23	W/m²	0.11	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0062	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	120	kPa	40	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.0	W/m²	0.09	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	20.9	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	2.0	kWh/m².yr
Condenser Pump Energy Consumption	3.9	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.6	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	6.3	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	3.2
	MJ/m².yr	125.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Office	**> 50,000 m3**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**16.9** kWh/ft².yr	**656.3** MJ/m².yr	**Gas:**	**15.1** kWh/ft².yr **585.3** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	5.2	203.4
ARCHITECTURAL LIGHTING	1.0	37.5
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	0.7	27.7
HVAC FANS & PUMPS	3.2	125.0
REFRIGERATION	0.1	5.0
COMPUTER EQUIPMENT	2.7	105.7
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	0.9	34.6	11.8	457.9
SPACE COOLING	2.1	80.4	0.1	2.4
DOMESTIC HOT WATER	0.2	8.4	1.2	48.0
FOOD SERVICE EQUIPMENT	0.2	8.0	0.1	2.0
MISCELLANEOUS			1.9	75.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Small Office	< 50,000 m3		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.57	W/m².°C	0.10	Btu/hr.ft² .°F	Typical Building Size	1,000 m²	10,760	ft²
Roof U value (W/m².°C)	0.41	W/m².°C	0.07	Btu/hr.ft² .°F	Typical Footprint (m²)	500 m²	5,380	ft²
Glazing U value (W/m².°C)	3.04	W/m².°C	0.53	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2		
					Percent Conditioned Space	100%		
					Percent Conditioned Space Defined as Exterior Zone	40%		
Window/Wall Ratio (WIWAR) (%)	0.31							
Shading Coefficient (SC)	0.59				Typical # Stories	2		
					Floor to Floor Height (m)	3.3 m	10.9	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	80%				20%				100%
Min. Air Flow (%)					20%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	26	m²/person	280	ft²/person	%OA	7.66%
Occupancy Schedule Occ. Period	90%					
Occupancy Schedule Unocc. Period						
Fresh Air Requirements or Outside Air	10	L/s.person	21	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) 2
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² 0.10 CFM/ft²; 50% operation (%)

Sizing Factor	1.3			
Total Air Circulation or Design Air Flow	5.02	L/s.m²	0.99	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	334,200	
Peak Zone Sensible Load	175,977	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	8,186	
Total air circulation or Design air	5.02	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	30%	80%
DDC/Pneumatic	30%	
All DDC	40%	20%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	15	°C	59	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20.7	°C	69.26	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Small Office	< 50,000 m3		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	520 Lux	48.3 ft-candles
Floor Fraction (GLFF)	0.95	
Connected Load	16.3 W/m²	1.5 W/ft²

Occ. Period(Hrs./yr.)	2600
Unocc. Period(Hrs./yr.)	6160
Usage During Occupied Period	95%
Usage During Unoccupied Period	10%

Light Level (Lux)	300	500	700	1000				Total
% Distribution	20%	50%	30%					100%
Weighted Average								**520**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	3%	2%	50%		45%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval years

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	kWh/ft².yr	4.4
	MJ/m².yr	172

ARCHITECTURAL LIGHTING

Light Level	430 Lux	40.0 ft-candles
Floor Fraction (ALFF)	0.05	
Connected Load	14.6 W/m²	1.4 W/ft²

Occ. Period(Hrs./yr.)	3600
Unocc. Period(Hrs./yr.)	5160
Usage During Occupied Period	100%
Usage During Unoccupied Period	25%

Light Level (Lux)	300	500	700	1000				Total
% Distribution	35%	65%						100%
Weighted Average								**430**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%	45%		45%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval years

Relamping Strategy & Incidence of Practice	Group	Spot

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	0.3
	MJ/m².yr	13

OTHER (HIGH BAY) LIGHTING

Light Level	300.00 Lux	27.9 ft-candles
Floor Fraction (HBLFF)		
Connected Load	0.0 W/m²	0.0 W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval years

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 16.23 W/m²

EUI TOTAL	kWh/ft².yr	5
	MJ/m².yr	185

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.95	0.95	0.1	0.1	0.06	
Connected Load	2.0 W/m²	1.9 W/m²	0.4 W/m²	0.8 W/m²	0.5 W/m²	1.5 W/m²
	0.2 W/ft²	0.2 W/ft²	0.04 W/ft²	0.07 W/ft²	0.05 W/ft²	0.14 W/ft²
Diversity Occupied Period	70%	80%	50%	50%	100%	100%
Diversity Unoccupied Period	30%	30%	5%	5%	100%	10%
Operation Occ. Period (hrs./year)	2000	2000	2000	2000	2000	2000
Operation Unocc. Period (hrs./year)	6760	6760	6760	6760	6760	6760

Total end-use load (occupied period)	5.5 W/m²	0.5 W/ft²
Total end-use load (unocc. period)	1.9 W/m²	0.2 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	34%	

Computer Equipment	EUI	kWh/ft².yr	1.82
		MJ/m².yr	70.57
Plug Loads	EUI	kWh/ft².yr	0.37
		MJ/m².yr	14.45

FOOD SERVICE EQUIPMENT

Provide description below:

Gas Fuel Share: 20.0% Electricity Fuel Share: 80.0%

	Natural Gas EUI			All Electric EUI	
EUI	kWh/ft².yr	0.3	EUI	kWh/ft².yr	0.4
	MJ/m².yr	10.0		MJ/m².yr	15.0

REFRIGERATION

Provide description below:

EUI	kWh/ft².yr	0.1
	MJ/m².yr	5.0

MISCELLANEOUS

EUI	kWh/ft².yr	1.0
	MJ/m².yr	40

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Small Office	< 50,000 m3		Southern Franchise
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	30%	14%	1%		35%	10%	10%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	72.3	W/m²	22.9	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	413	MJ/m².yr	10.7	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 10.0% Gas Fuel Share 90.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	10.7
MJ/m².yr	413

Natural Gas EUI	
kWh/ft².yr	15.8
MJ/m².yr	613

Market Composite EUI	
kWh/ft².yr	15.3
MJ/m².yr	593

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Adsorption	Engine	
System Present (%)					100.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	98	W/m²	31	Btu/hr.ft²	386	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	257.6	MJ/m².yr	6.7	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 86.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	2.6
MJ/m².yr	99

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	2.6
MJ/m².yr	99

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	3%		76%	1%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	81%	19%	100%
Blended Efficiency	0.66	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 40.0

Wetting Use Percentage 50%

All Electric EUI	
kWh/ft².yr	1.1
MJ/m².yr	44

All Natural Gas EUI	
kWh/ft².yr	1.6
MJ/m².yr	61

Market Composite EUI	
kWh/ft².yr	1.5
MJ/m².yr	57.5

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Small Office	**< 50,000 m3**		**Southern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	5.0	L/s.m²	0.99	CFM/ft²
System Static Pressure CAV	562.5	Pa	2.3	wg
System Static Pressure VAV	562.5	Pa	2.3	wg
Fan Efficiency	55%			
Fan Motor Efficiency	82%			
Sizing Factor	1.00			
Fan Design Load CAV	6.3	W/m²	0.58	W/ft²
Fan Design Load VAV	6.3	W/m²	0.58	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	80%	20%	100%	
Operation	Continuous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	50%	50%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.4	L/s.m²	0.08	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.5	L/s.m²	0.10	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.7	W/m²	0.06	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	2.16	W/m²	0.20	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.005	L/s.m²	0.008	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0062	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	30	kPa	10	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.2	W/m²	0.02	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	34.4	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	4.2	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.4	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	1.6	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	3.9
	MJ/m².yr	149.9

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Small Office	**< 50,000 m3**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**15.2** kWh/ft².yr	**589.0** MJ/m².yr	**Gas:**	**16.6** kWh/ft².yr	**642.7** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING	4.4	172.1					
ARCHITECTURAL LIGHTING	0.3	12.9	SPACE HEATING	1.1	41.3	14.2	551.6
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	2.2	85.5		
OTHER PLUG LOADS	0.4	14.5	DOMESTIC HOT WATER	0.2	8.4	1.3	49.1
HVAC FANS & PUMPS	3.9	149.9	FOOD SERVICE EQUIPMENT	0.3	12.0	0.1	2.0
REFRIGERATION	0.1	5.0	MISCELLANEOUS			1.0	40.0
COMPUTER EQUIPMENT	1.8	70.6					
ELEVATORS							
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Retail	All		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.67	W/m².°C	0.12	Btu/hr.ft² .°F	Typical Building Size	2,400 m²	25,824	ft²
Roof U value (W/m².°C)	0.50	W/m².°C	0.09	Btu/hr.ft² .°F	Typical Footprint (m²)	2,400 m²	25,824	ft²
Glazing U value (W/m².°C)	3.36	W/m².°C	0.59	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	1.5		
					Percent Conditioned Space	100%		
					Percent Conditioned Space Defined as Exterior Zone	40%		
Window/Wall Ratio (WIWAR) (%)	0.20							
Shading Coefficient (SC)	0.60				Typical # Stories	1		
					Floor to Floor Height (m)	4.5 m	14.8	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	100%								100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	50	m²/person	538	ft²/person	%OA	10.81%
Occupancy Schedule Occ. Period	90%					
Occupancy Schedule Unocc. Period						
Fresh Air Requirements or Outside Air	20	L/s.person	42	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) | 2 | If Fresh Air Control Type = "2" enter % FA. to the right: 10%
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air) | If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation | 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	3.70	L/s.m²	0.73	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	654,501	
Peak Zone Sensible Load	404,452	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	18,815	
Total air circulation or Design air	3.70	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	15	°C	59	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	19.5	°C	67.1	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	21	°C	69.8	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Retail	All		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	685	Lux	63.7	ft-candles
Floor Fraction (GLFF)	0.95			
Connected Load	29.4	W/m²	2.7	W/ft²

Occ. Period(Hrs./yr.)	3800
Unocc. Period(Hrs./yr.)	4960
Usage During Occupied Period	100%
Usage During Unoccupied Period	10%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution		30%	55%	15%				100%
Weighted Average								**685**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	10%	5%	35%		35%	15%	0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	11.2
	MJ/m².yr	432

ARCHITECTURAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.05			
Connected Load	33.7	W/m²	3.1	W/ft²

Occ. Period(Hrs./yr.)	3800
Unocc. Period(Hrs./yr.)	4960
Usage During Occupied Period	100%
Usage During Unoccupied Period	10%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	70%	10%	10%		10%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	0.7
	MJ/m².yr	26

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 — 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING — Overall LP 29.63 W/m²

EUI TOTAL	kWh/ft².yr	12
	MJ/m².yr	458

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.2	0.2	0.15	0.1	0.12	
Connected Load	0.2 W/m²	0.2 W/m²	0.3 W/m²	0.4 W/m²	0.5 W/m²	1.5 W/m²
	0.0 W/ft²	0.0 W/ft²	0.03 W/ft²	0.04 W/ft²	0.05 W/ft²	0.14 W/ft²
Diversity Occupied Period	80%	80%	80%	80%	100%	80%
Diversity Unoccupied Period	50%	50%	50%	50%	100%	50%
Operation Occ. Period (hrs./year)	2000	2000	2000	2000	2000	2500
Operation Unocc. Period (hrs./year)	6760	6760	6760	6760	6760	6260

Total end-use load (occupied period)	2.6 W/m²	0.2 W/ft²
Total end-use load (unocc. period)	1.8 W/m²	0.2 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	70%	

Computer Equipment	EUI	kWh/ft².yr	0.94
		MJ/m².yr	36.30
Plug Loads	EUI	kWh/ft².yr	0.72
		MJ/m².yr	27.70

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 40.0% Electricity Fuel Share: 60.0%

Gas - cooking, baking not seperately metered

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	1.0	EUI	kWh/ft².yr	1.0
	MJ/m².yr	40.0		MJ/m².yr	40.0

REFRIGERATION EQUIPMENT

Provide description below:

Walk-in, display merchandisers, reach-ins, and fridges

EUI	kWh/ft².yr	1.0
	MJ/m².yr	40.0

MISCELLANEOUS

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Retail	**All**		**Southern Franchise**
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers Standard	Near Cond	Cond		RTU	Furnace	Resistance	Total
System Present (%)	6%	3%	1%		75%	5%	10%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	59.0	W/m²	18.7	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	384	MJ/m².yr	9.9	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 10.0% Gas Fuel Share 90.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	kWh/ft².yr	9.9
	MJ/m².yr	384
Natural Gas EUI	kWh/ft².yr	15.6
	MJ/m².yr	606
Market Composite EUI	kWh/ft².yr	14.3
	MJ/m².yr	554

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)	5.0%	5.0%			90.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	15.0	°C	59	°F

Peak Cooling Load	80	W/m²	25	Btu/hr.ft²	473	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	216.9	MJ/m².yr	5.6	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 85.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	kWh/ft².yr	2.2
	MJ/m².yr	87
Natural Gas EUI	kWh/ft².yr	
	MJ/m².yr	
Market Composite EUI	kWh/ft².yr	2.2
	MJ/m².yr	87

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	1%	31%	32%	1%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	66%	34%
Blended Efficiency	0.64	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 35.0

Wetting Use Percentage 10%

All Electric EUI	kWh/ft².yr	1.0
	MJ/m².yr	38
All Natural Gas EUI	kWh/ft².yr	1.4
	MJ/m².yr	55
Market Composite EUI	kWh/ft².yr	1.3
	MJ/m².yr	49.4

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Retail	All		Southern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.7	L/s.m²	0.73	CFM/ft²
System Static Pressure CAV	625	Pa	2.5	wg
System Static Pressure VAV	625	Pa	2.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	80%			
Sizing Factor	1.00			
Fan Design Load CAV	5.6	W/m²	0.52	W/ft²
Fan Design Load VAV	5.6	W/m²	0.52	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	75%	25%	75%	25%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.04	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.77	W/m²	0.16	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0051	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure		kPa		ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load		W/m²		W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	41.9	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.8	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.3	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption		kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	4.2
	MJ/m².yr	162.2

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Retail** **Baseline**

SIZE: **All**

VINTAGE:

REGION: **Southern Franchise**

EUI SUMMARY

TOTAL ALL END-USES: **Electricity:** **23.1** kWh/ft².yr **894.6** MJ/m².yr **Gas:** **15.9** kWh/ft².yr **617.7** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	11.2	432.1
ARCHITECTURAL LIGHTING	0.7	26.1
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	0.7	27.7
HVAC FANS & PUMPS	4.2	162.2
REFRIGERATION EQUIPMENT	1.0	40.0
COMPUTER EQUIPMENT	0.9	36.3
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	1.0	38.4	14.1	545.4
SPACE COOLING	1.9	73.8		
DOMESTIC HOT WATER	0.3	13.1	0.9	36.3
FOOD SERVICE EQUIPMENT	0.6	24.0	0.4	16.0
MISCELLANEOUS			0.5	20.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Large Hotel** **Baseline**
SIZE: **> 50,000 m³**
VINTAGE:
REGION: **Southern Franchise**

CONSTRUCTION

Wall U value (W/m².°C)	0.63	W/m².°C	0.11	Btu/hr.ft² .°F		
Roof U value (W/m².°C)	0.47	W/m².°C	0.08	Btu/hr.ft² .°F		
Glazing U value (W/m².°C)	3.27	W/m².°C	0.58	Btu/hr.ft² .°F		
Window/Wall Ratio (WIWAR) (%)	0.25					
Shading Coefficient (SC)	0.64					

Typical Building Size	8,000	m²	86,080	ft²
Typical Footprint (m²)	2,000	m²	21,520	ft²
Footprint Aspect Ratio (L:W)	5			
Percent Conditioned Space	100%			
Percent Conditioned Space Defined as Exterior Zone	75%			
Typical # Stories	4			
Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	25%		5%		65%		5%		100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	60	m²/person	646	ft²/person
Occupancy Schedule Occ. Period	45%			
Occupancy Schedule Unocc. Period	80%			
Fresh Air Requirements or Outside Air	35	L/s.person	74	CFM/person

%OA 20.36%

Fresh Air Control Type *(enter a 1, 2 or 3)
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air): 1

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² 0.10 CFM/ft²; 50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	2.86	L/s.m²	0.56	CFM/ft²
Infiltration Rate (air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)	0.30	L/s.m²	0.06	CFM/ft²

Separate Make-up air unit (100% OA)	L/s.m² CFM/ft²
Operation occupied period	50%
Operation unoccupied period	50%

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,974,360	
Peak Zone Sensible Load	1,043,800	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	48,558	
Total air circulation or Design air	2.86	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	22	°C	71.6	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	23	°C	73.4	°F	24	°C	75.2	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	21	°C	69.8	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Hotel	> 50,000 m^3		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	120	Lux	11.2	ft-candles
Floor Fraction (GLFF)	0.75			
Connected Load	12.2	W/m²	1.1	W/ft²

Occ. Period(Hrs./yr.)	2100
Unocc. Period(Hrs./yr.)	6660
Usage During Occupied Period	70%
Usage During Unoccupied Period	30%

Light Level (Lux)	50	100	200	300	Total
% Distribution	20%	50%	30%		100%
Weighted Average					**120**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	60%	15%	15%		10%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval years

Relamping Strategy & Incidence of Practice: Group | Spot

EUI kWh/ft².yr 2.9
MJ/m².yr 114

GENERAL LIGHTING (LOBBY BALLROOMS, CORRIDORS, BACK OF HOUSE)

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.25			
Connected Load	23.4	W/m²	2.2	W/ft²

Occ. Period(Hrs./yr.)	3600
Unocc. Period(Hrs./yr.)	5160
Usage During Occupied Period	100%
Usage During Unoccupied Period	70%

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	40%	15%	30%		15%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval years

Relamping Strategy & Incidence of Practice: Group | Spot

EUI kWh/ft².yr 3.9
MJ/m².yr 152

EUI = Load X Hrs. X SF X GLFF

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval years

Relamping Strategy & Incidence of Practice: Group | Spot

EUI kWh/ft².yr
MJ/m².yr

TOTAL LIGHTING — Overall LP 14.99 W/m²

EUI TOTAL kWh/ft².yr 7
MJ/m².yr 266

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)						
Connected Load (W/m²)					0.5	4
Connected Load (W/ft²)					0.05	0.37
Diversity Occupied Period						70%
Diversity Unoccupied Period						70%
Operation Occ. Period (hrs./year)						3000
Operation Unocc. Period (hrs./year)	8760	8760	8760	8760	8760	5760

Total end-use load (occupied period)	2.8	W/m²	0.3	W/ft²
Total end-use load (unocc. period)	2.8	W/m²	0.3	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	100%			

Computer Equipment EUI kWh/ft².yr
MJ/m².yr

Plug Loads EUI kWh/ft².yr 2.28
MJ/m².yr 88.30

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 50.0% Electricity Fuel Share: 50.0%

Cooking

	Natural Gas EUI	All Electric EUI
EUI kWh/ft².yr	1.8	1.8
MJ/m².yr	70.0	70.0

REFRIGERATION

Provide description below:
Coolers, ice machines, pop machines, fridges etc

EUI kWh/ft².yr 0.5
MJ/m².yr 20.0

MISCELLANEOUS

EUI kWh/ft².yr 1.3
MJ/m².yr 50

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Hotel	**> 50,000 m³**		**Southern Franchise**
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	40%	10%	2%		13%		35%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	65.9	W/m²	20.9	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	454	MJ/m².yr	11.7	kWh/ft².yr
Sizing Factor	1.50			

Electric Fuel Share 35.0% Gas Fuel Share 65.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	11.7
MJ/m².yr	454

Natural Gas EUI	
kWh/ft².yr	15.8
MJ/m².yr	614

Market Composite EUI	
kWh/ft².yr	14.4
MJ/m².yr	558

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorption	Engine	
System Present (%)	20.0%	20.0%		10.0%	50.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	72	W/m²	23	Btu/hr.ft²	523	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	223.5	MJ/m².yr	5.8	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 85.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	1.9
MJ/m².yr	73

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	1.9
MJ/m².yr	73

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	70%		12%	5%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	88%	12%	100%
Blended Efficiency	0.75	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 220.0

Wetting Use Percentage 50%

All Electric EUI	
kWh/ft².yr	6.2
MJ/m².yr	242

All Natural Gas EUI	
kWh/ft².yr	7.6
MJ/m².yr	295

Market Composite EUI	
kWh/ft².yr	7.4
MJ/m².yr	288.3

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Hotel	**> 50,000 m³**		**Southern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	2.9	L/s.m²	0.56	CFM/ft²
System Static Pressure CAV	500	Pa	2.0	wg
System Static Pressure VAV	500	Pa	2.0	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	3.2	W/m²	0.30	W/ft²
Fan Design Load VAV	3.2	W/m²	0.30	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	80%	20%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	50%	50%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.04	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.3	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.60	W/m²	0.15	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.13	W/m²	0.10	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0046	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.9	W/m²	0.09	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	17.5	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.7	kWh/m².yr
Condenser Pump Energy Consumption	3.8	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.2	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	4.2	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	2.6
	MJ/m².yr	102.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Hotel	**> 50,000 m^3**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES: **Electricity:** **20.2** kWh/ft².yr **782.5** MJ/m².yr **Gas:** **19.2** kWh/ft².yr **743.2** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	2.9	114.1
GENERAL LIGHTING (LOBBY BALLROOMS, COR	3.9	151.9
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	2.3	88.3
HVAC FANS & PUMPS	2.6	102.0
REFRIGERATION	0.5	20.0
COMPUTER EQUIPMENT		
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	4.1	158.9	10.3	398.9
SPACE COOLING	1.6	62.4		
DOMESTIC HOT WATER	0.7	29.0	6.7	259.3
FOOD SERVICE EQUIPMENT	0.9	35.0	0.9	35.0
MISCELLANEOUS			1.3	50.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hotel/Motel	< 50,000 m^3		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.66	W/m².°C	0.12	Btu/hr.ft² .°F	Typical Building Size	950	m²	10,222	ft²
Roof U value (W/m².°C)	0.44	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Footprint (m²)	950	m²	10,222	ft²
Glazing U value (W/m².°C)	3.39	W/m².°C	0.60	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	5			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	75%			
Window/Wall Ratio (WIWAR) (%)	0.25								
Shading Coefficient (SC)	0.64				Typical # Stories	1			
					Floor to Floor Height (m)	3.2	m	10.5	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	90%				10%				100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	60	m²/person	646	ft²/person
Occupancy Schedule Occ. Period	45%			
Occupancy Schedule Unocc. Period	80%			
Fresh Air Requirements or Outside Air	15	L/s.person	32	CFM/person

%OA 7.17%

Fresh Air Control Type *(enter a 1, 2 or 3) — 2
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² — 0.10 CFM/ft²; 50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	3.49	L/s.m²	0.69	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	294,672	
Peak Zone Sensible Load	150,930	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	7,021	
Total air circulation or Design air	3.49	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional	PI / PID	Total
Control Mode			
	Fixed Discharge	Reset	
Control Strategy			

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	22	°C	71.6	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	23	°C	73.4	°F	20.75	°C	69.35	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20	°C	68	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hotel/Motel	< 50,000 m^3		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	120	Lux	11.2	ft-candles
Floor Fraction (GLFF)	0.90			
Connected Load	12.2	W/m²	1.1	W/ft²
Occ. Period(Hrs./yr.)	2100			
Unocc. Period(Hrs./yr.)	6660			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	50	100	200	300				Total
% Distribution	20%	50%	30%					100%
Weighted Average								**120**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	60%	15%	15%		10%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	2.8
	MJ/m².yr	109

ARCHITECTURAL LIGHTING (LOBBY BALLROOMS, CORRIDORS, BACK OF HOUSE)

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.10			
Connected Load	23.4	W/m²	2.2	W/ft²
Occ. Period(Hrs./yr.)	3600			
Unocc. Period(Hrs./yr.)	5160			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	70%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	40%	15%	30%		15%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	1.6
	MJ/m².yr	61

EUI = Load X Hrs. X SF X GLFF

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	0%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING Overall LP 13.30 W/m²

EUI TOTAL	kWh/ft².yr	4
	MJ/m².yr	170

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)												
Connected Load		W/m²		W/m²		W/m²		W/m²		W/m²	1.5	W/m²
		W/ft²		W/ft²		W/ft²		W/ft²		W/ft²	0.14	W/ft²
Diversity Occupied Period											70%	
Diversity Unoccupied Period											70%	
Operation Occ. Period (hrs./year)											3000	
Operation Unocc. Period (hrs./year)	8760		8760		8760		8760		8760		5760	

Total end-use load (occupied period)	1.1	W/m²	0.1	W/ft²
Total end-use load (unocc. period)	1.1	W/m²	0.1	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	100%			

	EUI		
Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	0.85
		MJ/m².yr	33.11

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 20.0% Electricity Fuel Share: 80.0%

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	0.8	EUI	kWh/ft².yr	0.8
	MJ/m².yr	30.0		MJ/m².yr	30.0

REFRIGERATION EQUIPMENT

Provide description below:

EUI	kWh/ft².yr	0.3
	MJ/m².yr	10.0

MISCELLANEOUS

EUI	kWh/ft².yr	1.5
	MJ/m².yr	60

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hotel/Motel	< 50,000 m^3		Southern Franchise
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total
System Present (%)	40%	11%	1%		13%		35%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	113.1	W/m²	35.9	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	450	MJ/m².yr	11.6	kWh/ft².yr
Sizing Factor	1.30			

Electric Fuel Share 35.0% — Gas Fuel Share 65.0% — Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

EUI	kWh/ft².yr	MJ/m².yr
All Electric EUI	11.6	450
Natural Gas EUI	16.6	645
Market Composite EUI	14.9	577

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Absorptior	Engine	Total
System Present (%)					100.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	14.0	57.2

Peak Cooling Load	91	W/m²	29	Btu/hr.ft²	416	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	201.3	MJ/m².yr	5.2	kWh/ft².yr		

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 85.0%

Electric Fuel Share 100.0% — Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

EUI	kWh/ft².yr	MJ/m².yr
All Electric EUI	1.7	68
Natural Gas EUI		
Market Composite EUI	1.7	68

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	60%		20%	3%	2%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	85%	15%
Blended Efficiency	0.74	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 240.0

Wetting Use Percentage 50%

EUI	kWh/ft².yr	MJ/m².yr
All Electric EUI	6.8	264
All Natural Gas EUI	8.4	326
Market Composite EUI	8.2	317.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Hotel/Motel	**< 50,000 m^3**		**Southern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.5	L/s.m²	0.69	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV	375	Pa	1.5	wg
Fan Efficiency	45%			
Fan Motor Efficiency	80%			
Sizing Factor	1.00			
Fan Design Load CAV	3.6	W/m²	0.34	W/ft²
Fan Design Load VAV	3.6	W/m²	0.34	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use		100%		100%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.2	L/s.m²	0.04	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.3	L/s.m²	0.06	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.4	W/m²	0.04	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	2.01	W/m²	0.19	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.005	L/s.m²	0.007	U.S. gpm/ft²
Pump Head Pressure	8	kPa	2.6666667	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.08	W/m²	0.01	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0058	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	8	kPa	3	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.1	W/m²	0.01	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	14.2	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.6	kWh/m².yr
Condenser Pump Energy Consumption	0.1	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.9	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	0.3	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	1.6
	MJ/m².yr	61.7

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Hotel/Motel	**< 50,000 m^3**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**14.7** kWh/ft².yr	**570.3** MJ/m².yr	**Gas:**	**19.7** kWh/ft².yr	**762.6** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING (SUITES)	2.8	109.2
ARCHITECTURAL LIGHTING (LOBI	1.6	60.8
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	0.9	33.1
HVAC FANS & PUMPS	1.6	61.7
REFRIGERATION EQUIPMENT	0.3	10.0
COMPUTER EQUIPMENT		
ELEVATORS		
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	4.1	157.6	10.8	419.2
SPACE COOLING	1.5	57.4		
DOMESTIC HOT WATER	1.0	39.6	7.2	277.4
FOOD SERVICE EQUIPMENT	0.6	24.0	0.2	6.0
MISCELLANEOUS			1.5	60.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Contract Hospital	All volumes		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.52	W/m².°C	0.09	Btu/hr.ft² .°F	Typical Building Size	15,000	m²	161,400	ft²
Roof U value (W/m².°C)	0.40	W/m².°C	0.07	Btu/hr.ft² .°F	Typical Footprint (m²)	3,750	m²	40,350	ft²
Glazing U value (W/m².°C)	3.03	W/m².°C	0.53	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	3			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.27								
Shading Coefficient (SC)	0.51				Typical # Stories	4			
					Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	10%	25%	5%		5%	5%		50%	50%
Min. Air Flow (%)					20%	20%			

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	26 m²/person	280 ft²/person	%OA	49.95%
Occupancy Schedule Occ. Period	90%			
Occupancy Schedule Unocc. Period				
Fresh Air Requirements or Outside Air	40 L/s.person	85 CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) | 1 | If Fresh Air Control Type = "2" enter % FA. to the right: 15%
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air) | If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1.6	
Total Air Circulation or Design Air Flow	3.08 L/s.m²	0.61 CFM/ft²
Infiltration Rate	0.30 L/s.m²	0.06 CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA) | | L/s.m² | | CFM/ft²
Operation occupied period |
Operation unoccupied period |

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	5,973,568	
Peak Zone Sensible Load	1,315,154	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	61,181	
Total air circulation or Design air	3.08	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic		50%
DDC/Pneumatic	50%	
All DDC	50%	50%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	24	°C	75.2	°F	22	°C	71.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	24	°C	75.2	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Contract Hospital	All volumes		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (PATIENTS ROOM)

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (GLFF)	0.50			
Connected Load	8.3	W/m²	0.8	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	50%			
Usage During Unoccupied Period	20%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	200	300	500	1000				Total
% Distribution		100%						100%
Weighted Average	4							**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	3%	2%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	1.3
	MJ/m².yr	51

ARCHITECTURAL LIGHTING (NURSING STATIONS, EXAMINATION, LABORATORY, ICU, RECOVERY)

Light Level	500	Lux	46.5	ft-candles
Floor Fraction (ALFF)	0.40			
Connected Load	16.5	W/m²	1.5	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	65%			
Usage During Unoccupied Period	40%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution		100%						100%
Weighted Average								**500**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%	30%		60%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	3.0
	MJ/m².yr	115

CORRIDORS OTHER

Light Level	400.00	Lux	37.2	ft-candles
Floor Fraction (HBLFF)	0.10			
Connected Load	13.1	W/m²	1.2	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	50%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 — 1.00

Light Level (Lux)	200	400	500	1000				Total
% Distribution		100%						100%
Weighted Average								**400**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	0.9
	MJ/m².yr	33

TOTAL LIGHTING — Overall LP 10.76 W/m²

EUI TOTAL	kWh/ft².yr	5
	MJ/m².yr	199

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.05		0.05		0.01		0.01					
Connected Load	0.1	W/m²	0.1	W/m²	0.0	W/m²	0.1	W/m²		W/m²	5	W/m²
	0.0	W/ft²	0.0	W/ft²	0.00	W/ft²	0.01	W/ft²		W/ft²	0.46	W/ft²
Diversity Occupied Period	90%		90%		90%		90%				100%	
Diversity Unoccupied Period	40%		40%		20%		10%					
Operation Occ. Period (hrs./year)	5400		5400		5400		5400				3000	
Operation Unocc. Period (hrs./year)	3360		3360		3360		3360		8760		5760	

Total end-use load (occupied period)	5.3	W/m²	0.5	W/ft²
Total end-use load (unocc. period)	0.1	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	2%			

Computer Equipment	EUI	kWh/ft².yr	0.17
		MJ/m².yr	6.73
Plug Loads	EUI	kWh/ft².yr	1.39
		MJ/m².yr	54.00

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 65.0% Electricity Fuel Share: 35.0%

Cooking

	Natural Gas EUI			All Electric EUI	
EUI	kWh/ft².yr	1.5	EUI	kWh/ft².yr	1.5
	MJ/m².yr	60.0		MJ/m².yr	60.0

KITCHEN & REFRIGERATION

Provide description below:

EUI	kWh/ft².yr	0.8
	MJ/m².yr	30.0

Misc

EUI	kWh/ft².yr	6.5
	MJ/m².yr	250

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Contract Hospital	All volumes		Southern Franchise
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	10%	80%	1%		5%		4%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	28.0 W/m²	8.9	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	1169 MJ/m².yr	30.2	kWh/ft².yr
Sizing Factor	1.00		

Electric Fuel Share	4.0%	Gas Fuel Share	96.0%	Oil Fuel Share	

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	30.2
MJ/m².yr	1169

Natural Gas EUI	
kWh/ft².yr	38.7
MJ/m².yr	1497

Market Composite EUI	
kWh/ft².yr	38.3
MJ/m².yr	1484

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)	25.0%	25.0%		25.0%	20.0%	5.0%		100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6 °C	42.8 °F
Condenser Water	35 °C	95 °F
Supply Air	14.0 °C	57.2 °F

Peak Cooling Load	117 W/m²	37 Btu/hr.ft²	324 ft²/Ton
Seasonal Cooling Load (Tertiary Load)	284.1 MJ/m².yr	7.3 kWh/ft².yr	

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 95.0% — Gas Fuel Share 5.0%

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

All Electric EUI	
kWh/ft².yr	2.4
MJ/m².yr	93

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

Natural Gas EUI	
kWh/ft².yr	7.8
MJ/m².yr	302

Market Composite EUI	
kWh/ft².yr	2.7
MJ/m².yr	104

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	70%		10%	1%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	82%	18%	100%
Blended Efficiency	0.74	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 350.0

Wetting Use Percentage 25%

All Electric EUI	
kWh/ft².yr	9.9
MJ/m².yr	385

All Natural Gas EUI	
kWh/ft².yr	12.2
MJ/m².yr	472

Market Composite EUI	
kWh/ft².yr	11.8
MJ/m².yr	456.3

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Contract Hospital	All volumes		Southern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.1	L/s.m²	0.61	CFM/ft²
System Static Pressure CAV	875	Pa	3.5	wg
System Static Pressure VAV	875	Pa	3.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	6.1	W/m²	0.57	W/ft²
Fan Design Load VAV	6.1	W/m²	0.57	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	80%	20%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	90%	10%	100%	

Comments:

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	2.58	W/m²	0.24	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.006	L/s.m²	0.009	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.82	W/m²	0.17	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.005	L/s.m²	0.0074	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.5	W/m²	0.14	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	43.7	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.8	kWh/m².yr
Condenser Pump Energy Consumption	4.9	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.7	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	9.9	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	5.8
	MJ/m².yr	223.1

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Contract Hospital	**All volumes**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**19.9** kWh/ft².yr	**772.2** MJ/m².yr	**Gas:**	**54.9** kWh/ft².yr	**2,124.9** MJ/m².yr		

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING (PATIENTS R(	1.3	50.6					
ARCHITECTURAL LIGHTING (NUR	3.0	115.3	SPACE HEATING	1.2	46.8	37.1	1,437.5
CORRIDORS OTHER	0.9	33.4	SPACE COOLING	1.7	66.4	0.3	11.3
OTHER PLUG LOADS	1.4	54.0	DOMESTIC HOT WATER	1.8	69.2	10.0	387.1
HVAC FANS & PUMPS	5.8	223.1	FOOD SERVICE EQUIPMENT	0.5	21.0	1.0	39.0
KITCHEN & REFRIGERATION	0.8	30.0	Misc			6.5	250.0
COMPUTER EQUIPMENT	0.2	6.7					
ELEVATORS	1.0	38.7					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hospital	All volumes		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.52	W/m².°C	0.09	Btu/hr.ft² .°F	Typical Building Size	6,000 m²	64,560	ft²
Roof U value (W/m².°C)	0.42	W/m².°C	0.07	Btu/hr.ft² .°F	Typical Footprint (m²)	2,000 m²	21,520	ft²
Glazing U value (W/m².°C)	3.03	W/m².°C	0.53	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	3		
					Percent Conditioned Space	100%		
					Percent Conditioned Space Defined as Exterior Zone	36%		
Window/Wall Ratio (WIWAR) (%)	0.27							
Shading Coefficient (SC)	0.51				Typical # Stories	3		
					Floor to Floor Height (m)	3.7 m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	10%	25%	5%		5%	5%		50%	50%
Min. Air Flow (%)					20%	20%			

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	26	m²/person	280	ft²/person
Occupancy Schedule Occ. Period	90%			
Occupancy Schedule Unocc. Period				
Fresh Air Requirements or Outside Air	30	L/s.person	64	CFM/person

%OA 33.20%

Fresh Air Control Type *(enter a 1, 2 or 3) 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.5 L/s.m² 0.10 CFM/ft²
50% operation (%)

Sizing Factor	1.6			
Total Air Circulation or Design Air Flow	3.48	L/s.m²	0.68	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA) ____ L/s.m² ____ CFM/ft²
Operation occupied period
Operation unoccupied period

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	2,004,352	
Peak Zone Sensible Load	593,587	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	27,614	
Total air circulation or Design air	3.48	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic		50%
DDC/Pneumatic	50%	
All DDC	50%	50%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	24	°C	75.2	°F	22	°C	71.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	24	°C	75.2	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning Changes/Year 4

Incidence of Annual Room Controls Maintenance 100.0%

Incidence of Annual HVAC Controls Maintenance 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hospital	All volumes		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (PATIENTS ROOM)

Light Level	250	Lux	23.2	ft-candles
Floor Fraction (GLFF)	0.50			
Connected Load	6.9	W/m²	0.6	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	50%			
Usage During Unoccupied Period	20%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	200	300	500	1000				Total
% Distribution	50%	50%						100%
Weighted Average	4							**250**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	3%	2%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	1.1
	MJ/m².yr	42

ARCHITECTURAL LIGHTING (NURSING STATIONS, EXAMINATION, LABORATORY, ICU, RECOVERY)

Light Level	430	Lux	40.0	ft-candles
Floor Fraction (ALFF)	0.40			
Connected Load	14.2	W/m²	1.3	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	65%			
Usage During Unoccupied Period	40%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	35%	65%						100%
Weighted Average								**430**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%	30%		60%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	2.6
	MJ/m².yr	99

CORRIDORS OTHER

Light Level	250.00	Lux	23.2	ft-candles
Floor Fraction (HBLFF)	0.10			
Connected Load	8.2	W/m²	0.8	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	50%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	200	300	500	1000				Total
% Distribution	50%	50%						100%
Weighted Average								**250**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	0.5
	MJ/m².yr	21

TOTAL LIGHTING

Overall LP 9.15 W/m²

EUI TOTAL	kWh/ft².yr	4
	MJ/m².yr	162

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.05		0.05		0.01		0.01					
Connected Load	0.1	W/m²	0.1	W/m²	0.0	W/m²	0.1	W/m²		W/m²	5	W/m²
	0.0	W/ft²	0.0	W/ft²	0.00	W/ft²	0.01	W/ft²		W/ft²	0.46	W/ft²
Diversity Occupied Period	90%		90%		90%		90%				100%	
Diversity Unoccupied Period	40%		40%		20%		10%					
Operation Occ. Period (hrs./year)	5400		5400		5400		5400				3000	
Operation Unocc. Period (hrs./year)	3360		3360		3360		3360		8760		5760	

Total end-use load (occupied period)	5.3	W/m²	0.5	W/ft²
Total end-use load (unocc. period)	0.1	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	2%			

Computer Equipment	EUI	kWh/ft².yr	0.17
		MJ/m².yr	6.73
Plug Loads	EUI	kWh/ft².yr	1.39
		MJ/m².yr	54.00

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 65.0% Electricity Fuel Share: 35.0%

Cooking

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	1.3	EUI	kWh/ft².yr	1.3
	MJ/m².yr	50.0		MJ/m².yr	50.0

KITCHEN & REFRIGERATION

Provide description below:

EUI	kWh/ft².yr	0.8
	MJ/m².yr	30.0

Misc

EUI	kWh/ft².yr	2.6
	MJ/m².yr	100

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: Hospital Baseline | **SIZE:** All volumes | **VINTAGE:** | **REGION:** Southern Franchise

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total
System Present (%)	10%	80%	1%		5%		4%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	38.4	W/m²	12.2	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	986	MJ/m².yr	25.5	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 4.0% Gas Fuel Share 96.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	kWh/ft².yr	MJ/m².yr
All Electric EUI	25.5	986
Natural Gas EUI	32.3	1250
Market Composite EUI	32.0	1239

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Absorption	Engine	Total
System Present (%)	25.0%	25.0%		25.0%	20.0%	5.0%		100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	14.0	57.2

Peak Cooling Load	98	W/m²	31	Btu/hr.ft²	387	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	236.1	MJ/m².yr	6.1	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 95.0% Gas Fuel Share 5.0%

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	kWh/ft².yr	MJ/m².yr
All Electric EUI	2.0	78
Natural Gas EUI	6.4	250
Market Composite EUI	2.2	86

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	70%		10%	1%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	82%	18%
Blended Efficiency	0.74	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 250.0

Wetting Use Percentage 25%

	kWh/ft².yr	MJ/m².yr
All Electric EUI	7.1	275
All Natural Gas EUI	8.7	337
Market Composite EUI	8.4	325.9

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Hospital	**All volumes**		**Southern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.5	L/s.m²	0.68	CFM/ft²
System Static Pressure CAV	875	Pa	3.5	wg
System Static Pressure VAV	875	Pa	3.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	6.9	W/m²	0.64	W/ft²
Fan Design Load VAV	6.9	W/m²	0.64	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	80%	20%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	90%	10%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.04	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.3	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	2.16	W/m²	0.20	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.005	L/s.m²	0.008	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.53	W/m²	0.14	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0062	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.2	W/m²	0.12	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	49.3	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	2.3	kWh/m².yr
Condenser Pump Energy Consumption	4.1	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.4	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	8.3	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	6.1
	MJ/m².yr	235.7

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Hospital	**All volumes**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**17.7** kWh/ft².yr	**686.8** MJ/m².yr	**Gas:**	**41.8** kWh/ft².yr	**1,618.4** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING (PATIENTS R(	1.1	42.1
ARCHITECTURAL LIGHTING (NUR	2.6	99.2
CORRIDORS OTHER	0.5	20.9
OTHER PLUG LOADS	1.4	54.0
HVAC FANS & PUMPS	6.1	235.7
KITCHEN & REFRIGERATION	0.8	30.0
COMPUTER EQUIPMENT	0.2	6.7
ELEVATORS	0.5	19.4
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	1.0	39.4	31.0	1,200.0
SPACE COOLING	1.4	55.5	0.2	9.4
DOMESTIC HOT WATER	1.3	49.5	7.1	276.5
FOOD SERVICE EQUIPMENT	0.5	17.5	0.8	32.5
Misc			2.6	100.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Long Term Care (Nursing Home)	**All volumes**		**Southern Franchise**
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.48	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Building Size	6,000	m²	64,560	ft²
Roof U value (W/m².°C)	0.48	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Footprint (m²)	3,000	m²	32,280	ft²
Glazing U value (W/m².°C)	3.03	W/m².°C	0.53	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	5			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	40%			
Window/Wall Ratio (WIWAR) (%)	0.25								
Shading Coefficient (SC)	0.60				Typical # Stories	2			
					Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	65%				35%				100%
Min. Air Flow (%)					20%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	30	m²/person	323	ft²/person
Occupancy Schedule Occ. Period	90%			
Occupancy Schedule Unocc. Period	90%			
Fresh Air Requirements or Outside Air	26	L/s.person	55	CFM/person

%OA 23.93%

Fresh Air Control Type *(enter a 1, 2 or 3): 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1.5			
Total Air Circulation or Design Air Flow	3.62	L/s.m²	0.71	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA) L/s.m² CFM/ft²
Operation occupied period 50%
Operation unoccupied period 50%

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,725,707	
Peak Zone Sensible Load	659,946	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	30,701	
Total air circulation or Design air	3.62	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	16	°C	60.8	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	24	°C	75.2	°F	24	°C	75.2	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	24	°C	75.2	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Long Term Care (Nursing Home)	All volumes		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	200	Lux	18.6	ft-candles
Floor Fraction (GLFF)	0.75			
Connected Load	12.9	W/m²	1.2	W/ft²

Occ. Period(Hrs./yr.)	3000
Unocc. Period(Hrs./yr.)	5760
Usage During Occupied Period	85%
Usage During Unoccupied Period	45%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	200	300	500	700				Total
% Distribution	100%							100%
Weighted Average								**200**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	30%	10%	25%		35%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI		
	kWh/ft².yr	4.6
	MJ/m².yr	179

ARCHITECTURAL LIGHTING (SERVICES, KITCHEN, OFFICES, DINING, RECREATION)

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.25			
Connected Load	14.0	W/m²	1.3	W/ft²

Occ. Period(Hrs./yr.)	5000
Unocc. Period(Hrs./yr.)	3760
Usage During Occupied Period	95%
Usage During Unoccupied Period	55%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	15%	5%	35%		40%	5%	0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI		
	kWh/ft².yr	2.2
	MJ/m².yr	86

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI		
	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING — Overall LP 13.16 W/m²

EUI TOTAL		
	kWh/ft².yr	7
	MJ/m².yr	265

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)						
Connected Load W/m²						3.5
Connected Load W/ft²						0.33
Diversity Occupied Period	80%	80%	80%	80%		70%
Diversity Unoccupied Period	50%	50%	50%	50%		40%
Operation Occ. Period (hrs./year)	2000	2000	2000	2000		3000
Operation Unocc. Period (hrs./year)	6760	6760	6760	6760	8760	5760

Total end-use load (occupied period)	2.5	W/m²	0.2	W/ft²
Total end-use load (unocc. period)	1.4	W/m²	0.1	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	57%			

	EUI		
Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	1.43
		MJ/m².yr	55.49

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 82.0% Electricity Fuel Share: 18.0%

Commercial Food Preparation

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	1.5	EUI	kWh/ft².yr	1.5
	MJ/m².yr	60.0		MJ/m².yr	60.0

REFRIGERATION EQUIPMENT

Provide description below:

EUI		
	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI		
	kWh/ft².yr	1.8
	MJ/m².yr	70

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Long Term Care (Nursing Home)** **Baseline**
SIZE: **All volumes**
VINTAGE:
REGION: **Southern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total	
System Present (%)	21%	21%	3%		20%		35%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load	93.9 W/m²	29.8 Btu/hr.ft²	
Seasonal Heating Load (Tertiary Load)	814 MJ/m².yr	21.0 kWh/ft².yr	
Sizing Factor	2.00		
Electric Fuel Share	35.0%	Gas Fuel Share 65.0%	Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	21.0	27.6	25.3
MJ/m².yr	814	1069	980

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	Centrifugal Chillers HE	Screw Chillers	Recprocting Chillers Open	Recprocting Chillers DX	Gas Cooling Absorption	Gas Cooling Engine	Total
System Present (%)	20.0%	10.0%		40.0%	30.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	16.0	60.8

Peak Cooling Load	84 W/m²	27 Btu/hr.ft²	449 ft²/Ton
Seasonal Cooling Load (Tertiary Load)	238.5 MJ/m².yr	6.2 kWh/ft².yr	

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 60.0%

Electric Fuel Share 100.0% — Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	1.9		1.9
MJ/m².yr	74		74

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	65%		20%	3%	2%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	90%	10%	100%
Blended Efficiency	0.74	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 180.0

Wetting Use Percentage 10%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	5.1	6.3	6.2
MJ/m².yr	198	245	239.9

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Long Term Care (Nursing Home)** **Baseline**
SIZE: **All volumes**
VINTAGE:
REGION: **Southern Franchise**

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.6	L/s.m²	0.71	CFM/ft²
System Static Pressure CAV	625	Pa	2.5	wg
System Static Pressure VAV	625	Pa	2.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	5.1	W/m²	0.48	W/ft²
Fan Design Load VAV	5.1	W/m²	0.48	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	25%	75%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	50%	50%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.86	W/m²	0.17	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.007	U.S. gpm/ft²
Pump Head Pressure	75	kPa	25	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.66	W/m²	0.06	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0053	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	75	kPa	25	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.5	W/m²	0.05	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	16.4	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.4	kWh/m².yr
Condenser Pump Energy Consumption	1.9	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.2	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	2.4	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	2.2
	MJ/m².yr	84.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Long Term Care (Nursing Home)	**All volumes**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**20.8** kWh/ft².yr	**805.1** MJ/m².yr	**Gas:**	**26.7** kWh/ft².yr	**1,034.3** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING (SUITES)	4.6	178.7					
ARCHITECTURAL LIGHTING (SER'	2.2	86.1	SPACE HEATING	7.4	284.9	17.9	695.0
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	1.1	44.4		
OTHER PLUG LOADS	1.4	55.5	DOMESTIC HOT WATER	0.5	19.8	5.7	220.1
HVAC FANS & PUMPS	2.2	84.0	FOOD SERVICE EQUIPMENT	0.3	10.8	1.3	49.2
REFRIGERATION EQUIPMENT	0.5	20.0	MISCELLANEOUS			1.8	70.0
COMPUTER EQUIPMENT							
ELEVATORS	0.1	3.9					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
School	All Volumes		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.49	W/m².°C	0.09	Btu/hr.ft² .°F	Typical Building Size	5,200	m²	55,952	ft²
Roof U value (W/m².°C)	0.40	W/m².°C	0.07	Btu/hr.ft² .°F	Typical Footprint (m²)	2,600	m²	27,976	ft²
Glazing U value (W/m².°C)	3.47	W/m².°C	0.61	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	50%			
Window/Wall Ratio (WIWAR) (%)	0.28								
Shading Coefficient (SC)	0.68				Typical # Stories	2			
					Floor to Floor Height (m)	3.5	m	11.5	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	100%								100%
Min. Air Flow (%)									

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	10	m²/person	108	ft²/person
Occupancy Schedule Occ. Period	90%			
Occupancy Schedule Unocc. Period				
Fresh Air Requirements or Outside Air	7	L/s.person	15	CFM/person

%OA 29.86%

Fresh Air Control Type *(enter a 1, 2 or 3) 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 10%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.5 L/s.m² 0.10 CFM/ft²
50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	2.34	L/s.m²	0.46	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA) L/s.m² CFM/ft²
Operation occupied period 50%
Operation unoccupied period 50%

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	20%		80%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,388,520	
Peak Zone Sensible Load	555,278	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	25,831	
Total air circulation or Design air	2.34	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	35%	90%
DDC/Pneumatic	55%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	17	°C	62.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	17.4	°C	63.32	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning Changes/Year 4

Incidence of Annual Room Controls Maintenance 100.0%

Incidence of Annual HVAC Controls Maintenance 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
School	All Volumes		Southern Franchise
Baseline			

LIGHTING

GENERAL (CLASSROOM) LIGHTING

Light Level	420	Lux	39.0	ft-candles
Floor Fraction (GLFF)	0.60			
Connected Load	10.5	W/m²	1.0	W/ft²
Occ. Period(Hrs./yr.)	2200			
Unocc. Period(Hrs./yr.)	6560			
Usage During Occupied Period	90%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000	Total
% Distribution	40%	60%			100%
Weighted Average					**420**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)			20%		80%			100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	1.6
	MJ/m².yr	60

ARCHITECTURAL LIGHTING

Light Level	370	Lux	34.4	ft-candles
Floor Fraction (ALFF)	0.30			
Connected Load	11.7	W/m²	1.1	W/ft²
Occ. Period(Hrs./yr.)	2200			
Unocc. Period(Hrs./yr.)	6560			
Usage During Occupied Period	90%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000	Total
% Distribution	65%	35%			100%
Weighted Average					**370**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%	10%		80%			100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	0.9
	MJ/m².yr	33

HIGH BAY (GYMNASIUM) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)	0.10			
Connected Load	13.5	W/m²	1.3	W/ft²
Occ. Period(Hrs./yr.)	2600			
Unocc. Period(Hrs./yr.)	6160			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)			10%			90%	0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	0.4
	MJ/m².yr	16

TOTAL LIGHTING — Overall LP 9.83 W/m²

EUI TOTAL	kWh/ft².yr	3
	MJ/m².yr	109

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.1	0.1	0.01	0.01		
Connected Load	0.5 W/m²	0.5 W/m²	0.1 W/m²	0.2 W/m²	0.5 W/m²	1.1 W/m²
	0.1 W/ft²	0.0 W/ft²	0.01 W/ft²	0.02 W/ft²	0.05 W/ft²	0.10 W/ft²
Diversity Occupied Period	50%	50%	50%	50%		50%
Diversity Unoccupied Period	30%	30%				10%
Operation Occ. Period (hrs./year)	2000	2000	2000	2000		2000
Operation Unocc. Period (hrs./year)	6760	6760	6760	6760	8760	6760

Total end-use load (occupied period)	1.2 W/m²	0.1 W/ft²
Total end-use load (unocc. period)	0.4 W/m²	0.0 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	35%	

Computer Equipment	EUI	kWh/ft².yr	0.32
		MJ/m².yr	12.56
Plug Loads	EUI	kWh/ft².yr	0.17
		MJ/m².yr	6.64

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 53.0% Electricity Fuel Share: 47.0%

Cooking

	Natural Gas EUI		All Electric EUI	
EUI	kWh/ft².yr	0.5	kWh/ft².yr	0.5
	MJ/m².yr	20.0	MJ/m².yr	20.0

REFRIGERATION

Provide description below:

Coolers, freezers, pop machines

EUI	kWh/ft².yr	0.1
	MJ/m².yr	5.0

MISCELLANEOUS

EUI	kWh/ft².yr	0.1
	MJ/m².yr	5

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **School** **Baseline**
SIZE: **All Volumes**
VINTAGE:
REGION: **Southern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total	
System Present (%)	30%	30%	20%		9%		11%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load: 47.6 W/m² — 15.1 Btu/hr.ft²
Seasonal Heating Load (Tertiary Load): 616 MJ/m².yr — 15.9 kWh/ft².yr
Sizing Factor: 1.00

Electric Fuel Share: 11.0% — Gas Fuel Share: 89.0% — Oil Fuel Share:

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	15.9
MJ/m².yr	616
Natural Gas EUI	
kWh/ft².yr	20.1
MJ/m².yr	777
Market Composite EUI	
kWh/ft².yr	19.6
MJ/m².yr	759

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Absorption	Engine	Total
System Present (%)	10.0%			15.0%	75.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	14.0	57.2

Peak Cooling Load: 78 W/m² — 25 Btu/hr.ft² — 484 ft²/Ton
Seasonal Cooling Load (Tertiary Load): 194.3 MJ/m².yr — 5.0 kWh/ft².yr

Sizing Factor: 1.00 — Operation (occ. period): 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C): 15.0%

Electric Fuel Share: 100.0% — Gas Fuel Share:

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	1.7
MJ/m².yr	66
Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	
Market Composite EUI	
kWh/ft².yr	1.7
MJ/m².yr	66

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	30%		44%	1%	2%
Eff./COP	75%		65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	77%	23%	100%
Blended Efficiency	0.70	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load): 40.0

Wetting Use Percentage: 80%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	1.1	1.5	1.4
MJ/m².yr	44	57	54.2

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
School	All Volumes		Southern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	2.3	L/s.m²	0.46	CFM/ft²
System Static Pressure CAV	500	Pa	2.0	wg
System Static Pressure VAV	500	Pa	2.0	wg
Fan Efficiency	55%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	2.5	W/m²	0.23	W/ft²
Fan Design Load VAV	2.5	W/m²	0.23	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	20%	80%	20%	80%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.003	kW/kW	0.01	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	0.23	W/m²	0.02	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0050	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	30	kPa	10	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.2	W/m²	0.02	W/ft²		

Supply Fan Occ. Period	2200	hrs./year
Supply Fan Unocc. Period	6560	hrs./year
Supply Fan Energy Consumption	8.8	kWh/m².yr
Exhaust Fan Occ. Period	2200	hrs./year
Exhaust Fan Unocc. Period	6560	hrs./year
Exhaust Fan Energy Consumption	0.8	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.1	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	1.2	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	1.0
	MJ/m².yr	39.6

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
School	**All Volumes**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**7.5** kWh/ft².yr	**290.8** MJ/m².yr	**Gas:**	**19.4** kWh/ft².yr	**751.1** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL (CLASSROOM) LIGHTIN(	1.6	60.1
ARCHITECTURAL LIGHTING	0.9	33.2
HIGH BAY (GYMNASIUM) LIGHTINC	0.4	15.6
OTHER PLUG LOADS	0.2	6.6
HVAC FANS & PUMPS	1.0	39.6
REFRIGERATION	0.1	5.0
COMPUTER EQUIPMENT	0.3	12.6
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	1.8	67.8	17.9	691.4
SPACE COOLING	0.3	9.9		
DOMESTIC HOT WATER	0.3	10.1	1.1	44.1
FOOD SERVICE EQUIPMENT	0.2	9.4	0.3	10.6
MISCELLANEOUS			0.1	5.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
University/College	Contract		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.53	W/m².°C	0.09	Btu/hr.ft² .°F	Typical Building Size	12,500	m²	134,500	ft²
Roof U value (W/m².°C)	0.45	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Footprint (m²)	4,167	m²	44,833	ft²
Glazing U value (W/m².°C)	3.23	W/m².°C	0.57	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.29								
Shading Coefficient (SC)	0.65				Typical # Stories	3			
					Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	30%	5%	5%		30%			30%	70%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	15	m²/person	161	ft²/person
Occupancy Schedule Occ. Period	80%			
Occupancy Schedule Unocc. Period				
Fresh Air Requirements or Outside Air	14	L/s.person	30	CFM/person

%OA 21.76%

Fresh Air Control Type *(enter a 1, 2 or 3) 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² 0.10 CFM/ft²; 50% operation (%)

Sizing Factor	1.7			
Total Air Circulation or Design Air Flow	4.29	L/s.m²	0.84	CFM/ft²
Infiltration Rate	0.50	L/s.m²	0.10	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	3,894,291	
Peak Zone Sensible Load	1,436,142	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	66,809	
Total air circulation or Design air	4.29	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	17	°C	62.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20.25	°C	68.45	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
University/College	**Contract**		**Southern Franchise**
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	540	Lux	50.2	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	15.0	W/m²	1.4	W/ft²

Occ. Period(Hrs./yr.)	4100
Unocc. Period(Hrs./yr.)	4660
Usage During Occupied Period	90%
Usage During Unoccupied Period	10%
Fixture Cleaning:	
Incidence of Practice	
Interval	years

Light Level (Lux)	300	500	700	1000				Total
% Distribution	10%	60%	30%					100%
Weighted Average								**540**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	3%	2%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	kWh/ft².yr	4.9
	MJ/m².yr	191

ARCHITECTURAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	12.1	W/m²	1.1	W/ft²

Occ. Period(Hrs./yr.)	4100
Unocc. Period(Hrs./yr.)	4660
Usage During Occupied Period	90%
Usage During Unoccupied Period	50%
Fixture Cleaning:	
Incidence of Practice	
Interval	years

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	10%	10%			90%		0%	110.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence of Practice	Group	Spot

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	1.0
	MJ/m².yr	39

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 14.56 W/m²

EUI TOTAL	kWh/ft².yr	6
	MJ/m².yr	230

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.1	0.1	0.02	0.01		
Connected Load	0.4 W/m²	0.3 W/m²	0.1 W/m²	0.1 W/m²	0.5 W/m²	3 W/m²
	0.0 W/ft²	0.0 W/ft²	0.01 W/ft²	0.01 W/ft²	0.05 W/ft²	0.28 W/ft²
Diversity Occupied Period	85%	80%	90%	90%	100%	100%
Diversity Unoccupied Period	35%	35%	20%	10%	100%	50%
Operation Occ. Period (hrs./year)	2900	2900	2600	2600	2000	3000
Operation Unocc. Period (hrs./year)	5860	5860	6160	6160	6760	5760

Total end-use load (occupied period)	4.4	W/m²	0.4	W/ft²
Total end-use load (unocc. period)	2.3	W/m²	0.2	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	53%			

Computer Equipment	EUI	kWh/ft².yr	0.79
		MJ/m².yr	30.57
Plug Loads	EUI	kWh/ft².yr	1.66
		MJ/m².yr	64.21

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 70.0% Electricity Fuel Share: 30.0%

Cafeteria/food service

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	1.0	EUI	kWh/ft².yr	1.0
	MJ/m².yr	40.0		MJ/m².yr	40.0

REFRIGERATION

Provide description below:

Coolers, freezers, fridges, pop machines

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI	kWh/ft².yr	1.8
	MJ/m².yr	70

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
University/College	Contract		Southern Franchise
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric		
	Boilers				RTU	Furnace	Resistance	Total	
	Standard	Near Cond	Cond						
System Present (%)	10%	50%	3%		20%		17%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load	47.7 W/m²	15.1 Btu/hr.ft²	
Seasonal Heating Load (Tertiary Load)	520 MJ/m².yr	13.4 kWh/ft².yr	
Sizing Factor	1.00		
Electric Fuel Share	17.0%	Gas Fuel Share 83.0%	Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	kWh/ft².yr	13.4
	MJ/m².yr	520
Natural Gas EUI	kWh/ft².yr	17.6
	MJ/m².yr	682
Market Composite EUI	kWh/ft².yr	16.9
	MJ/m².yr	655

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)	56.0%	20.0%		5.0%	15.0%	4.0%		100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6 °C	42.8 °F
Condenser Water	35 °C	95 °F
Supply Air	14.0 °C	57.2 °F

Peak Cooling Load	91 W/m²	29 Btu/hr.ft²	414 ft²/Ton
Seasonal Cooling Load (Tertiary Load)	252.5 MJ/m².yr	6.5 kWh/ft².yr	

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 96.0% — Gas Fuel Share 4.0%

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	kWh/ft².yr	2.0
	MJ/m².yr	77
Natural Gas EUI	kWh/ft².yr	5.5
	MJ/m².yr	215
Market Composite EUI	kWh/ft².yr	2.1
	MJ/m².yr	82

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	68%		20%	1%	2%
Eff./COP	75%		65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	91%	9%	100%
Blended Efficiency	0.73	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 80.0

Wetting Use Percentage 50%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	2.3	2.8	2.8
MJ/m².yr	88	109	107.2

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
University/College	**Contract**		**Southern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	4.3	L/s.m²	0.84	CFM/ft²
System Static Pressure CAV	875	Pa	3.5	wg
System Static Pressure VAV	875	Pa	3.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	8.5	W/m²	0.79	W/ft²
Fan Design Load VAV	8.5	W/m²	0.79	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	70%	30%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	35%	65%	35%	65%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.0	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.1	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	2.02	W/m²	0.19	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.005	L/s.m²	0.007	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.42	W/m²	0.13	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0058	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.2	W/m²	0.11	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	37.1	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.1	kWh/m².yr
Condenser Pump Energy Consumption	5.2	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.2	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	6.7	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	4.8
	MJ/m².yr	184.7

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
University/College	**Contract**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**18.4** kWh/ft².yr	**714.0** MJ/m².yr	**Gas:**	**19.9** kWh/ft².yr	**769.9** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	4.9	190.7
ARCHITECTURAL LIGHTING	1.0	39.4
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	1.7	64.2
HVAC FANS & PUMPS	4.8	184.7
REFRIGERATION	0.5	20.0
COMPUTER EQUIPMENT	0.8	30.6
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	2.3	88.4	14.6	566.1
SPACE COOLING	1.4	55.3	0.2	6.4
DOMESTIC HOT WATER	0.2	7.9	2.6	99.3
FOOD SERVICE EQUIPMENT	0.3	12.0	0.7	28.0
MISCELLANEOUS			1.8	70.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
University / College	All volumes except contract customers		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.57	W/m².°C	0.10	Btu/hr.ft² .°F	Typical Building Size	12,500	m²	134,500	ft²
Roof U value (W/m².°C)	0.48	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Footprint (m²)	4,167	m²	44,833	ft²
Glazing U value (W/m².°C)	3.23	W/m².°C	0.57	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.29								
Shading Coefficient (SC)	0.65				Typical # Stories	3			
					Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	30%	5%	5%		30%			30%	70%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	15	m²/person	161	ft²/person	%OA	21.96%
Occupancy Schedule Occ. Period	80%					
Occupancy Schedule Unocc. Period						
Fresh Air Requirements or Outside Air	14	L/s.person	30	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) | 1 | If Fresh Air Control Type = "2" enter % FA. to the right: | 15%
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air) | If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation | 0.5 L/s.m² | 0.10 CFM/ft²
50% operation (%)

Sizing Factor	1.7			
Total Air Circulation or Design Air Flow	4.25	L/s.m²	0.84	CFM/ft²
Infiltration Rate	0.50	L/s.m²	0.10	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²	CFM/ft²
Operation occupied period	50%		
Operation unoccupied period	50%		

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	3,881,325	
Peak Zone Sensible Load	1,423,175	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	66,206	
Total air circulation or Design air	4.25	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	17	°C	62.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20.25	°C	68.45	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
University / College	All volumes except contract customers		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	540	Lux	50.2	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	15.0	W/m²	1.4	W/ft²

Occ. Period(Hrs./yr.)	4100
Unocc. Period(Hrs./yr.)	4660
Usage During Occupied Period	90%
Usage During Unoccupied Period	10%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	10%	60%	30%					100%
Weighted Average								**540**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	3%	2%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	4.9
	MJ/m².yr	191

ARCHITECTURAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	9.3	W/m²	0.9	W/ft²

Occ. Period(Hrs./yr.)	4100
Unocc. Period(Hrs./yr.)	4660
Usage During Occupied Period	90%
Usage During Unoccupied Period	50%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	0.8
	MJ/m².yr	30

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 14.13 W/m²

EUI TOTAL	kWh/ft².yr	6
	MJ/m².yr	221

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.1	0.1	0.02	0.01		
Connected Load	0.4 W/m²	0.3 W/m²	0.1 W/m²	0.1 W/m²	0.5 W/m²	3 W/m²
	0.0 W/ft²	0.0 W/ft²	0.01 W/ft²	0.01 W/ft²	0.05 W/ft²	0.28 W/ft²
Diversity Occupied Period	85%	80%	90%	90%	100%	100%
Diversity Unoccupied Period	35%	35%	20%	10%	100%	50%
Operation Occ. Period (hrs./year)	2900	2900	2600	2600	2000	3000
Operation Unocc. Period (hrs./year)	5860	5860	6160	6160	6760	5760

Total end-use load (occupied period)	4.4	W/m²	0.4	W/ft²
Total end-use load (unocc. period)	2.3	W/m²	0.2	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	53%			

Computer Equipment	EUI	kWh/ft².yr	0.79
		MJ/m².yr	30.57
Plug Loads	EUI	kWh/ft².yr	1.66
		MJ/m².yr	64.21

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 70.0% Electricity Fuel Share: 30.0%

Cafeteria/food service

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	0.8	EUI	kWh/ft².yr	0.8
	MJ/m².yr	30.0		MJ/m².yr	30.0

REFRIGERATION

Provide description below:

Coolers, freezers, fridges, pop machines

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI	kWh/ft².yr	1.0
	MJ/m².yr	40

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
University / College	**All volumes except contract customers**		**Southern Franchise**
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	10%	50%	3%		20%		17%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	48.8 W/m²	15.5 Btu/hr.ft²	
Seasonal Heating Load (Tertiary Load)	527 MJ/m².yr	13.6 kWh/ft².yr	
Sizing Factor	1.00		
Electric Fuel Share	17.0%	Gas Fuel Share 83.0%	Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	kWh/ft².yr	13.6
	MJ/m².yr	527
Natural Gas EUI	kWh/ft².yr	17.9
	MJ/m².yr	693
Market Composite EUI	kWh/ft².yr	17.2
	MJ/m².yr	665

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)	56.0%	20.0%		5.0%	15.0%	4.0%		100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6 °C	42.8 °F
Condenser Water	35 °C	95 °F
Supply Air	14.0 °C	57.2 °F

Peak Cooling Load	91 W/m²	29 Btu/hr.ft²	416 ft²/Ton
Seasonal Cooling Load (Tertiary Load)	248.9 MJ/m².yr	6.4 kWh/ft².yr	

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 96.0% — Gas Fuel Share 4.0%

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	kWh/ft².yr	1.9
	MJ/m².yr	73
Natural Gas EUI	kWh/ft².yr	5.4
	MJ/m².yr	210
Market Composite EUI	kWh/ft².yr	2.0
	MJ/m².yr	79

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	68%		20%	1%	2%
Eff./COP	75%		65%	90%	90%

	Fossil		Elec. Res.	
Fuel Share	91%		9%	100%
Blended Efficiency	0.73		0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 70.0

Wetting Use Percentage 50%

All Electric EUI	kWh/ft².yr	2.0
	MJ/m².yr	77
All Natural Gas EUI	kWh/ft².yr	2.5
	MJ/m².yr	96
Market Composite EUI	kWh/ft².yr	2.4
	MJ/m².yr	93.8

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **University / College** **Baseline**

SIZE: **All volumes except contract customers**

VINTAGE:

REGION: **Southern Franchise**

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	4.2	L/s.m²	0.84	CFM/ft²
System Static Pressure CAV	875	Pa	3.5	wg
System Static Pressure VAV	875	Pa	3.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	8.4	W/m²	0.78	W/ft²
Fan Design Load VAV	8.4	W/m²	0.78	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	70%	30%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	35%	65%	35%	65%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.0	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.1	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	2.01	W/m²	0.19	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.005	L/s.m²	0.007	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.42	W/m²	0.13	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0058	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.2	W/m²	0.11	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	36.7	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.1	kWh/m².yr
Condenser Pump Energy Consumption	4.8	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.2	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	6.7	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	4.7
	MJ/m².yr	182.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
University / College	**All volumes except contract customers**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**18.0** kWh/ft².yr	**696.8** MJ/m².yr	**Gas:**	**18.8** kWh/ft².yr	**729.8** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING	4.9	190.7					
ARCHITECTURAL LIGHTING	0.8	30.1	SPACE HEATING	2.3	89.7	14.9	575.6
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	1.4	52.8	0.2	6.3
OTHER PLUG LOADS	1.7	64.2	DOMESTIC HOT WATER	0.2	6.9	2.2	86.9
HVAC FANS & PUMPS	4.7	182.0	FOOD SERVICE EQUIPMENT	0.2	9.0	0.5	21.0
REFRIGERATION	0.5	20.0	MISCELLANEOUS			1.0	40.0
COMPUTER EQUIPMENT	0.8	30.6					
ELEVATORS	0.1	3.9					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Restaurant	All		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.64	W/m².°C	0.11	Btu/hr.ft² .°F	Typical Building Size	500 m²	5,380	ft²
Roof U value (W/m².°C)	0.47	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Footprint (m²)	500 m²	5,380	ft²
Glazing U value (W/m².°C)	4.07	W/m².°C	0.72	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	1		
					Percent Conditioned Space	100%		
					Percent Conditioned Space Defined as Exterior Zone	40%		
Window/Wall Ratio (WIWAR) (%)	0.15							
Shading Coefficient (SC)	0.70				Typical # Stories	1		
					Floor to Floor Height (m)	4.5 m	14.8	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	60%							40%	60%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	50	m²/person	538	ft²/person	%OA	8.16%
Occupancy Schedule Occ. Period	90%					
Occupancy Schedule Unocc. Period						
Fresh Air Requirements or Outside Air	22	L/s.person	47	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) | 2 | If Fresh Air Control Type = "2" enter % FA. to the right: 40%
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air) | If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1.2			
Total Air Circulation or Design Air Flow	5.39	L/s.m²	1.06	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)	2	L/s.m²	0.39	CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	499,906	
Peak Zone Sensible Load	102,283	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	4,758	
Total air circulation or Design air	5.39	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	15	°C	59	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	20	°C	68	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20	°C	68	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Restaurant	All		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	400	Lux	37.2	ft-candles
Floor Fraction (GLFF)	0.90			
Connected Load	25.6	W/m²	2.4	W/ft²

Occ. Period(Hrs./yr.)	4300	Light Level (Lux)	400	500	700	1000				Total
Unocc. Period(Hrs./yr.)	4460	% Distribution	100%							100%
Usage During Occupied Period	100%	Weighted Average								**400**
Usage During Unoccupied Period	10%									
			INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
Fixture Cleaning:		System Present (%)	30%	5%	35%		30%		0%	100.0%
Incidence of Practice		CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
Interval	years	LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
		Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence	Group	Spot			
of Practice			EUI	kWh/ft².yr	10.2
				MJ/m².yr	394

ARCHITECTURAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.10			
Connected Load	19.4	W/m²	1.8	W/ft²

Occ. Period(Hrs./yr.)	4300	Light Level (Lux)	300	500	700	1000				Total
Unocc. Period(Hrs./yr.)	4460	% Distribution	100%							100%
Usage During Occupied Period	100%	Weighted Average								**300**
Usage During Unoccupied Period	10%									
			INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
Fixture Cleaning:		System Present (%)	30%	5%	45%		20%		0%	100.0%
Incidence of Practice		CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
Interval	years	LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
		Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence	Group	Spot			
of Practice			EUI	kWh/ft².yr	0.9
		EUI = Load X Hrs. X SF X GLFF		MJ/m².yr	33

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles	Floor fraction check: should = 1.00	1.00
Floor Fraction (HBLFF)						
Connected Load	0.0	W/m²	0.0	W/ft²		

Occ. Period(Hrs./yr.)	4000	Light Level (Lux)	300	500	700	1000				Total
Unocc. Period(Hrs./yr.)	4760	% Distribution	100%							100%
Usage During Occupied Period	0%	Weighted Average								**300**
Usage During Unoccupied Period	100%									
			INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
Fixture Cleaning:		System Present (%)							0%	0.0%
Incidence of Practice		CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
Interval	years	LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
		Efficacy (L/W)	15	50	72	84	88	65	90	

Relamping Strategy & Incidence	Group	Spot			
of Practice			EUI	kWh/ft².yr	
				MJ/m².yr	

TOTAL LIGHTING	Overall LP	25.01 W/m²	EUI TOTAL kWh/ft².yr	11
			MJ/m².yr	427

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)												
Connected Load		W/m²		W/m²		W/m²		W/m²	0.5	W/m²	2	W/m²
		W/ft²		W/ft²		W/ft²		W/ft²	0.05	W/ft²	0.19	W/ft²
Diversity Occupied Period											100%	
Diversity Unoccupied Period											90%	
Operation Occ. Period (hrs./year)											4000	
Operation Unocc. Period (hrs./year)	8760		8760		8760		8760		8760		4760	

Total end-use load (occupied period)	2.0 W/m²	0.2 W/ft²					
Total end-use load (unocc. period)	1.8 W/m²	0.2 W/ft²					
			Computer Equipment	EUI	kWh/ft².yr	
Usage during occupied period	100%				MJ/m².yr	
Usage during unoccupied period	90%		Plug Loads	EUI	kWh/ft².yr	1.54
					MJ/m².yr	59.64

FOOD SERVICE EQUIPMENT

Provide description below:	Gas Fuel Share:	88.0%	Electricity Fuel Share:	12.0%	Natural Gas EUI			All Electric EUI		
Cooking					EUI	kWh/ft².yr	23.2	EUI	kWh/ft².yr	23.2
						MJ/m².yr	900.0		MJ/m².yr	900.0

REFRIGERATION

Provide description below:			
Walk-ins, reach ins, fridges etc	EUI	kWh/ft².yr	9.0
		MJ/m².yr	350.0

MISCELLANEOUS

	EUI	kWh/ft².yr	0.3
		MJ/m².yr	10

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Restaurant	All		Southern Franchise
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	10%	4%	1%		62%	5%	18%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load: 90.4 W/m² — 28.7 Btu/hr.ft²
Seasonal Heating Load (Tertiary Load): 911 MJ/m².yr — 23.5 kWh/ft².yr
Sizing Factor: 1.00

Electric Fuel Share: 18.0% Gas Fuel Share: 82.0% Oil Fuel Share:

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	23.5
MJ/m².yr	911

Natural Gas EUI	
kWh/ft².yr	37.5
MJ/m².yr	1454

Market Composite EUI	
kWh/ft².yr	35.0
MJ/m².yr	1356

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)	20.0%				80.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	15.0	59

Peak Cooling Load: 293 W/m² — 93 Btu/hr.ft² — 129 ft²/Ton
Seasonal Cooling Load (Tertiary Load): 556.4 MJ/m².yr — 14.4 kWh/ft².yr

Sizing Factor: 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C): 85.0%

Electric Fuel Share: 100.0% Gas Fuel Share:

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

All Electric EUI	
kWh/ft².yr	5.0
MJ/m².yr	195

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	5.0
MJ/m².yr	195

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	10%		65%	4%	3%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	82%	18%
Blended Efficiency	0.68	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load): 400.0

Wetting Use Percentage: 10%

All Electric EUI	
kWh/ft².yr	11.3
MJ/m².yr	440

All Natural Gas EUI	
kWh/ft².yr	15.1
MJ/m².yr	585

Market Composite EUI	
kWh/ft².yr	14.4
MJ/m².yr	559.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Restaurant	**All**		**Southern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	5.4	L/s.m²	1.06	CFM/ft²
System Static Pressure CAV	500	Pa	2.0	wg
System Static Pressure VAV	500	Pa	2.0	wg
Fan Efficiency	52%			
Fan Motor Efficiency	80%			
Sizing Factor	1.00			
Fan Design Load CAV	6.5	W/m²	0.60	W/ft²
Fan Design Load VAV	6.5	W/m²	0.60	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	50%	50%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.4	L/s.m²	0.08	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.5	L/s.m²	0.10	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	72%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.7	W/m²	0.06	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	6.47	W/m²	0.60	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.016	L/s.m²	0.023	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.013	L/s.m²	0.0186	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure		kPa		ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load		W/m²		W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	41.0	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	4.4	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	2.7	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption		kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	4.5
	MJ/m².yr	173.2

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Restaurant	**All**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES: **Electricity:** **43.1** kWh/ft².yr **1,671.4** MJ/m².yr **Gas:** **63.9** kWh/ft².yr **2,473.8** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	10.2	394.0
ARCHITECTURAL LIGHTING	0.9	33.2
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	1.5	59.6
HVAC FANS & PUMPS	4.5	173.2
REFRIGERATION	9.0	350.0
COMPUTER EQUIPMENT		
ELEVATORS		
OUTDOOR LIGHTING	3.7	144.2

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	4.2	164.0	30.8	1,192.0
SPACE COOLING	4.3	166.0		
DOMESTIC HOT WATER	2.0	79.1	12.4	479.9
FOOD SERVICE EQUIPMENT	2.8	108.0	20.4	792.0
misc			0.3	10

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: Warehouse Baseline | **SIZE:** All volumes | **VINTAGE:** | **REGION:** Southern Franchise

CONSTRUCTION

Wall U value (W/m².°C)	0.70 W/m².°C	0.12 Btu/hr.ft² .°F	Typical Building Size	5,500	m²	59,180	ft²
Roof U value (W/m².°C)	0.31 W/m².°C	0.05 Btu/hr.ft² .°F	Typical Footprint (m²)	5,500	m²	59,180	ft²
Glazing U value (W/m².°C)	3.30 W/m².°C	0.58 Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2			
			Percent Conditioned Space	100%			
			Percent Conditioned Space Defined as Exterior Zone	40%			
Window/Wall Ratio (WIWAR) (%)	0.02						
Shading Coefficient (SC)	0.70		Typical # Stories	1			
			Floor to Floor Height (m)	9.1	m	30.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	100%								100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	100 m²/person	1076 ft²/person	%OA	13.40%
Occupancy Schedule Occ. Period	90%			
Occupancy Schedule Unocc. Period				
Fresh Air Requirements or Outside Air	30 L/s.person	64 CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) | 2 | If Fresh Air Control Type = "2" enter % FA. to the right: 15%
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air) | If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1	
Total Air Circulation or Design Air Flow	2.24 L/s.m²	0.44 CFM/ft²
Infiltration Rate	0.30 L/s.m²	0.06 CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA): L/s.m² | CFM/ft²
Operation occupied period: 50%
Operation unoccupied period: 50%

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,395,321	
Peak Zone Sensible Load	561,024	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	26,099	
Total air circulation or Design air	2.24	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	15	°C	59	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	20	°C	68	°F	20	°C	68	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20	°C	68	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Warehouse	All volumes		Southern Franchise
Baseline			

LIGHTING

GENERAL (HIGH BAY) LIGHTING

Light Level	350 Lux	32.5	ft-candles
Floor Fraction (GLFF)	0.95		
Connected Load	15.4 W/m²	1.4	W/ft²
Occ. Period(Hrs./yr.)	2500		
Unocc. Period(Hrs./yr.)	6260		
Usage During Occupied Period	100%		
Usage During Unoccupied Period	5%		
Fixture Cleaning:			
Incidence of Practice			
Interval		years	
Relamping Strategy & Incidence of Practice	Group	Spot	

Light Level (Lux)	300	400	700	1000				Total
% Distribution	50%	50%						100%
Weighted Average								**350**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)			5%		5%	85%	5%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI		
	kWh/ft².yr	3.8
	MJ/m².yr	148

ARCHITECTURAL (OFFICE AREA) LIGHTING

Light Level	400 Lux	37.2	ft-candles
Floor Fraction (ALFF)	0.05		
Connected Load	14.3 W/m²	1.3	W/ft²
Occ. Period(Hrs./yr.)	2500		
Unocc. Period(Hrs./yr.)	6260		
Usage During Occupied Period	100%		
Usage During Unoccupied Period	5%		
Fixture Cleaning:			
Incidence of Practice			
Interval		years	
Relamping Strategy & Incidence of Practice	Group	Spot	

Light Level (Lux)	300	500	700	1000				Total
% Distribution	50%	50%						100%
Weighted Average								**400**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%	70%		20%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI		
	kWh/ft².yr	0.2
	MJ/m².yr	7

OTHER (HIGH BAY) LIGHTING

Light Level	300.00 Lux	27.9	ft-candles
Floor Fraction (HBLFF)			
Connected Load	0.0 W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000		
Unocc. Period(Hrs./yr.)	4760		
Usage During Occupied Period	0%		
Usage During Unoccupied Period	100%		
Fixture Cleaning:			
Incidence of Practice			
Interval		years	
Relamping Strategy & Incidence of Practice	Group	Spot	

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI		
	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP	15.36 W/m²	EUI TOTAL	kWh/ft².yr	4
			MJ/m².yr	156

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.05	0.05	0.01	0.01		
Connected Load	0.0 W/m²	0.0 W/m²	0.0 W/m²	0.0 W/m²	0.5 W/m²	1 W/m²
	0.0 W/ft²	0.0 W/ft²	0.00 W/ft²	0.00 W/ft²	0.05 W/ft²	0.09 W/ft²
Diversity Occupied Period	100%	100%	90%			100%
Diversity Unoccupied Period						5%
Operation Occ. Period (hrs./year)	4000	4000	4000			4000
Operation Unocc. Period (hrs./year)	4760	4760	4760	8760	8760	4760

Total end-use load (occupied period)	1.1 W/m²	0.1 W/ft²
Total end-use load (unocc. period)	0.1 W/m²	0.0 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	5%	

Computer Equipment	EUI	kWh/ft².yr	0.02
		MJ/m².yr	0.89
Plug Loads	EUI	kWh/ft².yr	0.39
		MJ/m².yr	15.26

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 10.0% Electricity Fuel Share: 90.0%

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	0.3	EUI	kWh/ft².yr	0.3
	MJ/m².yr	10.0		MJ/m².yr	10.0

REFRIGERATION EQUIPMENT

Provide description below:

Coolers

EUI		
	kWh/ft².yr	1.0
	MJ/m².yr	40.0

MISCELLANEOUS EQUIPMENT

EUI		
	kWh/ft².yr	0.5
	MJ/m².yr	20

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: Warehouse Baseline | **SIZE:** All volumes | **VINTAGE:** | **REGION:** Southern Franchise

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond	U/H	RTU	Furnace	Electric Resistance	Total
System Present (%)	5%	5%	1%	55%	25%	5%	4%	100%
Eff./COP	75%	80%	90%	75%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.33	1.30	1.25	1.00	

100%

Peak Heating Load	49.7	W/m²	15.8	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	507	MJ/m².yr	13.1	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 4.0% | Gas Fuel Share 96.0% | Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

EUI	kWh/ft².yr	MJ/m².yr
All Electric EUI	13.1	507
Natural Gas EUI	19.1	738
Market Composite EUI	18.8	729

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	Centrifugal Chillers HE	Screw Chillers	Recprocting Chillers Open	Recprocting Chillers DX	Gas Cooling Absorption	Gas Cooling Engine	Total
System Present (%)	10.0%				90.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	15.0	59

Peak Cooling Load	74	W/m²	24	Btu/hr.ft²	509	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	92.7	MJ/m².yr	2.4	kWh/ft².yr		

Sizing Factor 1.00 | Operation (occ. period) 3000 hrs/year | Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 10.0%

Electric Fuel Share 100.0% | Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

EUI	kWh/ft².yr	MJ/m².yr
All Electric EUI	0.9	36
Natural Gas EUI		
Market Composite EUI	0.9	36

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	5%		57%	1%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	64%	36%
Blended Efficiency	0.67	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 25.0

Wetting Use Percentage 50%

EUI	kWh/ft².yr	MJ/m².yr
All Electric EUI	0.7	27
All Natural Gas EUI	1.0	38
Market Composite EUI	0.9	33.9

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Warehouse	**All volumes**		**Southern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	2.2	L/s.m²	0.44	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV	375	Pa	1.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	80%			
Sizing Factor	1.00			
Fan Design Load CAV	2.0	W/m²	0.19	W/ft²
Fan Design Load VAV	2.0	W/m²	0.19	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.0	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.1	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	72%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.64	W/m²	0.15	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0047	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure		kPa		ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load		W/m²		W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	12.8	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.7	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.5	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption		kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	1.4
	MJ/m².yr	53.8

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Warehouse	**All volumes**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**8.4**	kWh/ft².yr	**325.3**	MJ/m².yr	**Gas:**	**19.5** kWh/ft².yr	**753.9** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL (HIGH BAY) LIGHTING	3.8	148.3					
ARCHITECTURAL (OFFICE AREA) L	0.2	7.3	SPACE HEATING	0.5	20.3	18.3	708.9
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	0.1	3.6		
OTHER PLUG LOADS	0.4	15.3	DOMESTIC HOT WATER	0.3	9.9	0.6	24.0
HVAC FANS & PUMPS	1.4	53.8	FOOD SERVICE EQUIPMENT	0.2	9.0	0.03	1.0
REFRIGERATION EQUIPMENT	1.0	40.0	MISCELLANEOUS EQUIPMENT			0.5	20.0
COMPUTER EQUIPMENT	0.0	0.9					
ELEVATORS							
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Highrise	> 50,000 m3 contract customers		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.64	W/m².°C	0.11	Btu/hr.ft² .°F	Typical Building Size	7,300	m²	78,548	ft²
Roof U value (W/m².°C)	0.48	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Footprint (m²)	1,217	m²	13,091	ft²
Glazing U value (W/m².°C)	3.30	W/m².°C	0.58	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2.5			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.25								
Shading Coefficient (SC)	0.65				Typical # Stories	6			
					Floor to Floor Height (m)	2.8	m	9.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)								100%	
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	35	m²/person	377	ft²/person	%OA	81.63%
Occupancy Schedule Occ. Period	30%					
Occupancy Schedule Unocc. Period	90%					
Fresh Air Requirements or Outside Air	20	L/s.person	42	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) 3
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.7 L/s.m² 0.14 CFM/ft²
50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	0.70	L/s.m²	0.14	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,538,903	
Peak Zone Sensible Load	520,702	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	24,223	
Total air circulation or Design air	1.57	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	18	°C	64.4	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	22	°C	71.6	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Highrise	> 50,000 m3 contract customers		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	50	Lux	4.6	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	5.9	W/m²	0.5	W/ft²
Occ. Period(Hrs./yr.)	2100			
Unocc. Period(Hrs./yr.)	6660			
Usage During Occupied Period	30%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	50	100	200	300				Total
% Distribution	100%							100%
Weighted Average								**50**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	75%	5%	15%		5%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	0.6
	MJ/m².yr	23

ARCHITECTURAL LIGHTING (CORRIDORS)

Light Level	200	Lux	18.6	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	12.7	W/m²	1.2	W/ft²
Occ. Period(Hrs./yr.)	3000			
Unocc. Period(Hrs./yr.)	5760			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	100	200	300	500				Total
% Distribution		100%						100%
Weighted Average								**200**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	25%	35%	30%		10%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	1.6
	MJ/m².yr	60

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	0%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 6.92 W/m²

EUI TOTAL	kWh/ft².yr	2
	MJ/m².yr	84

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.9		0.9		0.15		0.1		0.08			
Connected Load	1.4	W/m²	1.3	W/m²	0.4	W/m²	0.6	W/m²	0.5	W/m²	2.5	W/m²
	0.1	W/ft²	0.1	W/ft²	0.04	W/ft²	0.05	W/ft²	0.05	W/ft²	0.23	W/ft²
Diversity Occupied Period											5%	
Diversity Unoccupied Period											20%	
Operation Occ. Period (hrs./year)											3000	
Operation Unocc. Period (hrs./year)	8760		8760		8760		8760		8760		5760	

Total end-use load (occupied period)	0.1	W/m²	0.0	W/ft²
Total end-use load (unocc. period)	0.5	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	400%			

Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	0.30
		MJ/m².yr	11.72

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 5.0% Electricity Fuel Share: 95.0%

Cooking

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	1.3	EUI	kWh/ft².yr	1.3
	MJ/m².yr	50.0		MJ/m².yr	50.0

REFRIGERATION

Provide description below:

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Highrise	> 50,000 m3 contract customers		Southern Franchise
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	47%	20%	3%		20%		10%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	42.9	W/m²	13.6	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	477	MJ/m².yr	12.3	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 10.0% Gas Fuel Share 90.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	12.3
MJ/m².yr	477
Natural Gas EUI	
kWh/ft².yr	16.3
MJ/m².yr	633
Market Composite EUI	
kWh/ft².yr	15.9
MJ/m².yr	617

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)	25.0%	25.0%			50.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	62	W/m²	20	Btu/hr.ft²	612	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	107.7	MJ/m².yr	2.8	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 40.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	0.9
MJ/m².yr	36
Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	
Market Composite EUI	
kWh/ft².yr	0.9
MJ/m².yr	36

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	23%		54%	1%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	79%	21%
Blended Efficiency	0.69	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 180.0

Wetting Use Percentage 10%

All Electric EUI		All Natural Gas EUI		Market Composite EUI	
kWh/ft².yr	5.1	kWh/ft².yr	6.8	kWh/ft².yr	6.4
MJ/m².yr	198	MJ/m².yr	263	MJ/m².yr	249.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Highrise	**> 50,000 m3 contract customers**		**Southern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	0.7	L/s.m²	0.14	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV		Pa		wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	0.6	W/m²	0.06	W/ft²
Fan Design Load VAV		W/m²		W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	100%	

Comments:

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.2	L/s.m²	0.03	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.3	L/s.m²	0.05	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.4	W/m²	0.03	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.37	W/m²	0.13	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.003	L/s.m²	0.005	U.S. gpm/ft²
Pump Head Pressure	0.1	kPa	0.0333333	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.00	W/m²	0.00	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0039	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	100	kPa	33	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.5	W/m²	0.05	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	3.8	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	3.1	kWh/m².yr
Condenser Pump Energy Consumption	0.0	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.5	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	3.3	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	1.0
	MJ/m².yr	38.4

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Highrise	> 50,000 m3 contract customers		Southern Franchise
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	Electricity:	8.4 kWh/ft².yr	325.6 MJ/m².yr	Gas:	20.6 kWh/ft².yr	799.3 MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING (SUITES)	0.6	23.4
ARCHITECTURAL LIGHTING (COR	1.6	60.2
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	0.3	11.7
HVAC FANS & PUMPS	1.0	38.4
REFRIGERATION	0.5	20.0
COMPUTER EQUIPMENT		
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	1.2	47.7	14.7	569.4
SPACE COOLING	0.4	14.3		
DOMESTIC HOT WATER	1.1	41.5	5.4	207.5
FOOD SERVICE EQUIPMENT	1.2	47.5	0.1	2.5
MISCELLANEOUS			0.5	20

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Highrise	> 50,000 m3 excluding contract customers		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.61	W/m².°C	0.11	Btu/hr.ft² .°F	Typical Building Size	7,300 m²	78,548	ft²
Roof U value (W/m².°C)	0.50	W/m².°C	0.09	Btu/hr.ft² .°F	Typical Footprint (m²)	1,217 m²	13,091	ft²
Glazing U value (W/m².°C)	3.30	W/m².°C	0.58	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2.5		
					Percent Conditioned Space	100%		
					Percent Conditioned Space Defined as Exterior Zone	36%		
Window/Wall Ratio (WIWAR) (%)	0.25							
Shading Coefficient (SC)	0.65				Typical # Stories	6		
					Floor to Floor Height (m)	2.8 m	9.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)								100%	
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	35	m²/person	377	ft²/person
Occupancy Schedule Occ. Period	30%			
Occupancy Schedule Unocc. Period	90%			
Fresh Air Requirements or Outside Air	20	L/s.person	42	CFM/person

%OA 81.63%

Fresh Air Control Type *(enter a 1, 2 or 3) 3
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.7 L/s.m² 0.14 CFM/ft²
50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	0.70	L/s.m²	0.14	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA) L/s.m² CFM/ft²
Operation occupied period 50%
Operation unoccupied period 50%

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,538,816	
Peak Zone Sensible Load	520,615	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	24,219	
Total air circulation or Design air	1.57	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	18	°C	64.4	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	22	°C	71.6	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning Changes/Year 4

Incidence of Annual Room Controls Maintenance 100.0%

Incidence of Annual HVAC Controls Maintenance 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Highrise	> 50,000 m3 excluding contract customers		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	50	Lux	4.6	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	5.9	W/m²	0.5	W/ft²
Occ. Period(Hrs./yr.)	2100			
Unocc. Period(Hrs./yr.)	6660			
Usage During Occupied Period	30%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	50	100	200	300	Total
% Distribution	100%				100%
Weighted Average					**50**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	75%	5%	15%		5%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	0.6
	MJ/m².yr	23

ARCHITECTURAL LIGHTING (CORRIDORS)

Light Level	200	Lux	18.6	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	12.7	W/m²	1.2	W/ft²
Occ. Period(Hrs./yr.)	3000			
Unocc. Period(Hrs./yr.)	5760			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	100	200	300	500	Total
% Distribution		100%			100%
Weighted Average					**200**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	25%	35%	30%		10%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	1.6
	MJ/m².yr	60

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	0%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING — Overall LP 6.92 W/m²

EUI TOTAL	kWh/ft².yr	2
	MJ/m².yr	84

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.9		0.9		0.15		0.1		0.08			
Connected Load	1.4	W/m²	1.3	W/m²	0.4	W/m²	0.6	W/m²	0.5	W/m²	2.5	W/m²
	0.1	W/ft²	0.1	W/ft²	0.04	W/ft²	0.05	W/ft²	0.05	W/ft²	0.23	W/ft²
Diversity Occupied Period											5%	
Diversity Unoccupied Period											20%	
Operation Occ. Period (hrs./year)											3000	
Operation Unocc. Period (hrs./year)	8760		8760		8760		8760		8760		5760	

Total end-use load (occupied period)	0.1	W/m²	0.0	W/ft²
Total end-use load (unocc. period)	0.5	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	400%			

Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	0.30
		MJ/m².yr	11.72

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 5.0% Electricity Fuel Share: 95.0%

Cooking

	Natural Gas EUI			All Electric EUI	
EUI	kWh/ft².yr	1.3	EUI	kWh/ft².yr	1.3
	MJ/m².yr	50.0		MJ/m².yr	50.0

REFRIGERATION

Provide description below:

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Highrise** **Baseline**

SIZE: **> 50,000 m3 excluding contract customers**

VINTAGE:

REGION: **Southern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	47%	20%	3%		20%		10%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	42.2	W/m²	13.4	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	472	MJ/m².yr	12.2	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 10.0% Gas Fuel Share 90.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	12.2
MJ/m².yr	472

Natural Gas EUI	
kWh/ft².yr	16.2
MJ/m².yr	626

Market Composite EUI	
kWh/ft².yr	15.8
MJ/m².yr	611

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)	25.0%	25.0%			50.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	62	W/m²	20	Btu/hr.ft²	613	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	107.8	MJ/m².yr	2.8	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 40.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	0.9
MJ/m².yr	36

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	0.9
MJ/m².yr	36

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	23%		54%	1%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	79%	21%	100%
Blended Efficiency	0.69	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 170.0

Wetting Use Percentage 10%

All Electric EUI	
kWh/ft².yr	4.8
MJ/m².yr	187

All Natural Gas EUI	
kWh/ft².yr	6.4
MJ/m².yr	248

Market Composite EUI	
kWh/ft².yr	6.1
MJ/m².yr	235.2

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **SIZE:** **VINTAGE:** **REGION:**
Highrise **> 50,000 m3 excluding contract customers** **Southern Franchise**
Baseline

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	0.7	L/s.m²	0.14	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV		Pa		wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	0.6	W/m²	0.06	W/ft²
Fan Design Load VAV		W/m²		W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.2	L/s.m²	0.03	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.3	L/s.m²	0.05	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.4	W/m²	0.03	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.36	W/m²	0.13	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.003	L/s.m²	0.005	U.S. gpm/ft²
Pump Head Pressure	0.1	kPa	0.0333333	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.00	W/m²	0.00	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0039	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	100	kPa	33	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.5	W/m²	0.05	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	3.8	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	3.1	kWh/m².yr
Condenser Pump Energy Consumption	0.0	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.5	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	3.3	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	1.0
	MJ/m².yr	38.4

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Highrise	**> 50,000 m3 excluding contract customers**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**8.3** kWh/ft².yr	**322.8** MJ/m².yr	**Gas:**	**20.2** kWh/ft².yr	**782.1** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING (SUITES)	0.6	23.4					
ARCHITECTURAL LIGHTING (COR	1.6	60.2	SPACE HEATING	1.2	47.2	14.6	563.7
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	0.4	14.4		
OTHER PLUG LOADS	0.3	11.7	DOMESTIC HOT WATER	1.0	39.2	5.1	195.9
HVAC FANS & PUMPS	1.0	38.4	FOOD SERVICE EQUIPMENT	1.2	47.5	0.1	2.5
REFRIGERATION	0.5	20.0	MISCELLANEOUS			0.5	20.0
COMPUTER EQUIPMENT							
ELEVATORS	0.1	3.9					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Medium Rise** **Baseline**
SIZE: **> 5 Units, Excluding Contract Customers**
VINTAGE:
REGION: **Southern Franchise**

CONSTRUCTION

Wall U value (W/m².°C)	0.53	W/m².°C	0.09	Btu/hr.ft² .°F	Typical Building Size	800 m²	8,608	ft²
Roof U value (W/m².°C)	0.46	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Footprint (m²)	267 m²	2,869	ft²
Glazing U value (W/m².°C)	3.27	W/m².°C	0.58	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2.5		
					Percent Conditioned Space	100%		
					Percent Conditioned Space Defined as Exterior Zone	36%		
Window/Wall Ratio (WIWAR) (%)	0.25							
Shading Coefficient (SC)	0.65				Typical # Stories	3		
					Floor to Floor Height (m)	2.8 m	9.2	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)									100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	35 m²/person	377 ft²/person	%OA	14.27%
Occupancy Schedule Occ. Period	30%			
Occupancy Schedule Unocc. Period	90%			
Fresh Air Requirements or Outside Air	15 L/s.person	32 CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) (1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air): 1
If Fresh Air Control Type = "2" enter % FA. to the right:
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.25 L/s.m² | 0.05 CFM/ft² | 50% operation (%)

Sizing Factor: 1
Total Air Circulation or Design Air Flow: 3.00 L/s.m² | 0.59 CFM/ft²

Separate Make-up air unit (100% OA): L/s.m² | CFM/ft²
Operation occupied period: 50%
Operation unoccupied period: 50%

Infiltration Rate: 0.30 L/s.m² | 0.06 CFM/ft²
(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	178,453	
Peak Zone Sensible Load	109,461	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	5,092	
Total air circulation or Design air	3.00	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	14	°C	57.2	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	22	°C	71.6	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Medium Rise** **Baseline**
SIZE: **> 5 Units, Excluding Contract Customers**
VINTAGE:
REGION: **Southern Franchise**

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	50	Lux	4.6	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	5.9	W/m²	0.5	W/ft²

			Light Level (Lux)	50	100	200	300				Total
Occ. Period(Hrs./yr.)	2100		% Distribution	100%							100%
Unocc. Period(Hrs./yr.)	6660		Weighted Average								**50**
Usage During Occupied Period	30%										
Usage During Unoccupied Period	10%			INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
Fixture Cleaning:			System Present (%)	75%	5%	15%		5%		0%	100.0%
Incidence of Practice			CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
Interval		years	LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
			Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence of Practice	Group	Spot

EUI kWh/ft².yr 0.6; MJ/m².yr 23

ARCHITECTURAL LIGHTING (CORRIDORS)

Light Level	200	Lux	18.6	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	12.7	W/m²	1.2	W/ft²

			Light Level (Lux)	100	200	300	500				Total
Occ. Period(Hrs./yr.)	3000		% Distribution		100%						100%
Unocc. Period(Hrs./yr.)	5760		Weighted Average								**200**
Usage During Occupied Period	100%										
Usage During Unoccupied Period	100%			INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
Fixture Cleaning:			System Present (%)	25%	35%	30%		10%		0%	100.0%
Incidence of Practice			CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
Interval		years	LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
			Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence of Practice	Group	Spot

EUI = Load X Hrs. X SF X GLFF

EUI kWh/ft².yr 1.6; MJ/m².yr 60

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 — 1.00

			Light Level (Lux)	300	500	700	1000				Total
Occ. Period(Hrs./yr.)	4000		% Distribution	100%							100%
Unocc. Period(Hrs./yr.)	4760		Weighted Average								**300**
Usage During Occupied Period	0%										
Usage During Unoccupied Period	100%			INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
Fixture Cleaning:			System Present (%)							0%	0.0%
Incidence of Practice			CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
Interval		years	LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
			Efficacy (L/W)	15	50	72	84	88	65	90	

Relamping Strategy & Incidence of Practice	Group	Spot

EUI kWh/ft².yr; MJ/m².yr

TOTAL LIGHTING — Overall LP 6.92 W/m² — EUI TOTAL kWh/ft².yr 2; MJ/m².yr 84

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)						
Connected Load (W/m²)					0.5	2.5
Connected Load (W/ft²)					0.05	0.23
Diversity Occupied Period						5%
Diversity Unoccupied Period						20%
Operation Occ. Period (hrs./year)						3000
Operation Unocc. Period (hrs./year)	8760	8760	8760	8760	8760	5760

Total end-use load (occupied period)	0.1	W/m²	0.0	W/ft²
Total end-use load (unocc. period)	0.5	W/m²	0.0	W/ft²

Usage during occupied period 100%
Usage during unoccupied period 400%

Computer Equipment EUI kWh/ft².yr; MJ/m².yr
Plug Loads EUI kWh/ft².yr 0.30; MJ/m².yr 11.72

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 10.0% Electricity Fuel Share: 90.0%

Cooking

	Natural Gas EUI	All Electric EUI
EUI kWh/ft².yr	1.0	1.0
MJ/m².yr	40.0	40.0

REFRIGERATION

Provide description below:

EUI kWh/ft².yr 0.5; MJ/m².yr 20.0

MISCELLANEOUS

EUI kWh/ft².yr 0.3; MJ/m².yr 10

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Medium Rise** **Baseline**

SIZE: **> 5 Units, Excluding Contract Customers**

VINTAGE:

REGION: **Southern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total
System Present (%)	34%	34%	2%		20%		10%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	66.5	W/m²	21.1	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	436	MJ/m².yr	11.3	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 10.0% | Gas Fuel Share 90.0% | Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	kWh/ft².yr	11.3
	MJ/m².yr	436
Natural Gas EUI	kWh/ft².yr	15.4
	MJ/m².yr	598
Market Composite EUI	kWh/ft².yr	15.0
	MJ/m².yr	582

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Absorption	Engine	Total
System Present (%)	40.0%	10.0%			50.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	65	W/m²	21	Btu/hr.ft²	579	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	147.6	MJ/m².yr	3.8	kWh/ft².yr		

Sizing Factor 1.00 | Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 40.0%

Electric Fuel Share 100.0% | Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	kWh/ft².yr	1.4
	MJ/m².yr	55
Natural Gas EUI	kWh/ft².yr	
	MJ/m².yr	
Market Composite EUI	kWh/ft².yr	1.4
	MJ/m².yr	55

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	17%		69%	1%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	88%	12%	100%
Blended Efficiency	0.68	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 157.5

Wetting Use Percentage 10%

All Electric EUI		All Natural Gas EUI		Market Composite EUI	
kWh/ft².yr	4.5	kWh/ft².yr	6.0	kWh/ft².yr	5.8
MJ/m².yr	173	MJ/m².yr	233	MJ/m².yr	226.1

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Medium Rise	**> 5 Units, Excluding Contract Customers**		**Southern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.0	L/s.m²	0.59	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV	375	Pa	1.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	2.5	W/m²	0.24	W/ft²
Fan Design Load VAV	2.5	W/m²	0.24	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	100%		100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.8	L/s.m²	0.15	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.9	L/s.m²	0.17	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	1.1	W/m²	0.11	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.44	W/m²	0.13	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.003	L/s.m²	0.005	U.S. gpm/ft²
Pump Head Pressure	0.1	kPa	0.0333333	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.00	W/m²	0.00	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0041	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	100	kPa	33	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.6	W/m²	0.05	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	22.3	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	9.9	kWh/m².yr
Condenser Pump Energy Consumption	0.0	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.9	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	3.5	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	3.4
	MJ/m².yr	131.9

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Medium Rise	**> 5 Units, Excluding Contract Customers**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES: **Electricity:** **10.0** kWh/ft².yr **386.7** MJ/m².yr **Gas:** **19.6** kWh/ft².yr **757.4** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING (SUITES)	0.6	23.4
ARCHITECTURAL LIGHTING (COR	1.6	60.2
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	0.3	11.7
HVAC FANS & PUMPS	3.4	131.9
REFRIGERATION	0.5	20.0
COMPUTER EQUIPMENT		
ELEVATORS		
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	1.1	43.6	13.9	538.1
SPACE COOLING	0.6	22.2		
DOMESTIC HOT WATER	0.5	20.8	5.3	205.3
FOOD SERVICE EQUIPMENT	0.9	36.0	0.1	4.0
MISCELLANEOUS			0.3	10.0

MARBEK
Resource Consultants Ltd.

APPENDIX B

Existing Building Profiles – Northern Region

Table of Contents

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Office	> 50,000 m3		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.75	W/m².°C	0.13	Btu/hr.ft² .°F	Typical Building Size	8,000 m²	86,080	ft²
Roof U value (W/m².°C)	0.50	W/m².°C	0.09	Btu/hr.ft² .°F	Typical Footprint (m²)	2,000 m²	21,520	ft²
Glazing U value (W/m².°C)	3.04	W/m².°C	0.53	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	1.5		
					Percent Conditioned Space	100%		
					Percent Conditioned Space Defined as Exterior Zone	36%		
Window/Wall Ratio (WIWAR) (%)	0.35							
Shading Coefficient (SC)	0.52				Typical # Stories	4		
					Floor to Floor Height (m)	3.7 m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	25%		5%		65%		5%		100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	26	m²/person	280	ft²/person	%OA	24.79%
Occupancy Schedule Occ. Period	90%					
Occupancy Schedule Unocc. Period						
Fresh Air Requirements or Outside Air	23	L/s.person	49	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) | 1 | If Fresh Air Control Type = "2" enter % FA. to the right: | 15%

(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air) | If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation | 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1.26			
Total Air Circulation or Design Air Flow	3.57	L/s.m²	0.70	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	2,490,388	
Peak Zone Sensible Load	1,031,796	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	47,999	
Total air circulation or Design air	3.57	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	14	°C	57.2	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20.7	°C	69.26	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Office	**> 50,000 m3**		**Northern Franchise**
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	520	Lux	48.3	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	15.7	W/m²	1.5	W/ft²
Occ. Period(Hrs./yr.)	2900			
Unocc. Period(Hrs./yr.)	5860			
Usage During Occupied Period	95%			
Usage During Unoccupied Period	25%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	20%	50%	30%					100%
Weighted Average								**520**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	3%	2%	35%		60%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	5.2
	MJ/m².yr	203

ARCHITECTURAL LIGHTING

Light Level	430	Lux	40.0	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	14.2	W/m²	1.3	W/ft²
Occ. Period(Hrs./yr.)	3600			
Unocc. Period(Hrs./yr.)	5160			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	25%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	35%	65%						100%
Weighted Average								**430**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%	30%		60%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	1.0
	MJ/m².yr	37

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	0%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP	15.51 W/m²	EUI TOTAL	kWh/ft².yr	6
			MJ/m².yr	241

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.9	0.9	0.15	0.1	0.06	
Connected Load	1.9 W/m²	1.8 W/m²	0.6 W/m²	0.8 W/m²	0.5 W/m²	1.5 W/m²
	0.2 W/ft²	0.2 W/ft²	0.05 W/ft²	0.07 W/ft²	0.05 W/ft²	0.14 W/ft²
Diversity Occupied Period	80%	80%	80%	80%	100%	80%
Diversity Unoccupied Period	50%	50%	50%	50%	100%	50%
Operation Occ. Period (hrs./year)	2000	2000	2000	2000	2000	2500
Operation Unocc. Period (hrs./year)	6760	6760	6760	6760	6760	6260

Total end-use load (occupied period)	5.7 W/m²	0.5 W/ft²
Total end-use load (unocc. period)	3.8 W/m²	0.3 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	66%	

Computer Equipment	EUI	kWh/ft².yr	2.73
		MJ/m².yr	105.68
Plug Loads	EUI	kWh/ft².yr	0.72
		MJ/m².yr	27.70

FOOD SERVICE EQUIPMENT

Provide description below:

Gas Fuel Share: 20.0% Electricity Fuel Share: 80.0%

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	0.3	EUI	kWh/ft².yr	0.4
	MJ/m².yr	10.0		MJ/m².yr	15.0

REFRIGERATION

Provide description below:

EUI	kWh/ft².yr	0.1
	MJ/m².yr	5.0

MISCELLANEOUS

EUI	kWh/ft².yr	1.8
	MJ/m².yr	70

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Large Office** **Baseline** | **SIZE:** **> 50,000 m3** | **VINTAGE:** | **REGION:** **Northern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	20%	24%	1%		45%		10%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load: 40.9 W/m² — 13.0 Btu/hr.ft²
Seasonal Heating Load (Tertiary Load): 521 MJ/m².yr — 13.5 kWh/ft².yr
Sizing Factor: 1.00

Electric Fuel Share: 10.0% — Gas Fuel Share: 90.0% — Oil Fuel Share:

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	13.5
MJ/m².yr	521

Natural Gas EUI	
kWh/ft².yr	19.4
MJ/m².yr	750

Market Composite EUI	
kWh/ft².yr	18.8
MJ/m².yr	727

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorption	Engine	
System Present (%)	25.0%	25.0%			50.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	14.0	57.2

Peak Cooling Load: 91 W/m² — 29 Btu/hr.ft² — 415 ft²/Ton
Seasonal Cooling Load (Tertiary Load): 189.8 MJ/m².yr — 4.9 kWh/ft².yr

Sizing Factor: 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C): 86.0%

Electric Fuel Share: 100.0% — Gas Fuel Share:

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	1.7
MJ/m².yr	67

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	1.7
MJ/m².yr	67

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	15%		64%	1%	1%
Eff./COP	75%		65%	90%	90%

	Fossil		Elec. Res.	
Fuel Share	81%		19%	100%
Blended Efficiency	0.67		0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load): 40.0

Wetting Use Percentage: 50%

All Electric EUI	
kWh/ft².yr	1.1
MJ/m².yr	44

All Natural Gas EUI	
kWh/ft².yr	1.5
MJ/m².yr	59

Market Composite EUI	
kWh/ft².yr	1.5
MJ/m².yr	56.4

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Office	**> 50,000 m3**		**Northern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.6	L/s.m²	0.70	CFM/ft²
System Static Pressure CAV	1000	Pa	4.0	wg
System Static Pressure VAV	750	Pa	3.0	wg
Fan Efficiency	55%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	7.6	W/m²	0.71	W/ft²
Fan Design Load VAV	5.7	W/m²	0.53	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	30%	70%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	75%	25%	75%	25%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.04	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.3	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	2.02	W/m²	0.19	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.005	L/s.m²	0.007	U.S. gpm/ft²
Pump Head Pressure	120	kPa	40	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.14	W/m²	0.11	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0058	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	120	kPa	40	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.9	W/m²	0.09	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	23.9	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	2.0	kWh/m².yr
Condenser Pump Energy Consumption	3.2	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.1	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	5.8	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	3.4
	MJ/m².yr	129.8

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Office	**> 50,000 m3**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**17.0** kWh/ft².yr	**660.2** MJ/m².yr	**Gas:**	**20.5** kWh/ft².yr	**795.1** MJ/m².yr	

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING	5.2	203.4					
ARCHITECTURAL LIGHTING	1.0	37.5	SPACE HEATING	1.3	52.1	17.4	675.1
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	1.5	57.8		
OTHER PLUG LOADS	0.7	27.7	DOMESTIC HOT WATER	0.2	8.4	1.2	48.0
HVAC FANS & PUMPS	3.4	129.8	FOOD SERVICE EQUIPMENT	0.3	12.0	0.1	2.0
REFRIGERATION	0.1	5.0	MISCELLANEOUS			1.8	70.0
COMPUTER EQUIPMENT	2.7	105.7					
ELEVATORS	0.1	3.9					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: Small Office, Baseline
SIZE: < 50,000 m3
VINTAGE:
REGION: Northern Franchise

CONSTRUCTION

Wall U value (W/m².°C)	0.48 W/m².°C	0.08 Btu/hr.ft² .°F	Typical Building Size	1,000 m²	10,760 ft²
Roof U value (W/m².°C)	0.45 W/m².°C	0.08 Btu/hr.ft² .°F	Typical Footprint (m²)	500 m²	5,380 ft²
Glazing U value (W/m².°C)	3.04 W/m².°C	0.53 Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2	
			Percent Conditioned Space	100%	
			Percent Conditioned Space Defined as Exterior Zone	40%	
Window/Wall Ratio (WIWAR) (%)	0.30				
Shading Coefficient (SC)	0.59		Typical # Stories	2	
			Floor to Floor Height (m)	3.5 m	11.5 ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	80%				20%				100%
Min. Air Flow (%)					20%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	26 m²/person	280 ft²/person	%OA 13.15%
Occupancy Schedule Occ. Period	90%		
Occupancy Schedule Unocc. Period			
Fresh Air Requirements or Outside Air	17 L/s.person	36 CFM/person	

Fresh Air Control Type *(enter a 1, 2 or 3): 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)
If Fresh Air Control Type = "2" enter % FA. to the right: 10%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1.3	
Total Air Circulation or Design Air Flow	4.97 L/s.m²	0.98 CFM/ft²
Infiltration Rate	0.30 L/s.m²	0.06 CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA): L/s.m² | CFM/ft²
Operation occupied period: 50%
Operation unoccupied period: 50%

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	311,236	
Peak Zone Sensible Load	174,172	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	8,102	
Total air circulation or Design air	4.97	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	30%	80%
DDC/Pneumatic	30%	
All DDC	40%	20%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	15	°C	59	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	21.6	°C	70.88	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Small Office	< 50,000 m3		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	520 Lux	48.3	ft-candles
Floor Fraction (GLFF)	0.95		
Connected Load	16.3 W/m²	1.5	W/ft²

Occ. Period(Hrs./yr.)	2900
Unocc. Period(Hrs./yr.)	5860
Usage During Occupied Period	95%
Usage During Unoccupied Period	10%
Fixture Cleaning:	
Incidence of Practice	
Interval	years

Light Level (Lux)	300	500	700	1000				Total
% Distribution	20%	50%	30%					100%
Weighted Average								**520**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	3%	2%	50%		45%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence	Group	Spot
of Practice		

EUI	kWh/ft².yr	4.8
	MJ/m².yr	186

ARCHITECTURAL LIGHTING

Light Level	430 Lux	40.0	ft-candles
Floor Fraction (ALFF)	0.05		
Connected Load	14.6 W/m²	1.4	W/ft²

Occ. Period(Hrs./yr.)	3600
Unocc. Period(Hrs./yr.)	5160
Usage During Occupied Period	100%
Usage During Unoccupied Period	25%
Fixture Cleaning:	
Incidence of Practice	
Interval	years

Light Level (Lux)	300	500	700	1000				Total
% Distribution	35%	65%						100%
Weighted Average								**430**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%	45%		45%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence	Group	Spot
of Practice		

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	0.3
	MJ/m².yr	13

OTHER (HIGH BAY) LIGHTING

Light Level	300.00 Lux	27.9	ft-candles
Floor Fraction (HBLFF)			
Connected Load	0.0 W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

Relamping Strategy & Incidence	Group	Spot
of Practice		

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING — Overall LP 16.23 W/m²

EUI TOTAL	kWh/ft².yr	5
	MJ/m².yr	199

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.95	0.95	0.1	0.1	0.06	
Connected Load	2.0 W/m²	1.9 W/m²	0.4 W/m²	0.8 W/m²	0.5 W/m²	1.5 W/m²
	0.2 W/ft²	0.2 W/ft²	0.04 W/ft²	0.07 W/ft²	0.05 W/ft²	0.14 W/ft²
Diversity Occupied Period	70%	80%	50%	50%	100%	100%
Diversity Unoccupied Period	30%	30%	5%	5%	100%	10%
Operation Occ. Period (hrs./year)	2000	2000	2000	2000	2000	2000
Operation Unocc. Period (hrs./year)	6760	6760	6760	6760	6760	6760

Total end-use load (occupied period)	5.5 W/m²	0.5 W/ft²
Total end-use load (unocc. period)	1.9 W/m²	0.2 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	34%	

Computer Equipment	EUI	kWh/ft².yr	1.82
		MJ/m².yr	70.57
Plug Loads	EUI	kWh/ft².yr	0.37
		MJ/m².yr	14.45

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 20.0% Electricity Fuel Share: 80.0%

	Natural Gas EUI			All Electric EUI	
EUI	kWh/ft².yr	0.3	EUI	kWh/ft².yr	0.4
	MJ/m².yr	10.0		MJ/m².yr	15.0

REFRIGERATION

Provide description below:

EUI	kWh/ft².yr	0.1
	MJ/m².yr	5.0

MISCELLANEOUS

EUI	kWh/ft².yr	1.0
	MJ/m².yr	40

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Small Office	**< 50,000 m3**		**Northern Franchise**
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric		
	Boilers				RTU	Furnace	Resistance	Total	
	Standard	Near Cond	Cond						
System Present (%)	30%	14%	1%		35%	10%	10%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load	73.5 W/m²	23.3 Btu/hr.ft²	
Seasonal Heating Load (Tertiary Load)	500 MJ/m².yr	12.9 kWh/ft².yr	
Sizing Factor	1.00		
Electric Fuel Share	10.0%	Gas Fuel Share 90.0%	Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	kWh/ft².yr	12.9
	MJ/m².yr	500
Natural Gas EUI	kWh/ft².yr	18.5
	MJ/m².yr	715
Market Composite EUI	kWh/ft².yr	17.9
	MJ/m².yr	694

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recproctíng Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Adsorption	Engine	
System Present (%)					100.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6 °C	42.8 °F
Condenser Water	35 °C	95 °F
Supply Air	14.0 °C	57.2 °F

Peak Cooling Load	91 W/m²	29 Btu/hr.ft²	415 ft²/Ton
Seasonal Cooling Load (Tertiary Load)	190.7 MJ/m².yr	4.9 kWh/ft².yr	
Sizing Factor	1.00	Operation (occ. period 3000 hrs/year	Note value cannot be less than 2,900 hrs/year)
A/C Saturation (Incidence of A/C)	86.0%		
Electric Fuel Share	100.0%	Gas Fuel Share	

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	kWh/ft².yr	2.0
	MJ/m².yr	76
Natural Gas EUI	kWh/ft².yr	
	MJ/m².yr	
Market Composite EUI	kWh/ft².yr	2.0
	MJ/m².yr	76

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	3%		76%	1%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	81%	19%	100%
Blended Efficiency	0.66	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load)	40.0
Wetting Use Percentage	50%

All Electric EUI		All Natural Gas EUI		Market Composite EUI	
kWh/ft².yr	1.1	kWh/ft².yr	1.6	kWh/ft².yr	1.5
MJ/m².yr	44	MJ/m².yr	61	MJ/m².yr	57.5

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Small Office	< 50,000 m3		Northern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	5.0	L/s.m²	0.98	CFM/ft²
System Static Pressure CAV	562.5	Pa	2.3	wg
System Static Pressure VAV	625	Pa	2.5	wg
Fan Efficiency	55%			
Fan Motor Efficiency	82%			
Sizing Factor	1.00			
Fan Design Load CAV	6.2	W/m²	0.58	W/ft²
Fan Design Load VAV	6.9	W/m²	0.64	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	80%	20%	100%	
Operation	Continuous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	50%	50%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.4	L/s.m²	0.08	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.5	L/s.m²	0.10	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.7	W/m²	0.06	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	2.02	W/m²	0.19	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.005	L/s.m²	0.007	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0058	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	30	kPa	10	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.2	W/m²	0.02	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	34.1	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	4.2	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.1	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	1.5	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	3.8
	MJ/m².yr	147.1

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Small Office	**< 50,000 m3**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**15.2** kWh/ft².yr	**589.3** MJ/m².yr	**Gas:**	**19.0** kWh/ft².yr	**734.9** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING	4.8	186.4					
ARCHITECTURAL LIGHTING	0.3	12.9	SPACE HEATING	1.3	50.0	16.6	643.8
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	1.7	65.6		
OTHER PLUG LOADS	0.4	14.5	DOMESTIC HOT WATER	0.2	8.4	1.3	49.1
HVAC FANS & PUMPS	3.8	147.1	FOOD SERVICE EQUIPMENT	0.3	12.0	0.1	2.0
REFRIGERATION	0.1	5.0	MISCELLANEOUS			1.0	40.0
COMPUTER EQUIPMENT	1.8	70.6					
ELEVATORS							
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Retail	All		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.65	W/m².°C	0.11	Btu/hr.ft² .°F	Typical Building Size	2,400	m²	25,824	ft²
Roof U value (W/m².°C)	0.50	W/m².°C	0.09	Btu/hr.ft² .°F	Typical Footprint (m²)	2,400	m²	25,824	ft²
Glazing U value (W/m².°C)	3.36	W/m².°C	0.59	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	1.5			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	40%			
Window/Wall Ratio (WIWAR) (%)	0.20								
Shading Coefficient (SC)	0.85				Typical # Stories	1			
					Floor to Floor Height (m)	4.5	m	14.8	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	100%								100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	50	m²/person	538	ft²/person	%OA 10.61%
Occupancy Schedule Occ. Period	90%				
Occupancy Schedule Unocc. Period					
Fresh Air Requirements or Outside Air	20	L/s.person	42	CFM/person	

Fresh Air Control Type *(enter a 1, 2 or 3): 2
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)
If Fresh Air Control Type = "2" enter % FA. to the right: 8%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	3.77	L/s.m²	0.74	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA): L/s.m² CFM/ft²
Operation occupied period: 50%
Operation unoccupied period: 50%

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	614,386	
Peak Zone Sensible Load	412,144	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	19,173	
Total air circulation or Design air	3.77	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	15	°C	59	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	19.5	°C	67.1	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	22	°C	71.6	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Retail	All		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	685	Lux	63.7	ft-candles
Floor Fraction (GLFF)	0.95			
Connected Load	29.4	W/m²	2.7	W/ft²

Occ. Period(Hrs./yr.)	3800
Unocc. Period(Hrs./yr.)	4960
Usage During Occupied Period	100%
Usage During Unoccupied Period	10%

Light Level (Lux)	300	500	700	1000	Total
% Distribution		30%	55%	15%	100%
Weighted Average					**685**

Fixture Cleaning:
Incidence of Practice
Interval — years

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	10%	5%	35%		35%	15%	0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	kWh/ft².yr	11.2
	MJ/m².yr	432

ARCHITECTURAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.05			
Connected Load	33.7	W/m²	3.1	W/ft²

Occ. Period(Hrs./yr.)	3800
Unocc. Period(Hrs./yr.)	4960
Usage During Occupied Period	100%
Usage During Unoccupied Period	10%

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

Fixture Cleaning:
Incidence of Practice
Interval — years

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	70%	10%	10%		10%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence of Practice	Group	Spot

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	0.7
	MJ/m².yr	26

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 — 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

Fixture Cleaning:
Incidence of Practice
Interval — years

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 29.63 W/m²

EUI TOTAL	kWh/ft².yr	12
	MJ/m².yr	458

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.2		0.2		0.15		0.1		0.12			
Connected Load	0.2	W/m²	0.2	W/m²	0.3	W/m²	0.4	W/m²	0.5	W/m²	1.5	W/m²
	0.0	W/ft²	0.0	W/ft²	0.03	W/ft²	0.04	W/ft²	0.05	W/ft²	0.14	W/ft²
Diversity Occupied Period	80%		80%		80%		80%		100%		80%	
Diversity Unoccupied Period	50%		50%		50%		50%		100%		50%	
Operation Occ. Period (hrs./year)	2000		2000		2000		2000		2000		2500	
Operation Unocc. Period (hrs./year)	6760		6760		6760		6760		6760		6260	

Total end-use load (occupied period)	2.6	W/m²	0.2	W/ft²
Total end-use load (unocc. period)	1.8	W/m²	0.2	W/ft²

Usage during occupied period	100%
Usage during unoccupied period	70%

	EUI		
Computer Equipment	EUI	kWh/ft².yr	0.94
		MJ/m².yr	36.30
Plug Loads	EUI	kWh/ft².yr	0.72
		MJ/m².yr	27.70

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 40.0% Electricity Fuel Share: 60.0%

Gas - cooking, baking not seperately metered

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	1.0	EUI	kWh/ft².yr	1.0
	MJ/m².yr	40.0		MJ/m².yr	40.0

REFRIGERATION EQUIPMENT

Provide description below:

Walk-in, display merchandisers, reach-ins, and fridges

EUI	kWh/ft².yr	1.0
	MJ/m².yr	40.0

MISCELLANEOUS

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Retail	All		Northern Franchise
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric		
	Boilers Standard	Near Cond	Cond		RTU	Furnace	Resistance	Total	
System Present (%)	6%	3%	1%		75%	5%	10%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load	54.5	W/m²	17.3	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	513	MJ/m².yr	13.3	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share: 10.0% Gas Fuel Share: 90.0% Oil Fuel Share:

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	13.3
MJ/m².yr	513

Natural Gas EUI	
kWh/ft².yr	19.6
MJ/m².yr	758

Market Composite EUI	
kWh/ft².yr	18.0
MJ/m².yr	695

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorption	Engine	
System Present (%)	5.0%	5.0%			90.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	15.0	°C	59	°F

Peak Cooling Load	75	W/m²	24	Btu/hr.ft²	504	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	170.7	MJ/m².yr	4.4	kWh/ft².yr		

Sizing Factor: 1.00 Operation (occ. period): 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C): 85.0%

Electric Fuel Share: 100.0% Gas Fuel Share:

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	1.9
MJ/m².yr	72

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	1.9
MJ/m².yr	72

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	1%	31%	32%	1%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	66%	34%	100%
Blended Efficiency	0.64	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load): 35.0

Wetting Use Percentage: 10%

All Electric EUI	
kWh/ft².yr	1.0
MJ/m².yr	38

All Natural Gas EUI	
kWh/ft².yr	1.4
MJ/m².yr	55

Market Composite EUI	
kWh/ft².yr	1.3
MJ/m².yr	49.4

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Retail	**All**		**Northern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.8	L/s.m²	0.74	CFM/ft²
System Static Pressure CAV	625	Pa	2.5	wg
System Static Pressure VAV	625	Pa	2.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	80%			
Sizing Factor	1.00			
Fan Design Load CAV	5.7	W/m²	0.53	W/ft²
Fan Design Load VAV	5.7	W/m²	0.53	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	100%		100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.04	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.66	W/m²	0.15	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0048	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure		kPa		ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load		W/m²		W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	49.6	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	2.1	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.0	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption		kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	4.9
	MJ/m².yr	190.1

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Retail	**All**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**23.8** kWh/ft².yr	**922.6** MJ/m².yr	**Gas:**	**19.5** kWh/ft².yr	**754.2** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity		Gas	
				kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	11.2	432.1					
ARCHITECTURAL LIGHTING	0.7	26.1	SPACE HEATING	1.3	51.3	17.6	681.9
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	1.6	61.0		
OTHER PLUG LOADS	0.7	27.7	DOMESTIC HOT WATER	0.3	13.1	0.9	36.3
HVAC FANS & PUMPS	4.9	190.1	FOOD SERVICE EQUIPMENT	0.6	24.0	0.4	16.0
REFRIGERATION EQUIPMENT	1.0	40.0	MISCELLANEOUS			0.5	20.0
COMPUTER EQUIPMENT	0.9	36.3					
ELEVATORS	0.1	3.9					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Hotel	> 50,000 m^3		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.63 W/m².°C	0.11 Btu/hr.ft² .°F		
Roof U value (W/m².°C)	0.49 W/m².°C	0.09 Btu/hr.ft² .°F		
Glazing U value (W/m².°C)	3.27 W/m².°C	0.58 Btu/hr.ft² .°F		
Window/Wall Ratio (WIWAR) (%)	0.25			
Shading Coefficient (SC)	0.64			

Typical Building Size	8,000 m²	86,080 ft²
Typical Footprint (m²)	2,000 m²	21,520 ft²
Footprint Aspect Ratio (L:W)	5	
Percent Conditioned Space	100%	
Percent Conditioned Space Defined as Exterior Zone	75%	
Typical # Stories	4	
Floor to Floor Height (m)	3.7 m	12.0 ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	25%		5%		65%		5%		100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	60 m²/person	646 ft²/person
Occupancy Schedule Occ. Period	45%	
Occupancy Schedule Unocc. Period	80%	
Fresh Air Requirements or Outside Air	35 L/s.person	74 CFM/person

%OA 21.65%

Fresh Air Control Type *(enter a 1, 2 or 3)
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air): 1

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1	
Total Air Circulation or Design Air Flow	2.69 L/s.m²	0.53 CFM/ft²
Infiltration Rate	0.30 L/s.m²	0.06 CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)	L/s.m²	CFM/ft²
Operation occupied period	50%	
Operation unoccupied period	50%	

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,912,424	
Peak Zone Sensible Load	981,864	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	45,676	
Total air circulation or Design air	2.69	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	22	°C	71.6	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	23	°C	73.4	°F	24	°C	75.2	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	21	°C	69.8	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Hotel	> 50,000 m³		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	120	Lux	11.2	ft-candles
Floor Fraction (GLFF)	0.75			
Connected Load	12.2	W/m²	1.1	W/ft²
Occ. Period(Hrs./yr.)	2100			
Unocc. Period(Hrs./yr.)	6660			
Usage During Occupied Period	70%			
Usage During Unoccupied Period	30%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	50	100	200	300				Total
% Distribution	20%	50%	30%					100%
Weighted Average								**120**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	60%	15%	15%		10%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI		
	kWh/ft².yr	2.9
	MJ/m².yr	114

GENERAL LIGHTING (LOBBY BALLROOMS, CORRIDORS, BACK OF HOUSE)

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.25			
Connected Load	23.4	W/m²	2.2	W/ft²
Occ. Period(Hrs./yr.)	3600			
Unocc. Period(Hrs./yr.)	5160			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	70%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	40%	15%	30%		15%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI		
	kWh/ft².yr	3.9
	MJ/m².yr	152

EUI = Load X Hrs. X SF X GLFF

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	0%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI		
	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP	14.99 W/m²	EUI TOTAL	kWh/ft².yr	7
			MJ/m².yr	266

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)												
Connected Load		W/m²		W/m²		W/m²		W/m²	0.5	W/m²	4	W/m²
		W/ft²		W/ft²		W/ft²		W/ft²	0.05	W/ft²	0.37	W/ft²
Diversity Occupied Period											70%	
Diversity Unoccupied Period											70%	
Operation Occ. Period (hrs./year)											3000	
Operation Unocc. Period (hrs./year)	8760		8760		8760		8760		8760		5760	

Total end-use load (occupied period)	2.8	W/m²	0.3	W/ft²
Total end-use load (unocc. period)	2.8	W/m²	0.3	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	100%			

Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	2.28
		MJ/m².yr	88.30

FOOD SERVICE EQUIPMENT

Provide description below: | Gas Fuel Share: 50.0% | Electricity Fuel Share: 50.0%

Cooking

	Natural Gas EUI		All Electric EUI	
EUI	kWh/ft².yr	1.8	kWh/ft².yr	1.8
	MJ/m².yr	70.0	MJ/m².yr	70.0

REFRIGERATION

Provide description below:

Coolers, ice machines, pop machines, fridges etc

EUI		
	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI		
	kWh/ft².yr	1.3
	MJ/m².yr	50

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Hotel	> 50,000 m^3		Northern Franchise
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	40%	10%	2%		13%		35%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	66.4	W/m²	21.0	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	600	MJ/m².yr	15.5	kWh/ft².yr
Sizing Factor	1.50			

Electric Fuel Share 35.0% Gas Fuel Share 65.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI		
	kWh/ft².yr	15.5
	MJ/m².yr	600

Natural Gas EUI		
	kWh/ft².yr	20.8
	MJ/m².yr	804

Market Composite EUI		
	kWh/ft².yr	18.9
	MJ/m².yr	732

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorption	Engine	
System Present (%)	20.0%	20.0%		10.0%	50.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	70	W/m²	22	Btu/hr.ft²	540	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	168.9	MJ/m².yr	4.4	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 85.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI		
	kWh/ft².yr	1.5
	MJ/m².yr	59

Natural Gas EUI		
	kWh/ft².yr	
	MJ/m².yr	

Market Composite EUI		
	kWh/ft².yr	1.5
	MJ/m².yr	59

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	70%		12%	5%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil		Elec. Res.	
Fuel Share	88%		12%	100%
Blended Efficiency	0.75		0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 220.0

Wetting Use Percentage 50%

All Electric EUI		
	kWh/ft².yr	6.2
	MJ/m².yr	242

All Natural Gas EUI		
	kWh/ft².yr	7.6
	MJ/m².yr	295

Market Composite EUI		
	kWh/ft².yr	7.4
	MJ/m².yr	288.3

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Hotel	> 50,000 m^3		Northern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	2.7	L/s.m²	0.53	CFM/ft²
System Static Pressure CAV	500	Pa	2.0	wg
System Static Pressure VAV	500	Pa	2.0	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	3.0	W/m²	0.28	W/ft²
Fan Design Load VAV	3.0	W/m²	0.28	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	80%	20%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	50%	50%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.04	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.3	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.55	W/m²	0.14	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.005	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.09	W/m²	0.10	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0044	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.9	W/m²	0.08	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	16.3	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.7	kWh/m².yr
Condenser Pump Energy Consumption	3.3	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.9	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	4.0	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	2.4
	MJ/m².yr	94.5

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Hotel	**> 50,000 m^3**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**21.0** kWh/ft².yr	**813.6** MJ/m².yr	**Gas:**	**22.4** kWh/ft².yr	**866.8** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	2.9	114.1
GENERAL LIGHTING (LOBBY BALLROOMS, COR	3.9	151.9
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	2.3	88.3
HVAC FANS & PUMPS	2.4	94.5
REFRIGERATION	0.5	20.0
COMPUTER EQUIPMENT		
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	5.4	209.9	13.5	522.5
SPACE COOLING	1.3	50.0		
DOMESTIC HOT WATER	0.7	29.0	6.7	259.3
FOOD SERVICE EQUIPMENT	0.9	35.0	0.9	35.0
MISCELLANEOUS			1.3	50.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hotel/Motel	< 50,000 m^3		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.65 W/m².°C	0.11 Btu/hr.ft² .°F		
Roof U value (W/m².°C)	0.51 W/m².°C	0.09 Btu/hr.ft² .°F		
Glazing U value (W/m².°C)	3.39 W/m².°C	0.60 Btu/hr.ft² .°F		
Window/Wall Ratio (WIWAR) (%)	0.25			
Shading Coefficient (SC)	0.64			

Typical Building Size	950 m²	10,222 ft²
Typical Footprint (m²)	950 m²	10,222 ft²
Footprint Aspect Ratio (L:W)	5	
Percent Conditioned Space	100%	
Percent Conditioned Space Defined as Exterior Zone	75%	
Typical # Stories	1	
Floor to Floor Height (m)	3.2 m	10.5 ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	90%				10%				100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	60 m²/person	646 ft²/person
Occupancy Schedule Occ. Period	45%	
Occupancy Schedule Unocc. Period	80%	
Fresh Air Requirements or Outside Air	20 L/s.person	42 CFM/person

%OA 10.27%

Fresh Air Control Type *(enter a 1, 2 or 3) 2
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 10%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.5 L/s.m² 0.10 CFM/ft²
50% operation (%)

Sizing Factor	1	
Total Air Circulation or Design Air Flow	3.25 L/s.m²	0.64 CFM/ft²
Infiltration Rate	0.30 L/s.m²	0.06 CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)	L/s.m²	CFM/ft²
Operation occupied period	50%	
Operation unoccupied period	50%	

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	236,850	
Peak Zone Sensible Load	140,416	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	6,532	
Total air circulation or Design air	3.25	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional	PI / PID	Total
Control Mode			
	Fixed Discharge	Reset	
Control Strategy			

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	22	°C	71.6	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	23	°C	73.4	°F	20.75	°C	69.35	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	19.5	°C	67.1	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning Changes/Year 4

Incidence of Annual Room Controls Maintenance 100.0%

Incidence of Annual HVAC Controls Maintenance 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hotel/Motel	< 50,000 m^3		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	120	Lux	11.2	ft-candles
Floor Fraction (GLFF)	0.90			
Connected Load	12.2	W/m²	1.1	W/ft²
Occ. Period(Hrs./yr.)	2100			
Unocc. Period(Hrs./yr.)	6660			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	50	100	200	300				Total
% Distribution	20%	50%	30%					100%
Weighted Average								**120**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	60%	15%	15%		10%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI		
	kWh/ft².yr	2.8
	MJ/m².yr	109

ARCHITECTURAL LIGHTING (LOBBY BALLROOMS, CORRIDORS, BACK OF HOUSE)

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.10			
Connected Load	23.4	W/m²	2.2	W/ft²
Occ. Period(Hrs./yr.)	3600			
Unocc. Period(Hrs./yr.)	5160			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	70%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	40%	15%	30%		15%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI		
	kWh/ft².yr	1.6
	MJ/m².yr	61

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	0%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI		
	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING — Overall LP 13.30 W/m²

EUI TOTAL		
	kWh/ft².yr	4
	MJ/m².yr	170

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)												
Connected Load		W/m²		W/m²		W/m²		W/m²		W/m²	1.5	W/m²
		W/ft²		W/ft²		W/ft²		W/ft²		W/ft²	0.14	W/ft²
Diversity Occupied Period											70%	
Diversity Unoccupied Period											70%	
Operation Occ. Period (hrs./year)											3000	
Operation Unocc. Period (hrs./year)	8760		8760		8760		8760		8760		5760	

Total end-use load (occupied period)	1.1	W/m²	0.1	W/ft²
Total end-use load (unocc. period)	1.1	W/m²	0.1	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	100%			

Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	0.85
		MJ/m².yr	33.11

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 20.0% Electricity Fuel Share: 80.0%

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	0.8	EUI	kWh/ft².yr	0.8
	MJ/m².yr	30.0		MJ/m².yr	30.0

REFRIGERATION EQUIPMENT

Provide description below:

EUI		
	kWh/ft².yr	0.3
	MJ/m².yr	10.0

MISCELLANEOUS

EUI		
	kWh/ft².yr	1.5
	MJ/m².yr	60

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hotel/Motel	< 50,000 m^3		Northern Franchise
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	40%	11%	1%		13%		35%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	116.5	W/m²	37.0	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	768	MJ/m².yr	19.8	kWh/ft².yr
Sizing Factor	1.30			

Electric Fuel Share 35.0% — Gas Fuel Share 65.0% — Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	19.8	27.1	24.6
MJ/m².yr	768	1051	952

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)					100.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	73	W/m²	23	Btu/hr.ft²	518	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	129.7	MJ/m².yr	3.3	kWh/ft².yr		

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 85.0%

Electric Fuel Share 100.0% — Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	1.3		1.3
MJ/m².yr	49		49

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	60%		20%	3%	2%
Eff./COP	75%	60%	65%	90%	90%

	Fossil		Elec. Res.	
Fuel Share	85%		15%	100%
Blended Efficiency	0.74		0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 240.0

Wetting Use Percentage 50%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	6.8	8.4	8.2
MJ/m².yr	264	326	317.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hotel/Motel	< 50,000 m^3		Northern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.2	L/s.m²	0.64	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV	375	Pa	1.5	wg
Fan Efficiency	45%			
Fan Motor Efficiency	80%			
Sizing Factor	1.00			
Fan Design Load CAV	3.4	W/m²	0.31	W/ft²
Fan Design Load VAV	3.4	W/m²	0.31	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use		100%		100%

Comments:

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.2	L/s.m²	0.04	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.3	L/s.m²	0.06	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.4	W/m²	0.04	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.61	W/m²	0.15	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure	8	kPa	2.6666667	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.06	W/m²	0.01	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0046	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	8	kPa	3	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.0	W/m²	0.00	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	13.2	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.6	kWh/m².yr
Condenser Pump Energy Consumption	0.1	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.7	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	0.2	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	1.5
	MJ/m².yr	56.9

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Hotel/Motel	**< 50,000 m^3**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**17.1** kWh/ft².yr	**660.7** MJ/m².yr	**Gas:**	**26.5** kWh/ft².yr	**1,026.4** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING (SUITES)	2.8	109.2
ARCHITECTURAL LIGHTING (LOBI	1.6	60.8
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	0.9	33.1
HVAC FANS & PUMPS	1.5	56.9
REFRIGERATION EQUIPMENT	0.3	10.0
COMPUTER EQUIPMENT		
ELEVATORS		
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	6.9	268.7	17.6	682.9
SPACE COOLING	1.1	41.6		
DOMESTIC HOT WATER	1.0	39.6	7.2	277.4
FOOD SERVICE EQUIPMENT	0.6	24.0	0.2	6.0
MISCELLANEOUS			1.5	60.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Contract Hospital** **Baseline**
SIZE: **All volumes**
VINTAGE:
REGION: **Northern Franchise**

CONSTRUCTION

Wall U value (W/m².°C)	0.52	W/m².°C	0.09	Btu/hr.ft² .°F	
Roof U value (W/m².°C)	0.40	W/m².°C	0.07	Btu/hr.ft² .°F	
Glazing U value (W/m².°C)	3.03	W/m².°C	0.53	Btu/hr.ft² .°F	
Window/Wall Ratio (WIWAR) (%)	0.27				
Shading Coefficient (SC)	0.51				

Typical Building Size	15,000	m²	161,400	ft²
Typical Footprint (m²)	3,750	m²	40,350	ft²
Footprint Aspect Ratio (L:W)	3			
Percent Conditioned Space	100%			
Percent Conditioned Space Defined as Exterior Zone	36%			
Typical # Stories	4			
Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	10%	25%	5%		5%	5%		50%	50%
Min. Air Flow (%)					20%	20%			

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	26	m²/person	280	ft²/person
Occupancy Schedule Occ. Period	90%			
Occupancy Schedule Unocc. Period				
Fresh Air Requirements or Outside Air	40	L/s.person	85	CFM/person

%OA 50.77%

Fresh Air Control Type *(enter a 1, 2 or 3) 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)
If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.5 L/s.m² 0.10 CFM/ft²
50% operation (%)

Sizing Factor	1.6			
Total Air Circulation or Design Air Flow	3.03	L/s.m²	0.60	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA) L/s.m² CFM/ft²
Operation occupied period
Operation unoccupied period

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	5,952,267	
Peak Zone Sensible Load	1,293,853	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	60,190	
Total air circulation or Design air	3.03	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic		50%
DDC/Pneumatic	50%	
All DDC	50%	50%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	24	°C	75.2	°F	22	°C	71.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	24	°C	75.2	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Contract Hospital	All volumes		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (PATIENTS ROOM)

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (GLFF)	0.50			
Connected Load	8.3	W/m²	0.8	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	50%			
Usage During Unoccupied Period	20%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	200	300	500	1000			Total
% Distribution		100%					100%
Weighted Average	4						**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	3%	2%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	1.3
	MJ/m².yr	51

ARCHITECTURAL LIGHTING (NURSING STATIONS, EXAMINATION, LABORATORY, ICU, RECOVERY)

Light Level	500	Lux	46.5	ft-candles
Floor Fraction (ALFF)	0.40			
Connected Load	16.5	W/m²	1.5	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	65%			
Usage During Unoccupied Period	40%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000			Total
% Distribution		100%					100%
Weighted Average							**500**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%	30%		60%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	3.0
	MJ/m².yr	115

CORRIDORS OTHER

Light Level	400.00	Lux	37.2	ft-candles
Floor Fraction (HBLFF)	0.10			
Connected Load	13.1	W/m²	1.2	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	50%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 — 1.00

Light Level (Lux)	200	400	500	1000			Total
% Distribution		100%					100%
Weighted Average							**400**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	0.9
	MJ/m².yr	33

TOTAL LIGHTING — Overall LP 10.76 W/m²

EUI TOTAL	kWh/ft².yr	5
	MJ/m².yr	199

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.05		0.05		0.01		0.01					
Connected Load	0.1	W/m²	0.1	W/m²	0.0	W/m²	0.1	W/m²		W/m²	5	W/m²
	0.0	W/ft²	0.0	W/ft²	0.00	W/ft²	0.01	W/ft²		W/ft²	0.46	W/ft²
Diversity Occupied Period	90%		90%		90%		90%				100%	
Diversity Unoccupied Period	40%		40%		20%		10%					
Operation Occ. Period (hrs./year)	5400		5400		5400		5400				3000	
Operation Unocc. Period (hrs./year)	3360		3360		3360		3360		8760		5760	

Total end-use load (occupied period)	5.3	W/m²	0.5	W/ft²
Total end-use load (unocc. period)	0.1	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	2%			

Computer Equipment	EUI	kWh/ft².yr	0.17
		MJ/m².yr	6.73
Plug Loads	EUI	kWh/ft².yr	1.39
		MJ/m².yr	54.00

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 65.0% Electricity Fuel Share: 35.0%

Cooking

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	1.5	EUI	kWh/ft².yr	1.5
	MJ/m².yr	60.0		MJ/m².yr	60.0

KITCHEN & REFRIGERATION

Provide description below:

EUI	kWh/ft².yr	0.8
	MJ/m².yr	30.0

Misc

EUI	kWh/ft².yr	6.5
	MJ/m².yr	250

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Contract Hospital** **Baseline**
SIZE: **All volumes**
VINTAGE:
REGION: **Northern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total
System Present (%)	10%	80%	1%		5%		4%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	28.0	W/m²	8.9	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	1469	MJ/m².yr	37.9	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 4.0% Gas Fuel Share 96.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	kWh/ft².yr	37.9
	MJ/m².yr	1469
Natural Gas EUI	kWh/ft².yr	48.9
	MJ/m².yr	1894
Market Composite EUI	kWh/ft².yr	48.5
	MJ/m².yr	1877

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Absorption	Engine	Total
System Present (%)	26.0%	26.0%		26.0%	21.0%	1.0%		100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	116	W/m²	37	Btu/hr.ft²	325	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	180.4	MJ/m².yr	4.7	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 99.0% Gas Fuel Share 1.0%

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	kWh/ft².yr	1.8
	MJ/m².yr	68
Natural Gas EUI	kWh/ft².yr	5.4
	MJ/m².yr	208
Market Composite EUI	kWh/ft².yr	1.8
	MJ/m².yr	69

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	70%		10%	1%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	82%	18%	100%
Blended Efficiency	0.74	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 350.0

Wetting Use Percentage 25%

All Electric EUI	kWh/ft².yr	9.9
	MJ/m².yr	385
All Natural Gas EUI	kWh/ft².yr	12.2
	MJ/m².yr	472
Market Composite EUI	kWh/ft².yr	11.8
	MJ/m².yr	456.3

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Contract Hospital	All volumes		Northern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.0	L/s.m²	0.60	CFM/ft²
System Static Pressure CAV	875	Pa	3.5	wg
System Static Pressure VAV	875	Pa	3.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	6.0	W/m²	0.56	W/ft²
Fan Design Load VAV	6.0	W/m²	0.56	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	80%	20%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	90%	10%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	2.57	W/m²	0.24	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.006	L/s.m²	0.009	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.81	W/m²	0.17	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.005	L/s.m²	0.0074	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.5	W/m²	0.14	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	42.7	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.8	kWh/m².yr
Condenser Pump Energy Consumption	4.5	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.1	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	9.9	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	5.6
	MJ/m².yr	215.9

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Contract Hospital	**All volumes**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES: **Electricity:** **19.6** kWh/ft².yr **761.1** MJ/m².yr **Gas:** **64.4** kWh/ft².yr **2,496.2** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING (PATIENTS R(	1.3	50.6
ARCHITECTURAL LIGHTING (NUR	3.0	115.3
CORRIDORS OTHER	0.9	33.4
OTHER PLUG LOADS	1.4	54.0
HVAC FANS & PUMPS	5.6	215.9
KITCHEN & REFRIGERATION	0.8	30.0
COMPUTER EQUIPMENT	0.2	6.7
ELEVATORS	1.0	38.7
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	1.5	58.7	46.9	1,818.5
SPACE COOLING	1.3	50.5	0.04	1.6
DOMESTIC HOT WATER	1.8	69.2	10.0	387.1
FOOD SERVICE EQUIPMENT	0.5	21.0	1.0	39.0
Misc			6.5	250.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hospital	All volumes		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.52	W/m².°C	0.09	Btu/hr.ft² .°F	Typical Building Size	6,000	m²	64,560	ft²
Roof U value (W/m².°C)	0.44	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Footprint (m²)	2,000	m²	21,520	ft²
Glazing U value (W/m².°C)	3.03	W/m².°C	0.53	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	3			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.27								
Shading Coefficient (SC)	0.51				Typical # Stories	3			
					Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	10%	25%	5%		5%	5%		50%	50%
Min. Air Flow (%)					20%	20%			

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	26	m²/person	280	ft²/person
Occupancy Schedule Occ. Period	90%			
Occupancy Schedule Unocc. Period				
Fresh Air Requirements or Outside Air	30	L/s.person	64	CFM/person

%OA 35.04%

Fresh Air Control Type *(enter a 1, 2 or 3) 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.5 L/s.m² 0.10 CFM/ft²
50% operation (%)

Sizing Factor	1.6			
Total Air Circulation or Design Air Flow	3.29	L/s.m²	0.65	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

Separate Make-up air unit (100% OA) L/s.m² CFM/ft²
Operation occupied period
Operation unoccupied period

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,973,241	
Peak Zone Sensible Load	562,476	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	26,166	
Total air circulation or Design air	3.29	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic		50%
DDC/Pneumatic	50%	
All DDC	50%	50%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	24	°C	75.2	°F	22	°C	71.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	24	°C	75.2	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning Changes/Year 4

Incidence of Annual Room Controls Maintenance 100.0%

Incidence of Annual HVAC Controls Maintenance 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hospital	All volumes		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (PATIENTS ROOM)

Light Level	250	Lux	23.2	ft-candles
Floor Fraction (GLFF)	0.50			
Connected Load	6.9	W/m²	0.6	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	50%			
Usage During Unoccupied Period	20%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	200	300	500	1000				Total
% Distribution	50%	50%						100%
Weighted Average	4							**250**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	3%	2%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	1.1
	MJ/m².yr	42

ARCHITECTURAL LIGHTING (NURSING STATIONS, EXAMINATION, LABORATORY, ICU, RECOVERY)

Light Level	430	Lux	40.0	ft-candles
Floor Fraction (ALFF)	0.40			
Connected Load	14.2	W/m²	1.3	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	65%			
Usage During Unoccupied Period	40%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	35%	65%						100%
Weighted Average								**430**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%	30%		60%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	2.6
	MJ/m².yr	99

CORRIDORS OTHER

Light Level	250.00	Lux	23.2	ft-candles
Floor Fraction (HBLFF)	0.10			
Connected Load	8.2	W/m²	0.8	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	50%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 — 1.00

Light Level (Lux)	200	300	500	1000				Total
% Distribution	50%	50%						100%
Weighted Average								**250**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	0.5
	MJ/m².yr	21

TOTAL LIGHTING — Overall LP 9.15 W/m²

EUI TOTAL	kWh/ft².yr	4
	MJ/m².yr	162

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.05		0.05		0.01		0.01					
Connected Load	0.1	W/m²	0.1	W/m²	0.0	W/m²	0.1	W/m²		W/m²	5	W/m²
	0.0	W/ft²	0.0	W/ft²	0.00	W/ft²	0.01	W/ft²		W/ft²	0.46	W/ft²
Diversity Occupied Period	90%		90%		90%		90%				100%	
Diversity Unoccupied Period	40%		40%		20%		10%					
Operation Occ. Period (hrs./year)	5400		5400		5400		5400				3000	
Operation Unocc. Period (hrs./year)	3360		3360		3360		3360		8760		5760	

Total end-use load (occupied period)	5.3	W/m²	0.5	W/ft²
Total end-use load (unocc. period)	0.1	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	2%			

Computer Equipment	EUI	kWh/ft².yr	0.17
		MJ/m².yr	6.73
Plug Loads	EUI	kWh/ft².yr	1.39
		MJ/m².yr	54.00

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 65.0% Electricity Fuel Share: 35.0%

Cooking

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	1.5	EUI	kWh/ft².yr	1.5
	MJ/m².yr	60.0		MJ/m².yr	60.0

KITCHEN & REFRIGERATION

Provide description below:

EUI	kWh/ft².yr	0.8
	MJ/m².yr	30.0

Misc

EUI	kWh/ft².yr	2.6
	MJ/m².yr	100

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: Hospital Baseline
SIZE: All volumes
VINTAGE:
REGION: Northern Franchise

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total
System Present (%)	10%	80%	1%		5%		4%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	38.8	W/m²	12.3	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	1282	MJ/m².yr	33.1	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 4.0% | Gas Fuel Share 96.0% | Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	33.1	42.1	41.7
MJ/m².yr	1282	1629	1615

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Absorption	Engine	Total
System Present (%)	26.0%	26.0%		26.0%	21.0%	1.0%		100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	96	W/m²	31	Btu/hr.ft²	393	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	152.1	MJ/m².yr	3.9	kWh/ft².yr		

Sizing Factor 1.00 | Operation (occ. period) 3000 hrs/year | Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 99.0% | Gas Fuel Share 1.0%

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	1.4	4.5	1.5
MJ/m².yr	56	173	57

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	70%		10%	1%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	82%	18%
Blended Efficiency	0.74	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 250.0

Wetting Use Percentage 25%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	7.1	8.7	8.4
MJ/m².yr	275	337	325.9

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hospital	All volumes		Northern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.3	L/s.m²	0.65	CFM/ft²
System Static Pressure CAV	875	Pa	3.5	wg
System Static Pressure VAV	875	Pa	3.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	6.5	W/m²	0.61	W/ft²
Fan Design Load VAV	6.5	W/m²	0.61	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	80%	20%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	90%	10%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.04	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.3	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	2.13	W/m²	0.20	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.005	L/s.m²	0.008	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.50	W/m²	0.14	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0061	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.2	W/m²	0.11	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	46.4	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	2.3	kWh/m².yr
Condenser Pump Energy Consumption	3.5	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.9	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	8.2	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	5.7
	MJ/m².yr	220.9

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Hospital	**All volumes**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES: **Electricity:** **17.4** kWh/ft².yr **673.1** MJ/m².yr **Gas:** **51.1** kWh/ft².yr **1,980.8** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING (PATIENTS R(	1.1	42.1
ARCHITECTURAL LIGHTING (NUR	2.6	99.2
CORRIDORS OTHER	0.5	20.9
OTHER PLUG LOADS	1.4	54.0
HVAC FANS & PUMPS	5.7	220.9
KITCHEN & REFRIGERATION	0.8	30.0
COMPUTER EQUIPMENT	0.2	6.7
ELEVATORS	0.5	19.4
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	1.3	51.3	40.4	1,564.1
SPACE COOLING	1.1	41.2	0.0	1.3
DOMESTIC HOT WATER	1.3	49.5	7.1	276.5
FOOD SERVICE EQUIPMENT	0.5	21.0	1.0	39.0
Misc			2.6	100.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Long Term Care (Nursing Home)** **Baseline**
SIZE: **All volumes**
VINTAGE:
REGION: **Northern Franchise**

CONSTRUCTION

Wall U value (W/m².°C)	0.56	W/m².°C	0.10	Btu/hr.ft² .°F	Typical Building Size	6,000 m²	64,560	ft²
Roof U value (W/m².°C)	0.47	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Footprint (m²)	3,000 m²	32,280	ft²
Glazing U value (W/m².°C)	3.03	W/m².°C	0.53	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	5		
					Percent Conditioned Space	100%		
					Percent Conditioned Space Defined as Exterior Zone	40%		
Window/Wall Ratio (WIWAR) (%)	0.25							
Shading Coefficient (SC)	0.60				Typical # Stories	2		
					Floor to Floor Height (m)	3.7 m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	65%				35%				100%
Min. Air Flow (%)					20%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	30	m²/person	323	ft²/person
Occupancy Schedule Occ. Period	90%			
Occupancy Schedule Unocc. Period	90%			
Fresh Air Requirements or Outside Air	25	L/s.person	53	CFM/person

%OA 24.51%

Fresh Air Control Type *(enter a 1, 2 or 3) 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² 0.10 CFM/ft²; 50% operation (%)

Sizing Factor	1.5			
Total Air Circulation or Design Air Flow	3.40	L/s.m²	0.67	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA) ___ L/s.m² ___ CFM/ft²
Operation occupied period 50%
Operation unoccupied period 50%

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,645,864	
Peak Zone Sensible Load	619,328	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	28,811	
Total air circulation or Design air	3.40	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	16	°C	60.8	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	24	°C	75.2	°F	24	°C	75.2	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	24	°C	75.2	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Long Term Care (Nursing Home)	**All volumes**		**Northern Franchise**
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	200 Lux	18.6	ft-candles
Floor Fraction (GLFF)	0.75		
Connected Load	12.9 W/m²	1.2	W/ft²

Occ. Period(Hrs./yr.)	3000	Light Level (Lux)	200	300	500	700			Total
Unocc. Period(Hrs./yr.)	5760	% Distribution	100%						100%
Usage During Occupied Period	85%	Weighted Average							**200**
Usage During Unoccupied Period	45%								

			INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
Fixture Cleaning:		System Present (%)	30%	10%	25%		35%		0%	100.0%
Incidence of Practice		CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
Interval	years	LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
		Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence	Group	Spot			
of Practice			EUI	kWh/ft².yr	4.6
				MJ/m².yr	179

ARCHITECTURAL LIGHTING (SERVICES, KITCHEN, OFFICES, DINING, RECREATION)

Light Level	300 Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.25		
Connected Load	14.0 W/m²	1.3	W/ft²

Occ. Period(Hrs./yr.)	5000	Light Level (Lux)	300	500	700	1000			Total
Unocc. Period(Hrs./yr.)	3760	% Distribution	100%						100%
Usage During Occupied Period	95%	Weighted Average							**300**
Usage During Unoccupied Period	55%								

			INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
Fixture Cleaning:		System Present (%)	15%	5%	35%		40%	5%	0%	100.0%
Incidence of Practice		CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
Interval	years	LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
		Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence	Group	Spot			
of Practice			EUI	kWh/ft².yr	2.2
		EUI = Load X Hrs. X SF X GLFF		MJ/m².yr	86

OTHER (HIGH BAY) LIGHTING

Light Level	300.00 Lux	27.9	ft-candles	Floor fraction check: should = 1.00	1.00
Floor Fraction (HBLFF)					
Connected Load	0.0 W/m²	0.0	W/ft²		

Occ. Period(Hrs./yr.)	4000	Light Level (Lux)	300	500	700	1000			Total
Unocc. Period(Hrs./yr.)	4760	% Distribution	100%						100%
Usage During Occupied Period	0%	Weighted Average							**300**
Usage During Unoccupied Period	100%								

			INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
Fixture Cleaning:		System Present (%)							0%	0.0%
Incidence of Practice		CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
Interval	years	LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
		Efficacy (L/W)	15	50	72	84	88	65	90	

Relamping Strategy & Incidence	Group	Spot			
of Practice			EUI	kWh/ft².yr	
				MJ/m².yr	

TOTAL LIGHTING	Overall LP 13.16 W/m²	EUI TOTAL	kWh/ft².yr	7
			MJ/m².yr	265

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)												
Connected Load		W/m²		W/m²		W/m²		W/m²		W/m²	3.5	W/m²
		W/ft²		W/ft²		W/ft²		W/ft²		W/ft²	0.33	W/ft²
Diversity Occupied Period	80%		80%		80%		80%				70%	
Diversity Unoccupied Period	50%		50%		50%		50%				40%	
Operation Occ. Period (hrs./year)	2000		2000		2000		2000				3000	
Operation Unocc. Period (hrs./year)	6760		6760		6760		6760		8760		5760	

Total end-use load (occupied period)	2.5 W/m²	0.2 W/ft²					
Total end-use load (unocc. period)	1.4 W/m²	0.1 W/ft²					
			Computer Equipment	EUI	kWh/ft².yr	
Usage during occupied period	100%				MJ/m².yr	
Usage during unoccupied period	57%		Plug Loads	EUI	kWh/ft².yr	1.43
					MJ/m².yr	55.49

FOOD SERVICE EQUIPMENT

Provide description below:	Gas Fuel Share:	82.0%	Electricity Fuel Share:	18.0%	Natural Gas EUI			All Electric EUI		
Commercial Food Preparation					EUI	kWh/ft².yr	1.5	EUI	kWh/ft².yr	1.5
						MJ/m².yr	60.0		MJ/m².yr	60.0

REFRIGERATION EQUIPMENT

Provide description below:			
	EUI	kWh/ft².yr	0.5
		MJ/m².yr	20.0

MISCELLANEOUS

	EUI	kWh/ft².yr	1.8
		MJ/m².yr	70

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Long Term Care (Nursing Home)** **Baseline**
SIZE: **All volumes**
VINTAGE:
REGION: **Northern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total
System Present (%)	21%	21%	3%		20%		35%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	96.6	W/m²	30.6	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	1041	MJ/m².yr	26.9	kWh/ft².yr
Sizing Factor	2.00			

Electric Fuel Share 35.0% Gas Fuel Share 65.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	kWh/ft².yr	26.9
	MJ/m².yr	1041
Natural Gas EUI	kWh/ft².yr	35.1
	MJ/m².yr	1361
Market Composite EUI	kWh/ft².yr	32.2
	MJ/m².yr	1249

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Absorption	Engine	Total
System Present (%)	20.0%	10.0%		40.0%	30.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	16.0	°C	60.8	°F

Peak Cooling Load	80	W/m²	25	Btu/hr.ft²	471	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	158.5	MJ/m².yr	4.1	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 60.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	kWh/ft².yr	1.3
	MJ/m².yr	52
Natural Gas EUI	kWh/ft².yr	
	MJ/m².yr	
Market Composite EUI	kWh/ft².yr	1.3
	MJ/m².yr	52

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	65%		20%	3%	2%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	90%	10%
Blended Efficiency	0.74	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 180.0

Wetting Use Percentage 10%

All Electric EUI		All Natural Gas EUI		Market Composite EUI	
kWh/ft².yr	5.1	kWh/ft².yr	6.3	kWh/ft².yr	6.2
MJ/m².yr	198	MJ/m².yr	245	MJ/m².yr	239.9

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Long Term Care (Nursing Home)** **Baseline**
SIZE: **All volumes**
VINTAGE:
REGION: **Northern Franchise**

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.4	L/s.m²	0.67	CFM/ft²
System Static Pressure CAV	625	Pa	2.5	wg
System Static Pressure VAV	625	Pa	2.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	4.8	W/m²	0.45	W/ft²
Fan Design Load VAV	4.8	W/m²	0.45	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	25%	75%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	50%	50%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.78	W/m²	0.17	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure	75	kPa	25	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.63	W/m²	0.06	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0051	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	75	kPa	25	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.5	W/m²	0.05	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	14.7	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.4	kWh/m².yr
Condenser Pump Energy Consumption	1.4	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.8	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	2.3	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	1.9
	MJ/m².yr	74.4

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Long Term Care (Nursing Home)	**All volumes**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**22.2** kWh/ft².yr	**861.7** MJ/m².yr	**Gas:**	**31.6** kWh/ft².yr	**1,224.1** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING (SUITES)	4.6	178.7
ARCHITECTURAL LIGHTING (SER\'	2.2	86.1
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	1.4	55.5
HVAC FANS & PUMPS	1.9	74.4
REFRIGERATION EQUIPMENT	0.5	20.0
COMPUTER EQUIPMENT		
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	9.4	364.4	22.8	884.8
SPACE COOLING	0.8	31.1		
DOMESTIC HOT WATER	0.5	19.8	5.7	220.1
FOOD SERVICE EQUIPMENT	0.3	10.8	1.3	49.2
MISCELLANEOUS			1.8	70.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
School	All Volumes		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.45	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Building Size	5,200	m²	55,952	ft²
Roof U value (W/m².°C)	0.37	W/m².°C	0.07	Btu/hr.ft² .°F	Typical Footprint (m²)	2,600	m²	27,976	ft²
Glazing U value (W/m².°C)	3.04	W/m².°C	0.53	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	50%			
Window/Wall Ratio (WIWAR) (%)	0.28								
Shading Coefficient (SC)	0.68				Typical # Stories	2			
					Floor to Floor Height (m)	3.5	m	11.5	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	100%								100%
Min. Air Flow (%)									

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	10	m²/person	108	ft²/person	%OA	31.25%
Occupancy Schedule Occ. Period	90%					
Occupancy Schedule Unocc. Period						
Fresh Air Requirements or Outside Air	7	L/s.person	15	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 10%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.5 L/s.m² 0.10 CFM/ft²
50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	2.24	L/s.m²	0.44	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA) ___ L/s.m² ___ CFM/ft²
Operation occupied period 50%
Operation unoccupied period 50%

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	20%		80%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,363,777	
Peak Zone Sensible Load	530,534	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	24,680	
Total air circulation or Design air	2.24	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	35%	90%
DDC/Pneumatic	55%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	17	°C	62.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	19.5	°C	67.1	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
School	All Volumes		Northern Franchise
Baseline			

LIGHTING

GENERAL (CLASSROOM) LIGHTING

Light Level	420	Lux	39.0	ft-candles
Floor Fraction (GLFF)	0.60			
Connected Load	10.5	W/m²	1.0	W/ft²

Occ. Period(Hrs./yr.)	2200
Unocc. Period(Hrs./yr.)	6560
Usage During Occupied Period	90%
Usage During Unoccupied Period	10%

Light Level (Lux)	300	500	700	1000	Total
% Distribution	40%	60%			100%
Weighted Average					**420**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)			20%		80%			100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval years

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	kWh/ft².yr	1.6
	MJ/m².yr	60

ARCHITECTURAL LIGHTING

Light Level	370	Lux	34.4	ft-candles
Floor Fraction (ALFF)	0.30			
Connected Load	11.7	W/m²	1.1	W/ft²

Occ. Period(Hrs./yr.)	2200
Unocc. Period(Hrs./yr.)	6560
Usage During Occupied Period	90%
Usage During Unoccupied Period	10%

Light Level (Lux)	300	500	700	1000	Total
% Distribution	65%	35%			100%
Weighted Average					**370**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%	10%		80%			100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval years

Relamping Strategy & Incidence of Practice	Group	Spot

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	0.9
	MJ/m².yr	33

HIGH BAY (GYMNASIUM) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)	0.10			
Connected Load	13.5	W/m²	1.3	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	2600
Unocc. Period(Hrs./yr.)	6160
Usage During Occupied Period	100%
Usage During Unoccupied Period	10%

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)			10%			90%	0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval years

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	kWh/ft².yr	0.4
	MJ/m².yr	16

TOTAL LIGHTING

Overall LP 9.83 W/m²

EUI TOTAL	kWh/ft².yr	3
	MJ/m².yr	109

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.1	0.1	0.01	0.01		
Connected Load (W/m²)	0.5	0.5	0.1	0.2	0.5	1.1
Connected Load (W/ft²)	0.1	0.0	0.01	0.02	0.05	0.10
Diversity Occupied Period	50%	50%	50%	50%		50%
Diversity Unoccupied Period	30%	30%				10%
Operation Occ. Period (hrs./year)	2000	2000	2000	2000		2000
Operation Unocc. Period (hrs./year)	6760	6760	6760	6760	8760	6760

Total end-use load (occupied period)	1.2	W/m²	0.1	W/ft²
Total end-use load (unocc. period)	0.4	W/m²	0.0	W/ft²

Usage during occupied period	100%
Usage during unoccupied period	35%

Computer Equipment	EUI	kWh/ft².yr	0.32
		MJ/m².yr	12.56
Plug Loads	EUI	kWh/ft².yr	0.17
		MJ/m².yr	6.64

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 53.0% Electricity Fuel Share: 47.0%

Cooking

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	0.5	EUI	kWh/ft².yr	0.5
	MJ/m².yr	20.0		MJ/m².yr	20.0

REFRIGERATION

Provide description below:

Coolers, freezers, pop machines

EUI	kWh/ft².yr	0.1
	MJ/m².yr	5.0

MISCELLANEOUS

EUI	kWh/ft².yr	0.1
	MJ/m².yr	5

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **School** **Baseline**
SIZE: **All Volumes**
VINTAGE:
REGION: **Northern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	30%	30%	20%		9%		11%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	46.4	W/m²	14.7	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	786	MJ/m².yr	20.3	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 11.0% Gas Fuel Share 89.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	20.3
MJ/m².yr	786

Natural Gas EUI	
kWh/ft².yr	25.6
MJ/m².yr	993

Market Composite EUI	
kWh/ft².yr	25.0
MJ/m².yr	970

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)	10.0%			15.0%	75.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	77	W/m²	24	Btu/hr.ft²	492	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	143.5	MJ/m².yr	3.7	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 15.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	1.4
MJ/m².yr	53

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	1.4
MJ/m².yr	53

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	30%		44%	1%	2%
Eff./COP	75%		65%	90%	90%

	Fossil		Elec. Res.	
Fuel Share	77%		23%	100%
Blended Efficiency	0.70		0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 40.0

Wetting Use Percentage 80%

All Electric EUI	
kWh/ft².yr	1.1
MJ/m².yr	44

All Natural Gas EUI	
kWh/ft².yr	1.5
MJ/m².yr	57

Market Composite EUI	
kWh/ft².yr	1.4
MJ/m².yr	54.2

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
School	**All Volumes**		**Northern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	2.2	L/s.m²	0.44	CFM/ft²
System Static Pressure CAV	500	Pa	2.0	wg
System Static Pressure VAV	500	Pa	2.0	wg
Fan Efficiency	55%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	2.4	W/m²	0.22	W/ft²
Fan Design Load VAV	2.4	W/m²	0.22	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	20%	80%	20%	80%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.003	kW/kW	0.01	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	0.23	W/m²	0.02	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0049	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	30	kPa	10	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.2	W/m²	0.02	W/ft²		

Supply Fan Occ. Period	2200	hrs./year
Supply Fan Unocc. Period	6560	hrs./year
Supply Fan Energy Consumption	8.4	kWh/m².yr
Exhaust Fan Occ. Period	2200	hrs./year
Exhaust Fan Unocc. Period	6560	hrs./year
Exhaust Fan Energy Consumption	0.8	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.1	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	1.2	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	1.0
	MJ/m².yr	38.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
School	**All Volumes**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**7.9** kWh/ft².yr	**305.9** MJ/m².yr	**Gas:**	**24.3** kWh/ft².yr	**943.0** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL (CLASSROOM) LIGHTIN(	1.6	60.1					
ARCHITECTURAL LIGHTING	0.9	33.2	SPACE HEATING	2.2	86.5	22.8	883.3
HIGH BAY (GYMNASIUM) LIGHTINC	0.4	15.6	SPACE COOLING	0.2	7.9		
OTHER PLUG LOADS	0.2	6.6	DOMESTIC HOT WATER	0.3	10.1	1.1	44.1
HVAC FANS & PUMPS	1.0	38.0	FOOD SERVICE EQUIPMENT	0.2	9.4	0.3	10.6
REFRIGERATION	0.1	5.0	MISCELLANEOUS			0.1	5.0
COMPUTER EQUIPMENT	0.3	12.6					
ELEVATORS	0.1	3.9					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
University/College	Contract		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.57 W/m².°C	0.10 Btu/hr.ft² .°F	Typical Building Size	12,500 m²	134,500 ft²
Roof U value (W/m².°C)	0.44 W/m².°C	0.08 Btu/hr.ft² .°F	Typical Footprint (m²)	4,167 m²	44,833 ft²
Glazing U value (W/m².°C)	3.23 W/m².°C	0.57 Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2	
			Percent Conditioned Space	100%	
			Percent Conditioned Space Defined as Exterior Zone	36%	
Window/Wall Ratio (WIWAR) (%)	0.29				
Shading Coefficient (SC)	0.65		Typical # Stories	3	
			Floor to Floor Height (m)	3.7 m	12.0 ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	30%	5%	5%		30%			30%	70%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	15 m²/person	161 ft²/person	%OA 19.06%
Occupancy Schedule Occ. Period	80%		
Occupancy Schedule Unocc. Period			
Fresh Air Requirements or Outside Air	12 L/s.person	25 CFM/person	

Fresh Air Control Type *(enter a 1, 2 or 3): 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)
If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1.7	
Total Air Circulation or Design Air Flow	4.20 L/s.m²	0.83 CFM/ft²
Infiltration Rate	0.50 L/s.m²	0.10 CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA): L/s.m² | CFM/ft²
Operation occupied period: 50%
Operation unoccupied period: 50%

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	3,537,075	
Peak Zone Sensible Load	1,405,804	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	65,398	
Total air circulation or Design air	4.20	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	17	°C	62.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20.25	°C	68.45	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
University/College	**Contract**		**Northern Franchise**
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	540 Lux	50.2	ft-candles
Floor Fraction (GLFF)	0.85		
Connected Load	15.0 W/m²	1.4	W/ft²
Occ. Period(Hrs./yr.)	4100		
Unocc. Period(Hrs./yr.)	4660		
Usage During Occupied Period	90%		
Usage During Unoccupied Period	10%		
Fixture Cleaning:			
Incidence of Practice			
Interval		years	
Relamping Strategy & Incidence of Practice	Group	Spot	

Light Level (Lux)	300	500	700	1000	Total
% Distribution	10%	60%	30%		100%
Weighted Average					**540**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	3%	2%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI kWh/ft².yr 4.9; MJ/m².yr 191

ARCHITECTURAL LIGHTING

Light Level	300 Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.15		
Connected Load	12.1 W/m²	1.1	W/ft²
Occ. Period(Hrs./yr.)	4100		
Unocc. Period(Hrs./yr.)	4660		
Usage During Occupied Period	90%		
Usage During Unoccupied Period	50%		
Fixture Cleaning:			
Incidence of Practice			
Interval		years	
Relamping Strategy & Incidence of Practice	Group	Spot	

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	10%	10%			90%		0%	110.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI kWh/ft².yr 1.0; MJ/m².yr 39

OTHER (HIGH BAY) LIGHTING

Light Level	300.00 Lux	27.9	ft-candles
Floor Fraction (HBLFF)			
Connected Load	0.0 W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000		
Unocc. Period(Hrs./yr.)	4760		
Usage During Occupied Period	0%		
Usage During Unoccupied Period	100%		
Fixture Cleaning:			
Incidence of Practice			
Interval		years	
Relamping Strategy & Incidence of Practice	Group	Spot	

Floor fraction check: should = 1.00 — 1.00

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI kWh/ft².yr; MJ/m².yr

TOTAL LIGHTING — Overall LP 14.56 W/m² — EUI TOTAL kWh/ft².yr 6; MJ/m².yr 230

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.1	0.1	0.02	0.01		
Connected Load	0.4 W/m²	0.3 W/m²	0.1 W/m²	0.1 W/m²	0.5 W/m²	3 W/m²
	0.0 W/ft²	0.0 W/ft²	0.01 W/ft²	0.01 W/ft²	0.05 W/ft²	0.28 W/ft²
Diversity Occupied Period	85%	80%	90%	90%	100%	100%
Diversity Unoccupied Period	35%	35%	20%	10%	100%	50%
Operation Occ. Period (hrs./year)	2900	2900	2600	2600	2000	3000
Operation Unocc. Period (hrs./year)	5860	5860	6160	6160	6760	5760

Total end-use load (occupied period)	4.4 W/m²	0.4 W/ft²
Total end-use load (unocc. period)	2.3 W/m²	0.2 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	53%	

		kWh/ft².yr	MJ/m².yr
Computer Equipment	EUI	0.79	30.57
Plug Loads	EUI	1.66	64.21

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 70.0% Electricity Fuel Share: 30.0%

Cafeteria/food service

	Natural Gas EUI	All Electric EUI
EUI kWh/ft².yr	1.0	1.0
MJ/m².yr	40.0	40.0

REFRIGERATION

Provide description below:

Coolers, freezers, fridges, pop machines

EUI kWh/ft².yr 0.5; MJ/m².yr 20.0

MISCELLANEOUS

EUI kWh/ft².yr 1.8; MJ/m².yr 70

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: University/College Baseline | **SIZE:** Contract | **VINTAGE:** | **REGION:** Northern Franchise

SPACE HEATING

Heating Plant Type

	Natural Gas: Boilers Standard	Boilers Near Cond	Boilers Cond		RTU	Furnace	Electric Resistance	Total
System Present (%)	10%	50%	3%		20%		17%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	48.1	W/m²	15.2	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	679	MJ/m².yr	17.5	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 17.0% | Gas Fuel Share 83.0% | Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	17.5	22.9	22.0
MJ/m².yr	679	888	853

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	Centrifugal Chillers HE	Screw Chillers	Recprocting Chillers Open	Recprocting Chillers DX	Gas Cooling Absorption	Gas Cooling Engine	Total
System Present (%)	59.0%	20.0%		5.0%	15.0%	1.0%		100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	83	W/m²	26	Btu/hr.ft²	456	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	168.7	MJ/m².yr	4.4	kWh/ft².yr		

Sizing Factor 1.00 | Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 99.0% | Gas Fuel Share 1.0%

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	1.5	4.1	1.5
MJ/m².yr	58	159	59

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	68%		20%	1%	2%
Eff./COP	75%		65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	91%	9%
Blended Efficiency	0.73	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 80.0

Wetting Use Percentage 50%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	2.3	2.8	2.8
MJ/m².yr	88	109	107.2

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
University/College	Contract		Northern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	4.2	L/s.m²	0.83	CFM/ft²
System Static Pressure CAV	875	Pa	3.5	wg
System Static Pressure VAV	875	Pa	3.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	8.3	W/m²	0.77	W/ft²
Fan Design Load VAV	8.3	W/m²	0.77	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	70%	30%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	35%	65%	35%	65%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.0	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.1	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.83	W/m²	0.17	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.29	W/m²	0.12	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0053	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.1	W/m²	0.10	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	35.8	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.1	kWh/m².yr
Condenser Pump Energy Consumption	4.1	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.9	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	6.1	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	4.5
	MJ/m².yr	172.6

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
University/College	**Contract**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**18.5** kWh/ft².yr	**716.5** MJ/m².yr	**Gas:**	**24.2** kWh/ft².yr	**935.8** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	4.9	190.7
ARCHITECTURAL LIGHTING	1.0	39.4
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	1.7	64.2
HVAC FANS & PUMPS	4.5	172.6
REFRIGERATION	0.5	20.0
COMPUTER EQUIPMENT	0.8	30.6
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	3.0	115.5	19.0	737.3
SPACE COOLING	1.1	42.8	0.03	1.2
DOMESTIC HOT WATER	0.2	7.9	2.6	99.3
FOOD SERVICE EQUIPMENT	0.3	12.0	0.7	28.0
MISCELLANEOUS			1.8	70.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
University / College	All volumes except contract customers		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.49	W/m².°C	0.09	Btu/hr.ft² .°F	Typical Building Size	12,500	m²	134,500	ft²
Roof U value (W/m².°C)	0.44	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Footprint (m²)	4,167	m²	44,833	ft²
Glazing U value (W/m².°C)	3.23	W/m².°C	0.57	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.29								
Shading Coefficient (SC)	0.65				Typical # Stories	3			
					Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	30%	5%	5%		30%			30%	70%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	15	m²/person	161	ft²/person	%OA 19.07%
Occupancy Schedule Occ. Period	80%				
Occupancy Schedule Unocc. Period					
Fresh Air Requirements or Outside Air	12	L/s.person	25	CFM/person	

Fresh Air Control Type *(enter a 1, 2 or 3): 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² — 0.10 CFM/ft²; 50% operation (%)

Sizing Factor	1.7			
Total Air Circulation or Design Air Flow	4.19	L/s.m²	0.83	CFM/ft²
Infiltration Rate	0.50	L/s.m²	0.10	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	3,535,993	
Peak Zone Sensible Load	1,404,722	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	65,348	
Total air circulation or Design air	4.19	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	17	°C	62.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20.25	°C	68.45	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
University / College	**All volumes except contract customers**		**Northern Franchise**
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	540	Lux	50.2	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	15.0	W/m²	1.4	W/ft²
Occ. Period(Hrs./yr.)	4100			
Unocc. Period(Hrs./yr.)	4660			
Usage During Occupied Period	90%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	10%	60%	30%					100%
Weighted Average								**540**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	3%	2%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	4.9
	MJ/m².yr	191

ARCHITECTURAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	12.1	W/m²	1.1	W/ft²
Occ. Period(Hrs./yr.)	4100			
Unocc. Period(Hrs./yr.)	4660			
Usage During Occupied Period	90%			
Usage During Unoccupied Period	50%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	10%	10%			90%		0%	110.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	1.0
	MJ/m².yr	39

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	0%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 14.56 W/m²

EUI TOTAL	kWh/ft².yr	6
	MJ/m².yr	230

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.1	0.1	0.02	0.01		
Connected Load	0.4 W/m²	0.3 W/m²	0.1 W/m²	0.1 W/m²	0.5 W/m²	3 W/m²
	0.0 W/ft²	0.0 W/ft²	0.01 W/ft²	0.01 W/ft²	0.05 W/ft²	0.28 W/ft²
Diversity Occupied Period	85%	80%	90%	90%	100%	100%
Diversity Unoccupied Period	35%	35%	20%	10%	100%	50%
Operation Occ. Period (hrs./year)	2900	2900	2600	2600	2000	3000
Operation Unocc. Period (hrs./year)	5860	5860	6160	6160	6760	5760

Total end-use load (occupied period)	4.4	W/m²	0.4	W/ft²
Total end-use load (unocc. period)	2.3	W/m²	0.2	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	53%			

Computer Equipment	EUI	kWh/ft².yr	0.79
		MJ/m².yr	30.57
Plug Loads	EUI	kWh/ft².yr	1.66
		MJ/m².yr	64.21

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 70.0% Electricity Fuel Share: 30.0%

Cafeteria/food service

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	0.8	EUI	kWh/ft².yr	0.8
	MJ/m².yr	30.0		MJ/m².yr	30.0

REFRIGERATION

Provide description below:

Coolers, freezers, fridges, pop machines

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI	kWh/ft².yr	1.0
	MJ/m².yr	40

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **University / College** **Baseline**
SIZE: **All volumes except contract customers**
VINTAGE:
REGION: **Northern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total	
System Present (%)	10%	50%	3%		20%		17%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load	47.1 W/m²	14.9 Btu/hr.ft²	
Seasonal Heating Load (Tertiary Load)	672 MJ/m².yr	17.4 kWh/ft².yr	
Sizing Factor	1.00		
Electric Fuel Share	17.0%	Gas Fuel Share 83.0%	Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	kWh/ft².yr	MJ/m².yr
All Electric EUI	17.4	672
Natural Gas EUI	22.7	879
Market Composite EUI	21.8	844

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Absorptior	Engine	Total
System Present (%)	59.0%	20.0%		5.0%	15.0%	1.0%		100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	14.0	57.2

Peak Cooling Load	83 W/m²	26 Btu/hr.ft²	456 ft²/Ton
Seasonal Cooling Load (Tertiary Load)	170.2 MJ/m².yr	4.4 kWh/ft².yr	

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 99.0% — Gas Fuel Share 1.0%

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	kWh/ft².yr	MJ/m².yr
All Electric EUI	1.5	58
Natural Gas EUI	4.1	160
Market Composite EUI	1.5	59

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	68%		20%	1%	2%
Eff./COP	75%		65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	91%	9%	100%
Blended Efficiency	0.73	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 70.0

Wetting Use Percentage 50%

	kWh/ft².yr	MJ/m².yr
All Electric EUI	2.0	77
All Natural Gas EUI	2.5	96
Market Composite EUI	2.4	93.8

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
University / College	**All volumes except contract customers**		**Northern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	4.2	L/s.m²	0.83	CFM/ft²
System Static Pressure CAV	875	Pa	3.5	wg
System Static Pressure VAV	875	Pa	3.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	8.3	W/m²	0.77	W/ft²
Fan Design Load VAV	8.3	W/m²	0.77	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	70%	30%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	35%	65%	35%	65%

Comments:

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.0	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.1	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.83	W/m²	0.17	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.29	W/m²	0.12	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0053	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.0	W/m²	0.10	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	35.7	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.1	kWh/m².yr
Condenser Pump Energy Consumption	4.1	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.9	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	6.1	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	4.5
	MJ/m².yr	172.5

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
University / College	**All volumes except contract customers**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**18.4** kWh/ft².yr	**711.3** MJ/m².yr	**Gas:**	**22.7** kWh/ft².yr	**878.8** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING	4.9	190.7					
ARCHITECTURAL LIGHTING	1.0	39.4	SPACE HEATING	2.9	114.3	18.8	729.7
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	1.1	42.9	0.0	1.2
OTHER PLUG LOADS	1.7	64.2	DOMESTIC HOT WATER	0.2	6.9	2.2	86.9
HVAC FANS & PUMPS	4.5	172.5	FOOD SERVICE EQUIPMENT	0.2	9.0	0.5	21.0
REFRIGERATION	0.5	20.0	MISCELLANEOUS			1.0	40.0
COMPUTER EQUIPMENT	0.8	30.6					
ELEVATORS	0.1	3.9					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: Restaurant Baseline | **SIZE:** All | **VINTAGE:** | **REGION:** Northern Franchise

CONSTRUCTION

Wall U value (W/m².°C)	0.64 W/m².°C	0.11 Btu/hr.ft² .°F	Typical Building Size	500 m²	5,380 ft²
Roof U value (W/m².°C)	0.48 W/m².°C	0.08 Btu/hr.ft² .°F	Typical Footprint (m²)	500 m²	5,380 ft²
Glazing U value (W/m².°C)	3.34 W/m².°C	0.59 Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	1	
			Percent Conditioned Space	100%	
			Percent Conditioned Space Defined as Exterior Zone	40%	
Window/Wall Ratio (WIWAR) (%)	0.15		Typical # Stories	1	
Shading Coefficient (SC)	0.85		Floor to Floor Height (m)	4.5 m	14.8 ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	60%							40%	60%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	50 m²/person	538 ft²/person	%OA 6.72%
Occupancy Schedule Occ. Period	90%		
Occupancy Schedule Unocc. Period			
Fresh Air Requirements or Outside Air	17 L/s.person	36 CFM/person	

Fresh Air Control Type *(enter a 1, 2 or 3): 2
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)
If Fresh Air Control Type = "2" enter % FA. to the right: 38%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1.2	
Total Air Circulation or Design Air Flow	5.06 L/s.m²	1.00 CFM/ft²

Separate Make-up air unit (100% OA): 2 L/s.m² | 0.39 CFM/ft²
Operation occupied period: 50%
Operation unoccupied period: 50%

Infiltration Rate: 0.30 L/s.m² | 0.06 CFM/ft²
(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	483,647	
Peak Zone Sensible Load	95,984	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	4,465	
Total air circulation or Design air	5.06	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	15	°C	59	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	20	°C	68	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	21	°C	69.8	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Restaurant	All		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	400	Lux	37.2	ft-candles
Floor Fraction (GLFF)	0.90			
Connected Load	25.6	W/m²	2.4	W/ft²
Occ. Period(Hrs./yr.)	4300			
Unocc. Period(Hrs./yr.)	4460			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	400	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**400**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	30%	5%	35%		30%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	10.2
	MJ/m².yr	394

ARCHITECTURAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.10			
Connected Load	19.4	W/m²	1.8	W/ft²
Occ. Period(Hrs./yr.)	4300			
Unocc. Period(Hrs./yr.)	4460			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	30%	5%	45%		20%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	0.9
	MJ/m².yr	33

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	0%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 25.01 W/m²

EUI TOTAL	kWh/ft².yr	11
	MJ/m².yr	427

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)												
Connected Load		W/m²		W/m²		W/m²		W/m²	0.5	W/m²	2	W/m²
		W/ft²		W/ft²		W/ft²		W/ft²	0.05	W/ft²	0.19	W/ft²
Diversity Occupied Period											100%	
Diversity Unoccupied Period											90%	
Operation Occ. Period (hrs./year)											4000	
Operation Unocc. Period (hrs./year)	8760		8760		8760		8760		8760		4760	

Total end-use load (occupied period)	2.0	W/m²	0.2	W/ft²
Total end-use load (unocc. period)	1.8	W/m²	0.2	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	90%			

Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	1.54
		MJ/m².yr	59.64

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 88.0% Electricity Fuel Share: 12.0%

Cooking

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	23.2	EUI	kWh/ft².yr	23.2
	MJ/m².yr	900.0		MJ/m².yr	900.0

REFRIGERATION

Provide description below:

Walk-ins, reach ins, fridges etc

EUI	kWh/ft².yr	9.0
	MJ/m².yr	350.0

MISCELLANEOUS

EUI	kWh/ft².yr	0.3
	MJ/m².yr	10

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Restaurant** **Baseline**
SIZE: **All**
VINTAGE:
REGION: **Northern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric		
	Boilers				RTU	Furnace	Resistance	Total	
	Standard	Near Cond	Cond						
System Present (%)	10%	4%	1%		62%	5%	18%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load	86.9	W/m²	27.6	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	1168	MJ/m².yr	30.1	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 18.0% Gas Fuel Share 82.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	30.1	49.4	46.0
MJ/m².yr	1168	1915	1780

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)	20.0%				80.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	15.0	°C	59	°F

Peak Cooling Load	283	W/m²	90	Btu/hr.ft²	133	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	351.4	MJ/m².yr	9.1	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 85.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	3.4		3.4
MJ/m².yr	133		133

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	10%		65%	4%	3%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	82%	18%	100%
Blended Efficiency	0.68	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 400.0

Wetting Use Percentage 10%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	11.3	15.1	14.4
MJ/m².yr	440	585	559.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Restaurant** **Baseline**
SIZE: **All**
VINTAGE:
REGION: **Northern Franchise**

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	5.1	L/s.m²	1.00	CFM/ft²
System Static Pressure CAV	500	Pa	2.0	wg
System Static Pressure VAV	500	Pa	2.0	wg
Fan Efficiency	52%			
Fan Motor Efficiency	80%			
Sizing Factor	1.00			
Fan Design Load CAV	6.1	W/m²	0.56	W/ft²
Fan Design Load VAV	6.1	W/m²	0.56	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	50%	50%

Comments:

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.4	L/s.m²	0.08	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.5	L/s.m²	0.10	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	72%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.7	W/m²	0.06	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	6.26	W/m²	0.58	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.015	L/s.m²	0.022	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.012	L/s.m²	0.0180	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure		kPa		ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load		W/m²		W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	38.5	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	4.4	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.8	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption		kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	4.1
	MJ/m².yr	160.7

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Restaurant	**All**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**42.7** kWh/ft².yr	**1,652.4** MJ/m².yr	**Gas:**	**73.6** kWh/ft².yr	**2,851.9** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING	10.2	394.0					
ARCHITECTURAL LIGHTING	0.9	33.2	SPACE HEATING	5.4	210.2	40.5	1,570.1
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	2.9	113.3		
OTHER PLUG LOADS	1.5	59.6	DOMESTIC HOT WATER	2.0	79.1	12.4	479.9
HVAC FANS & PUMPS	4.1	160.7	FOOD SERVICE EQUIPMENT	2.8	108.0	20.4	792.0
REFRIGERATION	9.0	350.0				0.3	10
COMPUTER EQUIPMENT							
ELEVATORS							
OUTDOOR LIGHTING	3.7	144.2					

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Warehouse	All volumes		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.64	W/m².°C	0.11	Btu/hr.ft² .°F	Typical Building Size	5,500	m²	59,180	ft²
Roof U value (W/m².°C)	0.44	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Footprint (m²)	5,500	m²	59,180	ft²
Glazing U value (W/m².°C)	3.30	W/m².°C	0.58	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	40%			
Window/Wall Ratio (WIWAR) (%)	0.02								
Shading Coefficient (SC)	0.85				Typical # Stories	1			
					Floor to Floor Height (m)	9.1	m	30.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	100%								100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	100	m²/person	1076	ft²/person	%OA	7.14%
Occupancy Schedule Occ. Period	90%					
Occupancy Schedule Unocc. Period						
Fresh Air Requirements or Outside Air	14	L/s.person	30	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) | 2 | If Fresh Air Control Type = "2" enter % FA. to the right: | 15%
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air) | If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation | 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	1.96	L/s.m²	0.39	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,325,483	
Peak Zone Sensible Load	491,186	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	22,850	
Total air circulation or Design air	1.96	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	15	°C	59	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	20	°C	68	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	19	°C	66.2	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Warehouse	All volumes		Northern Franchise
Baseline			

LIGHTING

GENERAL (HIGH BAY) LIGHTING

Light Level	350	Lux	32.5	ft-candles
Floor Fraction (GLFF)	0.95			
Connected Load	15.4	W/m²	1.4	W/ft²

Occ. Period(Hrs./yr.)	2500
Unocc. Period(Hrs./yr.)	6260
Usage During Occupied Period	100%
Usage During Unoccupied Period	5%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	400	700	1000				Total
% Distribution	50%	50%						100%
Weighted Average								**350**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)			5%		5%	85%	5%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	3.8
	MJ/m².yr	148

ARCHITECTURAL (OFFICE AREA) LIGHTING

Light Level	400	Lux	37.2	ft-candles
Floor Fraction (ALFF)	0.05			
Connected Load	14.3	W/m²	1.3	W/ft²

Occ. Period(Hrs./yr.)	2500
Unocc. Period(Hrs./yr.)	6260
Usage During Occupied Period	100%
Usage During Unoccupied Period	5%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	50%	50%						100%
Weighted Average								**400**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%	70%		20%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	0.2
	MJ/m².yr	7

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 — 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING — Overall LP 15.36 W/m²

EUI TOTAL	kWh/ft².yr	4
	MJ/m².yr	156

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.05	0.05	0.01	0.01		
Connected Load	0.0 W/m²	0.0 W/m²	0.0 W/m²	0.0 W/m²	0.5 W/m²	1 W/m²
	0.0 W/ft²	0.0 W/ft²	0.00 W/ft²	0.00 W/ft²	0.05 W/ft²	0.09 W/ft²
Diversity Occupied Period	100%	100%	90%			100%
Diversity Unoccupied Period						5%
Operation Occ. Period (hrs./year)	4000	4000	4000			4000
Operation Unocc. Period (hrs./year)	4760	4760	4760	8760	8760	4760

Total end-use load (occupied period)	1.1 W/m²	0.1 W/ft²
Total end-use load (unocc. period)	0.1 W/m²	0.0 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	5%	

Computer Equipment	EUI	kWh/ft².yr	0.02
		MJ/m².yr	0.89
Plug Loads	EUI	kWh/ft².yr	0.39
		MJ/m².yr	15.26

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 10.0% Electricity Fuel Share: 90.0%

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	0.3	EUI	kWh/ft².yr	0.3
	MJ/m².yr	10.0		MJ/m².yr	10.0

REFRIGERATION EQUIPMENT

Provide description below:

Coolers

EUI	kWh/ft².yr	1.0
	MJ/m².yr	40.0

MISCELLANEOUS EQUIPMENT

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Warehouse	All volumes		Northern Franchise
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond	U/H	RTU	Furnace	Electric Resistance	Total	
System Present (%)	5%	5%	1%	55%	25%	5%	4%	100%	100%
Eff./COP	75%	80%	90%	75%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.33	1.30	1.25	1.00		

Peak Heating Load	54.1	W/m²	17.2	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	451	MJ/m².yr	11.6	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 4.0% | Gas Fuel Share 96.0% | Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	kWh/ft².yr	MJ/m².yr
All Electric EUI	11.6	451
Natural Gas EUI	17.3	671
Market Composite EUI	17.1	662

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Absorption	Engine	Total
System Present (%)	10.0%				90.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	15.0	59

Peak Cooling Load	71 W/m²	22	Btu/hr.ft²	536	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	51.6 MJ/m².yr	1.3	kWh/ft².yr		

Sizing Factor 1.00 | Operation (occ. period) 3000 hrs/year | Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 10.0%

Electric Fuel Share 100.0% | Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	kWh/ft².yr	MJ/m².yr
All Electric EUI	0.6	21
Natural Gas EUI		
Market Composite EUI	0.6	21

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	5%		57%	1%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	64%	36%	100%
Blended Efficiency	0.67	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 25.0

Wetting Use Percentage 50%

	kWh/ft².yr	MJ/m².yr
All Electric EUI	0.7	27
All Natural Gas EUI	1.0	38
Market Composite EUI	0.9	33.9

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Warehouse** **Baseline**
SIZE: **All volumes**
VINTAGE:
REGION: **Northern Franchise**

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	2.0	L/s.m²	0.39	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV	375	Pa	1.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	80%			
Sizing Factor	1.00			
Fan Design Load CAV	1.8	W/m²	0.16	W/ft²
Fan Design Load VAV	1.8	W/m²	0.16	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.0	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.1	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	72%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.56	W/m²	0.15	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0045	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure		kPa		ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load		W/m²		W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	11.2	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.7	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.3	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption		kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	1.2
	MJ/m².yr	47.3

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Warehouse	**All volumes**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**8.1** kWh/ft².yr	**315.0** MJ/m².yr	**Gas:**	**17.8** kWh/ft².yr	**689.1** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL (HIGH BAY) LIGHTING	3.8	148.3
ARCHITECTURAL (OFFICE AREA) L	0.2	7.3
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	0.4	15.3
HVAC FANS & PUMPS	1.2	47.3
REFRIGERATION EQUIPMENT	1.0	40.0
COMPUTER EQUIPMENT	0.0	0.9
ELEVATORS		
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	0.5	18.0	16.6	644.0
SPACE COOLING	0.1	2.1		
DOMESTIC HOT WATER	0.3	9.9	0.6	24.0
FOOD SERVICE EQUIPMENT	0.2	9.0	0.0	1.0
MISCELLANEOUS EQUIPMENT			0.5	20.0

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Highrise** **Baseline**
SIZE: **> 50,000 m3 excluding contract customers**
VINTAGE:
REGION: **Northern Franchise**

CONSTRUCTION

Wall U value (W/m².°C)	0.64	W/m².°C	0.11	Btu/hr.ft² .°F
Roof U value (W/m².°C)	0.48	W/m².°C	0.08	Btu/hr.ft² .°F
Glazing U value (W/m².°C)	3.30	W/m².°C	0.58	Btu/hr.ft² .°F
Window/Wall Ratio (WIWAR) (%)	0.25			
Shading Coefficient (SC)	0.65			

Typical Building Size	7,300	m²	78,548	ft²
Typical Footprint (m²)	1,217	m²	13,091	ft²
Footprint Aspect Ratio (L:W)	2.5			
Percent Conditioned Space	100%			
Percent Conditioned Space Defined as Exterior Zone	36%			
Typical # Stories	6			
Floor to Floor Height (m)	2.8	m	9.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)								100%	
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	35	m²/person	377	ft²/person
Occupancy Schedule Occ. Period	30%			
Occupancy Schedule Unocc. Period	90%			
Fresh Air Requirements or Outside Air	20	L/s.person	42	CFM/person

%OA 81.63%

Fresh Air Control Type *(enter a 1, 2 or 3) 3
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.7 L/s.m² 0.14 CFM/ft²
50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	0.70	L/s.m²	0.14	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)	L/s.m²	CFM/ft²
Operation occupied period	50%	
Operation unoccupied period	50%	

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,507,394	
Peak Zone Sensible Load	489,193	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	22,757	
Total air circulation or Design air	1.47	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	18	°C	64.4	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	22	°C	71.6	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning Changes/Year 4

Incidence of Annual Room Controls Maintenance 100.0%

Incidence of Annual HVAC Controls Maintenance 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Highrise	> 50,000 m3 excluding contract customers		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	50	Lux	4.6	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	5.9	W/m²	0.5	W/ft²
Occ. Period(Hrs./yr.)	2100			
Unocc. Period(Hrs./yr.)	6660			
Usage During Occupied Period	30%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	50	100	200	300				Total
% Distribution	100%							100%
Weighted Average								**50**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	75%	5%	15%		5%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI		
	kWh/ft².yr	0.6
	MJ/m².yr	23

ARCHITECTURAL LIGHTING (CORRIDORS)

Light Level	200	Lux	18.6	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	12.7	W/m²	1.2	W/ft²
Occ. Period(Hrs./yr.)	3000			
Unocc. Period(Hrs./yr.)	5760			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	100	200	300	500				Total
% Distribution		100%						100%
Weighted Average								**200**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	25%	35%	30%		10%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI		
	kWh/ft².yr	1.6
	MJ/m².yr	60

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	0%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI		
	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING — Overall LP 6.92 W/m²

EUI TOTAL		
	kWh/ft².yr	2
	MJ/m².yr	84

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.9		0.9		0.15		0.1		0.08			
Connected Load	1.4	W/m²	1.3	W/m²	0.4	W/m²	0.6	W/m²	0.5	W/m²	2.5	W/m²
	0.1	W/ft²	0.1	W/ft²	0.04	W/ft²	0.05	W/ft²	0.05	W/ft²	0.23	W/ft²
Diversity Occupied Period											5%	
Diversity Unoccupied Period											20%	
Operation Occ. Period (hrs./year)											3000	
Operation Unocc. Period (hrs./year)	8760		8760		8760		8760		8760		5760	

Total end-use load (occupied period)	0.1	W/m²	0.0	W/ft²
Total end-use load (unocc. period)	0.5	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	400%			

Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	0.30
		MJ/m².yr	11.72

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 5.0% Electricity Fuel Share: 95.0%

Cooking

	Natural Gas EUI			All Electric EUI	
EUI	kWh/ft².yr	1.3	EUI	kWh/ft².yr	1.3
	MJ/m².yr	50.0		MJ/m².yr	50.0

REFRIGERATION

Provide description below:

EUI		
	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI		
	kWh/ft².yr	0.5
	MJ/m².yr	20

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Highrise** **Baseline**
SIZE: **> 50,000 m3 excluding contract customers**
VINTAGE:
REGION: **Northern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	47%	20%	3%		20%		10%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	42.9	W/m²	13.6	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	609	MJ/m².yr	15.7	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 10.0% — Gas Fuel Share 90.0% — Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	kWh/ft².yr	15.7
	MJ/m².yr	609
Natural Gas EUI	kWh/ft².yr	20.8
	MJ/m².yr	805
Market Composite EUI	kWh/ft².yr	20.3
	MJ/m².yr	785

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)	25.0%	25.0%			50.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	61	W/m²	19	Btu/hr.ft²	625	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	75.7	MJ/m².yr	2.0	kWh/ft².yr		

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 25.0%

Electric Fuel Share 100.0% — Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	kWh/ft².yr	0.7
	MJ/m².yr	26
Natural Gas EUI	kWh/ft².yr	
	MJ/m².yr	
Market Composite EUI	kWh/ft².yr	0.7
	MJ/m².yr	26

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	23%		54%	1%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	79%	21%
Blended Efficiency	0.69	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 170.0

Wetting Use Percentage 10%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	4.8	6.4	6.1
MJ/m².yr	187	248	235.2

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Highrise	> 50,000 m3 excluding contract customers		Northern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	0.7	L/s.m²	0.14	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV		Pa		wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	0.6	W/m²	0.06	W/ft²
Fan Design Load VAV		W/m²		W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.2	L/s.m²	0.03	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.3	L/s.m²	0.05	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.4	W/m²	0.03	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.34	W/m²	0.12	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.003	L/s.m²	0.005	U.S. gpm/ft²
Pump Head Pressure	0.1	kPa	0.0333333	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.00	W/m²	0.00	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0038	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	100	kPa	33	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.5	W/m²	0.05	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	3.8	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	3.1	kWh/m².yr
Condenser Pump Energy Consumption	0.0	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.4	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	3.2	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	1.0
	MJ/m².yr	37.6

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Highrise	**> 50,000 m3 excluding contract customers**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**8.5** kWh/ft².yr	**328.0** MJ/m².yr	**Gas:**	**24.3** kWh/ft².yr	**943.0** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING (SUITES)	0.6	23.4					
ARCHITECTURAL LIGHTING (COR	1.6	60.2	SPACE HEATING	1.6	60.9	18.7	724.5
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	0.2	6.6		
OTHER PLUG LOADS	0.3	11.7	DOMESTIC HOT WATER	1.0	39.2	5.1	195.9
HVAC FANS & PUMPS	1.0	37.6	FOOD SERVICE EQUIPMENT	1.2	47.5	0.1	2.5
REFRIGERATION	0.5	20.0	MISCELLANEOUS			0.5	20.0
COMPUTER EQUIPMENT							
ELEVATORS	0.1	3.9					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Medium Rise	> 5 Units, Excluding Contract Customers		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.48	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Building Size	800	m²	8,608	ft²
Roof U value (W/m².°C)	0.44	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Footprint (m²)	267	m²	2,869	ft²
Glazing U value (W/m².°C)	3.27	W/m².°C	0.58	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2.5			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.25								
Shading Coefficient (SC)	0.65				Typical # Stories	3			
					Floor to Floor Height (m)	2.8	m	9.2	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)									100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	35	m²/person	377	ft²/person	%OA	7.14%
Occupancy Schedule Occ. Period	30%					
Occupancy Schedule Unocc. Period	90%					
Fresh Air Requirements or Outside Air	7	L/s.person	15	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) | 1 | If Fresh Air Control Type = "2" enter % FA. to the right:
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air) | If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation | 0.25 L/s.m² | 0.05 CFM/ft² | 50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	2.80	L/s.m²	0.55	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	135,248	
Peak Zone Sensible Load	102,120	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	4,751	
Total air circulation or Design air	2.80	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	14	°C	57.2	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	21	°C	69.8	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Medium Rise	> 5 Units, Excluding Contract Customers		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	50	Lux	4.6	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	5.9	W/m²	0.5	W/ft²
Occ. Period(Hrs./yr.)	2100			
Unocc. Period(Hrs./yr.)	6660			
Usage During Occupied Period	30%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	50	100	200	300				Total
% Distribution	100%							100%
Weighted Average								**50**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	75%	5%	15%		5%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI		
	kWh/ft².yr	0.6
	MJ/m².yr	23

ARCHITECTURAL LIGHTING (CORRIDORS)

Light Level	200	Lux	18.6	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	12.7	W/m²	1.2	W/ft²
Occ. Period(Hrs./yr.)	3000			
Unocc. Period(Hrs./yr.)	5760			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	100	200	300	500				Total
% Distribution		100%						100%
Weighted Average								**200**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	25%	35%	30%		10%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI		
	kWh/ft².yr	1.6
	MJ/m².yr	60

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	0%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 — 1.00

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI		
	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 6.92 W/m²

EUI TOTAL		
	kWh/ft².yr	2
	MJ/m².yr	84

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)												
Connected Load		W/m²		W/m²		W/m²		W/m²	0.5	W/m²	2.5	W/m²
		W/ft²		W/ft²		W/ft²		W/ft²	0.05	W/ft²	0.23	W/ft²
Diversity Occupied Period											5%	
Diversity Unoccupied Period											20%	
Operation Occ. Period (hrs./year)											3000	
Operation Unocc. Period (hrs./year)	8760		8760		8760		8760		8760		5760	

Total end-use load (occupied period)	0.1	W/m²	0.0	W/ft²
Total end-use load (unocc. period)	0.5	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	400%			

	EUI		
Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	0.30
		MJ/m².yr	11.72

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 10.0% Electricity Fuel Share: 90.0%

Cooking

	Natural Gas EUI		All Electric EUI	
EUI	kWh/ft².yr	1.0	kWh/ft².yr	1.0
	MJ/m².yr	40.0	MJ/m².yr	40.0

REFRIGERATION

Provide description below:

EUI		
	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI		
	kWh/ft².yr	0.3
	MJ/m².yr	10

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS: **Medium Rise** **Baseline**

SIZE: **> 5 Units, Excluding Contract Customers**

VINTAGE:

REGION: **Northern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total
System Present (%)	34%	34%	2%		20%		10%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load: 83.7 W/m² — 26.5 Btu/hr.ft²

Seasonal Heating Load (Tertiary Load): 587 MJ/m².yr — 15.2 kWh/ft².yr

Sizing Factor: 1.00

Electric Fuel Share: 10.0% — Gas Fuel Share: 90.0% — Oil Fuel Share:

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	15.2	20.5	19.9
MJ/m².yr	587	792	772

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Absorptior	Engine	Total
System Present (%)	40.0%	10.0%			50.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	14.0	57.2

Peak Cooling Load: 50 W/m² — 16 Btu/hr.ft² — 764 ft²/Ton

Seasonal Cooling Load (Tertiary Load): 103.0 MJ/m².yr — 2.7 kWh/ft².yr

Sizing Factor: 1.00 — Operation (occ. period): 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C): 25.0%

Electric Fuel Share: 100.0% — Gas Fuel Share:

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	0.7		0.7
MJ/m².yr	28		28

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	17%		69%	1%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	88%	12%
Blended Efficiency	0.68	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load): 157.5

Wetting Use Percentage: 10%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	4.5	6.0	5.8
MJ/m².yr	173	233	226.1

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	SIZE:	VINTAGE:	REGION:
Medium Rise	> 5 Units, Excluding Contract Customers		Northern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	2.8	L/s.m²	0.55	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV		Pa		wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	2.4	W/m²	0.22	W/ft²
Fan Design Load VAV		W/m²		W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use		100%		100%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.8	L/s.m²	0.15	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.9	L/s.m²	0.17	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	1.1	W/m²	0.11	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.09	W/m²	0.10	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.003	L/s.m²	0.004	U.S. gpm/ft²
Pump Head Pressure	0.1	kPa	0.0333333	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.00	W/m²	0.00	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.002	L/s.m²	0.0031	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	100	kPa	33	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.4	W/m²	0.04	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	9.3	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	4.4	kWh/m².yr
Condenser Pump Energy Consumption	0.0	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.5	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	2.6	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	1.6
	MJ/m².yr	60.6

COMMERCIAL SECTOR BUILDING PROFILE

EXISTING BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Medium Rise	**> 5 Units, Excluding Contract Customers**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**8.1**	kWh/ft².yr	**315.5**	MJ/m².yr		
	Gas:	**24.1**	kWh/ft².yr	**932.6**	MJ/m².yr		

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING (SUITES)	0.6	23.4					
ARCHITECTURAL LIGHTING (COR	1.6	60.2	SPACE HEATING	1.5	58.7	18.4	713.2
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	0.2	7.1		
OTHER PLUG LOADS	0.3	11.7	DOMESTIC HOT WATER	0.5	20.8	5.3	205.3
HVAC FANS & PUMPS	1.6	60.6	FOOD SERVICE EQUIPMENT	0.9	36.0	0.1	4.0
REFRIGERATION	0.5	20.0	MISCELLANEOUS			0.3	10.0
COMPUTER EQUIPMENT							
ELEVATORS							
OUTDOOR LIGHTING	0.4	17.0					

APPENDIX C

New Building Profiles – Southern Region

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COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Office	> 50,000 m3		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.68	W/m².°C	0.12	Btu/hr.ft² .°F	Typical Building Size	8,000	m²	86,080	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	2,000	m²	21,520	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	1.5			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.36								
Shading Coefficient (SC)	0.52				Typical # Stories	4			
					Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)					100%				100%
Min. Air Flow (%)					30%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	26	m²/person	280	ft²/person	%OA	21.62%
Occupancy Schedule Occ. Period	90%					
Occupancy Schedule Unocc. Period						
Fresh Air Requirements or Outside Air	21	L/s.person	44	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) | 1 | If Fresh Air Control Type = "2" enter % FA. to the right: 15%

(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air) | If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1.5			
Total Air Circulation or Design Air Flow	3.74	L/s.m²	0.74	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	2,245,237	
Peak Zone Sensible Load	907,339	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	42,209	
Total air circulation or Design air	3.74	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	10%	60%
DDC/Pneumatic		
All DDC	90%	40%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	15	°C	59	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	21	°C	69.8	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Office	**> 50,000 m3**		**Southern Franchise**
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	440 Lux	40.9	ft-candles
Floor Fraction (GLFF)	0.85		
Connected Load	10.9 W/m²	1.0	W/ft²
Occ. Period(Hrs./yr.)	3400		
Unocc. Period(Hrs./yr.)	5360		
Usage During Occupied Period	95%		
Usage During Unoccupied Period	25%		
Fixture Cleaning:			
Incidence of Practice			
Interval		years	
Relamping Strategy & Incidence of Practice	Group	Spot	

Light Level (Lux)	300	500	700	1000	Total
% Distribution	40%	50%	10%		100%
Weighted Average					**440**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		5%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI kWh/ft².yr 3.9; MJ/m².yr 152

ARCHITECTURAL LIGHTING

Light Level	400 Lux	37.2	ft-candles
Floor Fraction (ALFF)	0.15		
Connected Load	10.3 W/m²	1.0	W/ft²
Occ. Period(Hrs./yr.)	3600		
Unocc. Period(Hrs./yr.)	5160		
Usage During Occupied Period	100%		
Usage During Unoccupied Period	25%		
Fixture Cleaning:			
Incidence of Practice			
Interval		years	
Relamping Strategy & Incidence of Practice	Group	Spot	

Light Level (Lux)	300	500	700	1000	Total
% Distribution	50%	50%			100%
Weighted Average					**400**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		10%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI kWh/ft².yr 0.7; MJ/m².yr 27

OTHER (HIGH BAY) LIGHTING

Light Level	300.00 Lux	27.9	ft-candles
Floor Fraction (HBLFF)			
Connected Load	0.0 W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000		
Unocc. Period(Hrs./yr.)	4760		
Usage During Occupied Period	0%		
Usage During Unoccupied Period	100%		
Fixture Cleaning:			
Incidence of Practice			
Interval		years	
Relamping Strategy & Incidence of Practice	Group	Spot	

Floor fraction check: should = 1.00 — 1.00

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI kWh/ft².yr; MJ/m².yr

TOTAL LIGHTING — Overall LP 10.78 W/m² — EUI TOTAL kWh/ft².yr 5; MJ/m².yr 179

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.9	0.9	0.15	0.1	0.06	
Connected Load	1.9 W/m²	1.8 W/m²	0.6 W/m²	0.8 W/m²	0.5 W/m²	1.5 W/m²
	0.2 W/ft²	0.2 W/ft²	0.05 W/ft²	0.07 W/ft²	0.05 W/ft²	0.14 W/ft²
Diversity Occupied Period	80%	80%	80%	80%	100%	80%
Diversity Unoccupied Period	50%	50%	50%	50%	100%	50%
Operation Occ. Period (hrs./year)	2000	2000	2000	2000	2000	2500
Operation Unocc. Period (hrs./year)	6760	6760	6760	6760	6760	6260

Total end-use load (occupied period)	5.7 W/m²	0.5 W/ft²
Total end-use load (unocc. period)	3.8 W/m²	0.3 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	66%	

		kWh/ft².yr	MJ/m².yr
Computer Equipment	EUI	2.73	105.68
Plug Loads	EUI	0.72	27.70

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 20.0% Electricity Fuel Share: 80.0%

		kWh/ft².yr	MJ/m².yr
Natural Gas EUI	EUI	0.4	15.0
All Electric EUI	EUI	0.4	15.0

REFRIGERATION

Provide description below:

EUI kWh/ft².yr 0.1; MJ/m².yr 5.0

MISCELLANEOUS

EUI kWh/ft².yr 1.0; MJ/m².yr 40

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Office	**> 50,000 m3**		**Southern Franchise**
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Natural Gas Boilers Near Cond	Natural Gas Boilers Cond	Natural Gas	Natural Gas RTU	Natural Gas Furnace	Electric Resistance	Total	
System Present (%)	10%	30%	5%		45%		10%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load	47.6	W/m²	15.1	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	291	MJ/m².yr	7.5	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share: 10.0% — Gas Fuel Share: 90.0% — Oil Fuel Share:

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	kWh/ft².yr	MJ/m².yr
All Electric EUI	7.5	291
Natural Gas EUI	10.9	424
Market Composite EUI	10.6	411

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	Centrifugal Chillers HE	Screw Chillers	Recprocting Chillers Open	Recprocting Chillers DX	Gas Cooling Absorption	Gas Cooling Engine	Total
System Present (%)		50.0%			50.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	82	W/m²	26	Btu/hr.ft²	460	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	236.1	MJ/m².yr	6.1	kWh/ft².yr		

Sizing Factor: 1.00 — Operation (occ. period): 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C): 90.0%

Electric Fuel Share: 100.0% — Gas Fuel Share:

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	kWh/ft².yr	MJ/m².yr
All Electric EUI	1.7	65
Natural Gas EUI		
Market Composite EUI	1.7	65

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	10%		70%	2%	3%
Eff./COP	75%		65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	85%	15%	100%
Blended Efficiency	0.68	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load): 40.0

Wetting Use Percentage: 50%

	kWh/ft².yr	MJ/m².yr
All Electric EUI	1.1	44
All Natural Gas EUI	1.5	59
Market Composite EUI	1.5	56.9

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Office	> 50,000 m3		Southern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.7	L/s.m²	0.74	CFM/ft²
System Static Pressure CAV	1000	Pa	4.0	wg
System Static Pressure VAV	1000	Pa	4.0	wg
Fan Efficiency	55%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	8.0	W/m²	0.74	W/ft²
Fan Design Load VAV	8.0	W/m²	0.74	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	15%	85%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	25%	75%	25%	75%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.04	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.3	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.82	W/m²	0.17	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure	120	kPa	40	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.03	W/m²	0.10	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0052	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	120	kPa	40	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.8	W/m²	0.08	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	21.2	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.4	kWh/m².yr
Condenser Pump Energy Consumption	3.3	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.1	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	5.2	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	3.0
	MJ/m².yr	115.9

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Office	**> 50,000 m3**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**14.5**	kWh/ft².yr	**560.5**	MJ/m².yr	**Gas:**	**12.3** kWh/ft².yr	**474.9** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING	3.9	151.9					
ARCHITECTURAL LIGHTING	0.7	27.2	SPACE HEATING	0.8	29.1	9.9	381.6
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	1.5	58.7		
OTHER PLUG LOADS	0.7	27.7	DOMESTIC HOT WATER	0.2	6.6	1.3	50.3
HVAC FANS & PUMPS	3.0	115.9	FOOD SERVICE EQUIPMENT	0.3	12.0	0.1	3.0
REFRIGERATION	0.1	5.0	MISCELLANEOUS			1.0	40.0
COMPUTER EQUIPMENT	2.7	105.7					
ELEVATORS	0.1	3.9					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Small Office	< 50,000 m3		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.40	W/m².°C	0.07	Btu/hr.ft² .°F	Typical Building Size	1,000	m²	10,760	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	500	m²	5,380	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	40%			
Window/Wall Ratio (WIWAR) (%)	0.30								
Shading Coefficient (SC)	0.59				Typical # Stories	2			
					Floor to Floor Height (m)	3.2	m	10.5	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)					100%				100%
Min. Air Flow (%)					20%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	26	m²/person	280	ft²/person	%OA	5.43%
Occupancy Schedule Occ. Period	90%					
Occupancy Schedule Unocc. Period						
Fresh Air Requirements or Outside Air	7	L/s.person	15	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) | 2 | If Fresh Air Control Type = "2" enter % FA. to the right: | 10%
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air) | If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation | 0.5 L/s.m² | 0.10 CFM/ft²
50% operation (%)

Sizing Factor	1.5			
Total Air Circulation or Design Air Flow	4.96	L/s.m²	0.98	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	259,014	
Peak Zone Sensible Load	150,590	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	7,005	
Total air circulation or Design air	4.96	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	30%	80%
DDC/Pneumatic	30%	
All DDC	40%	20%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	17	°C	62.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20.25	°C	68.45	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Small Office	< 50,000 m3		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	440 Lux	40.9	ft-candles
Floor Fraction (GLFF)	0.95		
Connected Load	10.9 W/m²	1.0	W/ft²

Occ. Period(Hrs./yr.)	2900
Unocc. Period(Hrs./yr.)	5860
Usage During Occupied Period	95%
Usage During Unoccupied Period	25%

Light Level (Lux)	300	500	700	1000			Total
% Distribution	40%	50%	10%				100%
Weighted Average							**440**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		5%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval years

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	kWh/ft².yr	4.0
	MJ/m².yr	157

ARCHITECTURAL LIGHTING

Light Level	400 Lux	37.2	ft-candles
Floor Fraction (ALFF)	0.05		
Connected Load	10.3 W/m²	1.0	W/ft²

Occ. Period(Hrs./yr.)	3600
Unocc. Period(Hrs./yr.)	5160
Usage During Occupied Period	100%
Usage During Unoccupied Period	25%

Light Level (Lux)	300	500	700	1000			Total
% Distribution	50%	50%					100%
Weighted Average							**400**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		10%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval years

Relamping Strategy & Incidence of Practice	Group	Spot

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	0.2
	MJ/m².yr	9

OTHER (HIGH BAY) LIGHTING

Light Level	300.00 Lux	27.9	ft-candles
Floor Fraction (HBLFF)			
Connected Load	0.0 W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 — 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%

Light Level (Lux)	300	500	700	1000			Total
% Distribution	100%						100%
Weighted Average							**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval years

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING — Overall LP 10.84 W/m²

EUI TOTAL	kWh/ft².yr	4
	MJ/m².yr	166

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.95		0.95		0.1		0.1		0.06			
Connected Load	2.0	W/m²	1.9	W/m²	0.4	W/m²	0.8	W/m²	0.5	W/m²	1.5	W/m²
	0.2	W/ft²	0.2	W/ft²	0.04	W/ft²	0.07	W/ft²	0.05	W/ft²	0.14	W/ft²
Diversity Occupied Period	70%		80%		50%		50%		100%		100%	
Diversity Unoccupied Period	30%		30%		5%		5%		100%		10%	
Operation Occ. Period (hrs./year)	2000		2000		2000		2000		2000		2000	
Operation Unocc. Period (hrs./year)	6760		6760		6760		6760		6760		6760	

Total end-use load (occupied period)	5.5	W/m²	0.5	W/ft²
Total end-use load (unocc. period)	1.9	W/m²	0.2	W/ft²

Usage during occupied period	100%
Usage during unoccupied period	34%

Computer Equipment	EUI	kWh/ft².yr	1.82
		MJ/m².yr	70.57
Plug Loads	EUI	kWh/ft².yr	0.37
		MJ/m².yr	14.45

FOOD SERVICE EQUIPMENT

Provide description below:

Gas Fuel Share: 20.0% Electricity Fuel Share: 80.0%

	Natural Gas EUI			All Electric EUI	
EUI	kWh/ft².yr	0.4	EUI	kWh/ft².yr	0.4
	MJ/m².yr	15.0		MJ/m².yr	15.0

REFRIGERATION

Provide description below:

EUI	kWh/ft².yr	0.1
	MJ/m².yr	5.0

MISCELLANEOUS

EUI	kWh/ft².yr	0.8
	MJ/m².yr	30

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS: **Small Office** **Baseline**

SIZE: **< 50,000 m3**

VINTAGE:

REGION: **Southern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric		
	Boilers				RTU	Furnace	Resistance	Total	
	Standard	Near Cond	Cond						
System Present (%)	10%	10%	2%		68%		10%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load	89.8	W/m²	28.5	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	326	MJ/m².yr	8.4	kWh/ft².yr
Sizing Factor	1.50			

Electric Fuel Share 10.0% Gas Fuel Share 90.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	8.4
MJ/m².yr	326

Natural Gas EUI	
kWh/ft².yr	15.7
MJ/m².yr	610

Market Composite EUI	
kWh/ft².yr	15.0
MJ/m².yr	582

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Adsorption	Engine	
System Present (%)					100.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	76	W/m²	24	Btu/hr.ft²	499	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	213.5	MJ/m².yr	5.5	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 90.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	2.1
MJ/m².yr	82

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	2.1
MJ/m².yr	82

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater	
System Present (%)	3%		76%	1%	1%	
Eff./COP	75%	60%	65%	90%	90%	

	Fossil		Elec. Res.	
Fuel Share	81%		19%	100%
Blended Efficiency	0.66		0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 40.0

Wetting Use Percentage 50%

All Electric EUI	
kWh/ft².yr	1.1
MJ/m².yr	44

All Natural Gas EUI	
kWh/ft².yr	1.6
MJ/m².yr	61

Market Composite EUI	
kWh/ft².yr	1.5
MJ/m².yr	57.5

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Small Office	< 50,000 m3		Southern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	5.0	L/s.m²	0.98	CFM/ft²
System Static Pressure CAV	562.5	Pa	2.3	wg
System Static Pressure VAV	562.5	Pa	2.3	wg
Fan Efficiency	55%			
Fan Motor Efficiency	82%			
Sizing Factor	1.00			
Fan Design Load CAV	6.2	W/m²	0.57	W/ft²
Fan Design Load VAV	6.2	W/m²	0.57	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use		100%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	50%	50%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.4	L/s.m²	0.08	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.5	L/s.m²	0.10	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.7	W/m²	0.06	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.68	W/m²	0.16	W/ft²

Condenser Pump

Pump Design Flow		L/s.KW		U.S. gpm/Ton
Pump Design Flow per unit floor area		L/s.m²		U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0048	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure		kPa		ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load		W/m²		W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	13.4	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	4.2	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.2	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption		kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	1.7
	MJ/m².yr	67.7

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Small Office	**< 50,000 m3**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**12.1** kWh/ft².yr	**467.4** MJ/m².yr	**Gas:**	**16.3** kWh/ft².yr

	Gas:	**16.3** kWh/ft².yr, **631.1** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	4.0	156.8
ARCHITECTURAL LIGHTING	0.2	9.1
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	0.4	14.5
HVAC FANS & PUMPS	1.7	67.7
REFRIGERATION	0.1	5.0
COMPUTER EQUIPMENT	1.8	70.6
ELEVATORS		
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	0.8	32.6	14.2	549.0
SPACE COOLING	1.9	73.9		
DOMESTIC HOT WATER	0.2	8.4	1.3	49.1
FOOD SERVICE EQUIPMENT	0.3	12.0	0.1	3.0
MISCELLANEOUS			0.8	30.0

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Retail	**All**		**Southern Franchise**
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.45	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Building Size	2,500	m²	26,900	ft²
Roof U value (W/m².°C)	0.36	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	2,500	m²	26,900	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	1.5			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	40%			
Window/Wall Ratio (WIWAR) (%)	0.20								
Shading Coefficient (SC)	0.85				Typical # Stories	1			
					Floor to Floor Height (m)	4.5	m	14.8	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	100%								100%
Min. Air Flow (%)									

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	50	m²/person	538	ft²/person	%OA	12.94%
Occupancy Schedule Occ. Period	90%					
Occupancy Schedule Unocc. Period						
Fresh Air Requirements or Outside Air	25	L/s.person	53	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3)	2	If Fresh Air Control Type = "2" enter % FA. to the right:	10%			
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)		If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation	0.5	L/s.m²	0.10	CFM/ft²
			50%	operation (%)		

Sizing Factor	1.1			
Total Air Circulation or Design Air Flow	3.86	L/s.m²	0.76	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	660,474	
Peak Zone Sensible Load	400,007	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	18,608	
Total air circulation or Design air	3.86	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	15	°C	59	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	19.5	°C	67.1	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	21	°C	69.8	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Retail	All		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	760	Lux	70.6	ft-candles
Floor Fraction (GLFF)	0.95			
Connected Load	26.8	W/m^2	2.5	W/ft^2

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	100%
Usage During Unoccupied Period	25%

Light Level (Lux)	300	500	700	1000	Total
% Distribution		15%	55%	30%	100%
Weighted Average					**760**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	10%			70%	15%	0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval — years

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	
kWh/ft^2.yr	12.3
MJ/m^2.yr	476

ARCHITECTURAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.05			
Connected Load	20.6	W/m^2	1.9	W/ft^2

Occ. Period(Hrs./yr.)	3800
Unocc. Period(Hrs./yr.)	4960
Usage During Occupied Period	100%
Usage During Unoccupied Period	60%

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	30%	40%			30%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval — years

Relamping Strategy & Incidence of Practice	Group	Spot

EUI = Load X Hrs. X SF X GLFF

EUI	
kWh/ft^2.yr	0.6
MJ/m^2.yr	25

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m^2	0.0	W/ft^2

Floor fraction check: should = 1.00 — 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval — years

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	
kWh/ft^2.yr	
MJ/m^2.yr	

TOTAL LIGHTING

Overall LP 26.51 W/m^2

EUI TOTAL	
kWh/ft^2.yr	13
MJ/m^2.yr	501

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.2	0.2	0.15	0.1	0.12	
Connected Load (W/m^2)	0.2	0.2	0.3	0.4	0.5	1.5
Connected Load (W/ft^2)	0.0	0.0	0.03	0.04	0.05	0.14
Diversity Occupied Period	80%	80%	80%	80%	100%	80%
Diversity Unoccupied Period	50%	50%	50%	50%	100%	50%
Operation Occ. Period (hrs./year)	2000	2000	2000	2000	2000	2500
Operation Unocc. Period (hrs./year)	6760	6760	6760	6760	6760	6260

Total end-use load (occupied period)	2.6	W/m^2	0.2	W/ft^2
Total end-use load (unocc. period)	1.8	W/m^2	0.2	W/ft^2

Usage during occupied period 100%
Usage during unoccupied period 70%

	EUI	
Computer Equipment	kWh/ft^2.yr	0.94
	MJ/m^2.yr	36.30
Plug Loads	kWh/ft^2.yr	0.72
	MJ/m^2.yr	27.70

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 40.0% Electricity Fuel Share: 60.0%

Gas - cooking, baking not seperately metered

EUI	Natural Gas EUI	All Electric EUI
kWh/ft^2.yr	1.0	1.0
MJ/m^2.yr	40.0	40.0

REFRIGERATION EQUIPMENT

Provide description below:

Walk-in, display merchandisers, reach-ins, and fridges

EUI	
kWh/ft^2.yr	1.0
MJ/m^2.yr	40.0

MISCELLANEOUS

EUI	
kWh/ft^2.yr	0.5
MJ/m^2.yr	20

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Retail	All		Southern Franchise
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric		
	Boilers Standard	Near Cond	Cond		RTU	Furnace	Resistance	Total	
System Present (%)	4%	4%	2%		75%	5%	10%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load	51.3 W/m²	16.3 Btu/hr.ft²	
Seasonal Heating Load (Tertiary Load)	330 MJ/m².yr	8.5 kWh/ft².yr	
Sizing Factor	1.30		
Electric Fuel Share	10.0%	Gas Fuel Share 90.0%	Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	kWh/ft².yr	8.5
	MJ/m².yr	330
Natural Gas EUI	kWh/ft².yr	13.2
	MJ/m².yr	510
Market Composite EUI	kWh/ft².yr	12.0
	MJ/m².yr	467

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Absorption	Engine	Total
System Present (%)		10.0%			90.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	15.0	59

Peak Cooling Load	77 W/m²	25 Btu/hr.ft²	489 ft²/Ton
Seasonal Cooling Load (Tertiary Load)	243.6 MJ/m².yr	6.3 kWh/ft².yr	

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 90.0%

Electric Fuel Share 100.0% — Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	kWh/ft².yr	2.6
	MJ/m².yr	100
Natural Gas EUI	kWh/ft².yr	
	MJ/m².yr	
Market Composite EUI	kWh/ft².yr	2.6
	MJ/m².yr	100

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	1%		65%	1%	3%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	70%	30%	100%
Blended Efficiency	0.67	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 35.0

Wetting Use Percentage 10%

All Electric EUI		All Natural Gas EUI		Market Composite EUI	
kWh/ft².yr	1.0	kWh/ft².yr	1.4	kWh/ft².yr	1.2
MJ/m².yr	38	MJ/m².yr	53	MJ/m².yr	48.3

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS: Retail Baseline | **SIZE:** All | **VINTAGE:** | **REGION:** Southern Franchise

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.9	L/s.m²	0.76	CFM/ft²
System Static Pressure CAV	625	Pa	2.5	wg
System Static Pressure VAV	625	Pa	2.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	80%			
Sizing Factor	1.00			
Fan Design Load CAV	5.8	W/m²	0.54	W/ft²
Fan Design Load VAV	5.8	W/m²	0.54	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use		100%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	90%	10%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.04	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.71	W/m²	0.16	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0049	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure		kPa		ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load		W/m²		W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	8.0	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	2.1	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.5	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption		kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	1.1
	MJ/m².yr	41.6

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Retail	**All**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES: **Electricity:** **21.3** kWh/ft².yr **825.8** MJ/m².yr **Gas:** **13.7** kWh/ft².yr **532.1** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	12.3	476.1
ARCHITECTURAL LIGHTING	0.6	25.1
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	0.7	27.7
HVAC FANS & PUMPS	1.1	41.6
REFRIGERATION EQUIPMENT	1.0	40.0
COMPUTER EQUIPMENT	0.9	36.3
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	0.9	33.0	11.9	459.3
SPACE COOLING	2.3	89.6		
DOMESTIC HOT WATER	0.3	11.5	1.0	36.8
FOOD SERVICE EQUIPMENT	0.6	24.0	0.4	16.0
MISCELLANEOUS			0.5	20.0

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Hotel	> 50,000 m^3		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.56	W/m².°C	0.10	Btu/hr.ft² .°F	Typical Building Size	8,000	m²	86,080	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	2,000	m²	21,520	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	5			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	75%			
Window/Wall Ratio (WIWAR) (%)	0.25								
Shading Coefficient (SC)	0.64				Typical # Stories	4			
					Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	80%				20%				100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	60	m²/person	646	ft²/person	%OA	14.49%
Occupancy Schedule Occ. Period	45%					
Occupancy Schedule Unocc. Period	80%					
Fresh Air Requirements or Outside Air	25	L/s.person	53	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3)
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air): 1

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² — 0.10 CFM/ft²; 50% operation (%)

Sizing Factor	1.25			
Total Air Circulation or Design Air Flow	2.88	L/s.m²	0.57	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,507,478	
Peak Zone Sensible Load	838,421	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	39,003	
Total air circulation or Design air	2.88	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	22	°C	71.6	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	23	°C	73.4	°F	24	°C	75.2	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20	°C	68	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Hotel	> 50,000 m^3		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	120	Lux	11.2	ft-candles
Floor Fraction (GLFF)	0.75			
Connected Load	4.7	W/m²	0.4	W/ft²

Occ. Period(Hrs./yr.)	2100
Unocc. Period(Hrs./yr.)	6660
Usage During Occupied Period	70%
Usage During Unoccupied Period	30%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	50	100	200	300				Total
% Distribution	20%	50%	30%					100%
Weighted Average								**120**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		75%			25%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	1.1
	MJ/m².yr	44

GENERAL LIGHTING (LOBBY BALLROOMS, CORRIDORS, BACK OF HOUSE)

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.25			
Connected Load	15.1	W/m²	1.4	W/ft²

Occ. Period(Hrs./yr.)	3600
Unocc. Period(Hrs./yr.)	5160
Usage During Occupied Period	100%
Usage During Unoccupied Period	70%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	15%	40%			45%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	2.5
	MJ/m².yr	98

EUI = Load X Hrs. X SF X GLFF

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 7.27 W/m²

EUI TOTAL	kWh/ft².yr	4
	MJ/m².yr	141

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)						
Connected Load	W/m²	W/m²	W/m²	W/m²	0.5 W/m²	4 W/m²
	W/ft²	W/ft²	W/ft²	W/ft²	0.05 W/ft²	0.37 W/ft²
Diversity Occupied Period						70%
Diversity Unoccupied Period						70%
Operation Occ. Period (hrs./year)						3000
Operation Unocc. Period (hrs./year)	8760	8760	8760	8760	8760	5760

Total end-use load (occupied period)	2.8 W/m²	0.3 W/ft²
Total end-use load (unocc. period)	2.8 W/m²	0.3 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	100%	

Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	2.28
		MJ/m².yr	88.30

FOOD SERVICE EQUIPMENT

Provide description below:

Gas Fuel Share: 50.0% Electricity Fuel Share: 50.0%

Cooking

	Natural Gas EUI		All Electric EUI	
EUI kWh/ft².yr	1.8	EUI kWh/ft².yr	1.8
MJ/m².yr	70.0	MJ/m².yr	70.0

REFRIGERATION

Provide description below:

Coolers, ice machines, pop machines, fridges etc

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI	kWh/ft².yr	1.3
	MJ/m².yr	50

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Hotel Baseline	> 50,000 m^3		Southern Franchise

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	15%	20%	5%		25%		35%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	58.5	W/m²	18.6	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	394	MJ/m².yr	10.2	kWh/ft².yr
Sizing Factor	1.50			

Electric Fuel Share 35.0%   Gas Fuel Share 65.0%   Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	10.2
MJ/m².yr	394

Natural Gas EUI	
kWh/ft².yr	13.9
MJ/m².yr	538

Market Composite EUI	
kWh/ft².yr	12.6
MJ/m².yr	487

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Reciprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorption	Engine	
System Present (%)		70.0%		10.0%	20.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	55	W/m²	18	Btu/hr.ft²	685	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	163.0	MJ/m².yr	4.2	kWh/ft².yr		

Sizing Factor 1.00   Operation (occ. period) 3000 hrs/year   Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 90.0%

Electric Fuel Share 100.0%   Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	1.2
MJ/m².yr	45

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	1.2
MJ/m².yr	45

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	45%		25%	19%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	90%	10%	100%
Blended Efficiency	0.76	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 220.0

Wetting Use Percentage 50%

All Electric EUI	
kWh/ft².yr	6.2
MJ/m².yr	242

All Natural Gas EUI	
kWh/ft².yr	7.5
MJ/m².yr	291

Market Composite EUI	
kWh/ft².yr	7.4
MJ/m².yr	286.2

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Hotel	> 50,000 m^3		Southern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	2.9	L/s.m²	0.57	CFM/ft²
System Static Pressure CAV	500	Pa	2.0	wg
System Static Pressure VAV	500	Pa	2.0	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	3.3	W/m²	0.30	W/ft²
Fan Design Load VAV	3.3	W/m²	0.30	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	80%	20%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	50%	50%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.04	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.3	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.22	W/m²	0.11	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.003	L/s.m²	0.004	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.86	W/m²	0.08	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.002	L/s.m²	0.0035	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.7	W/m²	0.06	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	17.5	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.7	kWh/m².yr
Condenser Pump Energy Consumption	2.8	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.9	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	3.2	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	2.4
	MJ/m².yr	93.8

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Hotel	**> 50,000 m^3**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**15.5** kWh/ft².yr	**601.8** MJ/m².yr	**Gas:**	**18.0** kWh/ft².yr	**696.6** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	1.1	43.7
GENERAL LIGHTING (LOBBY BALLROOMS, COR	2.5	97.8
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	2.3	88.3
HVAC FANS & PUMPS	2.4	93.8
REFRIGERATION	0.5	20.0
COMPUTER EQUIPMENT		
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	3.6	137.8	9.0	349.5
SPACE COOLING	1.0	40.4		
DOMESTIC HOT WATER	0.6	24.2	6.8	262.1
FOOD SERVICE EQUIPMENT	0.9	35.0	0.9	35.0
MISCELLANEOUS			1.3	50.0

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hotel/Motel	< 50,000 m^3		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.41	W/m².°C	0.07	Btu/hr.ft² .°F	Typical Building Size	950 m²	10,222	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	950 m²	10,222	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	5		
					Percent Conditioned Space	100%		
					Percent Conditioned Space Defined as Exterior Zone	75%		
Window/Wall Ratio (WIWAR) (%)	0.25							
Shading Coefficient (SC)	0.64				Typical # Stories	1		
					Floor to Floor Height (m)	3.2 m	10.5	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	90%				10%				100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	60	m²/person	646	ft²/person
Occupancy Schedule Occ. Period	45%			
Occupancy Schedule Unocc. Period	80%			
Fresh Air Requirements or Outside Air	7	L/s.person	15	CFM/person

%OA 4.07%

Fresh Air Control Type *(enter a 1, 2 or 3) — 2
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 10%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² — 0.10 CFM/ft² — 50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	2.87	L/s.m²	0.56	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)	L/s.m²	CFM/ft²
Operation occupied period	50%	
Operation unoccupied period	50%	

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	220,547	
Peak Zone Sensible Load	124,113	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	5,774	
Total air circulation or Design air	2.87	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional	PI / PID	Total
Control Mode			
	Fixed Discharge	Reset	
Control Strategy			

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	22	°C	71.6	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	23	°C	73.4	°F	24	°C	75.2	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	19	°C	66.2	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hotel/Motel	< 50,000 m^3		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	120	Lux	11.2	ft-candles
Floor Fraction (GLFF)	0.75			
Connected Load	7.1	W/m²	0.7	W/ft²

Occ. Period(Hrs./yr.)	2100
Unocc. Period(Hrs./yr.)	6660
Usage During Occupied Period	70%
Usage During Unoccupied Period	30%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	50	100	200	300				Total
% Distribution	20%	50%	30%					100%
Weighted Average								**120**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	20%	55%			25%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	1.7
	MJ/m².yr	67

ARCHITECTURAL LIGHTING (LOBBY BALLROOMS, CORRIDORS, BACK OF HOUSE)

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.25			
Connected Load	16.6	W/m²	1.5	W/ft²

Occ. Period(Hrs./yr.)	3600
Unocc. Period(Hrs./yr.)	5160
Usage During Occupied Period	100%
Usage During Unoccupied Period	70%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	20%	35%			45%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	2.8
	MJ/m².yr	108

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 9.50 W/m²

EUI TOTAL	kWh/ft².yr	5
	MJ/m².yr	175

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)												
Connected Load		W/m²		W/m²		W/m²		W/m²		W/m²	1.5	W/m²
		W/ft²		W/ft²		W/ft²		W/ft²		W/ft²	0.14	W/ft²
Diversity Occupied Period											70%	
Diversity Unoccupied Period											70%	
Operation Occ. Period (hrs./year)											3000	
Operation Unocc. Period (hrs./year)	8760		8760		8760		8760		8760		5760	

Total end-use load (occupied period)	1.1	W/m²	0.1	W/ft²
Total end-use load (unocc. period)	1.1	W/m²	0.1	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	100%			

Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	0.85
		MJ/m².yr	33.11

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 20.0% Electricity Fuel Share: 80.0%

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	0.8	EUI	kWh/ft².yr	0.8
	MJ/m².yr	30.0		MJ/m².yr	30.0

REFRIGERATION EQUIPMENT

Provide description below:

EUI	kWh/ft².yr	0.3
	MJ/m².yr	10.0

MISCELLANEOUS

EUI	kWh/ft².yr	1.0
	MJ/m².yr	40

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Hotel/Motel	**< 50,000 m^3**		**Southern Franchise**
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	25%	25%	10%		5%		35%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	62.8	W/m²	19.9	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	404	MJ/m².yr	10.4	kWh/ft².yr
Sizing Factor	1.30			

Electric Fuel Share 35.0% Gas Fuel Share 65.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

EUI		
All Electric EUI	kWh/ft².yr	10.4
	MJ/m².yr	404
Natural Gas EUI	kWh/ft².yr	13.4
	MJ/m².yr	519
Market Composite EUI	kWh/ft².yr	12.4
	MJ/m².yr	479

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorption	Engine	
System Present (%)				15.0%	85.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	68	W/m²	22	Btu/hr.ft²	556	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	150.7	MJ/m².yr	3.9	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 90.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

EUI		
All Electric EUI	kWh/ft².yr	1.7
	MJ/m².yr	66
Natural Gas EUI	kWh/ft².yr	
	MJ/m².yr	
Market Composite EUI	kWh/ft².yr	1.7
	MJ/m².yr	66

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	35%		40%	5%	5%
Eff./COP	75%	60%	65%	90%	90%

	Fossil		Elec. Res.	
Fuel Share	85%		15%	100%
Blended Efficiency	0.72		0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 240.0

Wetting Use Percentage 50%

All Electric EUI		All Natural Gas EUI		Market Composite EUI	
kWh/ft².yr	6.8	kWh/ft².yr	8.6	kWh/ft².yr	8.3
MJ/m².yr	264	MJ/m².yr	333	MJ/m².yr	322.7

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hotel/Motel	< 50,000 m^3		Southern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	2.9	L/s.m²	0.56	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV	625	Pa	2.5	wg
Fan Efficiency	45%			
Fan Motor Efficiency	80%			
Sizing Factor	1.00			
Fan Design Load CAV	3.0	W/m²	0.28	W/ft²
Fan Design Load VAV	5.0	W/m²	0.46	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	80%	20%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	100%		100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.2	L/s.m²	0.04	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.3	L/s.m²	0.06	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.4	W/m²	0.04	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.50	W/m²	0.14	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.005	U.S. gpm/ft²
Pump Head Pressure	24	kPa	8	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.17	W/m²	0.02	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0043	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	8	kPa	3	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.0	W/m²	0.00	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	23.1	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	3.6	kWh/m².yr
Condenser Pump Energy Consumption	0.5	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.9	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	0.2	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	2.6
	MJ/m².yr	102.2

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Hotel/Motel	**< 50,000 m^3**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**15.5**	kWh/ft².yr	**601.6**	MJ/m².yr		
	Gas:	**17.2**	kWh/ft².yr	**666.7**	MJ/m².yr		

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING (SUITES)	1.7	66.7					
ARCHITECTURAL LIGHTING (LOBI	2.8	107.8	SPACE HEATING	3.7	141.5	8.7	337.6
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	1.5	59.8		
OTHER PLUG LOADS	0.9	33.1	DOMESTIC HOT WATER	1.0	39.6	7.3	283.1
HVAC FANS & PUMPS	2.6	102.2	FOOD SERVICE EQUIPMENT	0.6	24.0	0.2	6.0
REFRIGERATION EQUIPMENT	0.3	10.0	MISCELLANEOUS			1.0	40.0
COMPUTER EQUIPMENT							
ELEVATORS							
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: **Hospital** **Baseline** | **SIZE:** **All volumes** | **VINTAGE:** | **REGION:** **Southern Franchise**

CONSTRUCTION

Wall U value (W/m².°C)	0.35 W/m².°C	0.06 Btu/hr.ft² .°F	Typical Building Size	10,000 m²	107,600 ft²
Roof U value (W/m².°C)	0.35 W/m².°C	0.06 Btu/hr.ft² .°F	Typical Footprint (m²)	3,333 m²	35,867 ft²
Glazing U value (W/m².°C)	2.80 W/m².°C	0.49 Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	3	
			Percent Conditioned Space	100%	
			Percent Conditioned Space Defined as Exterior Zone	36%	
Window/Wall Ratio (WIWAR) (%)	0.27				
Shading Coefficient (SC)	0.51		Typical # Stories	3	
			Floor to Floor Height (m)	3.7 m	12.0 ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	15%	25%			5%	5%		50%	50%
Min. Air Flow (%)					20%	20%			

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	26 m²/person	280 ft²/person	%OA 33.89%
Occupancy Schedule Occ. Period	90%		
Occupancy Schedule Unocc. Period	60%		
Fresh Air Requirements or Outside Air	30 L/s.person	64 CFM/person	

Fresh Air Control Type *(enter a 1, 2 or 3) 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)
If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.5 L/s.m² 0.10 CFM/ft²; 50% operation (%)

Sizing Factor 1.75
Total Air Circulation or Design Air Flow 3.40 L/s.m² 0.67 CFM/ft²

Separate Make-up air unit (100% OA) L/s.m² CFM/ft²
Operation occupied period
Operation unoccupied period

Infiltration Rate 0.30 L/s.m² 0.06 CFM/ft²
(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	3,237,394	
Peak Zone Sensible Load	886,120	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	41,222	
Total air circulation or Design air	3.40	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic		50%
DDC/Pneumatic	50%	
All DDC	50%	50%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	24	°C	75.2	°F	22	°C	71.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	24	°C	75.2	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year 4

Incidence of Annual Room Controls Maintenance 100.0%

Incidence of Annual HVAC Controls Maintenance 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hospital	All volumes		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (PATIENTS ROOM)

Light Level	250	Lux	23.2	ft-candles
Floor Fraction (GLFF)	0.50			
Connected Load	6.2	W/m²	0.6	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	50%			
Usage During Unoccupied Period	20%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	200	300	500	1000				Total
% Distribution	50%	50%						100%
Weighted Average	4							**250**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		5%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	1.0
	MJ/m².yr	37

ARCHITECTURAL LIGHTING (NURSING STATIONS, EXAMINATION, LABORATORY, ICU, RECOVERY)

Light Level	700	Lux	65.1	ft-candles
Floor Fraction (ALFF)	0.40			
Connected Load	18.0	W/m²	1.7	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	65%			
Usage During Unoccupied Period	40%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution			100%					100%
Weighted Average								**700**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		10%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	3.2
	MJ/m².yr	126

CORRIDORS OTHER

Light Level	250.00	Lux	23.2	ft-candles
Floor Fraction (HBLFF)	0.10			
Connected Load	6.9	W/m²	0.6	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	50%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	200	300	500	1000				Total
% Distribution	50%	50%						100%
Weighted Average								**250**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		10%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	0.5
	MJ/m².yr	18

TOTAL LIGHTING — Overall LP 10.28 W/m²

EUI TOTAL	kWh/ft².yr	5
	MJ/m².yr	181

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.05		0.05		0.01		0.01					
Connected Load	0.1	W/m²	0.1	W/m²	0.0	W/m²	0.1	W/m²		W/m²	5	W/m²
	0.0	W/ft²	0.0	W/ft²	0.00	W/ft²	0.01	W/ft²		W/ft²	0.46	W/ft²
Diversity Occupied Period	90%		90%		90%		90%				100%	
Diversity Unoccupied Period	40%		40%		20%		10%					
Operation Occ. Period (hrs./year)	5400		5400		5400		5400				3000	
Operation Unocc. Period (hrs./year)	3360		3360		3360		3360		8760		5760	

Total end-use load (occupied period)	5.3	W/m²	0.5	W/ft²
Total end-use load (unocc. period)	0.1	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	2%			

Computer Equipment	EUI	kWh/ft².yr	0.17
		MJ/m².yr	6.73
Plug Loads	EUI	kWh/ft².yr	1.39
		MJ/m².yr	54.00

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 65.0% Electricity Fuel Share: 35.0%

Cooking

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	1.3	EUI	kWh/ft².yr	1.3
	MJ/m².yr	50.0		MJ/m².yr	50.0

KITCHEN & REFRIGERATION

Provide description below:

EUI	kWh/ft².yr	0.8
	MJ/m².yr	30.0

Misc

EUI	kWh/ft².yr	2.6
	MJ/m².yr	100

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: Hospital Baseline | **SIZE:** All volumes | **VINTAGE:** | **REGION:** Southern Franchise

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total
System Present (%)		70%	20%		8%		2%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load: 58.1 W/m² — 18.4 Btu/hr.ft²
Seasonal Heating Load (Tertiary Load): 897 MJ/m².yr — 23.2 kWh/ft².yr
Sizing Factor: 2.20

Electric Fuel Share: 2.0% Gas Fuel Share: 98.0% Oil Fuel Share:

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	kWh/ft².yr	MJ/m².yr
All Electric EUI	23.2	897
Natural Gas EUI	28.5	1105
Market Composite EUI	28.4	1101

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	Centrifugal Chillers HE	Screw Chillers	Recprocting Chillers Open	Recprocting Chillers DX	Gas Cooling Absorptior	Gas Cooling Engine	Total
System Present (%)		87.0%		4.0%	4.0%	5.0%		100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	14.0	57.2

Peak Cooling Load: 95 W/m² — 30 Btu/hr.ft² — 399 ft²/Ton
Seasonal Cooling Load (Tertiary Load): 242.3 MJ/m².yr — 6.3 kWh/ft².yr

Sizing Factor: 1.00 Operation (occ. period): 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C): 75.0%

Electric Fuel Share: 95.0% Gas Fuel Share: 5.0%

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	kWh/ft².yr	MJ/m².yr
All Electric EUI	1.6	61
Natural Gas EUI	6.6	254
Market Composite EUI	1.8	71

DOMESTIC HOT WATER & PROCESS STREAM

Service Hot Water Plant Type

Fossil Fuel SHW	Med Eff Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	79%		10%	5%	1%
Eff./COP	84%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	95%	5%
Blended Efficiency	0.82	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load): 250.0

Wetting Use Percentage: 25%

	kWh/ft².yr	MJ/m².yr
All Electric EUI	7.1	275
All Natural Gas EUI	7.8	303
Market Composite EUI	7.8	302.0

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hospital	All volumes		Southern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.4	L/s.m²	0.67	CFM/ft²
System Static Pressure CAV	1000	Pa	4.0	wg
System Static Pressure VAV	1000	Pa	4.0	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	7.7	W/m²	0.72	W/ft²
Fan Design Load VAV	7.7	W/m²	0.72	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	80%	20%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	90%	10%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	2.10	W/m²	0.19	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.005	L/s.m²	0.007	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.48	W/m²	0.14	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0060	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.2	W/m²	0.11	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	55.2	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.9	kWh/m².yr
Condenser Pump Energy Consumption	4.0	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.4	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	8.2	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	6.6
	MJ/m².yr	254.6

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Hospital	**All volumes**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**16.9**	kWh/ft².yr	**655.2**	MJ/m².yr	**Gas:**	**39.1** kWh/ft².yr	**1,513.0** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING (PATIENTS R(	1.0	37.5
ARCHITECTURAL LIGHTING (NUR	3.2	125.8
CORRIDORS OTHER	0.5	17.6
OTHER PLUG LOADS	1.4	54.0
HVAC FANS & PUMPS	6.6	254.6
KITCHEN & REFRIGERATION	0.8	30.0
COMPUTER EQUIPMENT	0.2	6.7
ELEVATORS	0.5	19.4
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	0.5	17.9	28.0	1,082.7
SPACE COOLING	1.1	43.5	0.2	9.5
DOMESTIC HOT WATER & PRO(	0.4	13.7	7.4	288.3
FOOD SERVICE EQUIPMENT	0.5	17.5	0.8	32.5
Misc			2.6	100.0

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: Hospital Baseline | **SIZE:** All volumes | **VINTAGE:** | **REGION:** Southern Franchise

CONSTRUCTION

Wall U value (W/m².°C)	0.36	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Building Size	10,000	m²	107,600	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	3,333	m²	35,867	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	3			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.27								
Shading Coefficient (SC)	0.51				Typical # Stories	3			
					Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	15%	25%			5%	5%		50%	50%
Min. Air Flow (%)					20%	20%			

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	26	m²/person	280	ft²/person
Occupancy Schedule Occ. Period	90%			
Occupancy Schedule Unocc. Period	60%			
Fresh Air Requirements or Outside Air	30	L/s.person	64	CFM/person

%OA 33.88%

Fresh Air Control Type *(enter a 1, 2 or 3) 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.5 L/s.m² 0.10 CFM/ft²; 50% operation (%)

Sizing Factor	1.75			
Total Air Circulation or Design Air Flow	3.41	L/s.m²	0.67	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA) L/s.m² CFM/ft²
Operation occupied period
Operation unoccupied period

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	3,237,625	
Peak Zone Sensible Load	886,350	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	41,233	
Total air circulation or Design air	3.41	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic		50%
DDC/Pneumatic	50%	
All DDC	50%	50%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	24	°C	75.2	°F	22	°C	71.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	24	°C	75.2	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning Changes/Year 4

Incidence of Annual Room Controls Maintenance 100.0%

Incidence of Annual HVAC Controls Maintenance 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hospital	All volumes		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (PATIENTS ROOM)

Light Level	250	Lux	23.2	ft-candles
Floor Fraction (GLFF)	0.50			
Connected Load	6.2	W/m²	0.6	W/ft²

Occ. Period(Hrs./yr.)	5400	Light Level (Lux)	200	300	500	1000			Total
Unocc. Period(Hrs./yr.)	3360	% Distribution	50%	50%					100%
Usage During Occupied Period	50%	Weighted Average	4						**250**
Usage During Unoccupied Period	20%								

			INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
Fixture Cleaning:		System Present (%)		5%			95%		0%	100.0%
Incidence of Practice		CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
Interval	years	LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
		Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence	Group	Spot			
of Practice			EUI	kWh/ft².yr	1.0
				MJ/m².yr	37

ARCHITECTURAL LIGHTING (NURSING STATIONS, EXAMINATION, LABORATORY, ICU, RECOVERY)

Light Level	700	Lux	65.1	ft-candles
Floor Fraction (ALFF)	0.40			
Connected Load	18.0	W/m²	1.7	W/ft²

Occ. Period(Hrs./yr.)	5400	Light Level (Lux)	300	500	700	1000			Total
Unocc. Period(Hrs./yr.)	3360	% Distribution			100%				100%
Usage During Occupied Period	65%	Weighted Average							**700**
Usage During Unoccupied Period	40%								

			INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
Fixture Cleaning:		System Present (%)		10%			90%		0%	100.0%
Incidence of Practice		CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
Interval	years	LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
		Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence	Group	Spot				
of Practice				EUI	kWh/ft².yr	3.2
			EUI = Load X Hrs. X SF X GLFF		MJ/m².yr	126

CORRIDORS OTHER

Light Level	250.00	Lux	23.2	ft-candles	Floor fraction check: should = 1.00	1.00
Floor Fraction (HBLFF)	0.10					
Connected Load	6.9	W/m²	0.6	W/ft²		

Occ. Period(Hrs./yr.)	5400	Light Level (Lux)	200	300	500	1000			Total
Unocc. Period(Hrs./yr.)	3360	% Distribution	50%	50%					100%
Usage During Occupied Period	100%	Weighted Average							**250**
Usage During Unoccupied Period	50%								

			INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
Fixture Cleaning:		System Present (%)		10%			90%		0%	100.0%
Incidence of Practice		CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
Interval	years	LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
		Efficacy (L/W)	15	50	72	84	88	65	90	

Relamping Strategy & Incidence	Group	Spot			
of Practice			EUI	kWh/ft².yr	0.5
				MJ/m².yr	18

TOTAL LIGHTING	Overall LP	10.28 W/m²	EUI TOTAL kWh/ft².yr	5
			MJ/m².yr	181

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.05		0.05		0.01		0.01					
Connected Load	0.1	W/m²	0.1	W/m²	0.0	W/m²	0.1	W/m²		W/m²	5	W/m²
	0.0	W/ft²	0.0	W/ft²	0.00	W/ft²	0.01	W/ft²		W/ft²	0.46	W/ft²
Diversity Occupied Period	90%		90%		90%		90%				100%	
Diversity Unoccupied Period	40%		40%		20%		10%					
Operation Occ. Period (hrs./year)	5400		5400		5400		5400				3000	
Operation Unocc. Period (hrs./year)	3360		3360		3360		3360		8760		5760	

Total end-use load (occupied period)	5.3	W/m²	0.5	W/ft²
Total end-use load (unocc. period)	0.1	W/m²	0.0	W/ft²

		Computer Equipment	EUI	kWh/ft².yr	0.17
Usage during occupied period	100%			MJ/m².yr	6.73
Usage during unoccupied period	2%	Plug Loads	EUI	kWh/ft².yr	1.39
				MJ/m².yr	54.00

FOOD SERVICE EQUIPMENT

Provide description below:	Gas Fuel Share:	65.0%	Electricity Fuel Share:	35.0%	Natural Gas EUI			All Electric EUI		
Cooking					EUI	kWh/ft².yr	1.3	EUI	kWh/ft².yr	1.3
						MJ/m².yr	50.0		MJ/m².yr	50.0

KITCHEN & REFRIGERATION

Provide description below:			
	EUI	kWh/ft².yr	0.8
		MJ/m².yr	30.0

Misc

	EUI	kWh/ft².yr	2.6
		MJ/m².yr	100

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Hospital	**All volumes**		**Southern Franchise**
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)		70%	20%		8%		2%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	58.8	W/m²	18.7	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	900	MJ/m².yr	23.2	kWh/ft².yr
Sizing Factor	2.20			

Electric Fuel Share 2.0% — Gas Fuel Share 98.0% — Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	23.2	28.6	28.5
MJ/m².yr	900	1108	1104

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorption	Engine	
System Present (%)		87.0%		4.0%	4.0%	5.0%		100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	95	W/m²	30	Btu/hr.ft²	399	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	242.2	MJ/m².yr	6.3	kWh/ft².yr		

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 95.0% — Gas Fuel Share 5.0%

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	1.6	6.6	1.8
MJ/m².yr	61	254	71

DOMESTIC HOT WATER & PROCESS STREAM

Service Hot Water Plant Type

Fossil Fuel SHW	Med Eff Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	79%		10%	5%	1%
Eff./COP	84%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	95%	5%	100%
Blended Efficiency	0.82	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 250.0

Wetting Use Percentage 25%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	7.1	7.8	7.8
MJ/m².yr	275	303	302.0

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Hospital	**All volumes**		**Southern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.4	L/s.m²	0.67	CFM/ft²
System Static Pressure CAV	1000	Pa	4.0	wg
System Static Pressure VAV	1000	Pa	4.0	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	7.7	W/m²	0.72	W/ft²
Fan Design Load VAV	7.7	W/m²	0.72	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	80%	20%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	90%	10%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.1	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	2.10	W/m²	0.19	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.005	L/s.m²	0.007	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.48	W/m²	0.14	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0060	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.2	W/m²	0.11	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	55.2	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.9	kWh/m².yr
Condenser Pump Energy Consumption	4.0	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.4	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	8.2	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	6.6
	MJ/m².yr	254.7

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Hospital	**All volumes**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**16.9** kWh/ft².yr	**655.3** MJ/m².yr	**Gas:**	**39.1** kWh/ft².yr	**1,516.0** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING (PATIENTS R(	1.0	37.5
ARCHITECTURAL LIGHTING (NUR	3.2	125.8
CORRIDORS OTHER	0.5	17.6
OTHER PLUG LOADS	1.4	54.0
HVAC FANS & PUMPS	6.6	254.7
KITCHEN & REFRIGERATION	0.8	30.0
COMPUTER EQUIPMENT	0.2	6.7
ELEVATORS	0.5	19.4
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	0.5	18.0	28.0	1,085.7
SPACE COOLING	1.1	43.5	0.2	9.5
DOMESTIC HOT WATER & PRO(	0.4	13.7	7.4	288.3
FOOD SERVICE EQUIPMENT	0.5	17.5	0.8	32.5
Misc			2.6	100.0

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Long Term Care (Nursing Home)	All volumes		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.39	W/m².°C	0.07	Btu/hr.ft² .°F	Typical Building Size	8,364	m²	89,997	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	4,182	m²	44,998	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	5			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	40%			
Window/Wall Ratio (WIWAR) (%)	0.25								
Shading Coefficient (SC)	0.60				Typical # Stories	2			
					Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	90%				10%				100%
Min. Air Flow (%)					20%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	30	m²/person	323	ft²/person
Occupancy Schedule Occ. Period	90%			
Occupancy Schedule Unocc. Period	90%			
Fresh Air Requirements or Outside Air	18	L/s.person	38	CFM/person

%OA 19.95%

Fresh Air Control Type *(enter a 1, 2 or 3) 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.5 L/s.m² 0.10 CFM/ft²
50% operation (%)

Sizing Factor	1.5			
Total Air Circulation or Design Air Flow	3.01	L/s.m²	0.59	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)	L/s.m²	CFM/ft²
Operation occupied period	50%	
Operation unoccupied period	50%	

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,812,115	
Peak Zone Sensible Load	763,886	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	35,536	
Total air circulation or Design air	3.01	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	16	°C	60.8	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	24	°C	75.2	°F	24	°C	75.2	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	24	°C	75.2	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Long Term Care (Nursing Home)	All volumes		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	200	Lux	18.6	ft-candles
Floor Fraction (GLFF)	0.75			
Connected Load	10.1	W/m²	0.9	W/ft²

Occ. Period(Hrs./yr.)	3000
Unocc. Period(Hrs./yr.)	5760
Usage During Occupied Period	85%
Usage During Unoccupied Period	45%
Fixture Cleaning:	
Incidence of Practice	
Interval	years

Light Level (Lux)	200	300	500	700	Total
% Distribution	100%				100%
Weighted Average					**200**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	20%	10%			70%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence of Practice: Group | Spot

EUI	kWh/ft².yr	3.6
	MJ/m².yr	140

ARCHITECTURAL LIGHTING (SERVICES, KITCHEN, OFFICES, DINING, RECREATION)

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.25			
Connected Load	10.9	W/m²	1.0	W/ft²

Occ. Period(Hrs./yr.)	5000
Unocc. Period(Hrs./yr.)	3760
Usage During Occupied Period	95%
Usage During Unoccupied Period	55%
Fixture Cleaning:	
Incidence of Practice	
Interval	years

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	20%			75%	5%	0%	105.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence of Practice: Group | Spot

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	1.7
	MJ/m².yr	67

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

Relamping Strategy & Incidence of Practice: Group | Spot

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING — Overall LP 10.26 W/m²

EUI TOTAL	kWh/ft².yr	5
	MJ/m².yr	206

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)												
Connected Load		W/m²		W/m²		W/m²		W/m²		W/m²	3.5	W/m²
		W/ft²		W/ft²		W/ft²		W/ft²		W/ft²	0.33	W/ft²
Diversity Occupied Period	80%		80%		80%		80%				70%	
Diversity Unoccupied Period	50%		50%		50%		50%				40%	
Operation Occ. Period (hrs./year)	2000		2000		2000		2000				3000	
Operation Unocc. Period (hrs./year)	6760		6760		6760		6760		8760		5760	

Total end-use load (occupied period)	2.5	W/m²	0.2	W/ft²
Total end-use load (unocc. period)	1.4	W/m²	0.1	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	57%			

Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	1.43
		MJ/m².yr	55.49

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 82.0% Electricity Fuel Share: 18.0%

Commercial Food Preparation

	Natural Gas EUI			All Electric EUI	
EUI	kWh/ft².yr	1.5	EUI	kWh/ft².yr	1.5
	MJ/m².yr	60.0		MJ/m².yr	60.0

REFRIGERATION EQUIPMENT

Provide description below:

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI	kWh/ft².yr	1.3
	MJ/m².yr	50

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS: **Long Term Care (Nursing Home)** **Baseline**
SIZE: **All volumes**
VINTAGE:
REGION: **Southern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total
System Present (%)	10%	50%	5%		25%		10%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load 75.3 W/m² 23.9 Btu/hr.ft²
Seasonal Heating Load (Tertiary Load) 582 MJ/m².yr 15.0 kWh/ft².yr
Sizing Factor 2.00

Electric Fuel Share 10.0% Gas Fuel Share 90.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	15.0
MJ/m².yr	582

Natural Gas EUI	
kWh/ft².yr	19.5
MJ/m².yr	757

Market Composite EUI	
kWh/ft².yr	19.1
MJ/m².yr	740

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recproctng Chillers Open	DX	Gas Cooling Absorptior	Engine	Total
System Present (%)		30.0%		30.0%	40.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	16.0	°C	60.8	°F

Peak Cooling Load 63 W/m² 20 Btu/hr.ft² 596 ft²/Ton
Seasonal Cooling Load (Tertiary Load) 186.0 MJ/m².yr 4.8 kWh/ft².yr

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	1.5
MJ/m².yr	57

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	1.5
MJ/m².yr	57

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	65%		20%	3%	2%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	90%	10%
Blended Efficiency	0.74	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 180.0

Wetting Use Percentage 10%

All Electric EUI	
kWh/ft².yr	5.1
MJ/m².yr	198

All Natural Gas EUI	
kWh/ft².yr	6.3
MJ/m².yr	245

Market Composite EUI	
kWh/ft².yr	6.2
MJ/m².yr	239.9

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Long Term Care (Nursing Home)	All volumes		Southern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.0	L/s.m²	0.59	CFM/ft²
System Static Pressure CAV	625	Pa	2.5	wg
System Static Pressure VAV	625	Pa	2.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	4.3	W/m²	0.40	W/ft²
Fan Design Load VAV	4.3	W/m²	0.40	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	25%	75%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	50%	50%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.0	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.1	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.40	W/m²	0.13	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.003	L/s.m²	0.005	U.S. gpm/ft²
Pump Head Pressure	75	kPa	25	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.49	W/m²	0.05	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0040	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	75	kPa	25	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.4	W/m²	0.04	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	13.6	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.2	kWh/m².yr
Condenser Pump Energy Consumption	1.4	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.9	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	2.5	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	1.8
	MJ/m².yr	71.2

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Long Term Care (Nursing Home)	**All volumes**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**13.0** kWh/ft².yr	**505.2** MJ/m².yr	**Gas:**	**25.8** kWh/ft².yr	**1,000.8** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING (SUITES)	3.6	139.6
ARCHITECTURAL LIGHTING (SER'	1.7	66.7
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	1.4	55.5
HVAC FANS & PUMPS	1.8	71.2
REFRIGERATION EQUIPMENT	0.5	20.0
COMPUTER EQUIPMENT		
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	1.5	58.2	17.6	681.6
SPACE COOLING	1.1	42.6		
DOMESTIC HOT WATER	0.5	19.8	5.7	220.1
FOOD SERVICE EQUIPMENT	0.3	10.8	1.3	49.2
MISCELLANEOUS			1.3	50.0

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
School	All Volumes		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Building Size	5,200 m²	55,952	ft²
Roof U value (W/m².°C)	0.33	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	2,600 m²	27,976	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2		
					Percent Conditioned Space	100%		
					Percent Conditioned Space Defined as Exterior Zone	50%		
Window/Wall Ratio (WIWAR) (%)	0.28							
Shading Coefficient (SC)	0.68				Typical # Stories	2		
					Floor to Floor Height (m)	3.5 m	11.5	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	100%								100%
Min. Air Flow (%)									

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	10	m²/person	108	ft²/person	%OA	29.03%
Occupancy Schedule Occ. Period	90%					
Occupancy Schedule Unocc. Period						
Fresh Air Requirements or Outside Air	7	L/s.person	15	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) | 1 | If Fresh Air Control Type = "2" enter % FA. to the right: 10%
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air) | If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1.1			
Total Air Circulation or Design Air Flow	2.41	L/s.m²	0.47	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	20%		80%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,352,353	
Peak Zone Sensible Load	519,110	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	24,149	
Total air circulation or Design air	2.41	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	35%	90%
DDC/Pneumatic	55%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	17	°C	62.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	18.75	°C	65.75	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
School	All Volumes		Southern Franchise
Baseline			

LIGHTING

GENERAL (CLASSROOM) LIGHTING

Light Level	420	Lux	39.0	ft-candles
Floor Fraction (GLFF)	0.60			
Connected Load	9.9	W/m²	0.9	W/ft²
Occ. Period(Hrs./yr.)	2200			
Unocc. Period(Hrs./yr.)	6560			
Usage During Occupied Period	90%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000	Total
% Distribution	40%	60%			100%
Weighted Average					**420**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)					100%			100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI		
	kWh/ft².yr	1.5
	MJ/m².yr	57

ARCHITECTURAL LIGHTING

Light Level	370	Lux	34.4	ft-candles
Floor Fraction (ALFF)	0.30			
Connected Load	9.5	W/m²	0.9	W/ft²
Occ. Period(Hrs./yr.)	2200			
Unocc. Period(Hrs./yr.)	6560			
Usage During Occupied Period	90%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000	Total
% Distribution	65%	35%			100%
Weighted Average					**370**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		10%			90%			100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI		
	kWh/ft².yr	0.7
	MJ/m².yr	27

HIGH BAY (GYMNASIUM) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)	0.10			
Connected Load	13.4	W/m²	1.2	W/ft²
Occ. Period(Hrs./yr.)	2600			
Unocc. Period(Hrs./yr.)	6160			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 — 1.00

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)					10%	90%	0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI		
	kWh/ft².yr	0.4
	MJ/m².yr	15

TOTAL LIGHTING

Overall LP	8.82 W/m²	EUI TOTAL kWh/ft².yr	3
		MJ/m².yr	99

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.1		0.1		0.01		0.01					
Connected Load	0.5	W/m²	0.5	W/m²	0.1	W/m²	0.2	W/m²	0.5	W/m²	1.1	W/m²
	0.1	W/ft²	0.0	W/ft²	0.01	W/ft²	0.02	W/ft²	0.05	W/ft²	0.10	W/ft²
Diversity Occupied Period	50%		50%		50%		50%				50%	
Diversity Unoccupied Period	30%		30%								10%	
Operation Occ. Period (hrs./year)	2000		2000		2000		2000				2000	
Operation Unocc. Period (hrs./year)	6760		6760		6760		6760		8760		6760	

Total end-use load (occupied period)	1.2	W/m²	0.1	W/ft²
Total end-use load (unocc. period)	0.4	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	35%			

	EUI		
Computer Equipment	EUI	kWh/ft².yr	0.32
		MJ/m².yr	12.56
Plug Loads	EUI	kWh/ft².yr	0.17
		MJ/m².yr	6.64

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 53.0% Electricity Fuel Share: 47.0%

Cooking

	Natural Gas EUI		All Electric EUI
EUI kWh/ft².yr	0.5	EUI kWh/ft².yr	0.5
MJ/m².yr	20.0	MJ/m².yr	20.0

REFRIGERATION

Provide description below:

Coolers, freezers, pop machines

EUI		
	kWh/ft².yr	0.1
	MJ/m².yr	5.0

MISCELLANEOUS

EUI		
	kWh/ft².yr	0.1
	MJ/m².yr	5

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
School	All Volumes		Southern Franchise
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	5%	50%	25%		10%		10%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	42.1	W/m²	13.4	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	540	MJ/m².yr	13.9	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 10.0% | Gas Fuel Share 90.0% | Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	13.9
MJ/m².yr	540
Natural Gas EUI	
kWh/ft².yr	17.2
MJ/m².yr	666
Market Composite EUI	
kWh/ft².yr	16.9
MJ/m².yr	653

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)	10.0%			15.0%	75.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	76	W/m²	24	Btu/hr.ft²	496	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	196.1	MJ/m².yr	5.1	kWh/ft².yr		

Sizing Factor 1.00 | Operation (occ. period) 3000 hrs/year | Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 25.0%

Electric Fuel Share 100.0% | Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	1.7
MJ/m².yr	67
Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	
Market Composite EUI	
kWh/ft².yr	1.7
MJ/m².yr	67

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	10%		70%	5%	10%
Eff./COP	75%		65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	95%	5%
Blended Efficiency	0.70	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 40.0

Wetting Use Percentage 80%

All Electric EUI		All Natural Gas EUI		Market Composite EUI	
kWh/ft².yr	1.1	kWh/ft².yr	1.5	kWh/ft².yr	1.5
MJ/m².yr	44	MJ/m².yr	57	MJ/m².yr	56.5

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
School	**All Volumes**		**Southern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	2.4	L/s.m²	0.47	CFM/ft²
System Static Pressure CAV	500	Pa	2.0	wg
System Static Pressure VAV	500	Pa	2.0	wg
Fan Efficiency	55%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	2.6	W/m²	0.24	W/ft²
Fan Design Load VAV	2.6	W/m²	0.24	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	20%	80%	20%	80%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.003	kW/kW	0.01	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	0.22	W/m²	0.02	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0048	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	30	kPa	10	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.2	W/m²	0.02	W/ft²		

Supply Fan Occ. Period	2200	hrs./year
Supply Fan Unocc. Period	6560	hrs./year
Supply Fan Energy Consumption	9.1	kWh/m².yr
Exhaust Fan Occ. Period	2200	hrs./year
Exhaust Fan Unocc. Period	6560	hrs./year
Exhaust Fan Energy Consumption	0.8	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.1	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	1.2	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	1.0
	MJ/m².yr	40.4

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
School	All Volumes		Southern Franchise
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	Electricity:	6.9 kWh/ft².yr	267.0 MJ/m².yr	Gas:	17.3 kWh/ft².yr	668.9 MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL (CLASSROOM) LIGHTIN(	1.5	56.6
ARCHITECTURAL LIGHTING	0.7	27.1
HIGH BAY (GYMNASIUM) LIGHTINC	0.4	15.5
OTHER PLUG LOADS	0.2	6.6
HVAC FANS & PUMPS	1.0	40.4
REFRIGERATION	0.1	5.0
COMPUTER EQUIPMENT	0.3	12.6
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	1.4	54.0	15.5	599.1
SPACE COOLING	0.4	16.8		
DOMESTIC HOT WATER	0.1	2.2	1.4	54.3
FOOD SERVICE EQUIPMENT	0.2	9.4	0.3	10.6
MISCELLANEOUS			0.1	5.0

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
University / College	All volumes except contract customers		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.36	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Building Size	12,500 m²	134,500	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	4,167 m²	44,833	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2		
					Percent Conditioned Space	100%		
					Percent Conditioned Space Defined as Exterior Zone	36%		
Window/Wall Ratio (WIWAR) (%)	0.29							
Shading Coefficient (SC)	0.65				Typical # Stories	3		
					Floor to Floor Height (m)	3.7 m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)					70%			30%	70%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	15	m²/person	161	ft²/person
Occupancy Schedule Occ. Period	80%			
Occupancy Schedule Unocc. Period				
Fresh Air Requirements or Outside Air	14	L/s.person	30	CFM/person

%OA 21.68%

Fresh Air Control Type *(enter a 1, 2 or 3): 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1.85			
Total Air Circulation or Design Air Flow	4.31	L/s.m²	0.85	CFM/ft²
Infiltration Rate	0.50	L/s.m²	0.10	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)	L/s.m²	CFM/ft²
Operation occupied period	50%	
Operation unoccupied period	50%	

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	3,783,193	
Peak Zone Sensible Load	1,325,043	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	61,641	
Total air circulation or Design air	4.31	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	10%	90%
DDC/Pneumatic	60%	
All DDC	30%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	17	°C	62.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20	°C	68	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
University / College	**All volumes except contract customers**		**Southern Franchise**
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	540	Lux	50.2	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	13.3	W/m²	1.2	W/ft²

Occ. Period(Hrs./yr.)	4100
Unocc. Period(Hrs./yr.)	4660
Usage During Occupied Period	90%
Usage During Unoccupied Period	10%
Fixture Cleaning:	
Incidence of Practice	
Interval	years

Light Level (Lux)	300	500	700	1000				Total
% Distribution	10%	60%	30%					100%
Weighted Average								**540**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		5%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	kWh/ft².yr	4.4
	MJ/m².yr	170

ARCHITECTURAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	8.3	W/m²	0.8	W/ft²

Occ. Period(Hrs./yr.)	4100
Unocc. Period(Hrs./yr.)	4660
Usage During Occupied Period	90%
Usage During Unoccupied Period	50%
Fixture Cleaning:	
Incidence of Practice	
Interval	years

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		20%			80%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence of Practice	Group	Spot

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	0.7
	MJ/m².yr	27

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 12.58 W/m²

EUI TOTAL	kWh/ft².yr	5
	MJ/m².yr	197

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.1		0.1		0.02		0.01					
Connected Load	0.4	W/m²	0.3	W/m²	0.1	W/m²	0.1	W/m²	0.5	W/m²	3	W/m²
	0.0	W/ft²	0.0	W/ft²	0.01	W/ft²	0.01	W/ft²	0.05	W/ft²	0.28	W/ft²
Diversity Occupied Period	85%		80%		90%		90%		100%		100%	
Diversity Unoccupied Period	35%		35%		20%		10%		100%		50%	
Operation Occ. Period (hrs./year)	2900		2900		2600		2600		2000		3000	
Operation Unocc. Period (hrs./year)	5860		5860		6160		6160		6760		5760	

Total end-use load (occupied period)	4.4	W/m²	0.4	W/ft²
Total end-use load (unocc. period)	2.3	W/m²	0.2	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	53%			

Computer Equipment	EUI	kWh/ft².yr	0.79
		MJ/m².yr	30.57
Plug Loads	EUI	kWh/ft².yr	1.66
		MJ/m².yr	64.21

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 70.0% Electricity Fuel Share: 30.0%

Cafeteria/food service

	Natural Gas EUI			All Electric EUI	
EUI	kWh/ft².yr	0.8	EUI	kWh/ft².yr	0.8
	MJ/m².yr	30.0		MJ/m².yr	30.0

REFRIGERATION

Provide description below:

Coolers, freezers, fridges, pop machines

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI	kWh/ft².yr	0.8
	MJ/m².yr	30

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: **University / College** **Baseline**
SIZE: **All volumes except contract customers**
VINTAGE:
REGION: **Southern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total	
System Present (%)		77%	10%		10%		3%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load: 63.4 W/m² — 20.1 Btu/hr.ft²
Seasonal Heating Load (Tertiary Load): 490 MJ/m².yr — 12.6 kWh/ft².yr
Sizing Factor: 1.50

Electric Fuel Share: 3.0% — Gas Fuel Share: 97.0% — Oil Fuel Share:

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	12.6
MJ/m².yr	490
Natural Gas EUI	
kWh/ft².yr	16.0
MJ/m².yr	618
Market Composite EUI	
kWh/ft².yr	15.9
MJ/m².yr	614

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	Centrifugal Chillers HE	Screw Chillers	Recprocting Chillers Open	Recprocting Chillers DX	Gas Cooling Absorption	Gas Cooling Engine	Total
System Present (%)		43.0%	38.0%		19.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	14.0	57.2

Peak Cooling Load: 89 W/m² — 28 Btu/hr.ft² — 427 ft²/Ton
Seasonal Cooling Load (Tertiary Load): 248.8 MJ/m².yr — 6.4 kWh/ft².yr

Sizing Factor: 1.00 — Operation (occ. period): 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C): 75.0%

Electric Fuel Share: 100.0% — Gas Fuel Share:

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	2.2
MJ/m².yr	85
Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	
Market Composite EUI	
kWh/ft².yr	2.2
MJ/m².yr	85

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	74%		11%	5%	
Eff./COP	75%		65%	90%	90%

	Fossil		Elec. Res.	
Fuel Share	90%		10%	100%
Blended Efficiency	0.75		0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load): 70.0

Wetting Use Percentage: 50%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	2.0	2.4	2.4
MJ/m².yr	77	94	92.1

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: **University / College** **Baseline**
SIZE: **All volumes except contract customers**
VINTAGE:
REGION: **Southern Franchise**

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	4.3	L/s.m²	0.85	CFM/ft²
System Static Pressure CAV	1000	Pa	4.0	wg
System Static Pressure VAV	1000	Pa	4.0	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	9.7	W/m²	0.91	W/ft²
Fan Design Load VAV	9.7	W/m²	0.91	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	70%	30%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	35%	65%	35%	65%

Comments:

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.0	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.1	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.96	W/m²	0.18	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.005	L/s.m²	0.007	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.38	W/m²	0.13	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0056	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.1	W/m²	0.10	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	42.6	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.1	kWh/m².yr
Condenser Pump Energy Consumption	5.2	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.2	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	7.6	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	5.4
	MJ/m².yr	207.9

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: **SIZE:** **VINTAGE:** **REGION:**
University / College **All volumes except contract customers** **Southern Franchise**
Baseline

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**16.4** kWh/ft².yr	**635.5** MJ/m².yr	**Gas:**	**19.0** kWh/ft².yr	**734.8** MJ/m².yr		

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING	4.4	169.6					
ARCHITECTURAL LIGHTING	0.7	27.0	SPACE HEATING	0.4	14.7	15.5	599.3
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	1.7	64.0		
OTHER PLUG LOADS	1.7	64.2	DOMESTIC HOT WATER	0.2	7.7	2.2	84.4
HVAC FANS & PUMPS	5.4	207.9	FOOD SERVICE EQUIPMENT	0.2	9.0	0.5	21.0
REFRIGERATION	0.5	20.0	MISCELLANEOUS			0.8	30.0
COMPUTER EQUIPMENT	0.8	30.6					
ELEVATORS	0.1	3.9					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
University / College	All volumes except contract customers		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.36	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Building Size	12,500	m²	134,500	ft²
Roof U value (W/m².°C)	0.33	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	4,167	m²	44,833	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.29								
Shading Coefficient (SC)	0.65				Typical # Stories	3			
					Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)					70%			30%	70%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	15	m²/person	161	ft²/person	%OA 21.71%
Occupancy Schedule Occ. Period	80%				
Occupancy Schedule Unocc. Period					
Fresh Air Requirements or Outside Air	14	L/s.person	30	CFM/person	

Fresh Air Control Type *(enter a 1, 2 or 3) | 1 | If Fresh Air Control Type = "2" enter % FA. to the right: | 15%

(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air) | If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation | 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1.85			
Total Air Circulation or Design Air Flow	4.30	L/s.m²	0.85	CFM/ft²
Infiltration Rate	0.50	L/s.m²	0.10	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	3,780,951	
Peak Zone Sensible Load	1,322,802	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	61,537	
Total air circulation or Design air	4.30	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	10%	90%
DDC/Pneumatic	60%	
All DDC	30%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	17	°C	62.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20.25	°C	68.45	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
University / College	**All volumes except contract customers**		**Southern Franchise**
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	540	Lux	50.2	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	13.3	W/m²	1.2	W/ft²

Occ. Period(Hrs./yr.)	4100
Unocc. Period(Hrs./yr.)	4660
Usage During Occupied Period	90%
Usage During Unoccupied Period	10%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000	Total
% Distribution	10%	60%	30%		100%
Weighted Average					**540**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		5%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	4.4
	MJ/m².yr	170

ARCHITECTURAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	8.3	W/m²	0.8	W/ft²

Occ. Period(Hrs./yr.)	4100
Unocc. Period(Hrs./yr.)	4660
Usage During Occupied Period	90%
Usage During Unoccupied Period	50%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		20%			80%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	0.7
	MJ/m².yr	27

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 — 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING — Overall LP 12.58 W/m²

EUI TOTAL	kWh/ft².yr	5
	MJ/m².yr	197

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.1	0.1	0.02	0.01		
Connected Load	0.4 W/m²	0.3 W/m²	0.1 W/m²	0.1 W/m²	0.5 W/m²	3 W/m²
	0.0 W/ft²	0.0 W/ft²	0.01 W/ft²	0.01 W/ft²	0.05 W/ft²	0.28 W/ft²
Diversity Occupied Period	85%	80%	90%	90%	100%	100%
Diversity Unoccupied Period	35%	35%	20%	10%	100%	50%
Operation Occ. Period (hrs./year)	2900	2900	2600	2600	2000	3000
Operation Unocc. Period (hrs./year)	5860	5860	6160	6160	6760	5760

Total end-use load (occupied period)	4.4 W/m²	0.4 W/ft²
Total end-use load (unocc. period)	2.3 W/m²	0.2 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	53%	

	EUI		
Computer Equipment	EUI	kWh/ft².yr	0.79
		MJ/m².yr	30.57
Plug Loads	EUI	kWh/ft².yr	1.66
		MJ/m².yr	64.21

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 70.0% Electricity Fuel Share: 30.0%

Cafeteria/food service

	Natural Gas EUI		All Electric EUI	
EUI	kWh/ft².yr	0.8	kWh/ft².yr	0.8
	MJ/m².yr	30.0	MJ/m².yr	30.0

REFRIGERATION

Provide description below:

Coolers, freezers, fridges, pop machines

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI	kWh/ft².yr	0.8
	MJ/m².yr	30

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS: **University / College** **Baseline**
SIZE: **All volumes except contract customers**
VINTAGE:
REGION: **Southern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)		77%	10%		10%		3%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load 63.3 W/m² — 20.1 Btu/hr.ft²
Seasonal Heating Load (Tertiary Load) 490 MJ/m².yr — 12.7 kWh/ft².yr
Sizing Factor 1.50

Electric Fuel Share 3.0% — Gas Fuel Share 97.0% — Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	12.7
MJ/m².yr	490

Natural Gas EUI	
kWh/ft².yr	16.0
MJ/m².yr	619

Market Composite EUI	
kWh/ft².yr	15.9
MJ/m².yr	615

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)		43.0%	38.0%		19.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	14.0	57.2

Peak Cooling Load 89 W/m² — 28 Btu/hr.ft² — 427 ft²/Ton
Seasonal Cooling Load (Tertiary Load) 249.2 MJ/m².yr — 6.4 kWh/ft².yr

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 100.0% — Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	2.2
MJ/m².yr	85

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	2.2
MJ/m².yr	85

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	74%		11%	5%	
Eff./COP	75%		65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	90%	10%
Blended Efficiency	0.75	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 70.0

Wetting Use Percentage 50%

All Electric EUI	
kWh/ft².yr	2.0
MJ/m².yr	77

All Natural Gas EUI	
kWh/ft².yr	2.4
MJ/m².yr	94

Market Composite EUI	
kWh/ft².yr	2.4
MJ/m².yr	92.1

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
University / College	**All volumes except contract customers**		**Southern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	4.3	L/s.m²	0.85	CFM/ft²
System Static Pressure CAV	1000	Pa	4.0	wg
System Static Pressure VAV	1000	Pa	4.0	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	9.7	W/m²	0.90	W/ft²
Fan Design Load VAV	9.7	W/m²	0.90	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	70%	30%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	35%	65%	35%	65%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.0	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.1	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.96	W/m²	0.18	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.005	L/s.m²	0.007	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.38	W/m²	0.13	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0056	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.1	W/m²	0.10	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	42.5	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.1	kWh/m².yr
Condenser Pump Energy Consumption	5.2	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.2	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	7.6	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	5.4
	MJ/m².yr	207.6

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS: **University / College** **Baseline**

SIZE: **All volumes except contract customers**

VINTAGE:

REGION: **Southern Franchise**

EUI SUMMARY

TOTAL ALL END-USES: **Electricity:** **16.4** kWh/ft².yr **635.3** MJ/m².yr **Gas:** **19.0** kWh/ft².yr **735.4** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	4.4	169.6
ARCHITECTURAL LIGHTING	0.7	27.0
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	1.7	64.2
HVAC FANS & PUMPS	5.4	207.6
REFRIGERATION	0.5	20.0
COMPUTER EQUIPMENT	0.8	30.6
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	0.4	14.7	15.5	600.0
SPACE COOLING	1.7	64.0		
DOMESTIC HOT WATER	0.2	7.7	2.2	84.4
FOOD SERVICE EQUIPMENT	0.2	9.0	0.5	21.0
MISCELLANEOUS			0.8	30.0

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Restaurant	All		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.44	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Building Size	500	m²	5,380	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	500	m²	5,380	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	1			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	40%			
Window/Wall Ratio (WIWAR) (%)	0.15								
Shading Coefficient (SC)	0.70				Typical # Stories	1			
					Floor to Floor Height (m)	4.5	m	14.8	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	60%							40%	60%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	50	m²/person	538	ft²/person	%OA	11.46%
Occupancy Schedule Occ. Period	90%					
Occupancy Schedule Unocc. Period						
Fresh Air Requirements or Outside Air	19	L/s.person	40	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) | 2 | If Fresh Air Control Type = "2" enter % FA. to the right: | 40%

(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air) | If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation | 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	3.32	L/s.m²	0.65	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	277,008	
Peak Zone Sensible Load	75,519	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	3,513	
Total air circulation or Design air	3.32	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	15	°C	59	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	20	°C	68	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20	°C	68	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Restaurant	**All**		**Southern Franchise**
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (GLFF)	0.90			
Connected Load	15.4	W/m²	1.4	W/ft²
Occ. Period(Hrs./yr.)	4300			
Unocc. Period(Hrs./yr.)	4460			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	20%	15%			65%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	6.1
	MJ/m².yr	237

ARCHITECTURAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.10			
Connected Load	15.4	W/m²	1.4	W/ft²
Occ. Period(Hrs./yr.)	4300			
Unocc. Period(Hrs./yr.)	4460			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	20%	15%			65%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	0.7
	MJ/m².yr	26

OTHER (HIGH BAY) LIGHTING

Light Level		Lux		ft-candles
Floor Fraction (HBLFF)				
Connected Load		W/m²		W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	0%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	300	500	700	1000				Total
% Distribution								
Weighted Average								
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP	15.39 W/m²	EUI TOTAL	kWh/ft².yr	7
			MJ/m².yr	263

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)												
Connected Load		W/m²		W/m²		W/m²		W/m²	0.5	W/m²	2	W/m²
		W/ft²		W/ft²		W/ft²		W/ft²	0.05	W/ft²	0.19	W/ft²
Diversity Occupied Period											100%	
Diversity Unoccupied Period											90%	
Operation Occ. Period (hrs./year)											4000	
Operation Unocc. Period (hrs./year)	8760		8760		8760		8760		8760		4760	

Total end-use load (occupied period)	2.0	W/m²	0.2	W/ft²
Total end-use load (unocc. period)	1.8	W/m²	0.2	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	90%			

Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	1.54
		MJ/m².yr	59.64

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 88.0% Electricity Fuel Share: 12.0%

Cooking

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	23.2	EUI	kWh/ft².yr	23.2
	MJ/m².yr	900.0		MJ/m².yr	900.0

REFRIGERATION

Provide description below:

Walk-ins, reach ins, fridges etc

EUI	kWh/ft².yr	9.0
	MJ/m².yr	350.0

MISCELLANEOUS

EUI	kWh/ft².yr	0.3
	MJ/m².yr	10

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Restaurant	**All**		**Southern Franchise**
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total	
System Present (%)	6%	6%	3%		65%	5%	15%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load	58.7	W/m²	18.6	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	860	MJ/m².yr	22.2	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 15.0% Gas Fuel Share 85.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	kWh/ft².yr	22.2
	MJ/m².yr	860
Natural Gas EUI	kWh/ft².yr	31.7
	MJ/m².yr	1228
Market Composite EUI	kWh/ft².yr	30.3
	MJ/m².yr	1172

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Absorption	Engine	Total
System Present (%)	15.0%	5.0%		10.0%	70.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	15.0	°C	59	°F

Peak Cooling Load	162	W/m²	51	Btu/hr.ft²	233	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	288.3	MJ/m².yr	7.4	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 85.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	kWh/ft².yr	3.1
	MJ/m².yr	120
Natural Gas EUI	kWh/ft².yr	
	MJ/m².yr	
Market Composite EUI	kWh/ft².yr	3.1
	MJ/m².yr	120

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	5%		70%	5%	5%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	85%	15%	100%
Blended Efficiency	0.69	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 400.0

Wetting Use Percentage 10%

All Electric EUI	kWh/ft².yr	11.3
	MJ/m².yr	440
All Natural Gas EUI	kWh/ft².yr	15.1
	MJ/m².yr	584
Market Composite EUI	kWh/ft².yr	14.5
	MJ/m².yr	562.1

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Restaurant	All		Southern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.3	L/s.m²	0.65	CFM/ft²
System Static Pressure CAV	500	Pa	2.0	wg
System Static Pressure VAV	625	Pa	2.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	80%			
Sizing Factor	1.00			
Fan Design Load CAV	4.0	W/m²	0.37	W/ft²
Fan Design Load VAV	5.0	W/m²	0.46	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	90%	10%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.4	L/s.m²	0.08	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.5	L/s.m²	0.10	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	72%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.7	W/m²	0.06	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	3.59	W/m²	0.33	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.009	L/s.m²	0.013	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.007	L/s.m²	0.0103	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure		kPa		ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load		W/m²		W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	33.0	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	6.1	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.7	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption		kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	3.8
	MJ/m².yr	146.8

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: **Restaurant** **Baseline**

SIZE: **All**

VINTAGE:

REGION: **Southern Franchise**

EUI SUMMARY

TOTAL ALL END-USES: **Electricity:** **35.3** kWh/ft².yr **1,368.8** MJ/m².yr **Gas:** **60.4** kWh/ft².yr **2,341.5** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	6.1	236.6
ARCHITECTURAL LIGHTING	0.7	26.3
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	1.5	59.6
HVAC FANS & PUMPS	3.8	146.8
REFRIGERATION	9.0	350.0
COMPUTER EQUIPMENT		
ELEVATORS		
OUTDOOR LIGHTING	3.7	144.2

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	3.3	128.9	26.9	1,043.4
SPACE COOLING	2.6	102.4		
DOMESTIC HOT WATER	1.7	65.9	12.8	496.1
FOOD SERVICE EQUIPMENT	2.8	108.0	20.4	792.0
			0.3	10

COMMERCIAL SECTOR BUILDING PROFILE

New Buildings	**SIZE:**	**VINTAGE:**	**REGION:**
Warehouse	**All volumes**		**Southern Franchise**
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.45	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Building Size	5,500	m²	59,180	ft²
Roof U value (W/m².°C)	0.33	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	5,500	m²	59,180	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	40%			
Window/Wall Ratio (WIWAR) (%)	0.02								
Shading Coefficient (SC)	0.70				Typical # Stories	1			
					Floor to Floor Height (m)	9.1	m	30.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	100%								100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	100	m²/person	1076	ft²/person	%OA 8.82%
Occupancy Schedule Occ. Period	90%				
Occupancy Schedule Unocc. Period					
Fresh Air Requirements or Outside Air	20	L/s.person	42	CFM/person	

Fresh Air Control Type *(enter a 1, 2 or 3) 2
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.5 L/s.m² 0.10 CFM/ft²
50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	2.27	L/s.m²	0.45	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA) L/s.m² CFM/ft²
Operation occupied period 50%
Operation unoccupied period 50%

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,402,255	
Peak Zone Sensible Load	567,958	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	26,421	
Total air circulation or Design air	2.27	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	15	°C	59	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	20	°C	68	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	21	°C	69.8	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning Changes/Year 4

Incidence of Annual Room Controls Maintenance 100.0%

Incidence of Annual HVAC Controls Maintenance 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New Buildings	**SIZE:**	**VINTAGE:**	**REGION:**
Warehouse	**All volumes**		**Southern Franchise**
Baseline			

LIGHTING

GENERAL (HIGH BAY) LIGHTING

Light Level	420	Lux	39.0	ft-candles
Floor Fraction (GLFF)	0.95			
Connected Load	17.4	W/m²	1.6	W/ft²
Occ. Period(Hrs./yr.)	4500			
Unocc. Period(Hrs./yr.)	4260			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	40%	60%						100%
Weighted Average								**420**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)					20%	75%	5%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	7.6
	MJ/m².yr	293

ARCHITECTURAL (OFFICE AREA) LIGHTING

Light Level	400	Lux	37.2	ft-candles
Floor Fraction (ALFF)	0.05			
Connected Load	12.3	W/m²	1.1	W/ft²
Occ. Period(Hrs./yr.)	4500			
Unocc. Period(Hrs./yr.)	4260			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	60%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	50%	50%						100%
Weighted Average								**400**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	0.4
	MJ/m².yr	16

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	0%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 17.13 W/m²

EUI TOTAL	kWh/ft².yr	8
	MJ/m².yr	308

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.05		0.05		0.01		0.01					
Connected Load	0.0	W/m²	0.0	W/m²	0.0	W/m²	0.0	W/m²	0.5	W/m²	1	W/m²
	0.0	W/ft²	0.0	W/ft²	0.00	W/ft²	0.00	W/ft²	0.05	W/ft²	0.09	W/ft²
Diversity Occupied Period	100%		100%		90%						100%	
Diversity Unoccupied Period											5%	
Operation Occ. Period (hrs./year)	4000		4000		4000						4000	
Operation Unocc. Period (hrs./year)	4760		4760		4760		8760		8760		4760	

Total end-use load (occupied period)	1.1	W/m²	0.1	W/ft²
Total end-use load (unocc. period)	0.1	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	5%			

Computer Equipment	EUI	kWh/ft².yr	0.02
		MJ/m².yr	0.89
Plug Loads	EUI	kWh/ft².yr	0.39
		MJ/m².yr	15.26

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 10.0% Electricity Fuel Share: 90.0%

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	0.3	EUI	kWh/ft².yr	0.3
	MJ/m².yr	10.0		MJ/m².yr	10.0

REFRIGERATION EQUIPMENT

Provide description below:

Coolers

EUI	kWh/ft².yr	1.0
	MJ/m².yr	40.0

MISCELLANEOUS EQUIPMENT

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20

COMMERCIAL SECTOR BUILDING PROFILE

New Buildings
Warehouse
Baseline

SIZE: **All volumes**

VINTAGE:

REGION: **Southern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond	U/H	RTU	Furnace	Electric Resistance	Total	
System Present (%)	4%	4%	3%	55%	25%	5%	4%	100%	100%
Eff./COP	75%	80%	90%	75%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.33	1.30	1.25	1.00		

Peak Heating Load	43.6 W/m²	13.8 Btu/hr.ft²	
Seasonal Heating Load (Tertiary Load)	308 MJ/m².yr	8.0 kWh/ft².yr	
Sizing Factor	1.00		
Electric Fuel Share	4.0%	Gas Fuel Share 96.0%	Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	kWh/ft².yr	MJ/m².yr
All Electric EUI	8.0	308
Natural Gas EUI	11.9	462
Market Composite EUI	11.8	455

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	Centrifugal Chillers HE	Screw Chillers	Recprocting Chillers Open	Recprocting Chillers DX	Gas Cooling Absorptior	Gas Cooling Engine	Total
System Present (%)	10.0%				90.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	15.0	59

Peak Cooling Load	75 W/m²	24 Btu/hr.ft²	506 ft²/Ton
Seasonal Cooling Load (Tertiary Load)	123.2 MJ/m².yr	3.2 kWh/ft².yr	
Sizing Factor	1.00	Operation (occ. period) 3000 hrs/year	Note value cannot be less than 2,900 hrs/year)
A/C Saturation (Incidence of A/C)	10.0%		
Electric Fuel Share	100.0%	Gas Fuel Share	

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Curent Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	kWh/ft².yr	MJ/m².yr
All Electric EUI	1.2	48
Natural Gas EUI		
Market Composite EUI	1.2	48

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	4%		55%	2%	3%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	64%	36%	100%
Blended Efficiency	0.68	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load): 25.0

Wetting Use Percentage: 50%

	kWh/ft².yr	MJ/m².yr
All Electric EUI	0.7	27
All Natural Gas EUI	1.0	37
Market Composite EUI	0.9	33.6

COMMERCIAL SECTOR BUILDING PROFILE

New Buildings	**SIZE:**	**VINTAGE:**	**REGION:**
Warehouse	**All volumes**		**Southern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	2.3	L/s.m²	0.45	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV	562.5	Pa	2.3	wg
Fan Efficiency	52%			
Fan Motor Efficiency	80%			
Sizing Factor	1.00			
Fan Design Load CAV	2.0	W/m²	0.19	W/ft²
Fan Design Load VAV	3.1	W/m²	0.28	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.0	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.1	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	72%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.65	W/m²	0.15	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0047	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure		kPa		ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load		W/m²		W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	12.9	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.7	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.7	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption		kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	1.4
	MJ/m².yr	54.9

COMMERCIAL SECTOR BUILDING PROFILE

New Buildings | **SIZE:** | **VINTAGE:** | **REGION:**
Warehouse | **All volumes** | | **Southern Franchise**
Baseline

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**12.2** kWh/ft².yr	**472.6** MJ/m².yr	**Gas:**	**12.6** kWh/ft².yr	**487.7** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL (HIGH BAY) LIGHTING	7.6	292.8					
ARCHITECTURAL (OFFICE AREA) I	0.4	15.7	SPACE HEATING	0.3	12.3	11.4	443.0
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	0.1	4.8		
OTHER PLUG LOADS	0.4	15.3	DOMESTIC HOT WATER	0.3	9.9	0.6	23.7
HVAC FANS & PUMPS	1.4	54.9	FOOD SERVICE EQUIPMENT	0.2	9.0	0.03	1.0
REFRIGERATION EQUIPMENT	1.0	40.0	MISCELLANEOUS EQUIPMENT			0.5	20.0
COMPUTER EQUIPMENT	0.0	0.9					
ELEVATORS							
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Highrise	> 50,000 m3 contract customers		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.38	W/m².°C	0.07	Btu/hr.ft² .°F	Typical Building Size	7,300	m²	78,548	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	1,217	m²	13,091	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2.5			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.25								
Shading Coefficient (SC)	0.65				Typical # Stories	6			
					Floor to Floor Height (m)	2.8	m	9.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)								100%	
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	35	m²/person	377	ft²/person	%OA	28.57%
Occupancy Schedule Occ. Period	30%					
Occupancy Schedule Unocc. Period	90%					
Fresh Air Requirements or Outside Air	7	L/s.person	15	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) 3
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right:	15%			
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation	0.7	L/s.m²	0.14	CFM/ft²
	50%	operation (%)		

Sizing Factor	1			
Total Air Circulation or Design Air Flow	0.70	L/s.m²	0.14	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,467,154	
Peak Zone Sensible Load	448,952	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	20,885	
Total air circulation or Design air	1.35	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	18	°C	64.4	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	22	°C	71.6	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Highrise	> 50,000 m3 contract customers		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	50	Lux	4.6	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	2.3	W/m²	0.2	W/ft²

Occ. Period(Hrs./yr.)	2100
Unocc. Period(Hrs./yr.)	6660
Usage During Occupied Period	30%
Usage During Unoccupied Period	10%

Light Level (Lux)	50	100	200	300	Total
% Distribution	100%				100%
Weighted Average					**50**

Fixture Cleaning:
- Incidence of Practice:
- Interval: years

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	75%			20%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence of Practice: Group | Spot

EUI	kWh/ft².yr	0.2
	MJ/m².yr	9

ARCHITECTURAL LIGHTING (CORRIDORS)

Light Level	200	Lux	18.6	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	8.2	W/m²	0.8	W/ft²

Occ. Period(Hrs./yr.)	3000
Unocc. Period(Hrs./yr.)	5760
Usage During Occupied Period	100%
Usage During Unoccupied Period	100%

Light Level (Lux)	100	200	300	500	Total
% Distribution		100%			100%
Weighted Average					**200**

Fixture Cleaning:
- Incidence of Practice:
- Interval: years

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	55%			40%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence of Practice: Group | Spot

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	1.0
	MJ/m².yr	39

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

Fixture Cleaning:
- Incidence of Practice:
- Interval: years

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

Relamping Strategy & Incidence of Practice: Group | Spot

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING — Overall LP 3.14 W/m²

EUI TOTAL	kWh/ft².yr	1
	MJ/m².yr	48

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.9	0.9	0.15	0.1	0.08	
Connected Load	1.4 W/m²	1.3 W/m²	0.4 W/m²	0.6 W/m²	0.5 W/m²	2.5 W/m²
	0.1 W/ft²	0.1 W/ft²	0.04 W/ft²	0.05 W/ft²	0.05 W/ft²	0.23 W/ft²
Diversity Occupied Period						5%
Diversity Unoccupied Period						20%
Operation Occ. Period (hrs./year)						3000
Operation Unocc. Period (hrs./year)	8760	8760	8760	8760	8760	5760

Total end-use load (occupied period)	0.1 W/m²	0.0 W/ft²
Total end-use load (unocc. period)	0.5 W/m²	0.0 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	400%	

Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	0.30
		MJ/m².yr	11.72

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 5.0% Electricity Fuel Share: 95.0%

Cooking

	Natural Gas EUI		All Electric EUI
EUI	kWh/ft².yr	1.3	1.3
	MJ/m².yr	50.0	50.0

REFRIGERATION

Provide description below:

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: **Highrise** **Baseline**

SIZE: **> 50,000 m3 contract customers**

VINTAGE:

REGION: **Southern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric		
	Boilers				RTU	Furnace	Resistance	Total	
	Standard	Near Cond	Cond						
System Present (%)	20%	40%	10%		20%		10%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load 69.4 W/m² — 22.0 Btu/hr.ft²
Seasonal Heating Load (Tertiary Load) 404 MJ/m².yr — 10.4 kWh/ft².yr
Sizing Factor 2.00

Electric Fuel Share 10.0% — Gas Fuel Share 90.0% — Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	10.4
MJ/m².yr	404
Natural Gas EUI	
kWh/ft².yr	13.9
MJ/m².yr	539
Market Composite EUI	
kWh/ft².yr	13.6
MJ/m².yr	525

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)		50.0%			50.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	14.0	57.2

Peak Cooling Load 59 W/m² — 19 Btu/hr.ft² — 642 ft²/Ton
Seasonal Cooling Load (Tertiary Load) 101.3 MJ/m².yr — 2.6 kWh/ft².yr

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 100.0% — Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	0.9
MJ/m².yr	34
Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	
Market Composite EUI	
kWh/ft².yr	0.9
MJ/m².yr	34

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	20%		55%	9%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	85%	15%	100%
Blended Efficiency	0.70	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 170.0

Wetting Use Percentage 10%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	4.8	6.2	6.0
MJ/m².yr	187	242	233.6

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Highrise	> 50,000 m3 contract customers		Southern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	0.7	L/s.m²	0.14	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV		Pa		wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	0.6	W/m²	0.06	W/ft²
Fan Design Load VAV		W/m²		W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.2	L/s.m²	0.03	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.3	L/s.m²	0.05	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.4	W/m²	0.03	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.30	W/m²	0.12	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.003	L/s.m²	0.005	U.S. gpm/ft²
Pump Head Pressure	0.1	kPa	0.0333333	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.00	W/m²	0.00	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0037	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	100	kPa	33	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.5	W/m²	0.05	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	3.8	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	3.1	kWh/m².yr
Condenser Pump Energy Consumption	0.0	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.5	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	3.1	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	1.0
	MJ/m².yr	37.8

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Highrise	**> 50,000 m3 contract customers**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**7.2**	kWh/ft².yr	**279.3**	MJ/m².yr	**Gas:**	**18.4** kWh/ft².yr	**713.0** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING (SUITES)	0.2	8.9
ARCHITECTURAL LIGHTING (COR	1.0	38.8
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	0.3	11.7
HVAC FANS & PUMPS	1.0	37.8
REFRIGERATION	0.5	20.0
COMPUTER EQUIPMENT		
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	1.0	40.4	12.5	484.9
SPACE COOLING	0.7	25.3		
DOMESTIC HOT WATER	0.7	28.0	5.3	205.6
FOOD SERVICE EQUIPMENT	1.2	47.5	0.1	2.5
MISCELLANEOUS			0.5	20.0

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Highrise	> 50,000 m3 excluding contract customers		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.41 W/m².°C	0.07 Btu/hr.ft² .°F	Typical Building Size	7,300 m²	78,548 ft²
Roof U value (W/m².°C)	0.35 W/m².°C	0.06 Btu/hr.ft² .°F	Typical Footprint (m²)	1,217 m²	13,091 ft²
Glazing U value (W/m².°C)	2.80 W/m².°C	0.49 Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2.5	
			Percent Conditioned Space	100%	
			Percent Conditioned Space Defined as Exterior Zone	36%	
Window/Wall Ratio (WIWAR) (%)	0.25				
Shading Coefficient (SC)	0.65		Typical # Stories	6	
			Floor to Floor Height (m)	2.8 m	9.0 ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)								100%	
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	35 m²/person	377 ft²/person	%OA 28.57%
Occupancy Schedule Occ. Period	30%		
Occupancy Schedule Unocc. Period	90%		
Fresh Air Requirements or Outside Air	7 L/s.person	15 CFM/person	

Fresh Air Control Type *(enter a 1, 2 or 3): 3
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.7 L/s.m² 0.14 CFM/ft²; 50% operation (%)

Sizing Factor	1	
Total Air Circulation or Design Air Flow	0.70 L/s.m²	0.14 CFM/ft²
Infiltration Rate	0.30 L/s.m²	0.06 CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA): L/s.m² CFM/ft²
Operation occupied period: 50%
Operation unoccupied period: 50%

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,467,631	
Peak Zone Sensible Load	449,430	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	20,907	
Total air circulation or Design air	1.35	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	18	°C	64.4	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	22	°C	71.6	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Highrise	> 50,000 m3 excluding contract customers		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	50	Lux	4.6	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	2.3	W/m²	0.2	W/ft²
Occ. Period(Hrs./yr.)	2100			
Unocc. Period(Hrs./yr.)	6660			
Usage During Occupied Period	30%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	50	100	200	300				Total
% Distribution	100%							100%
Weighted Average								**50**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	75%			20%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI kWh/ft².yr 0.2; MJ/m².yr 9

ARCHITECTURAL LIGHTING (CORRIDORS)

Light Level	200	Lux	18.6	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	8.2	W/m²	0.8	W/ft²
Occ. Period(Hrs./yr.)	3000			
Unocc. Period(Hrs./yr.)	5760			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	100	200	300	500				Total
% Distribution		100%						100%
Weighted Average								**200**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	55%			40%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI kWh/ft².yr 1.0; MJ/m².yr 39

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	0%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 — 1.00

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI kWh/ft².yr; MJ/m².yr

TOTAL LIGHTING — Overall LP 3.14 W/m² — EUI TOTAL kWh/ft².yr 1; MJ/m².yr 48

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.9		0.9		0.15		0.1		0.08			
Connected Load	1.4	W/m²	1.3	W/m²	0.4	W/m²	0.6	W/m²	0.5	W/m²	2.5	W/m²
	0.1	W/ft²	0.1	W/ft²	0.04	W/ft²	0.05	W/ft²	0.05	W/ft²	0.23	W/ft²
Diversity Occupied Period											5%	
Diversity Unoccupied Period											20%	
Operation Occ. Period (hrs./year)											3000	
Operation Unocc. Period (hrs./year)	8760		8760		8760		8760		8760		5760	

Total end-use load (occupied period)	0.1	W/m²	0.0	W/ft²
Total end-use load (unocc. period)	0.5	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	400%			

Computer Equipment EUI kWh/ft².yr; MJ/m².yr

Plug Loads EUI kWh/ft².yr 0.30; MJ/m².yr 11.72

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 5.0% Electricity Fuel Share: 95.0%

Cooking

Natural Gas EUI: EUI kWh/ft².yr 1.3; MJ/m².yr 50.0

All Electric EUI: EUI kWh/ft².yr 1.3; MJ/m².yr 50.0

REFRIGERATION

Provide description below:

EUI kWh/ft².yr 0.5; MJ/m².yr 20.0

MISCELLANEOUS

EUI kWh/ft².yr 0.5; MJ/m².yr 20

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: **Highrise** **Baseline**

SIZE: **> 50,000 m3 excluding contract customers**

VINTAGE:

REGION: **Southern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	20%	40%	10%		20%		10%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	70.7	W/m²	22.4	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	409	MJ/m².yr	10.6	kWh/ft².yr
Sizing Factor	2.00			

Electric Fuel Share 10.0% Gas Fuel Share 90.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	10.6
MJ/m².yr	409

Natural Gas EUI	
kWh/ft².yr	14.1
MJ/m².yr	545

Market Composite EUI	
kWh/ft².yr	13.7
MJ/m².yr	532

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)		50.0%			50.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	59	W/m²	19	Btu/hr.ft²	642	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	101.0	MJ/m².yr	2.6	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	0.9
MJ/m².yr	34

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	0.9
MJ/m².yr	34

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	20%		55%	9%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	85%	15%
Blended Efficiency	0.70	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 170.0

Wetting Use Percentage 10%

All Electric EUI	
kWh/ft².yr	4.8
MJ/m².yr	187

All Natural Gas EUI	
kWh/ft².yr	6.2
MJ/m².yr	242

Market Composite EUI	
kWh/ft².yr	6.0
MJ/m².yr	233.6

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Highrise	**> 50,000 m3 excluding contract customers**		**Southern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	0.7	L/s.m²	0.14	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV		Pa		wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	0.6	W/m²	0.06	W/ft²
Fan Design Load VAV		W/m²		W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	100%	

Comments:

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.2	L/s.m²	0.03	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.3	L/s.m²	0.05	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.4	W/m²	0.03	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.30	W/m²	0.12	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.003	L/s.m²	0.005	U.S. gpm/ft²
Pump Head Pressure	0.1	kPa	0.0333333	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.00	W/m²	0.00	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0037	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	100	kPa	33	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.5	W/m²	0.05	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	3.8	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	3.1	kWh/m².yr
Condenser Pump Energy Consumption	0.0	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.5	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	3.1	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	1.0
	MJ/m².yr	37.7

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Highrise	**> 50,000 m3 excluding contract customers**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**7.2** kWh/ft².yr	**279.6** MJ/m².yr	**Gas:**	**18.6** kWh/ft².yr	**718.7** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING (SUITES)	0.2	8.9					
ARCHITECTURAL LIGHTING (COR	1.0	38.8	SPACE HEATING	1.1	40.9	12.7	490.7
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	0.7	25.2		
OTHER PLUG LOADS	0.3	11.7	DOMESTIC HOT WATER	0.7	28.0	5.3	205.6
HVAC FANS & PUMPS	1.0	37.7	FOOD SERVICE EQUIPMENT	1.2	47.5	0.1	2.5
REFRIGERATION	0.5	20.0	MISCELLANEOUS			0.5	20.0
COMPUTER EQUIPMENT							
ELEVATORS	0.1	3.9					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Medium Rise	> 5 Units, Excluding Contract Customers		Southern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.36	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Building Size	1,000	m²	10,760	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	333	m²	3,587	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2.5			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.25								
Shading Coefficient (SC)	0.65				Typical # Stories	3			
					Floor to Floor Height (m)	2.8	m	9.2	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)								100%	
Min. Air Flow (%)									

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	35	m²/person	377	ft²/person	%OA	11.44%
Occupancy Schedule Occ. Period	30%					
Occupancy Schedule Unocc. Period	90%					
Fresh Air Requirements or Outside Air	10	L/s.person	21	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) [2]
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 10%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	2.50	L/s.m²	0.49	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	215,550	
Peak Zone Sensible Load	113,767	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	5,292	
Total air circulation or Design air	2.50	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	18	°C	64.4	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	22	°C	71.6	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Medium Rise	> 5 Units, Excluding Contract Customers		Southern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	50	Lux	4.6	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	4.0	W/m²	0.4	W/ft²

Occ. Period(Hrs./yr.)	2100
Unocc. Period(Hrs./yr.)	6660
Usage During Occupied Period	30%
Usage During Unoccupied Period	10%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	50	100	200	300				Total
% Distribution	100%							100%
Weighted Average								**50**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	40%	40%			20%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI		
	kWh/ft².yr	0.4
	MJ/m².yr	16

ARCHITECTURAL LIGHTING (CORRIDORS)

Light Level	200	Lux	18.6	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	10.2	W/m²	1.0	W/ft²

Occ. Period(Hrs./yr.)	3000
Unocc. Period(Hrs./yr.)	5760
Usage During Occupied Period	100%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	100	200	300	500				Total
% Distribution		100%						100%
Weighted Average								**200**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	15%	45%			40%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI		
	kWh/ft².yr	1.3
	MJ/m².yr	48

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI		
	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING Overall LP 4.98 W/m²

EUI TOTAL		
	kWh/ft².yr	2
	MJ/m².yr	65

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)												
Connected Load		W/m²		W/m²		W/m²		W/m²	0.5	W/m²	2.5	W/m²
		W/ft²		W/ft²		W/ft²		W/ft²	0.05	W/ft²	0.23	W/ft²
Diversity Occupied Period											5%	
Diversity Unoccupied Period											20%	
Operation Occ. Period (hrs./year)											3000	
Operation Unocc. Period (hrs./year)	8760		8760		8760		8760		8760		5760	

Total end-use load (occupied period)	0.1	W/m²	0.0	W/ft²
Total end-use load (unocc. period)	0.5	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	400%			

	EUI		
Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	0.30
		MJ/m².yr	11.72

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 10.0% Electricity Fuel Share: 90.0%

Cooking

	Natural Gas EUI		All Electric EUI	
EUI	kWh/ft².yr	1.0	kWh/ft².yr	1.0
	MJ/m².yr	40.0	MJ/m².yr	40.0

REFRIGERATION

Provide description below:

EUI		
	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI		
	kWh/ft².yr	0.3
	MJ/m².yr	10

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Medium Rise	**> 5 Units, Excluding Contract Customers**		**Southern Franchise**
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	25%	40%	5%		20%		10%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	87.2	W/m²	27.7	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	362	MJ/m².yr	9.3	kWh/ft².yr
Sizing Factor	1.50			

Electric Fuel Share 10.0%   Gas Fuel Share 90.0%   Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	9.3
MJ/m².yr	362

Natural Gas EUI	
kWh/ft².yr	13.5
MJ/m².yr	522

Market Composite EUI	
kWh/ft².yr	13.1
MJ/m².yr	506

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)					100.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	63	W/m²	20	Btu/hr.ft²	599	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	121.0	MJ/m².yr	3.1	kWh/ft².yr		

Sizing Factor 1.00   Operation (occ. period) 3000 hrs/year   Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 100.0%   Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	1.2
MJ/m².yr	48

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	1.2
MJ/m².yr	48

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	20%		60%	5%	5%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	90%	10%
Blended Efficiency	0.70	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 157.5

Wetting Use Percentage 10%

All Electric EUI	
kWh/ft².yr	4.5
MJ/m².yr	173

All Natural Gas EUI	
kWh/ft².yr	5.8
MJ/m².yr	225

Market Composite EUI	
kWh/ft².yr	5.7
MJ/m².yr	219.8

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Medium Rise	**> 5 Units, Excluding Contract Customers**		**Southern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	2.5	L/s.m²	0.49	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV	375	Pa	1.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	2.1	W/m²	0.20	W/ft²
Fan Design Load VAV	2.1	W/m²	0.20	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.6	L/s.m²	0.12	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.7	L/s.m²	0.14	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.9	W/m²	0.09	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.40	W/m²	0.13	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.003	L/s.m²	0.005	U.S. gpm/ft²
Pump Head Pressure	0.1	kPa	0.0333333	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.00	W/m²	0.00	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0040	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	100	kPa	33	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.5	W/m²	0.05	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	13.4	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	8.2	kWh/m².yr
Condenser Pump Energy Consumption	0.0	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.7	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	3.4	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	2.4
	MJ/m².yr	92.2

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Medium Rise	**> 5 Units, Excluding Contract Customers**		**Southern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**8.5** kWh/ft².yr	**330.5** MJ/m².yr	**Gas:**	**17.7** kWh/ft².yr	**686.6** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING (SUITES)	0.4	16.0
ARCHITECTURAL LIGHTING (COR	1.3	48.5
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	0.3	11.7
HVAC FANS & PUMPS	2.4	92.2
REFRIGERATION	0.5	20.0
COMPUTER EQUIPMENT		
ELEVATORS		
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	0.9	36.2	12.1	470.1
SPACE COOLING	0.9	35.7		
DOMESTIC HOT WATER	0.4	17.3	5.2	202.5
FOOD SERVICE EQUIPMENT	0.9	36.0	0.1	4.0
MISCELLANEOUS			0.3	10.0

APPENDIX D

New Building Profiles – Northern Region

Table of Contents

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Office	> 50,000 m3		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.57	W/m².°C	0.10	Btu/hr.ft² .°F	Typical Building Size	8,000	m²	86,080	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	2,000	m²	21,520	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	1.5			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.36								
Shading Coefficient (SC)	0.52				Typical # Stories	4			
					Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)					100%				100%
Min. Air Flow (%)					30%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	26 m²/person	280 ft²/person	%OA	20.72%
Occupancy Schedule Occ. Period	90%			
Occupancy Schedule Unocc. Period				
Fresh Air Requirements or Outside Air	20 L/s.person	42 CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² 0.10 CFM/ft²; 50% operation (%)

Sizing Factor	1.5	
Total Air Circulation or Design Air Flow	3.71 L/s.m²	0.73 CFM/ft²
Infiltration Rate	0.30 L/s.m²	0.06 CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²	CFM/ft²
Operation occupied period	50%		
Operation unoccupied period	50%		

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	2,179,230	
Peak Zone Sensible Load	901,679	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	41,946	
Total air circulation or Design air	3.71	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	10%	60%
DDC/Pneumatic		
All DDC	90%	40%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	15	°C	59	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20.4	°C	68.72	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Office	**> 50,000 m3**		**Northern Franchise**
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	440 Lux	40.9	ft-candles
Floor Fraction (GLFF)	0.85		
Connected Load	10.9 W/m²	1.0	W/ft²

Occ. Period(Hrs./yr.)	2900
Unocc. Period(Hrs./yr.)	5860
Usage During Occupied Period	95%
Usage During Unoccupied Period	25%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	40%	50%	10%					100%
Weighted Average								**440**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		5%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI		
	kWh/ft².yr	3.6
	MJ/m².yr	140

ARCHITECTURAL LIGHTING

Light Level	400 Lux	37.2	ft-candles
Floor Fraction (ALFF)	0.15		
Connected Load	10.3 W/m²	1.0	W/ft²

Occ. Period(Hrs./yr.)	3600
Unocc. Period(Hrs./yr.)	5160
Usage During Occupied Period	100%
Usage During Unoccupied Period	25%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	50%	50%						100%
Weighted Average								**400**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		10%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI		
	kWh/ft².yr	0.7
	MJ/m².yr	27

OTHER (HIGH BAY) LIGHTING

Light Level	300.00 Lux	27.9	ft-candles
Floor Fraction (HBLFF)			
Connected Load	0.0 W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI		
	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING — Overall LP 10.78 W/m²

EUI TOTAL		
	kWh/ft².yr	4
	MJ/m².yr	167

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.9	0.9	0.15	0.1	0.06	
Connected Load	1.9 W/m²	1.8 W/m²	0.6 W/m²	0.8 W/m²	0.5 W/m²	1.5 W/m²
	0.2 W/ft²	0.2 W/ft²	0.05 W/ft²	0.07 W/ft²	0.05 W/ft²	0.14 W/ft²
Diversity Occupied Period	80%	80%	80%	80%	100%	80%
Diversity Unoccupied Period	50%	50%	50%	50%	100%	50%
Operation Occ. Period (hrs./year)	2000	2000	2000	2000	2000	2500
Operation Unocc. Period (hrs./year)	6760	6760	6760	6760	6760	6260

Total end-use load (occupied period)	5.7 W/m²	0.5 W/ft²
Total end-use load (unocc. period)	3.8 W/m²	0.3 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	66%	

	EUI		
Computer Equipment	EUI	kWh/ft².yr	2.73
		MJ/m².yr	105.68
Plug Loads	EUI	kWh/ft².yr	0.72
		MJ/m².yr	27.70

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 20.0% Electricity Fuel Share: 80.0%

	Natural Gas EUI	All Electric EUI
kWh/ft².yr	0.4	0.4
MJ/m².yr	15.0	15.0

REFRIGERATION

Provide description below:

EUI		
	kWh/ft².yr	0.1
	MJ/m².yr	5.0

MISCELLANEOUS

EUI		
	kWh/ft².yr	1.0
	MJ/m².yr	40

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Office	**> 50,000 m3**		**Northern Franchise**
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric		
	Boilers				RTU	Furnace	Resistance	Total	
	Standard	Near Cond	Cond						
System Present (%)	10%	30%	5%		45%		10%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load	50.6	W/m²	16.0	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	456	MJ/m².yr	11.8	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 10.0% | Gas Fuel Share 90.0% | Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	kWh/ft².yr	11.8
	MJ/m².yr	456
Natural Gas EUI	kWh/ft².yr	16.5
	MJ/m².yr	641
Market Composite EUI	kWh/ft².yr	16.1
	MJ/m².yr	623

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)		50.0%			50.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	80	W/m²	25	Btu/hr.ft²	474	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	168.7	MJ/m².yr	4.4	kWh/ft².yr		

Sizing Factor 1.00 | Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 100.0%

Electric Fuel Share 100.0% | Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	kWh/ft².yr	1.1
	MJ/m².yr	43
Natural Gas EUI	kWh/ft².yr	
	MJ/m².yr	
Market Composite EUI	kWh/ft².yr	1.1
	MJ/m².yr	43

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	10%		70%	2%	3%
Eff./COP	75%		65%	90%	90%

	Fossil		Elec. Res.	
Fuel Share	85%		15%	100%
Blended Efficiency	0.68		0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 40.0

Wetting Use Percentage 50%

All Electric EUI	kWh/ft².yr	1.1
	MJ/m².yr	44
All Natural Gas EUI	kWh/ft².yr	1.5
	MJ/m².yr	59
Market Composite EUI	kWh/ft².yr	1.5
	MJ/m².yr	56.9

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: **Large Office** **Baseline** | **SIZE:** **> 50,000 m3** | **VINTAGE:** | **REGION:** **Northern Franchise**

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.7	L/s.m²	0.73	CFM/ft²
System Static Pressure CAV	750	Pa	3.0	wg
System Static Pressure VAV	1000	Pa	4.0	wg
Fan Efficiency	55%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	6.0	W/m²	0.55	W/ft²
Fan Design Load VAV	7.9	W/m²	0.74	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	15%	85%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use		100%		100%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.04	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.3	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.76	W/m²	0.16	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure	120	kPa	40	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.00	W/m²	0.09	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0051	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	120	kPa	40	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.8	W/m²	0.08	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	14.3	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.0	kWh/m².yr
Condenser Pump Energy Consumption	1.9	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.7	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	5.1	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	2.1
	MJ/m².yr	83.2

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Office	**> 50,000 m3**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**13.4** kWh/ft².yr	**517.3** MJ/m².yr	**Gas:**	**17.3** kWh/ft².yr	**670.2** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	3.6	140.3
ARCHITECTURAL LIGHTING	0.7	27.2
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	0.7	27.7
HVAC FANS & PUMPS	2.1	83.2
REFRIGERATION	0.1	5.0
COMPUTER EQUIPMENT	2.7	105.7
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	1.2	45.6	14.9	576.9
SPACE COOLING	1.1	43.2		
DOMESTIC HOT WATER	0.2	6.6	1.3	50.3
FOOD SERVICE EQUIPMENT	0.3	12.0	0.1	3.0
MISCELLANEOUS			1.0	40.0

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Small Office	**< 50,000 m3**		**Northern Franchise**
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.40	W/m².°C	0.07	Btu/hr.ft² .°F	Typical Building Size	1,000	m²	10,760	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	500	m²	5,380	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	40%			
Window/Wall Ratio (WIWAR) (%)	0.30								
Shading Coefficient (SC)	0.59				Typical # Stories	2			
					Floor to Floor Height (m)	3.5	m	11.5	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)					100%				100%
Min. Air Flow (%)					20%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	26	m²/person	280	ft²/person	%OA	4.96%
Occupancy Schedule Occ. Period	90%					
Occupancy Schedule Unocc. Period						
Fresh Air Requirements or Outside Air	7	L/s.person	15	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) | 2 | If Fresh Air Control Type = "2" enter % FA. to the right: | 11%
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air) | If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation | 0.5 L/s.m² | 0.10 CFM/ft²
50% operation (%)

Sizing Factor	1.6			
Total Air Circulation or Design Air Flow	5.43	L/s.m²	1.07	CFM/ft²

Separate Make-up air unit (100% OA) | | L/s.m² | | CFM/ft²
Operation occupied period | 50%
Operation unoccupied period | 50%

Infiltration Rate | 0.30 | L/s.m² | 0.06 | CFM/ft²
(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	272,881	
Peak Zone Sensible Load	154,497	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	7,187	
Total air circulation or Design air	5.43	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	30%	80%
DDC/Pneumatic	30%	
All DDC	40%	20%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	17	°C	62.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	21.6	°C	70.88	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning | Changes/Year | 4

Incidence of Annual Room Controls Maintenance | 100.0%

Incidence of Annual HVAC Controls Maintenance | 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Small Office	**< 50,000 m3**		**Northern Franchise**
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	440 Lux	40.9	ft-candles
Floor Fraction (GLFF)	0.95		
Connected Load	10.9 W/m²	1.0	W/ft²

Occ. Period(Hrs./yr.)	2900
Unocc. Period(Hrs./yr.)	5860
Usage During Occupied Period	95%
Usage During Unoccupied Period	25%
Fixture Cleaning:	
Incidence of Practice	
Interval	years

Light Level (Lux)	300	500	700	1000				Total
% Distribution	40%	50%	10%					100%
Weighted Average								**440**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		5%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	kWh/ft².yr	4.0
	MJ/m².yr	157

ARCHITECTURAL LIGHTING

Light Level	400 Lux	37.2	ft-candles
Floor Fraction (ALFF)	0.05		
Connected Load	10.3 W/m²	1.0	W/ft²

Occ. Period(Hrs./yr.)	3600
Unocc. Period(Hrs./yr.)	5160
Usage During Occupied Period	100%
Usage During Unoccupied Period	25%
Fixture Cleaning:	
Incidence of Practice	
Interval	years

Light Level (Lux)	300	500	700	1000				Total
% Distribution	50%	50%						100%
Weighted Average								**400**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		10%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Relamping Strategy & Incidence of Practice	Group	Spot

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	0.2
	MJ/m².yr	9

OTHER (HIGH BAY) LIGHTING

Light Level	300.00 Lux	27.9	ft-candles
Floor Fraction (HBLFF)			
Connected Load	0.0 W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING — Overall LP 10.84 W/m²

EUI TOTAL	kWh/ft².yr	4
	MJ/m².yr	166

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.95	0.95	0.1	0.1	0.06	
Connected Load	2.0 W/m²	1.9 W/m²	0.4 W/m²	0.8 W/m²	0.5 W/m²	1.5 W/m²
	0.2 W/ft²	0.2 W/ft²	0.04 W/ft²	0.07 W/ft²	0.05 W/ft²	0.14 W/ft²
Diversity Occupied Period	70%	80%	50%	50%	100%	100%
Diversity Unoccupied Period	30%	30%	5%	5%	100%	10%
Operation Occ. Period (hrs./year)	2000	2000	2000	2000	2000	2000
Operation Unocc. Period (hrs./year)	6760	6760	6760	6760	6760	6760

Total end-use load (occupied period)	5.5 W/m²	0.5 W/ft²
Total end-use load (unocc. period)	1.9 W/m²	0.2 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	34%	

Computer Equipment	EUI	kWh/ft².yr	1.82
		MJ/m².yr	70.57
Plug Loads	EUI	kWh/ft².yr	0.37
		MJ/m².yr	14.45

FOOD SERVICE EQUIPMENT

Provide description below:

Gas Fuel Share: 20.0% — Electricity Fuel Share: 80.0%

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	0.4	EUI	kWh/ft².yr	0.4
	MJ/m².yr	15.0		MJ/m².yr	15.0

REFRIGERATION

Provide description below:

EUI	kWh/ft².yr	0.1
	MJ/m².yr	5.0

MISCELLANEOUS

EUI	kWh/ft².yr	0.8
	MJ/m².yr	30

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: **Small Office** **Baseline** | **SIZE:** **< 50,000 m3** | **VINTAGE:** | **REGION:** **Northern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total
System Present (%)	10%	10%	2%		68%		10%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	97.9	W/m²	31.1	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	438	MJ/m².yr	11.3	kWh/ft².yr
Sizing Factor	1.50			

Electric Fuel Share 10.0% Gas Fuel Share 90.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	kWh/ft².yr	11.3
	MJ/m².yr	438
Natural Gas EUI	kWh/ft².yr	19.2
	MJ/m².yr	745
Market Composite EUI	kWh/ft².yr	18.4
	MJ/m².yr	714

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Adsorption	Engine	Total
System Present (%)					100.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	80	W/m²	25	Btu/hr.ft²	473	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	176.0	MJ/m².yr	4.5	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 100.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	kWh/ft².yr	1.8
	MJ/m².yr	70
Natural Gas EUI	kWh/ft².yr	
	MJ/m².yr	
Market Composite EUI	kWh/ft².yr	1.8
	MJ/m².yr	70

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	3%		76%	1%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	81%	19%	100%
Blended Efficiency	0.66	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 40.0

Wetting Use Percentage 50%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	1.1	1.6	1.5
MJ/m².yr	44	61	57.5

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: **Small Office** **Baseline**
SIZE: **< 50,000 m3**
VINTAGE:
REGION: **Northern Franchise**

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	5.4	L/s.m²	1.07	CFM/ft²
System Static Pressure CAV	562.5	Pa	2.3	wg
System Static Pressure VAV	625	Pa	2.5	wg
Fan Efficiency	55%			
Fan Motor Efficiency	82%			
Sizing Factor	1.00			
Fan Design Load CAV	6.8	W/m²	0.63	W/ft²
Fan Design Load VAV	7.5	W/m²	0.70	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use		100%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.4	L/s.m²	0.08	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.5	L/s.m²	0.10	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.7	W/m²	0.06	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.77	W/m²	0.16	W/ft²

Condenser Pump

Pump Design Flow		L/s.KW		U.S. gpm/Ton
Pump Design Flow per unit floor area		L/s.m²		U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0051	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure		kPa		ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load		W/m²		W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	14.8	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	5.8	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.0	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption		kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	2.0
	MJ/m².yr	77.9

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Small Office	< 50,000 m3		Northern Franchise
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	Electricity:	12.5 kWh/ft².yr	484.7 MJ/m².yr	Gas:	19.4 kWh/ft².yr	752.5 MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	4.0	156.8
ARCHITECTURAL LIGHTING	0.2	9.1
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	0.4	14.5
HVAC FANS & PUMPS	2.0	77.9
REFRIGERATION	0.1	5.0
COMPUTER EQUIPMENT	1.8	70.6
ELEVATORS		
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	1.1	43.8	17.3	670.4
SPACE COOLING	1.8	69.9		
DOMESTIC HOT WATER	0.2	8.4	1.3	49.1
FOOD SERVICE EQUIPMENT	0.3	12.0	0.1	3.0
MISCELLANEOUS			0.8	30.0

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: Retail Baseline | **SIZE:** All | **VINTAGE:** | **REGION:** Northern Franchise

CONSTRUCTION

Wall U value (W/m².°C)	0.45	W/m².°C	0.08	Btu/hr.ft² .°F	
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	
Window/Wall Ratio (WIWAR) (%)	0.20				
Shading Coefficient (SC)	0.85				

Typical Building Size	2,500	m²	26,900	ft²
Typical Footprint (m²)	2,500	m²	26,900	ft²
Footprint Aspect Ratio (L:W)	1.5			
Percent Conditioned Space	100%			
Percent Conditioned Space Defined as Exterior Zone	40%			
Typical # Stories	1			
Floor to Floor Height (m)	4.5	m	14.8	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	100%								100%
Min. Air Flow (%)									

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	50	m²/person	538	ft²/person
Occupancy Schedule Occ. Period	90%			
Occupancy Schedule Unocc. Period				
Fresh Air Requirements or Outside Air	20	L/s.person	42	CFM/person

%OA 10.61%

Fresh Air Control Type *(enter a 1, 2 or 3) 2
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 10%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1.1			
Total Air Circulation or Design Air Flow	3.77	L/s.m²	0.74	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)	L/s.m²	CFM/ft²
Operation occupied period	50%	
Operation unoccupied period	50%	

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	650,798	
Peak Zone Sensible Load	390,330	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	18,158	
Total air circulation or Design air	3.77	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	15	°C	59	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	19.5	°C	67.1	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	22	°C	71.6	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Retail	All		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	760	Lux	70.6	ft-candles
Floor Fraction (GLFF)	0.95			
Connected Load	26.8	W/m²	2.5	W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	25%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000	Total
% Distribution		15%	55%	30%	100%
Weighted Average					**760**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	10%			70%	15%	0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI		
	kWh/ft².yr	12.3
	MJ/m².yr	476

ARCHITECTURAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.05			
Connected Load	20.6	W/m²	1.9	W/ft²
Occ. Period(Hrs./yr.)	3800			
Unocc. Period(Hrs./yr.)	4960			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	60%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	30%	40%			30%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI		
	kWh/ft².yr	0.6
	MJ/m².yr	25

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	0%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI		
	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 26.51 W/m²

EUI TOTAL		
	kWh/ft².yr	13
	MJ/m².yr	501

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.2		0.2		0.15		0.1		0.12			
Connected Load	0.2	W/m²	0.2	W/m²	0.3	W/m²	0.4	W/m²	0.5	W/m²	1.5	W/m²
	0.0	W/ft²	0.0	W/ft²	0.03	W/ft²	0.04	W/ft²	0.05	W/ft²	0.14	W/ft²
Diversity Occupied Period	80%		80%		80%		80%		100%		80%	
Diversity Unoccupied Period	50%		50%		50%		50%		100%		50%	
Operation Occ. Period (hrs./year)	2000		2000		2000		2000		2000		2500	
Operation Unocc. Period (hrs./year)	6760		6760		6760		6760		6760		6260	

Total end-use load (occupied period)	2.6	W/m²	0.2	W/ft²
Total end-use load (unocc. period)	1.8	W/m²	0.2	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	70%			

	EUI		
Computer Equipment	EUI	kWh/ft².yr	0.94
		MJ/m².yr	36.30
Plug Loads	EUI	kWh/ft².yr	0.72
		MJ/m².yr	27.70

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 40.0% Electricity Fuel Share: 60.0%

Gas - cooking, baking not seperately metered

	Natural Gas EUI		All Electric EUI	
EUI	kWh/ft².yr	1.0	kWh/ft².yr	1.0
	MJ/m².yr	40.0	MJ/m².yr	40.0

REFRIGERATION EQUIPMENT

Provide description below:

Walk-in, display merchandisers, reach-ins, and fridges

EUI		
	kWh/ft².yr	1.0
	MJ/m².yr	40.0

MISCELLANEOUS

EUI		
	kWh/ft².yr	0.5
	MJ/m².yr	20

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: **Retail** **Baseline** — **SIZE:** **All** — **VINTAGE:** — **REGION:** **Northern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas: Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total
System Present (%)	5%	3%	2%		75%	5%	10%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	51.9 W/m²	16.5 Btu/hr.ft²	
Seasonal Heating Load (Tertiary Load)	423 MJ/m².yr	10.9 kWh/ft².yr	
Sizing Factor	1.30		
Electric Fuel Share	10.0%	Gas Fuel Share 90.0%	Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	10.9	16.3	15.0
MJ/m².yr	423	633	580

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Absorptior	Engine	Total
System Present (%)	5.0%	5.0%			90.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	15.0	59

Peak Cooling Load	76 W/m²	24 Btu/hr.ft²	496 ft²/Ton
Seasonal Cooling Load (Tertiary Load)	189.3 MJ/m².yr	4.9 kWh/ft².yr	

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 100.0%

Electric Fuel Share 100.0% — Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Curent Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	2.0		2.0
MJ/m².yr	79		79

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	1%	22%	40%	1%	2%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	66%	34%
Blended Efficiency	0.65	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 35.0

Wetting Use Percentage 10%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	1.0	1.4	1.3
MJ/m².yr	38	54	48.8

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Retail	All		Northern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.8	L/s.m²	0.74	CFM/ft²
System Static Pressure CAV	625	Pa	2.5	wg
System Static Pressure VAV	625	Pa	2.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	80%			
Sizing Factor	1.00			
Fan Design Load CAV	5.7	W/m²	0.53	W/ft²
Fan Design Load VAV	5.7	W/m²	0.53	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use		100%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	90%	10%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.04	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.69	W/m²	0.16	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0048	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure		kPa		ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load		W/m²		W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	6.2	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	2.1	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.1	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption		kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	0.9
	MJ/m².yr	33.9

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Retail	**All**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**21.1**	kWh/ft².yr	**818.3**	MJ/m².yr	**Gas:**	**16.6** kWh/ft².yr	**641.3** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	12.3	476.1
ARCHITECTURAL LIGHTING	0.6	25.1
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	0.7	27.7
HVAC FANS & PUMPS	0.9	33.9
REFRIGERATION EQUIPMENT	1.0	40.0
COMPUTER EQUIPMENT	0.9	36.3
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	1.1	42.3	14.7	569.5
SPACE COOLING	2.0	79.1		
DOMESTIC HOT WATER	0.3	13.1	0.9	35.7
FOOD SERVICE EQUIPMENT	0.6	24.0	0.4	16.0
MISCELLANEOUS			0.5	20.0

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Hotel	> 50,000 m^3		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.48	W/m².°C	0.09	Btu/hr.ft² .°F	Typical Building Size	8,000	m²	86,080	ft²
Roof U value (W/m².°C)	0.24	W/m².°C	0.04	Btu/hr.ft² .°F	Typical Footprint (m²)	2,000	m²	21,520	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	5			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	75%			
Window/Wall Ratio (WIWAR) (%)	0.25								
Shading Coefficient (SC)	0.64				Typical # Stories	4			
					Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	80%				20%				100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	60	m²/person	646	ft²/person	%OA	15.55%	
Occupancy Schedule Occ. Period	45%						
Occupancy Schedule Unocc. Period	80%						
Fresh Air Requirements or Outside Air	25	L/s.person	53	CFM/person			

Fresh Air Control Type *(enter a 1, 2 or 3)
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air): 1

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1.25			
Total Air Circulation or Design Air Flow	2.68	L/s.m²	0.53	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,449,968	
Peak Zone Sensible Load	780,911	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	36,328	
Total air circulation or Design air	2.68	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	22	°C	71.6	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	23	°C	73.4	°F	24	°C	75.2	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20.25	°C	68.45	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Hotel	> 50,000 m^3		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	120	Lux	11.2	ft-candles
Floor Fraction (GLFF)	0.75			
Connected Load	4.7	W/m²	0.4	W/ft²
Occ. Period(Hrs./yr.)	2100			
Unocc. Period(Hrs./yr.)	6660			
Usage During Occupied Period	70%			
Usage During Unoccupied Period	30%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	50	100	200	300				Total
% Distribution	20%	50%	30%					100%
Weighted Average								**120**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		75%			25%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI kWh/ft².yr 1.1; MJ/m².yr 44

GENERAL LIGHTING (LOBBY BALLROOMS, CORRIDORS, BACK OF HOUSE)

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.25			
Connected Load	15.1	W/m²	1.4	W/ft²
Occ. Period(Hrs./yr.)	3600			
Unocc. Period(Hrs./yr.)	5160			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	70%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	15%	40%			45%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI kWh/ft².yr 2.5; MJ/m².yr 98

EUI = Load X Hrs. X SF X GLFF

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	0%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 — 1.00

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI kWh/ft².yr; MJ/m².yr

TOTAL LIGHTING — Overall LP 7.27 W/m² — EUI TOTAL kWh/ft².yr 4; MJ/m².yr 141

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)												
Connected Load		W/m²		W/m²		W/m²		W/m²	0.5	W/m²	4	W/m²
		W/ft²		W/ft²		W/ft²		W/ft²	0.05	W/ft²	0.37	W/ft²
Diversity Occupied Period											70%	
Diversity Unoccupied Period											70%	
Operation Occ. Period (hrs./year)											3000	
Operation Unocc. Period (hrs./year)	8760		8760		8760		8760		8760		5760	

Total end-use load (occupied period)	2.8	W/m²	0.3	W/ft²
Total end-use load (unocc. period)	2.8	W/m²	0.3	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	100%			

Computer Equipment EUI kWh/ft².yr; MJ/m².yr

Plug Loads EUI kWh/ft².yr 2.28; MJ/m².yr 88.30

FOOD SERVICE EQUIPMENT

Provide description below: — Gas Fuel Share: 50.0% — Electricity Fuel Share: 50.0%

Cooking

	Natural Gas EUI	All Electric EUI
EUI kWh/ft².yr	1.8	1.8
MJ/m².yr	70.0	70.0

REFRIGERATION

Provide description below:

Coolers, ice machines, pop machines, fridges etc

EUI kWh/ft².yr 0.5; MJ/m².yr 20.0

MISCELLANEOUS

EUI kWh/ft².yr 1.3; MJ/m².yr 50

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Hotel	> 50,000 m^3		Northern Franchise
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	10%	25%	5%		25%		35%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	45.2 W/m²	14.3 Btu/hr.ft²	
Seasonal Heating Load (Tertiary Load)	432 MJ/m².yr	11.2 kWh/ft².yr	
Sizing Factor	1.50		
Electric Fuel Share	35.0%	Gas Fuel Share 65.0%	Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	11.2
MJ/m².yr	432

Natural Gas EUI	
kWh/ft².yr	14.8
MJ/m².yr	575

Market Composite EUI	
kWh/ft².yr	13.5
MJ/m².yr	525

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorption	Engine	
System Present (%)		65.0%		10.0%	25.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6 °C	42.8 °F
Condenser Water	35 °C	95 °F
Supply Air	14.0 °C	57.2 °F

Peak Cooling Load	53 W/m²	17 Btu/hr.ft²	712 ft²/Ton
Seasonal Cooling Load (Tertiary Load)	126.7 MJ/m².yr	3.3 kWh/ft².yr	

Sizing Factor: 1.00

Operation (occ. period): 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C): 90.0%

Electric Fuel Share: 100.0% — Gas Fuel Share:

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	1.0
MJ/m².yr	40

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	1.0
MJ/m².yr	40

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	65%			22%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	88%	12%	100%
Blended Efficiency	0.79	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load): 220.0

Wetting Use Percentage: 50%

All Electric EUI	
kWh/ft².yr	6.2
MJ/m².yr	242

All Natural Gas EUI	
kWh/ft².yr	7.2
MJ/m².yr	279

Market Composite EUI	
kWh/ft².yr	7.1
MJ/m².yr	274.3

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Large Hotel	> 50,000 m^3		Northern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	2.7	L/s.m²	0.53	CFM/ft²
System Static Pressure CAV	500	Pa	2.0	wg
System Static Pressure VAV	625	Pa	2.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	3.0	W/m²	0.28	W/ft²
Fan Design Load VAV	3.8	W/m²	0.35	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	80%	20%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	100%		100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.04	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.3	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.17	W/m²	0.11	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.003	L/s.m²	0.004	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.83	W/m²	0.08	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.002	L/s.m²	0.0034	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.7	W/m²	0.06	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	22.7	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	2.3	kWh/m².yr
Condenser Pump Energy Consumption	2.3	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.8	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	3.1	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	2.9
	MJ/m².yr	112.2

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Large Hotel	**> 50,000 m^3**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**16.4** kWh/ft².yr	**634.5** MJ/m².yr	**Gas:**	**18.2** kWh/ft².yr	**703.9** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING	1.1	43.7					
GENERAL LIGHTING (LOBBY BALLROOMS, COR	2.5	97.8	SPACE HEATING	3.9	151.3	9.6	373.5
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	0.9	36.3		
OTHER PLUG LOADS	2.3	88.3	DOMESTIC HOT WATER	0.7	29.0	6.3	245.3
HVAC FANS & PUMPS	2.9	112.2	FOOD SERVICE EQUIPMENT	0.9	35.0	0.9	35.0
REFRIGERATION	0.5	20.0	MISCELLANEOUS			1.3	50.0
COMPUTER EQUIPMENT							
ELEVATORS	0.1	3.9					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hotel/Motel	< 50,000 m^3		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.37	W/m².°C	0.07	Btu/hr.ft² .°F	Typical Building Size	1,000	m²	10,760	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	1,000	m²	10,760	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	5			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	75%			
Window/Wall Ratio (WIWAR) (%)	0.25								
Shading Coefficient (SC)	0.64				Typical # Stories	1			
					Floor to Floor Height (m)	3.2	m	10.5	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	90%				10%				100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	60	m²/person	646	ft²/person	%OA	6.40%
Occupancy Schedule Occ. Period	45%					
Occupancy Schedule Unocc. Period	80%					
Fresh Air Requirements or Outside Air	10	L/s.person	21	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) — 2
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² — 0.10 CFM/ft² — 50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	2.61	L/s.m²	0.51	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	269,967	
Peak Zone Sensible Load	118,659	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	5,520	
Total air circulation or Design air	2.61	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional	PI / PID	Total
Control Mode			
	Fixed Discharge	Reset	
Control Strategy			

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	22	°C	71.6	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	23	°C	73.4	°F	24	°C	75.2	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	20	°C	68	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hotel/Motel	< 50,000 m^3		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	120	Lux	11.2	ft-candles
Floor Fraction (GLFF)	0.75			
Connected Load	7.1	W/m²	0.7	W/ft²

Occ. Period(Hrs./yr.)	2100
Unocc. Period(Hrs./yr.)	6660
Usage During Occupied Period	70%
Usage During Unoccupied Period	30%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	50	100	200	300				Total
% Distribution	20%	50%	30%					100%
Weighted Average								**120**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	20%	55%			25%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	1.7
	MJ/m².yr	67

ARCHITECTURAL LIGHTING (LOBBY BALLROOMS, CORRIDORS, BACK OF HOUSE)

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.25			
Connected Load	16.6	W/m²	1.5	W/ft²

Occ. Period(Hrs./yr.)	3600
Unocc. Period(Hrs./yr.)	5160
Usage During Occupied Period	100%
Usage During Unoccupied Period	70%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	20%	35%			45%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	2.8
	MJ/m².yr	108

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 9.50 W/m²

EUI TOTAL	kWh/ft².yr	5
	MJ/m².yr	175

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)						
Connected Load	W/m²	W/m²	W/m²	W/m²	W/m²	1.5 W/m²
	W/ft²	W/ft²	W/ft²	W/ft²	W/ft²	0.14 W/ft²
Diversity Occupied Period						70%
Diversity Unoccupied Period						70%
Operation Occ. Period (hrs./year)						3000
Operation Unocc. Period (hrs./year)	8760	8760	8760	8760	8760	5760

Total end-use load (occupied period)	1.1	W/m²	0.1	W/ft²
Total end-use load (unocc. period)	1.1	W/m²	0.1	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	100%			

	EUI		
Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	0.85
		MJ/m².yr	33.11

FOOD SERVICE EQUIPMENT

Provide description below:

Gas Fuel Share: 20.0% | Electricity Fuel Share: 80.0%

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	0.8	EUI	kWh/ft².yr	0.8
	MJ/m².yr	30.0		MJ/m².yr	30.0

REFRIGERATION EQUIPMENT

Provide description below:

EUI	kWh/ft².yr	0.3
	MJ/m².yr	10.0

MISCELLANEOUS

EUI	kWh/ft².yr	1.0
	MJ/m².yr	40

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hotel/Motel	< 50,000 m^3		Northern Franchise
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric		
	Boilers				RTU	Furnace	Resistance	Total	
	Standard	Near Cond	Cond						
System Present (%)	25%	25%	10%		5%		35%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load	62.0	W/m²	19.7	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	626	MJ/m².yr	16.2	kWh/ft².yr
Sizing Factor	1.30			

Electric Fuel Share	35.0%	Gas Fuel Share	65.0%	Oil Fuel Share	

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	16.2
MJ/m².yr	626

Natural Gas EUI	
kWh/ft².yr	20.6
MJ/m².yr	798

Market Composite EUI	
kWh/ft².yr	19.1
MJ/m².yr	738

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)				15.0%	85.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	79	W/m²	25	Btu/hr.ft²	478	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	119.5	MJ/m².yr	3.1	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 90.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	1.4
MJ/m².yr	54

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	1.4
MJ/m².yr	54

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	35%		40%	5%	5%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	85%	15%	100%
Blended Efficiency	0.72	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 240.0

Wetting Use Percentage 50%

All Electric EUI	
kWh/ft².yr	6.8
MJ/m².yr	264

All Natural Gas EUI	
kWh/ft².yr	8.6
MJ/m².yr	333

Market Composite EUI	
kWh/ft².yr	8.3
MJ/m².yr	322.7

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Hotel/Motel	**< 50,000 m³**		**Northern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	2.6	L/s.m²	0.51	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV	625	Pa	2.5	wg
Fan Efficiency	45%			
Fan Motor Efficiency	80%			
Sizing Factor	1.00			
Fan Design Load CAV	2.7	W/m²	0.25	W/ft²
Fan Design Load VAV	4.5	W/m²	0.42	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	80%	20%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	100%		100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.2	L/s.m²	0.04	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.3	L/s.m²	0.06	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.4	W/m²	0.04	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.75	W/m²	0.16	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure	24	kPa	8	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.20	W/m²	0.02	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0050	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	8	kPa	3	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.1	W/m²	0.00	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	20.7	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	3.5	kWh/m².yr
Condenser Pump Energy Consumption	0.5	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.7	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	0.2	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	2.4
	MJ/m².yr	92.5

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hotel/Motel	< 50,000 m^3		Northern Franchise
Baseline			

EUI SUMMARY

TOTAL ALL END-USES: **Electricity:** **17.0** kWh/ft².yr **658.3** MJ/m².yr **Gas:** **21.9** kWh/ft².yr **847.9** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING (SUITES)	1.7	66.7
ARCHITECTURAL LIGHTING (LOBI	2.8	107.8
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	0.9	33.1
HVAC FANS & PUMPS	2.4	92.5
REFRIGERATION EQUIPMENT	0.3	10.0
COMPUTER EQUIPMENT		
ELEVATORS		
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	5.7	219.2	13.4	518.8
SPACE COOLING	1.2	48.4		
DOMESTIC HOT WATER	1.0	39.6	7.3	283.1
FOOD SERVICE EQUIPMENT	0.6	24.0	0.2	6.0
MISCELLANEOUS			1.0	40.0

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Contract Hospital	All volumes		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.36	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Building Size	10,000	m²	107,600	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	3,333	m²	35,867	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	3			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.27								
Shading Coefficient (SC)	0.51				Typical # Stories	3			
					Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	15%	25%			5%	5%		50%	50%
Min. Air Flow (%)					20%	20%			

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	26	m²/person	280	ft²/person
Occupancy Schedule Occ. Period	90%			
Occupancy Schedule Unocc. Period	60%			
Fresh Air Requirements or Outside Air	30	L/s.person	64	CFM/person

%OA 35.31%

Fresh Air Control Type *(enter a 1, 2 or 3) 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.5 L/s.m² 0.10 CFM/ft²; 50% operation (%)

Sizing Factor	1.75			
Total Air Circulation or Design Air Flow	3.27	L/s.m²	0.64	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA) ____ L/s.m² ____ CFM/ft²
Operation occupied period ____
Operation unoccupied period ____

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	3,201,718	
Peak Zone Sensible Load	850,444	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	39,563	
Total air circulation or Design air	3.27	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic		50%
DDC/Pneumatic	50%	
All DDC	50%	50%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	24	°C	75.2	°F	22	°C	71.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	24	°C	75.2	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Contract Hospital	All volumes		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (PATIENTS ROOM)

Light Level	250 Lux	23.2	ft-candles
Floor Fraction (GLFF)	0.50		
Connected Load	6.2 W/m²	0.6	W/ft²

Occ. Period(Hrs./yr.)	5400
Unocc. Period(Hrs./yr.)	3360
Usage During Occupied Period	50%
Usage During Unoccupied Period	20%

Light Level (Lux)	200	300	500	1000			Total
% Distribution	50%	50%					100%
Weighted Average	4						**250**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		5%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval years

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	kWh/ft².yr	1.0
	MJ/m².yr	37

ARCHITECTURAL LIGHTING (NURSING STATIONS, EXAMINATION, LABORATORY, ICU, RECOVERY)

Light Level	700 Lux	65.1	ft-candles
Floor Fraction (ALFF)	0.40		
Connected Load	18.0 W/m²	1.7	W/ft²

Occ. Period(Hrs./yr.)	5400
Unocc. Period(Hrs./yr.)	3360
Usage During Occupied Period	65%
Usage During Unoccupied Period	40%

Light Level (Lux)	300	500	700	1000			Total
% Distribution			100%				100%
Weighted Average							**700**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		10%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval years

Relamping Strategy & Incidence of Practice	Group	Spot

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	3.2
	MJ/m².yr	126

CORRIDORS OTHER

Light Level	250.00 Lux	23.2	ft-candles
Floor Fraction (HBLFF)	0.10		
Connected Load	6.9 W/m²	0.6	W/ft²

Floor fraction check: should = 1.00 — 1.00

Occ. Period(Hrs./yr.)	5400
Unocc. Period(Hrs./yr.)	3360
Usage During Occupied Period	100%
Usage During Unoccupied Period	50%

Light Level (Lux)	200	300	500	1000			Total
% Distribution	50%	50%					100%
Weighted Average							**250**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		10%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval years

Relamping Strategy & Incidence of Practice	Group	Spot

EUI	kWh/ft².yr	0.5
	MJ/m².yr	18

TOTAL LIGHTING — Overall LP 10.28 W/m²

EUI TOTAL	kWh/ft².yr	5
	MJ/m².yr	181

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.05	0.05	0.01	0.01		
Connected Load	0.1 W/m²	0.1 W/m²	0.0 W/m²	0.1 W/m²	W/m²	5 W/m²
	0.0 W/ft²	0.0 W/ft²	0.00 W/ft²	0.01 W/ft²	W/ft²	0.46 W/ft²
Diversity Occupied Period	90%	90%	90%	90%		100%
Diversity Unoccupied Period	40%	40%	20%	10%		
Operation Occ. Period (hrs./year)	5400	5400	5400	5400		3000
Operation Unocc. Period (hrs./year)	3360	3360	3360	3360	8760	5760

Total end-use load (occupied period)	5.3 W/m²	0.5 W/ft²
Total end-use load (unocc. period)	0.1 W/m²	0.0 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	2%	

Computer Equipment	EUI	kWh/ft².yr	0.17
		MJ/m².yr	6.73
Plug Loads	EUI	kWh/ft².yr	1.39
		MJ/m².yr	54.00

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 65.0% Electricity Fuel Share: 35.0%

Cooking

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	1.3	EUI	kWh/ft².yr	1.3
	MJ/m².yr	50.0		MJ/m².yr	50.0

KITCHEN & REFRIGERATION

Provide description below:

EUI	kWh/ft².yr	0.8
	MJ/m².yr	30.0

Misc

EUI	kWh/ft².yr	2.6
	MJ/m².yr	100

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS: **Contract Hospital** **Baseline** | **SIZE:** **All volumes** | **VINTAGE:** | **REGION:** **Northern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)		70%	20%		8%		2%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	58.8 W/m²	18.7 Btu/hr.ft²	
Seasonal Heating Load (Tertiary Load)	1134 MJ/m².yr	29.3 kWh/ft².yr	
Sizing Factor	2.20		
Electric Fuel Share	2.0%	Gas Fuel Share 98.0%	Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	29.3
MJ/m².yr	1134

Natural Gas EUI	
kWh/ft².yr	36.1
MJ/m².yr	1398

Market Composite EUI	
kWh/ft².yr	36.0
MJ/m².yr	1393

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorption	Engine	
System Present (%)		87.0%		4.0%	4.0%	5.0%		100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6 °C	42.8 °F
Condenser Water	35 °C	95 °F
Supply Air	14.0 °C	57.2 °F

Peak Cooling Load	94 W/m²	30 Btu/hr.ft²	403 ft²/Ton
Seasonal Cooling Load (Tertiary Load)	160.2 MJ/m².yr	4.1 kWh/ft².yr	

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 95.0% — Gas Fuel Share 5.0%

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	1.2
MJ/m².yr	47

Natural Gas EUI	
kWh/ft².yr	4.7
MJ/m².yr	182

Market Composite EUI	
kWh/ft².yr	1.4
MJ/m².yr	54

DOMESTIC HOT WATER & PROCESS STREAM

Service Hot Water Plant Type

Fossil Fuel SHW	Med Eff Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	79%		10%	5%	1%
Eff./COP	84%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	95%	5%	100%
Blended Efficiency	0.82	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 250.0

Wetting Use Percentage 25%

All Electric EUI	
kWh/ft².yr	7.1
MJ/m².yr	275

All Natural Gas EUI	
kWh/ft².yr	7.8
MJ/m².yr	303

Market Composite EUI	
kWh/ft².yr	7.8
MJ/m².yr	302.0

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Contract Hospital	All volumes		Northern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.3	L/s.m²	0.64	CFM/ft²
System Static Pressure CAV	1000	Pa	4.0	wg
System Static Pressure VAV	1000	Pa	4.0	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	7.4	W/m²	0.69	W/ft²
Fan Design Load VAV	7.4	W/m²	0.69	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	80%	20%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	90%	10%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	2.07	W/m²	0.19	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.005	L/s.m²	0.007	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.46	W/m²	0.14	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0060	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.2	W/m²	0.11	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	52.7	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.9	kWh/m².yr
Condenser Pump Energy Consumption	3.6	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.9	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	8.2	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	6.3
	MJ/m².yr	242.1

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Contract Hospital	All volumes		Northern Franchise
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	Electricity:	16.5 kWh/ft².yr	637.5 MJ/m².yr	Gas:	46.4 kWh/ft².yr	1,797.8 MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	END USE:	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING (PATIENTS R(	1.0	37.5					
ARCHITECTURAL LIGHTING (NUR	3.2	125.8	SPACE HEATING	0.6	22.7	35.4	1,370.2
CORRIDORS OTHER	0.5	17.6	SPACE COOLING	0.9	33.6	0.2	6.8
OTHER PLUG LOADS	1.4	54.0	DOMESTIC HOT WATER & PRO(	0.4	13.7	7.4	288.3
HVAC FANS & PUMPS	6.3	242.1	FOOD SERVICE EQUIPMENT	0.5	17.5	0.8	32.5
KITCHEN & REFRIGERATION	0.8	30.0	Misc			2.6	100.0
COMPUTER EQUIPMENT	0.2	6.7					
ELEVATORS	0.5	19.4					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hospital	All volumes		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.36	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Building Size	10,000	m²	107,600	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	3,333	m²	35,867	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	3			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.27								
Shading Coefficient (SC)	0.51				Typical # Stories	3			
					Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	15%	25%			5%	5%		50%	50%
Min. Air Flow (%)					20%	20%			

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	26	m²/person	280	ft²/person
Occupancy Schedule Occ. Period	90%			
Occupancy Schedule Unocc. Period	60%			
Fresh Air Requirements or Outside Air	30	L/s.person	64	CFM/person

%OA 35.31%

Fresh Air Control Type *(enter a 1, 2 or 3) 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.5 L/s.m² 0.10 CFM/ft²
50% operation (%)

Sizing Factor	1.75			
Total Air Circulation or Design Air Flow	3.27	L/s.m²	0.64	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA) L/s.m² CFM/ft²
Operation occupied period
Operation unoccupied period

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	3,201,718	
Peak Zone Sensible Load	850,444	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	39,563	
Total air circulation or Design air	3.27	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic		50%
DDC/Pneumatic	50%	
All DDC	50%	50%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	24	°C	75.2	°F	22	°C	71.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	24	°C	75.2	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hospital	All volumes		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (PATIENTS ROOM)

Light Level	250	Lux	23.2	ft-candles
Floor Fraction (GLFF)	0.50			
Connected Load	6.2	W/m²	0.6	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	50%			
Usage During Unoccupied Period	20%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	200	300	500	1000			Total
% Distribution	50%	50%					100%
Weighted Average	4						**250**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		5%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	1.0
	MJ/m².yr	37

ARCHITECTURAL LIGHTING (NURSING STATIONS, EXAMINATION, LABORATORY, ICU, RECOVERY)

Light Level	700	Lux	65.1	ft-candles
Floor Fraction (ALFF)	0.40			
Connected Load	18.0	W/m²	1.7	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	65%			
Usage During Unoccupied Period	40%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000			Total
% Distribution			100%				100%
Weighted Average							**700**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		10%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	3.2
	MJ/m².yr	126

CORRIDORS OTHER

Light Level	250.00	Lux	23.2	ft-candles
Floor Fraction (HBLFF)	0.10			
Connected Load	6.9	W/m²	0.6	W/ft²
Occ. Period(Hrs./yr.)	5400			
Unocc. Period(Hrs./yr.)	3360			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	50%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 — 1.00

Light Level (Lux)	200	300	500	1000			Total
% Distribution	50%	50%					100%
Weighted Average							**250**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		10%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	0.5
	MJ/m².yr	18

TOTAL LIGHTING — Overall LP 10.28 W/m²

EUI TOTAL	kWh/ft².yr	5
	MJ/m².yr	181

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.05	0.05	0.01	0.01		
Connected Load	0.1 W/m²	0.1 W/m²	0.0 W/m²	0.1 W/m²	W/m²	5 W/m²
	0.0 W/ft²	0.0 W/ft²	0.00 W/ft²	0.01 W/ft²	W/ft²	0.46 W/ft²
Diversity Occupied Period	90%	90%	90%	90%		100%
Diversity Unoccupied Period	40%	40%	20%	10%		
Operation Occ. Period (hrs./year)	5400	5400	5400	5400		3000
Operation Unocc. Period (hrs./year)	3360	3360	3360	3360	8760	5760

Total end-use load (occupied period)	5.3	W/m²	0.5	W/ft²
Total end-use load (unocc. period)	0.1	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	2%			

Computer Equipment	EUI	kWh/ft².yr	0.17
		MJ/m².yr	6.73
Plug Loads	EUI	kWh/ft².yr	1.39
		MJ/m².yr	54.00

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 65.0% Electricity Fuel Share: 35.0%

Cooking

	Natural Gas EUI		All Electric EUI	
EUI	kWh/ft².yr	1.3	kWh/ft².yr	1.3
	MJ/m².yr	50.0	MJ/m².yr	50.0

KITCHEN & REFRIGERATION

Provide description below:

EUI	kWh/ft².yr	0.8
	MJ/m².yr	30.0

Misc

EUI	kWh/ft².yr	2.6
	MJ/m².yr	100

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hospital	All volumes		Northern Franchise
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total
System Present (%)		70%	20%		8%		2%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	58.8 W/m²	18.7 Btu/hr.ft²	
Seasonal Heating Load (Tertiary Load)	1134 MJ/m².yr	29.3 kWh/ft².yr	
Sizing Factor	2.20		
Electric Fuel Share	2.0%	Gas Fuel Share 98.0%	Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	kWh/ft².yr	29.3
	MJ/m².yr	1134
Natural Gas EUI	kWh/ft².yr	36.1
	MJ/m².yr	1398
Market Composite EUI	kWh/ft².yr	36.0
	MJ/m².yr	1393

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Absorptior	Engine	Total
System Present (%)		87.0%		4.0%	4.0%	5.0%		100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6 °C	42.8 °F
Condenser Water	35 °C	95 °F
Supply Air	14.0 °C	57.2 °F

Peak Cooling Load	94 W/m²	30 Btu/hr.ft²	403 ft²/Ton
Seasonal Cooling Load (Tertiary Load)	160.2 MJ/m².yr	4.1 kWh/ft².yr	

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 95.0% — Gas Fuel Share 5.0%

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	kWh/ft².yr	1.2
	MJ/m².yr	47
Natural Gas EUI	kWh/ft².yr	4.7
	MJ/m².yr	182
Market Composite EUI	kWh/ft².yr	1.4
	MJ/m².yr	54

DOMESTIC HOT WATER & PROCESS STREAM

Service Hot Water Plant Type

Fossil Fuel SHW	Med Eff Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	79%		10%	5%	1%
Eff./COP	84%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	95%	5%
Blended Efficiency	0.82	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 250.0

Wetting Use Percentage 25%

All Electric EUI	kWh/ft².yr	7.1
	MJ/m².yr	275
All Natural Gas EUI	kWh/ft².yr	7.8
	MJ/m².yr	303
Market Composite EUI	kWh/ft².yr	7.8
	MJ/m².yr	302.0

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Hospital	All volumes		Northern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.3	L/s.m²	0.64	CFM/ft²
System Static Pressure CAV	1000	Pa	4.0	wg
System Static Pressure VAV	1000	Pa	4.0	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	7.4	W/m²	0.69	W/ft²
Fan Design Load VAV	7.4	W/m²	0.69	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	80%	20%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	90%	10%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.1	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	2.07	W/m²	0.19	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.005	L/s.m²	0.007	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.46	W/m²	0.14	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.004	L/s.m²	0.0060	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.2	W/m²	0.11	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	52.7	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.9	kWh/m².yr
Condenser Pump Energy Consumption	3.6	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.9	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	8.2	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	6.3
	MJ/m².yr	242.1

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Hospital	**All volumes**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES: **Electricity:** **16.5** kWh/ft².yr **637.5** MJ/m².yr **Gas:** **46.4** kWh/ft².yr **1,797.8** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING (PATIENTS R(	1.0	37.5
ARCHITECTURAL LIGHTING (NUR	3.2	125.8
CORRIDORS OTHER	0.5	17.6
OTHER PLUG LOADS	1.4	54.0
HVAC FANS & PUMPS	6.3	242.1
KITCHEN & REFRIGERATION	0.8	30.0
COMPUTER EQUIPMENT	0.2	6.7
ELEVATORS	0.5	19.4
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	0.6	22.7	35.4	1,370.2
SPACE COOLING	0.9	33.6	0.2	6.8
DOMESTIC HOT WATER & PRO(	0.4	13.7	7.4	288.3
FOOD SERVICE EQUIPMENT	0.5	17.5	0.8	32.5
Misc			2.6	100.0

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Long Term Care (Nursing Home)	All volumes		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.36 W/m².°C	0.06 Btu/hr.ft² .°F	Typical Building Size	8,364 m²	89,997 ft²
Roof U value (W/m².°C)	0.35 W/m².°C	0.06 Btu/hr.ft² .°F	Typical Footprint (m²)	4,182 m²	44,998 ft²
Glazing U value (W/m².°C)	3.03 W/m².°C	0.53 Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	5	
			Percent Conditioned Space	100%	
			Percent Conditioned Space Defined as Exterior Zone	40%	
Window/Wall Ratio (WIWAR) (%)	0.25				
Shading Coefficient (SC)	0.60		Typical # Stories	2	
			Floor to Floor Height (m)	3.7 m	12.0 ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	90%				10%				100%
Min. Air Flow (%)					20%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	30 m²/person	323 ft²/person	%OA 19.08%
Occupancy Schedule Occ. Period	90%		
Occupancy Schedule Unocc. Period	90%		
Fresh Air Requirements or Outside Air	18 L/s.person	38 CFM/person	

Fresh Air Control Type *(enter a 1, 2 or 3): 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1.5	
Total Air Circulation or Design Air Flow	3.14 L/s.m²	0.62 CFM/ft²

Separate Make-up air unit (100% OA): L/s.m² | CFM/ft²
Operation occupied period: 50%
Operation unoccupied period: 50%

Infiltration Rate: 0.30 L/s.m² | 0.06 CFM/ft²
(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,846,692	
Peak Zone Sensible Load	798,463	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	37,144	
Total air circulation or Design air	3.14	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	16	°C	60.8	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	24	°C	75.2	°F	24	°C	75.2	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	24	°C	75.2	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Long Term Care (Nursing Home)	**All volumes**		**Northern Franchise**
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	200	Lux	18.6	ft-candles
Floor Fraction (GLFF)	0.75			
Connected Load	12.9	W/m²	1.2	W/ft²

Occ. Period(Hrs./yr.)	3000
Unocc. Period(Hrs./yr.)	5760
Usage During Occupied Period	85%
Usage During Unoccupied Period	45%

Light Level (Lux)	200	300	500	700				Total
% Distribution	100%							100%
Weighted Average								**200**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	30%	10%	25%		35%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval — years

Relamping Strategy & Incidence of Practice: Group | Spot

EUI	kWh/ft².yr	4.6
	MJ/m².yr	179

ARCHITECTURAL LIGHTING (SERVICES, KITCHEN, OFFICES, DINING, RECREATION)

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.25			
Connected Load	14.0	W/m²	1.3	W/ft²

Occ. Period(Hrs./yr.)	5000
Unocc. Period(Hrs./yr.)	3760
Usage During Occupied Period	95%
Usage During Unoccupied Period	55%

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	15%	5%	35%		40%	5%	0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval — years

Relamping Strategy & Incidence of Practice: Group | Spot

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	2.2
	MJ/m².yr	86

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 — 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval — years

Relamping Strategy & Incidence of Practice: Group | Spot

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING — Overall LP 13.16 W/m²

EUI TOTAL	kWh/ft².yr	7
	MJ/m².yr	265

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)												
Connected Load		W/m²		W/m²		W/m²		W/m²		W/m²	3.5	W/m²
		W/ft²		W/ft²		W/ft²		W/ft²		W/ft²	0.33	W/ft²
Diversity Occupied Period	80%		80%		80%		80%				70%	
Diversity Unoccupied Period	50%		50%		50%		50%				40%	
Operation Occ. Period (hrs./year)	2000		2000		2000		2000				3000	
Operation Unocc. Period (hrs./year)	6760		6760		6760		6760		8760		5760	

Total end-use load (occupied period)	2.5	W/m²	0.2	W/ft²
Total end-use load (unocc. period)	1.4	W/m²	0.1	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	57%			

Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	1.43
		MJ/m².yr	55.49

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 82.0% Electricity Fuel Share: 18.0%

Commercial Food Preparation

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	1.5	EUI	kWh/ft².yr	1.5
	MJ/m².yr	60.0		MJ/m².yr	60.0

REFRIGERATION EQUIPMENT

Provide description below:

EUI	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI	kWh/ft².yr	1.8
	MJ/m².yr	70

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Long Term Care (Nursing Home)	**All volumes**		**Northern Franchise**
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric		
	Boilers				RTU	Furnace	Resistance	Total	
	Standard	Near Cond	Cond						
System Present (%)	10%	50%	5%		25%		10%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load	75.5	W/m²	24.0	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	730	MJ/m².yr	18.9	kWh/ft².yr
Sizing Factor	2.00			

Electric Fuel Share 10.0% Gas Fuel Share 90.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	18.9
MJ/m².yr	730

Natural Gas EUI	
kWh/ft².yr	24.3
MJ/m².yr	943

Market Composite EUI	
kWh/ft².yr	23.8
MJ/m².yr	922

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)		30.0%		30.0%	40.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	16.0	°C	60.8	°F

Peak Cooling Load	65	W/m²	21	Btu/hr.ft²	585	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	143.6	MJ/m².yr	3.7	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

All Electric EUI	
kWh/ft².yr	1.2
MJ/m².yr	46

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	1.2
MJ/m².yr	46

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	65%		20%	3%	2%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	90%	10%	100%
Blended Efficiency	0.74	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 180.0

Wetting Use Percentage 10%

All Electric EUI	
kWh/ft².yr	5.1
MJ/m².yr	198

All Natural Gas EUI	
kWh/ft².yr	6.3
MJ/m².yr	245

Market Composite EUI	
kWh/ft².yr	6.2
MJ/m².yr	239.9

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: Long Term Care (Nursing Home) Baseline | **SIZE:** All volumes | **VINTAGE:** | **REGION:** Northern Franchise

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.1	L/s.m²	0.62	CFM/ft²
System Static Pressure CAV	625	Pa	2.5	wg
System Static Pressure VAV	625	Pa	2.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	4.4	W/m²	0.41	W/ft²
Fan Design Load VAV	4.4	W/m²	0.41	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	25%	75%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	50%	50%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.0	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.1	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.43	W/m²	0.13	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.003	L/s.m²	0.005	U.S. gpm/ft²
Pump Head Pressure	75	kPa	25	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.50	W/m²	0.05	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0041	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	75	kPa	25	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.4	W/m²	0.04	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	13.6	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.2	kWh/m².yr
Condenser Pump Energy Consumption	1.2	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.7	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	2.6	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	1.8
	MJ/m².yr	69.9

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Long Term Care (Nursing Home)	**All volumes**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**14.7** kWh/ft².yr	**569.2** MJ/m².yr	**Gas:**	**30.7** kWh/ft².yr **1,187.8** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING (SUITES)	4.6	178.7
ARCHITECTURAL LIGHTING (SER\	2.2	86.1
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	1.4	55.5
HVAC FANS & PUMPS	1.8	69.9
REFRIGERATION EQUIPMENT	0.5	20.0
COMPUTER EQUIPMENT		
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	1.9	73.0	21.9	848.6
SPACE COOLING	0.9	34.5		
DOMESTIC HOT WATER	0.5	19.8	5.7	220.1
FOOD SERVICE EQUIPMENT	0.3	10.8	1.3	49.2
MISCELLANEOUS			1.8	70.0

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
School	All Volumes		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.39 W/m².°C	0.07 Btu/hr.ft² .°F	Typical Building Size	5,200 m²	55,952 ft²
Roof U value (W/m².°C)	0.33 W/m².°C	0.06 Btu/hr.ft² .°F	Typical Footprint (m²)	2,600 m²	27,976 ft²
Glazing U value (W/m².°C)	2.80 W/m².°C	0.49 Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2	
			Percent Conditioned Space	100%	
			Percent Conditioned Space Defined as Exterior Zone	50%	
Window/Wall Ratio (WIWAR) (%)	0.28				
Shading Coefficient (SC)	0.68		Typical # Stories	2	
			Floor to Floor Height (m)	3.5 m	11.5 ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	100%								100%
Min. Air Flow (%)									

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	10 m²/person	108 ft²/person	%OA 25.36%
Occupancy Schedule Occ. Period	90%		
Occupancy Schedule Unocc. Period			
Fresh Air Requirements or Outside Air	6 L/s.person	13 CFM/person	

Fresh Air Control Type *(enter a 1, 2 or 3) | 1 | If Fresh Air Control Type = "2" enter % FA. to the right: 10%
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air) | If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1.1	
Total Air Circulation or Design Air Flow	2.37 L/s.m²	0.47 CFM/ft²
Infiltration Rate	0.30 L/s.m²	0.06 CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA) | L/s.m² | CFM/ft²
Operation occupied period 50%
Operation unoccupied period 50%

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	20%		80%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,240,653	
Peak Zone Sensible Load	509,396	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	23,697	
Total air circulation or Design air	2.37	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	35%	90%
DDC/Pneumatic	55%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	17	°C	62.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	19.5	°C	67.1	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
School	All Volumes		Northern Franchise
Baseline			

LIGHTING

GENERAL (CLASSROOM) LIGHTING

Light Level	420	Lux	39.0	ft-candles
Floor Fraction (GLFF)	0.60			
Connected Load	9.9	W/m²	0.9	W/ft²
Occ. Period(Hrs./yr.)	2200			
Unocc. Period(Hrs./yr.)	6560			
Usage During Occupied Period	90%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	40%	60%						100%
Weighted Average								**420**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)					100%			100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI		
	kWh/ft².yr	1.5
	MJ/m².yr	57

ARCHITECTURAL LIGHTING

Light Level	370	Lux	34.4	ft-candles
Floor Fraction (ALFF)	0.30			
Connected Load	9.5	W/m²	0.9	W/ft²
Occ. Period(Hrs./yr.)	2200			
Unocc. Period(Hrs./yr.)	6560			
Usage During Occupied Period	90%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	300	500	700	1000				Total
% Distribution	65%	35%						100%
Weighted Average								**370**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		10%			90%			100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI		
	kWh/ft².yr	0.7
	MJ/m².yr	27

HIGH BAY (GYMNASIUM) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)	0.10			
Connected Load	13.4	W/m²	1.2	W/ft²
Occ. Period(Hrs./yr.)	2600			
Unocc. Period(Hrs./yr.)	6160			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 — 1.00

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)					10%	90%	0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI		
	kWh/ft².yr	0.4
	MJ/m².yr	15

TOTAL LIGHTING — Overall LP 8.82 W/m²

EUI TOTAL		
	kWh/ft².yr	3
	MJ/m².yr	99

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.1		0.1		0.01		0.01					
Connected Load	0.5	W/m²	0.5	W/m²	0.1	W/m²	0.2	W/m²	0.5	W/m²	1.1	W/m²
	0.1	W/ft²	0.0	W/ft²	0.01	W/ft²	0.02	W/ft²	0.05	W/ft²	0.10	W/ft²
Diversity Occupied Period	50%		50%		50%		50%				50%	
Diversity Unoccupied Period	30%		30%								10%	
Operation Occ. Period (hrs./year)	2000		2000		2000		2000				2000	
Operation Unocc. Period (hrs./year)	6760		6760		6760		6760		8760		6760	

Total end-use load (occupied period)	1.2	W/m²	0.1	W/ft²
Total end-use load (unocc. period)	0.4	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	35%			

	EUI		
Computer Equipment	EUI	kWh/ft².yr	0.32
		MJ/m².yr	12.56
Plug Loads	EUI	kWh/ft².yr	0.17
		MJ/m².yr	6.64

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 53.0% Electricity Fuel Share: 47.0%

Cooking

	Natural Gas EUI		All Electric EUI	
EUI	kWh/ft².yr	0.5	kWh/ft².yr	0.5
	MJ/m².yr	20.0	MJ/m².yr	20.0

REFRIGERATION

Provide description below:

Coolers, freezers, pop machines

EUI		
	kWh/ft².yr	0.1
	MJ/m².yr	5.0

MISCELLANEOUS

EUI		
	kWh/ft².yr	0.1
	MJ/m².yr	5

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: **School** **Baseline** | **SIZE:** **All Volumes** | **VINTAGE:** | **REGION:** **Northern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total	
System Present (%)	25%	30%	25%		10%		10%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load	43.3	W/m²	13.7	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	639	MJ/m².yr	16.5	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 10.0% | Gas Fuel Share 90.0% | Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	16.5	20.7	20.2
MJ/m².yr	639	800	784

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Absorptior	Engine	Total
System Present (%)	10.0%			15.0%	75.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	70	W/m²	22	Btu/hr.ft²	541	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	137.4	MJ/m².yr	3.5	kWh/ft².yr		

Sizing Factor 1.00 | Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 15.0%

Electric Fuel Share 100.0% | Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	1.3		1.3
MJ/m².yr	52		52

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	30%		58%	5%	2%
Eff./COP	75%		65%	90%	90%

	Fossil		Elec. Res.	
Fuel Share	95%		5%	100%
Blended Efficiency	0.70		0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 40.0

Wetting Use Percentage 80%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	1.1	1.5	1.5
MJ/m².yr	44	57	56.5

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
School	All Volumes		Northern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	2.4	L/s.m²	0.47	CFM/ft²
System Static Pressure CAV	500	Pa	2.0	wg
System Static Pressure VAV	500	Pa	2.0	wg
Fan Efficiency	55%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	2.5	W/m²	0.24	W/ft²
Fan Design Load VAV	2.5	W/m²	0.24	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	20%	80%	20%	80%
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.1	L/s.m²	0.02	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.2	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.003	kW/kW	0.01	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	0.21	W/m²	0.02	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.005	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0044	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	30	kPa	10	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.2	W/m²	0.02	W/ft²		

Supply Fan Occ. Period	2200	hrs./year
Supply Fan Unocc. Period	6560	hrs./year
Supply Fan Energy Consumption	8.9	kWh/m².yr
Exhaust Fan Occ. Period	2200	hrs./year
Exhaust Fan Unocc. Period	6560	hrs./year
Exhaust Fan Energy Consumption	0.8	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.1	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	1.1	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	1.0
	MJ/m².yr	39.3

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
School	**All Volumes**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**6.9**	kWh/ft².yr	**266.7**	MJ/m².yr	**Gas:**	**20.4** kWh/ft².yr	**789.9** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL (CLASSROOM) LIGHTIN(	1.5	56.6					
ARCHITECTURAL LIGHTING	0.7	27.1	SPACE HEATING	1.6	63.9	18.6	720.0
HIGH BAY (GYMNASIUM) LIGHTINC	0.4	15.5	SPACE COOLING	0.2	7.7		
OTHER PLUG LOADS	0.2	6.6	DOMESTIC HOT WATER	0.1	2.2	1.4	54.3
HVAC FANS & PUMPS	1.0	39.3	FOOD SERVICE EQUIPMENT	0.2	9.4	0.3	10.6
REFRIGERATION	0.1	5.0	MISCELLANEOUS			0.1	5.0
COMPUTER EQUIPMENT	0.3	12.6					
ELEVATORS	0.1	3.9					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
University / College	**Contract customers**		**Northern Franchise**
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.36	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Building Size	12,500	m²	134,500	ft²
Roof U value (W/m².°C)	0.37	W/m².°C	0.07	Btu/hr.ft² .°F	Typical Footprint (m²)	4,167	m²	44,833	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.29								
Shading Coefficient (SC)	0.65				Typical # Stories	3			
					Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)					70%			30%	70%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	15 m²/person	161 ft²/person	%OA	18.83%
Occupancy Schedule Occ. Period	80%			
Occupancy Schedule Unocc. Period				
Fresh Air Requirements or Outside Air	12 L/s.person	25 CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3) | 1 | If Fresh Air Control Type = "2" enter % FA. to the right: 15%
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air) | If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² | 0.10 CFM/ft² | 50% operation (%)

Sizing Factor	1.85	
Total Air Circulation or Design Air Flow	4.25 L/s.m²	0.84 CFM/ft²
Infiltration Rate	0.50 L/s.m²	0.10 CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA) | L/s.m² | CFM/ft²
Operation occupied period: 50%
Operation unoccupied period: 50%

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	3,438,923	
Peak Zone Sensible Load	1,307,652	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	60,832	
Total air circulation or Design air	4.25	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	10%	90%
DDC/Pneumatic	60%	
All DDC	30%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	17	°C	62.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	22	°C	71.6	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
University / College	Contract customers		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	540	Lux	50.2	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	13.3	W/m^2	1.2	W/ft^2

Occ. Period(Hrs./yr.)	4100
Unocc. Period(Hrs./yr.)	4660
Usage During Occupied Period	90%
Usage During Unoccupied Period	10%

Light Level (Lux)	300	500	700	1000	Total
% Distribution	10%	60%	30%		100%
Weighted Average					**540**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		5%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval: years

Relamping Strategy & Incidence of Practice: Group | Spot

EUI	kWh/ft^2.yr	4.4
	MJ/m^2.yr	170

ARCHITECTURAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	8.3	W/m^2	0.8	W/ft^2

Occ. Period(Hrs./yr.)	4100
Unocc. Period(Hrs./yr.)	4660
Usage During Occupied Period	90%
Usage During Unoccupied Period	50%

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		20%			80%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval: years

Relamping Strategy & Incidence of Practice: Group | Spot

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft^2.yr	0.7
	MJ/m^2.yr	27

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m^2	0.0	W/ft^2

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

Fixture Cleaning:
Incidence of Practice
Interval: years

Relamping Strategy & Incidence of Practice: Group | Spot

EUI	kWh/ft^2.yr	
	MJ/m^2.yr	

TOTAL LIGHTING

Overall LP 12.58 W/m^2

EUI TOTAL	kWh/ft^2.yr	5
	MJ/m^2.yr	197

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.1	0.1	0.02	0.01		
Connected Load	0.4 W/m^2	0.3 W/m^2	0.1 W/m^2	0.1 W/m^2	0.5 W/m^2	3 W/m^2
	0.0 W/ft^2	0.0 W/ft^2	0.01 W/ft^2	0.01 W/ft^2	0.05 W/ft^2	0.28 W/ft^2
Diversity Occupied Period	85%	80%	90%	90%	100%	100%
Diversity Unoccupied Period	35%	35%	20%	10%	100%	50%
Operation Occ. Period (hrs./year)	2900	2900	2600	2600	2000	3000
Operation Unocc. Period (hrs./year)	5860	5860	6160	6160	6760	5760

Total end-use load (occupied period)	4.4 W/m^2	0.4 W/ft^2
Total end-use load (unocc. period)	2.3 W/m^2	0.2 W/ft^2
Usage during occupied period	100%	
Usage during unoccupied period	53%	

Computer Equipment	EUI	kWh/ft^2.yr	0.79
		MJ/m^2.yr	30.57
Plug Loads	EUI	kWh/ft^2.yr	1.66
		MJ/m^2.yr	64.21

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 70.0% Electricity Fuel Share: 30.0%

Cafeteria/food service

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft^2.yr	0.8	EUI	kWh/ft^2.yr	0.8
	MJ/m^2.yr	30.0		MJ/m^2.yr	30.0

REFRIGERATION

Provide description below:

Coolers, freezers, fridges, pop machines

EUI	kWh/ft^2.yr	0.5
	MJ/m^2.yr	20.0

MISCELLANEOUS

EUI	kWh/ft^2.yr	0.8
	MJ/m^2.yr	30

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: **University / College** **Baseline**
SIZE: **Contract customers**
VINTAGE:
REGION: **Northern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total
System Present (%)		77%	10%		10%		3%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	66.3 W/m²	21.0	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	661 MJ/m².yr	17.1	kWh/ft².yr
Sizing Factor	1.50		

Electric Fuel Share 3.0% — Gas Fuel Share 97.0% — Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	17.1	21.4	21.3
MJ/m².yr	661	830	825

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	Centrifugal Chillers HE	Screw Chillers	Recprocting Chillers Open	Recprocting Chillers DX	Gas Cooling Absorption	Gas Cooling Engine	Total
System Present (%)		43.0%	38.0%		19.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	14.0	57.2

Peak Cooling Load	81 W/m²	26 Btu/hr.ft²	469 ft²/Ton
Seasonal Cooling Load (Tertiary Load)	167.9 MJ/m².yr	4.3 kWh/ft².yr	

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 100.0% — Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	All Electric EUI	Natural Gas EUI	Market Composite EUI
kWh/ft².yr	1.7		1.7
MJ/m².yr	65		65

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	74%		11%	5%	
Eff./COP	75%		65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	90%	10%	100%
Blended Efficiency	0.75	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 70.0

Wetting Use Percentage 50%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	2.0	2.4	2.4
MJ/m².yr	77	94	92.1

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: University / College Baseline | **SIZE:** Contract customers | **VINTAGE:** | **REGION:** Northern Franchise

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	4.2	L/s.m²	0.84	CFM/ft²
System Static Pressure CAV	1000	Pa	4.0	wg
System Static Pressure VAV	1000	Pa	4.0	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	9.6	W/m²	0.89	W/ft²
Fan Design Load VAV	9.6	W/m²	0.89	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	70%	30%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	35%	65%	35%	65%

Comments:

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.0	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.1	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.78	W/m²	0.17	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.26	W/m²	0.12	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0051	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.0	W/m²	0.09	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	41.4	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.1	kWh/m².yr
Condenser Pump Energy Consumption	4.2	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.9	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	6.9	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	5.1
	MJ/m².yr	196.0

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
University / College	**Contract customers**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES: **Electricity:** **15.8** kWh/ft².yr **613.2** MJ/m².yr **Gas:** **24.3** kWh/ft².yr **940.8** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL LIGHTING	4.4	169.6
ARCHITECTURAL LIGHTING	0.7	27.0
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	1.7	64.2
HVAC FANS & PUMPS	5.1	196.0
REFRIGERATION	0.5	20.0
COMPUTER EQUIPMENT	0.8	30.6
ELEVATORS	0.1	3.9
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	0.5	19.8	20.8	805.4
SPACE COOLING	1.3	48.4		
DOMESTIC HOT WATER	0.2	7.7	2.2	84.4
FOOD SERVICE EQUIPMENT	0.2	9.0	0.5	21.0
MISCELLANEOUS			0.8	30.0

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
University / College	All volumes except contract customers		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.36	W/m².°C	0.06	Btu/hr.ft² .°F
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F
Window/Wall Ratio (WIWAR) (%)	0.29			
Shading Coefficient (SC)	0.65			

Typical Building Size	12,500	m²	134,500	ft²
Typical Footprint (m²)	4,167	m²	44,833	ft²
Footprint Aspect Ratio (L:W)	2			
Percent Conditioned Space	100%			
Percent Conditioned Space Defined as Exterior Zone	36%			
Typical # Stories	3			
Floor to Floor Height (m)	3.7	m	12.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)					70%			30%	70%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	15	m²/person	161	ft²/person
Occupancy Schedule Occ. Period	80%			
Occupancy Schedule Unocc. Period				
Fresh Air Requirements or Outside Air	12	L/s.person	25	CFM/person

%OA 18.84%

Fresh Air Control Type *(enter a 1, 2 or 3) 1
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.5 L/s.m² 0.10 CFM/ft²
50% operation (%)

Sizing Factor	1.85			
Total Air Circulation or Design Air Flow	4.25	L/s.m²	0.84	CFM/ft²
Infiltration Rate	0.50	L/s.m²	0.10	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use			100%		100%
Switchover Point		KJ/kg.	20	°C	
		Btu/lbm	68	°F	

Summary of Design Parameters		
Peak Design Cooling Load	3,437,728	
Peak Zone Sensible Load	1,306,457	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	60,776	
Total air circulation or Design air	4.25	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	10%	90%
DDC/Pneumatic	60%	
All DDC	30%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	17	°C	62.6	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	19.5	°C	67.1	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
University / College	All volumes except contract customers		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	540	Lux	50.2	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	13.3	W/m²	1.2	W/ft²

Occ. Period(Hrs./yr.)	4100
Unocc. Period(Hrs./yr.)	4660
Usage During Occupied Period	90%
Usage During Unoccupied Period	10%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	10%	60%	30%					100%
Weighted Average								**540**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		5%			95%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI		
	kWh/ft².yr	4.4
	MJ/m².yr	170

ARCHITECTURAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	8.3	W/m²	0.8	W/ft²

Occ. Period(Hrs./yr.)	4100
Unocc. Period(Hrs./yr.)	4660
Usage During Occupied Period	90%
Usage During Unoccupied Period	50%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)		20%			80%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI		
	kWh/ft².yr	0.7
	MJ/m².yr	27

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI		
	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 12.58 W/m²

EUI TOTAL		
	kWh/ft².yr	5
	MJ/m².yr	197

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)	0.1	0.1	0.02	0.01		
Connected Load	0.4 W/m²	0.3 W/m²	0.1 W/m²	0.1 W/m²	0.5 W/m²	3 W/m²
	0.0 W/ft²	0.0 W/ft²	0.01 W/ft²	0.01 W/ft²	0.05 W/ft²	0.28 W/ft²
Diversity Occupied Period	85%	80%	90%	90%	100%	100%
Diversity Unoccupied Period	35%	35%	20%	10%	100%	50%
Operation Occ. Period (hrs./year)	2900	2900	2600	2600	2000	3000
Operation Unocc. Period (hrs./year)	5860	5860	6160	6160	6760	5760

Total end-use load (occupied period)	4.4 W/m²	0.4 W/ft²
Total end-use load (unocc. period)	2.3 W/m²	0.2 W/ft²
Usage during occupied period	100%	
Usage during unoccupied period	53%	

Computer Equipment	EUI	kWh/ft².yr	0.79
		MJ/m².yr	30.57
Plug Loads	EUI	kWh/ft².yr	1.66
		MJ/m².yr	64.21

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 70.0% Electricity Fuel Share: 30.0%

Cafeteria/food service

	Natural Gas EUI		All Electric EUI	
EUI	kWh/ft².yr	0.8	kWh/ft².yr	0.8
	MJ/m².yr	30.0	MJ/m².yr	30.0

REFRIGERATION

Provide description below:

Coolers, freezers, fridges, pop machines

EUI		
	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI		
	kWh/ft².yr	0.8
	MJ/m².yr	30

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: **University / College** **Baseline**

SIZE: **All volumes except contract customers**

VINTAGE:

REGION: **Northern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)		77%	10%		10%		3%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	62.9	W/m²	19.9	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	632	MJ/m².yr	16.3	kWh/ft².yr
Sizing Factor	1.50			

Electric Fuel Share 3.0% Gas Fuel Share 97.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	16.3
MJ/m².yr	632

Natural Gas EUI	
kWh/ft².yr	20.5
MJ/m².yr	795

Market Composite EUI	
kWh/ft².yr	20.4
MJ/m².yr	790

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)		43.0%	38.0%		19.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	81	W/m²	26	Btu/hr.ft²	469	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	168.7	MJ/m².yr	4.4	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	1.7
MJ/m².yr	65

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	1.7
MJ/m².yr	65

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	74%		11%	5%	
Eff./COP	75%		65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	90%	10%	100%
Blended Efficiency	0.75	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 70.0

Wetting Use Percentage 50%

All Electric EUI	
kWh/ft².yr	2.0
MJ/m².yr	77

All Natural Gas EUI	
kWh/ft².yr	2.4
MJ/m².yr	94

Market Composite EUI	
kWh/ft².yr	2.4
MJ/m².yr	92.1

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
University / College	All volumes except contract customers		Northern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	4.2	L/s.m²	0.84	CFM/ft²
System Static Pressure CAV	1000	Pa	4.0	wg
System Static Pressure VAV	1000	Pa	4.0	wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	9.6	W/m²	0.89	W/ft²
Fan Design Load VAV	9.6	W/m²	0.89	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	70%	30%	100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	35%	65%	35%	65%

Comments:

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.0	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.1	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.78	W/m²	0.17	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure	150	kPa	50	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	1.26	W/m²	0.12	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0051	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	150	kPa	50	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	1.0	W/m²	0.09	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	41.3	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.1	kWh/m².yr
Condenser Pump Energy Consumption	4.2	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.9	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	6.9	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	5.1
	MJ/m².yr	195.9

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
University / College	**All volumes except contract customers**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**15.8** kWh/ft².yr	**612.2** MJ/m².yr	**Gas:**	**23.4** kWh/ft².yr	**906.4** MJ/m².yr	

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING	4.4	169.6					
ARCHITECTURAL LIGHTING	0.7	27.0	SPACE HEATING	0.5	19.0	19.9	771.0
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	1.3	48.5		
OTHER PLUG LOADS	1.7	64.2	DOMESTIC HOT WATER	0.2	7.7	2.2	84.4
HVAC FANS & PUMPS	5.1	195.9	FOOD SERVICE EQUIPMENT	0.2	9.0	0.5	21.0
REFRIGERATION	0.5	20.0	MISCELLANEOUS			0.8	30.0
COMPUTER EQUIPMENT	0.8	30.6					
ELEVATORS	0.1	3.9					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Restaurant	All		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.48	W/m².°C	0.09	Btu/hr.ft² .°F
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F
Window/Wall Ratio (WIWAR) (%)	0.15			
Shading Coefficient (SC)	0.70			

Typical Building Size	500	m²	5,380	ft²
Typical Footprint (m²)	500	m²	5,380	ft²
Footprint Aspect Ratio (L:W)	1			
Percent Conditioned Space	100%			
Percent Conditioned Space Defined as Exterior Zone	40%			
Typical # Stories	1			
Floor to Floor Height (m)	4.5	m	14.8	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	60%							40%	60%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	50	m²/person	538	ft²/person
Occupancy Schedule Occ. Period	90%			
Occupancy Schedule Unocc. Period				
Fresh Air Requirements or Outside Air	20	L/s.person	42	CFM/person

%OA 12.81%

Fresh Air Control Type *(enter a 1, 2 or 3) 2
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 37%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.5 L/s.m² 0.10 CFM/ft²
50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	3.12	L/s.m²	0.61	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)		L/s.m²		CFM/ft²
Operation occupied period	50%			
Operation unoccupied period	50%			

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	257,658	
Peak Zone Sensible Load	71,108	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	3,308	
Total air circulation or Design air	3.12	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	15	°C	59	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	20	°C	68	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	22	°C	71.6	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Restaurant	All		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (GLFF)	0.90			
Connected Load	15.4	W/m²	1.4	W/ft²

Occ. Period(Hrs./yr.)	4300
Unocc. Period(Hrs./yr.)	4460
Usage During Occupied Period	100%
Usage During Unoccupied Period	10%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	20%	15%			65%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI	kWh/ft².yr	6.1
	MJ/m².yr	237

ARCHITECTURAL LIGHTING

Light Level	300	Lux	27.9	ft-candles
Floor Fraction (ALFF)	0.10			
Connected Load	15.4	W/m²	1.4	W/ft²

Occ. Period(Hrs./yr.)	4300
Unocc. Period(Hrs./yr.)	4460
Usage During Occupied Period	100%
Usage During Unoccupied Period	10%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	20%	15%			65%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI	kWh/ft².yr	0.7
	MJ/m².yr	26

OTHER (HIGH BAY) LIGHTING

Light Level		Lux		ft-candles
Floor Fraction (HBLFF)				
Connected Load		W/m²		W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution								
Weighted Average								

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 15.39 W/m²

EUI TOTAL	kWh/ft².yr	7
	MJ/m².yr	263

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)						
Connected Load	W/m²	W/m²	W/m²	W/m²	0.5 W/m²	2 W/m²
	W/ft²	W/ft²	W/ft²	W/ft²	0.05 W/ft²	0.19 W/ft²
Diversity Occupied Period						100%
Diversity Unoccupied Period						90%
Operation Occ. Period (hrs./year)						4000
Operation Unocc. Period (hrs./year)	8760	8760	8760	8760	8760	4760

Total end-use load (occupied period)	2.0	W/m²	0.2	W/ft²
Total end-use load (unocc. period)	1.8	W/m²	0.2	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	90%			

Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	1.54
		MJ/m².yr	59.64

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 88.0% Electricity Fuel Share: 12.0%

Cooking

Natural Gas EUI			All Electric EUI		
EUI	kWh/ft².yr	23.2	EUI	kWh/ft².yr	23.2
	MJ/m².yr	900.0		MJ/m².yr	900.0

REFRIGERATION

Provide description below:

Walk-ins, reach ins, fridges etc

EUI	kWh/ft².yr	9.0
	MJ/m².yr	350.0

MISCELLANEOUS

EUI	kWh/ft².yr	0.3
	MJ/m².yr	10

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Restaurant	All		Northern Franchise
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas Boilers Standard	Near Cond	Cond		RTU	Furnace	Electric Resistance	Total	
System Present (%)	6%	6%	3%		65%	5%	15%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load	62.8	W/m²	19.9	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	1287	MJ/m².yr	33.2	kWh/ft².yr
Sizing Factor	1.00			
Electric Fuel Share	15.0%	Gas Fuel Share	85.0%	Oil Fuel Share:

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

	kWh/ft².yr	MJ/m².yr
All Electric EUI	33.2	1287
Natural Gas EUI	46.2	1788
Market Composite EUI	44.2	1713

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers Standard	HE	Screw Chillers	Recprocting Chillers Open	DX	Gas Cooling Absorption	Engine	Total
System Present (%)	15.0%	5.0%		10.0%	70.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

	°C	°F
Chilled Water	6	42.8
Condenser Water	35	95
Supply Air	15.0	59

Peak Cooling Load	151 W/m²	48 Btu/hr.ft²	251 ft²/Ton		
Seasonal Cooling Load (Tertiary Load)	183.8 MJ/m².yr	4.7 kWh/ft².yr			

Sizing Factor: 1.00 — Operation (occ. period): 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C): 85.0%

Electric Fuel Share: 100.0% — Gas Fuel Share:

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

	kWh/ft².yr	MJ/m².yr
All Electric EUI	2.1	81
Natural Gas EUI		
Market Composite EUI	2.1	81

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	5%		70%	5%	5%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	85%	15%	100%
Blended Efficiency	0.69	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load): 400.0

Wetting Use Percentage: 10%

	kWh/ft².yr	MJ/m².yr
All Electric EUI	11.3	440
All Natural Gas EUI	15.1	584
Market Composite EUI	14.5	562.1

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Restaurant	All		Northern Franchise
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	3.1	L/s.m²	0.61	CFM/ft²
System Static Pressure CAV	500	Pa	2.0	wg
System Static Pressure VAV	625	Pa	2.5	wg
Fan Efficiency	52%			
Fan Motor Efficiency	80%			
Sizing Factor	1.00			
Fan Design Load CAV	3.8	W/m²	0.35	W/ft²
Fan Design Load VAV	4.7	W/m²	0.44	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	90%	10%	100%	

Comments:

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.4	L/s.m²	0.08	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.5	L/s.m²	0.10	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	72%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.7	W/m²	0.06	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	3.34	W/m²	0.31	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.008	L/s.m²	0.012	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.007	L/s.m²	0.0096	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure		kPa		ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load		W/m²		W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	31.1	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	6.1	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	1.1	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption		kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	3.6
	MJ/m².yr	137.6

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Restaurant	**All**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**35.9** kWh/ft².yr	**1,389.9** MJ/m².yr	**Gas:**	**72.7** kWh/ft².yr	**2,817.7** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING	6.1	236.6					
ARCHITECTURAL LIGHTING	0.7	26.3	SPACE HEATING	5.0	193.1	39.2	1,519.5
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	1.8	68.5		
OTHER PLUG LOADS	1.5	59.6	DOMESTIC HOT WATER	1.7	65.9	12.8	496.1
HVAC FANS & PUMPS	3.6	137.6	FOOD SERVICE EQUIPMENT	2.8	108.0	20.4	792.0
REFRIGERATION	9.0	350.0				0.3	10
COMPUTER EQUIPMENT							
ELEVATORS							
OUTDOOR LIGHTING	3.7	144.2					

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Warehouse	All volumes		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.45	W/m².°C	0.08	Btu/hr.ft² .°F	Typical Building Size	5,500 m²	59,180	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	5,500 m²	59,180	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2		
					Percent Conditioned Space	100%		
					Percent Conditioned Space Defined as Exterior Zone	40%		
Window/Wall Ratio (WIWAR) (%)	0.02							
Shading Coefficient (SC)	0.85				Typical # Stories	1		
					Floor to Floor Height (m)	9.1 m	30.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)	100%								100%
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	100	m²/person	1076	ft²/person
Occupancy Schedule Occ. Period	90%			
Occupancy Schedule Unocc. Period				
Fresh Air Requirements or Outside Air	20	L/s.person	42	CFM/person

%OA 9.99%

Fresh Air Control Type *(enter a 1, 2 or 3) 2
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation 0.5 L/s.m² 0.10 CFM/ft²
50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	2.00	L/s.m²	0.39	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA) [ ] L/s.m² [ ] CFM/ft²
Operation occupied period 50%
Operation unoccupied period 50%

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,336,034	
Peak Zone Sensible Load	501,737	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	23,341	
Total air circulation or Design air	2.00	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	24	°C	75.2	°F	15	°C	59	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	20	°C	68	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	21	°C	69.8	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning Changes/Year 4

Incidence of Annual Room Controls Maintenance 100.0%

Incidence of Annual HVAC Controls Maintenance 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Warehouse	All volumes		Northern Franchise
Baseline			

LIGHTING

GENERAL (HIGH BAY) LIGHTING

Light Level	420	Lux	39.0	ft-candles
Floor Fraction (GLFF)	0.95			
Connected Load	17.4	W/m²	1.6	W/ft²

Occ. Period(Hrs./yr.)	4500
Unocc. Period(Hrs./yr.)	4260
Usage During Occupied Period	100%
Usage During Unoccupied Period	10%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	40%	60%						100%
Weighted Average								**420**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)					20%	75%	5%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI		
	kWh/ft².yr	7.6
	MJ/m².yr	293

ARCHITECTURAL (OFFICE AREA) LIGHTING

Light Level	400	Lux	37.2	ft-candles
Floor Fraction (ALFF)	0.05			
Connected Load	12.3	W/m²	1.1	W/ft²

Occ. Period(Hrs./yr.)	4500
Unocc. Period(Hrs./yr.)	4260
Usage During Occupied Period	100%
Usage During Unoccupied Period	60%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	50%	50%						100%
Weighted Average								**400**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	5%			90%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI		
	kWh/ft².yr	0.4
	MJ/m².yr	16

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI		
	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING — Overall LP 17.13 W/m²

EUI TOTAL		
	kWh/ft².yr	8
	MJ/m².yr	308

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.05		0.05		0.01		0.01					
Connected Load	0.0	W/m²	0.0	W/m²	0.0	W/m²	0.0	W/m²	0.5	W/m²	1	W/m²
	0.0	W/ft²	0.0	W/ft²	0.00	W/ft²	0.00	W/ft²	0.05	W/ft²	0.09	W/ft²
Diversity Occupied Period	100%		100%		90%						100%	
Diversity Unoccupied Period											5%	
Operation Occ. Period (hrs./year)	4000		4000		4000						4000	
Operation Unocc. Period (hrs./year)	4760		4760		4760		8760		8760		4760	

Total end-use load (occupied period)	1.1	W/m²	0.1	W/ft²
Total end-use load (unocc. period)	0.1	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	5%			

	EUI		
Computer Equipment	EUI	kWh/ft².yr	0.02
		MJ/m².yr	0.89
Plug Loads	EUI	kWh/ft².yr	0.39
		MJ/m².yr	15.26

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 10.0% Electricity Fuel Share: 90.0%

	Natural Gas EUI			All Electric EUI	
EUI	kWh/ft².yr	0.3	EUI	kWh/ft².yr	0.3
	MJ/m².yr	10.0		MJ/m².yr	10.0

REFRIGERATION EQUIPMENT

Provide description below:

Coolers

EUI		
	kWh/ft².yr	1.0
	MJ/m².yr	40.0

MISCELLANEOUS EQUIPMENT

EUI		
	kWh/ft².yr	0.5
	MJ/m².yr	20

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: **Warehouse** **Baseline**
SIZE: **All volumes**
VINTAGE:
REGION: **Northern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond	U/H				
System Present (%)	4%	4%	3%	55%	25%	5%	4%	100%
Eff./COP	75%	80%	90%	75%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.33	1.30	1.25	1.00	

100%

Peak Heating Load	44.9	W/m²	14.3	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	480	MJ/m².yr	12.4	kWh/ft².yr
Sizing Factor	1.00			

Electric Fuel Share 4.0% Gas Fuel Share 96.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	12.4
MJ/m².yr	480

Natural Gas EUI	
kWh/ft².yr	17.5
MJ/m².yr	679

Market Composite EUI	
kWh/ft².yr	17.3
MJ/m².yr	671

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorption	Engine	
System Present (%)	10.0%				90.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	15.0	°C	59	°F

Peak Cooling Load	71	W/m²	23	Btu/hr.ft²	532	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	80.1	MJ/m².yr	2.1	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 10.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

All Electric EUI	
kWh/ft².yr	0.8
MJ/m².yr	33

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	0.8
MJ/m².yr	33

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	4%		55%	2%	3%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.
Fuel Share	64%	36%
Blended Efficiency	0.68	0.91

100%

Service Hot Water load (MJ/m².yr) (Tertiary Load) 25.0

Wetting Use Percentage 50%

All Electric EUI	
kWh/ft².yr	0.7
MJ/m².yr	27

All Natural Gas EUI	
kWh/ft².yr	1.0
MJ/m².yr	37

Market Composite EUI	
kWh/ft².yr	0.9
MJ/m².yr	33.6

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Warehouse	**All volumes**		**Northern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	2.0	L/s.m²	0.39	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV	562.5	Pa	2.3	wg
Fan Efficiency	52%			
Fan Motor Efficiency	80%			
Sizing Factor	1.00			
Fan Design Load CAV	1.8	W/m²	0.17	W/ft²
Fan Design Load VAV	2.7	W/m²	0.25	W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.0	L/s.m²	0.01	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.1	L/s.m²	0.03	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	72%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.2	W/m²	0.02	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.57	W/m²	0.15	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.004	L/s.m²	0.006	U.S. gpm/ft²
Pump Head Pressure		kPa		ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load		W/m²		W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0045	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure		kPa		ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load		W/m²		W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	11.4	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	1.7	kWh/m².yr
Condenser Pump Energy Consumption		kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.4	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption		kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	1.3
	MJ/m².yr	48.7

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Warehouse	**All volumes**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**12.2** kWh/ft².yr	**471.6** MJ/m².yr	**Gas:**	**18.0** kWh/ft².yr	**696.4** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr
GENERAL (HIGH BAY) LIGHTING	7.6	292.8
ARCHITECTURAL (OFFICE AREA) L	0.4	15.7
OTHER (HIGH BAY) LIGHTING		
OTHER PLUG LOADS	0.4	15.3
HVAC FANS & PUMPS	1.3	48.7
REFRIGERATION EQUIPMENT	1.0	40.0
COMPUTER EQUIPMENT	0.0	0.9
ELEVATORS		
OUTDOOR LIGHTING	0.4	17.0

END USE:	Electricity		Gas	
	kWh/ft².yr	MJ/m².yr	kWh/ft².yr	MJ/m².yr
SPACE HEATING	0.5	19.2	16.8	651.8
SPACE COOLING	0.1	3.3		
DOMESTIC HOT WATER	0.3	9.9	0.6	23.7
FOOD SERVICE EQUIPMENT	0.2	9.0	0.03	1.0
MISCELLANEOUS EQUIPMENT			0.5	20.0

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Highrise	> 50,000 m3 excluding contract customers		Northern Franchise
Baseline			

CONSTRUCTION

Wall U value (W/m².°C)	0.41	W/m².°C	0.07	Btu/hr.ft² .°F	Typical Building Size	7,300	m²	78,548	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	1,217	m²	13,091	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2.5			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.25								
Shading Coefficient (SC)	0.65				Typical # Stories	6			
					Floor to Floor Height (m)	2.8	m	9.0	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)								100%	
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	35	m²/person	377	ft²/person	%OA	20.41%
Occupancy Schedule Occ. Period	30%					
Occupancy Schedule Unocc. Period	90%					
Fresh Air Requirements or Outside Air	5	L/s.person	11	CFM/person		

Fresh Air Control Type *(enter a 1, 2 or 3): 3
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.7 L/s.m² | 0.14 CFM/ft² | 50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	0.70	L/s.m²	0.14	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA): L/s.m² | CFM/ft²
Operation occupied period: 50%
Operation unoccupied period: 50%

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	1,446,514	
Peak Zone Sensible Load	428,313	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	19,925	
Total air circulation or Design air	1.29	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	18	°C	64.4	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	22	°C	71.6	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	SIZE:	VINTAGE:	REGION:
Highrise	> 50,000 m3 excluding contract customers		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	50	Lux	4.6	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	2.3	W/m²	0.2	W/ft²
Occ. Period(Hrs./yr.)	2100			
Unocc. Period(Hrs./yr.)	6660			
Usage During Occupied Period	30%			
Usage During Unoccupied Period	10%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	50	100	200	300	Total
% Distribution	100%				100%
Weighted Average					**50**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	75%			20%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI		
	kWh/ft².yr	0.2
	MJ/m².yr	9

ARCHITECTURAL LIGHTING (CORRIDORS)

Light Level	200	Lux	18.6	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	8.2	W/m²	0.8	W/ft²
Occ. Period(Hrs./yr.)	3000			
Unocc. Period(Hrs./yr.)	5760			
Usage During Occupied Period	100%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Light Level (Lux)	100	200	300	500	Total
% Distribution		100%			100%
Weighted Average					**200**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	5%	55%			40%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI		
	kWh/ft².yr	1.0
	MJ/m².yr	39

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²
Occ. Period(Hrs./yr.)	4000			
Unocc. Period(Hrs./yr.)	4760			
Usage During Occupied Period	0%			
Usage During Unoccupied Period	100%			
Fixture Cleaning:				
Incidence of Practice				
Interval		years		
Relamping Strategy & Incidence of Practice	Group	Spot		

Floor fraction check: should = 1.00 | 1.00

Light Level (Lux)	300	500	700	1000	Total
% Distribution	100%				100%
Weighted Average					**300**

	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI		
	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 3.14 W/m²

EUI TOTAL		
	kWh/ft².yr	1
	MJ/m².yr	48

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers		Monitors		Printers		Copiers		Servers		Plug Loads	
Measured Power (W/device)	55		51		100		200		217			
Density (device/occupant)	0.9		0.9		0.15		0.1		0.08			
Connected Load	1.4	W/m²	1.3	W/m²	0.4	W/m²	0.6	W/m²	0.5	W/m²	2.5	W/m²
	0.1	W/ft²	0.1	W/ft²	0.04	W/ft²	0.05	W/ft²	0.05	W/ft²	0.23	W/ft²
Diversity Occupied Period											5%	
Diversity Unoccupied Period											20%	
Operation Occ. Period (hrs./year)											3000	
Operation Unocc. Period (hrs./year)	8760		8760		8760		8760		8760		5760	

Total end-use load (occupied period)	0.1	W/m²	0.0	W/ft²
Total end-use load (unocc. period)	0.5	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	400%			

	EUI		
Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	0.30
		MJ/m².yr	11.72

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 5.0% Electricity Fuel Share: 95.0%

Cooking

	Natural Gas EUI		All Electric EUI	
EUI	kWh/ft².yr	1.3	kWh/ft².yr	1.3
	MJ/m².yr	50.0	MJ/m².yr	50.0

REFRIGERATION

Provide description below:

EUI		
	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI		
	kWh/ft².yr	0.5
	MJ/m².yr	20

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS: **Highrise** **Baseline**

SIZE: **> 50,000 m3 excluding contract customers**

VINTAGE:

REGION: **Northern Franchise**

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric	
	Boilers				RTU	Furnace	Resistance	Total
	Standard	Near Cond	Cond					
System Present (%)	20%	40%	10%		20%		10%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00	
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00	

100%

Peak Heating Load	70.7	W/m²	22.4	Btu/hr.ft²
Seasonal Heating Load (Tertiary Load)	461	MJ/m².yr	11.9	kWh/ft².yr
Sizing Factor	2.00			

Electric Fuel Share 10.0% Gas Fuel Share 90.0% Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	
kWh/ft².yr	11.9
MJ/m².yr	461

Natural Gas EUI	
kWh/ft².yr	15.9
MJ/m².yr	615

Market Composite EUI	
kWh/ft².yr	15.5
MJ/m².yr	599

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)		50.0%			50.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6	°C	42.8	°F
Condenser Water	35	°C	95	°F
Supply Air	14.0	°C	57.2	°F

Peak Cooling Load	58	W/m²	18	Btu/hr.ft²	652	ft²/Ton
Seasonal Cooling Load (Tertiary Load)	74.7	MJ/m².yr	1.9	kWh/ft².yr		

Sizing Factor 1.00 Operation (occ. period) 3000 hrs/year Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 100.0% Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	
kWh/ft².yr	0.7
MJ/m².yr	27

Natural Gas EUI	
kWh/ft².yr	
MJ/m².yr	

Market Composite EUI	
kWh/ft².yr	0.7
MJ/m².yr	27

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	20%		55%	9%	1%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	85%	15%	100%
Blended Efficiency	0.70	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 170.0

Wetting Use Percentage 10%

All Electric EUI	
kWh/ft².yr	4.8
MJ/m².yr	187

All Natural Gas EUI	
kWh/ft².yr	6.2
MJ/m².yr	242

Market Composite EUI	
kWh/ft².yr	6.0
MJ/m².yr	233.6

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Highrise	**> 50,000 m3 excluding contract customers**		**Northern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	0.7	L/s.m²	0.14	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV		Pa		wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	0.6	W/m²	0.06	W/ft²
Fan Design Load VAV		W/m²		W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	100%	

Comments:

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit area	0.2	L/s.m²	0.03	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.3	L/s.m²	0.05	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.4	W/m²	0.03	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.28	W/m²	0.12	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.003	L/s.m²	0.005	U.S. gpm/ft²
Pump Head Pressure	0.1	kPa	0.0333333	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.00	W/m²	0.00	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0037	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	100	kPa	33	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.5	W/m²	0.05	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	3.8	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	3.1	kWh/m².yr
Condenser Pump Energy Consumption	0.0	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.4	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	3.1	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI		
	kWh/ft².yr	1.0
	MJ/m².yr	37.2

COMMERCIAL SECTOR BUILDING PROFILE

NEW BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Highrise	**> 50,000 m3 excluding contract customers**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**7.2** kWh/ft².yr	**279.2** MJ/m².yr	**Gas:** **20.2** kWh/ft².yr	**781.3** MJ/m².yr

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING (SUITES)	0.2	8.9					
ARCHITECTURAL LIGHTING (COR	1.0	38.8	SPACE HEATING	1.2	46.1	14.3	553.2
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	0.5	20.1		
OTHER PLUG LOADS	0.3	11.7	DOMESTIC HOT WATER	0.7	28.0	5.3	205.6
HVAC FANS & PUMPS	1.0	37.2	FOOD SERVICE EQUIPMENT	1.2	47.5	0.1	2.5
REFRIGERATION	0.5	20.0	MISCELLANEOUS			0.5	20.0
						5.9	
COMPUTER EQUIPMENT							
ELEVATORS	0.1	3.9					
OUTDOOR LIGHTING	0.4	17.0					

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS: **Medium Rise** **Baseline**

SIZE: **> 5 Units, Excluding Contract Customers**

VINTAGE:

REGION: **Northern Franchise**

CONSTRUCTION

Wall U value (W/m².°C)	0.38	W/m².°C	0.07	Btu/hr.ft² .°F	Typical Building Size	1,000	m²	10,760	ft²
Roof U value (W/m².°C)	0.35	W/m².°C	0.06	Btu/hr.ft² .°F	Typical Footprint (m²)	333	m²	3,587	ft²
Glazing U value (W/m².°C)	2.80	W/m².°C	0.49	Btu/hr.ft² .°F	Footprint Aspect Ratio (L:W)	2.5			
					Percent Conditioned Space	100%			
					Percent Conditioned Space Defined as Exterior Zone	36%			
Window/Wall Ratio (WIWAR) (%)	0.25								
Shading Coefficient (SC)	0.65				Typical # Stories	3			
					Floor to Floor Height (m)	2.8	m	9.2	ft

VENTILATION SYSTEM, BUILDING CONTROLS & INDOOR CONDITIONS

Ventilation System Type

	CAV	CAVR	DDMZ	DDMZVV	VAV	VAVR	IU	100% O.A	TOTAL
System Present (%)								100%	
Min. Air Flow (%)					10%				

(Minimum Throttled Air Volume as Percent of Full Flow)

Occupancy or People Density	35	m²/person	377	ft²/person	%OA:
Occupancy Schedule Occ. Period	30%				
Occupancy Schedule Unocc. Period	90%				
Fresh Air Requirements or Outside Air		L/s.person		CFM/person	

Fresh Air Control Type *(enter a 1, 2 or 3) — 3
(1 = mixed air control, 2 = Fixed fresh air, 3 100% fresh air)

If Fresh Air Control Type = "2" enter % FA. to the right: 15%
If Fresh Air Control Type = "3" enter Make-up Air Ventilation and operation: 0.5 L/s.m² — 0.10 CFM/ft² — 50% operation (%)

Sizing Factor	1			
Total Air Circulation or Design Air Flow	0.50	L/s.m²	0.10	CFM/ft²
Infiltration Rate	0.30	L/s.m²	0.06	CFM/ft²

(air infiltration is assumed to occur during unoccupied hours only if the ventilation system shuts down)

Separate Make-up air unit (100% OA)	L/s.m²	CFM/ft²
Operation occupied period	50%	
Operation unoccupied period	50%	

Economizer

	Enthalpy Based		Dry-Bulb Based		Total
Incidence of Use	50%		50%		100%
Switchover Point		KJ/kg.	18	°C	
		Btu/lbm	64.4	°F	

Summary of Design Parameters		
Peak Design Cooling Load	208,502	
Peak Zone Sensible Load	108,249	
Room air enthalpy	28.2	Btu/lbm
Discharge air enthalpy	23.4	Btu/lbm
Specific volume of air at 55F & 100% R	13.2	ft³/lbm
Design CFM	5,036	
Total air circulation or Design air	2.38	l/s.m²

Controls Type

System Present (%)	HVAC Equipment	Room Controls
All Pneumatic	60%	90%
DDC/Pneumatic	30%	
All DDC	10%	10%
Total (should add-up to 100%)	100%	100%

Control mode

	Proportional		PI / PID	Total
Control Mode				
	Fixed Discharge		Reset	
Control Strategy				

Indoor Design Conditions

	Room				Supply Air			
Summer Temperature	23	°C	73.4	°F	14	°C	57.2	°F
Summer Humidity (%)	50%				100%			
Enthalpy	65.5	KJ/kg.	28.2	Btu/lbm	54.5	KJ/kg.	23.4	Btu/lbm
Winter Occ. Temperature	22	°C	71.6	°F	18	°C	64.4	°F
Winter Occ. Humidity	30%				45%			
Enthalpy	53	KJ/kg.	22.8	Btu/lbm	45.5	KJ/kg.	19.6	Btu/lbm
Winter Unocc. Temperature	22	°C	71.6	°F				
Winter Unocc. Humidity	30%							
Enthalpy	50	KJ/kg.	21.5	Btu/lbm				

Damper Maintenance

	Incidence (%)	Frequency (years)
Control Arm Adjustment		
Lubrication		
Blade Seal Replacement		

Air Filter Cleaning — Changes/Year: 4

Incidence of Annual Room Controls Maintenance: 100.0%

Incidence of Annual HVAC Controls Maintenance: 100%

Annual Maintenance Tasks	Incidence (%)
Calibration of Transmitters	
Calibration of Panel Gauges	100%
Inspection of Auxiliary Devices	
Inspection of Control Devices	

Annual Maintenance Tasks	Incidence (%)
Inspection/Calibration of Room Thermostat	100%
Inspection of PE Switches	
Inspection of Auxiliary Devices	
Inspection of Control Devices (Valves, (Dampers, VAV Boxes)	

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	SIZE:	VINTAGE:	REGION:
Medium Rise	> 5 Units, Excluding Contract Customers		Northern Franchise
Baseline			

LIGHTING

GENERAL LIGHTING (SUITES)

Light Level	50	Lux	4.6	ft-candles
Floor Fraction (GLFF)	0.85			
Connected Load	4.0	W/m²	0.4	W/ft²

Occ. Period(Hrs./yr.)	2100
Unocc. Period(Hrs./yr.)	6660
Usage During Occupied Period	30%
Usage During Unoccupied Period	10%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	50	100	200	300				Total
% Distribution	100%							100%
Weighted Average								**50**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	40%	40%			20%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI		
	kWh/ft².yr	0.4
	MJ/m².yr	16

ARCHITECTURAL LIGHTING (CORRIDORS)

Light Level	200	Lux	18.6	ft-candles
Floor Fraction (ALFF)	0.15			
Connected Load	10.2	W/m²	1.0	W/ft²

Occ. Period(Hrs./yr.)	3000
Unocc. Period(Hrs./yr.)	5760
Usage During Occupied Period	100%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	100	200	300	500				Total
% Distribution		100%						100%
Weighted Average								**200**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)	15%	45%			40%		0%	100.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	82	88	65	90	

EUI = Load X Hrs. X SF X GLFF

EUI		
	kWh/ft².yr	1.3
	MJ/m².yr	48

OTHER (HIGH BAY) LIGHTING

Light Level	300.00	Lux	27.9	ft-candles
Floor Fraction (HBLFF)				
Connected Load	0.0	W/m²	0.0	W/ft²

Floor fraction check: should = 1.00 | 1.00

Occ. Period(Hrs./yr.)	4000
Unocc. Period(Hrs./yr.)	4760
Usage During Occupied Period	0%
Usage During Unoccupied Period	100%
Fixture Cleaning:	
Incidence of Practice	
Interval	years
Relamping Strategy & Incidence of Practice	Group / Spot

Light Level (Lux)	300	500	700	1000				Total
% Distribution	100%							100%
Weighted Average								**300**
	INC	CFL	T12 ES	T8 Mag	T8 Elec	MH	HPS	TOTAL
System Present (%)							0%	0.0%
CU	0.7	0.7	0.6	0.6	0.6	0.6	0.6	
LLF	0.65	0.65	0.75	0.80	0.80	0.55	0.55	
Efficacy (L/W)	15	50	72	84	88	65	90	

EUI		
	kWh/ft².yr	
	MJ/m².yr	

TOTAL LIGHTING

Overall LP 4.98 W/m²

EUI TOTAL		
	kWh/ft².yr	2
	MJ/m².yr	65

OFFICE EQUIPMENT & PLUG LOADS

Equipment Type	Computers	Monitors	Printers	Copiers	Servers	Plug Loads
Measured Power (W/device)	55	51	100	200	217	
Density (device/occupant)						
Connected Load (W/m²)					0.5	2.5
Connected Load (W/ft²)					0.05	0.23
Diversity Occupied Period						5%
Diversity Unoccupied Period						20%
Operation Occ. Period (hrs./year)						3000
Operation Unocc. Period (hrs./year)	8760	8760	8760	8760	8760	5760

Total end-use load (occupied period)	0.1	W/m²	0.0	W/ft²
Total end-use load (unocc. period)	0.5	W/m²	0.0	W/ft²
Usage during occupied period	100%			
Usage during unoccupied period	400%			

	EUI		
Computer Equipment	EUI	kWh/ft².yr	
		MJ/m².yr	
Plug Loads	EUI	kWh/ft².yr	0.30
		MJ/m².yr	11.72

FOOD SERVICE EQUIPMENT

Provide description below: Gas Fuel Share: 10.0% Electricity Fuel Share: 90.0%

Cooking

	Natural Gas EUI		All Electric EUI	
EUI	kWh/ft².yr	1.0	kWh/ft².yr	1.0
	MJ/m².yr	40.0	MJ/m².yr	40.0

REFRIGERATION

Provide description below:

EUI		
	kWh/ft².yr	0.5
	MJ/m².yr	20.0

MISCELLANEOUS

EUI		
	kWh/ft².yr	0.3
	MJ/m².yr	10

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Medium Rise	**> 5 Units, Excluding Contract Customers**		**Northern Franchise**
Baseline			

SPACE HEATING

Heating Plant Type

	Natural Gas						Electric		
	Boilers				RTU	Furnace	Resistance	Total	
	Standard	Near Cond	Cond						
System Present (%)	25%	40%	5%		20%		10%	100%	100%
Eff./COP	75%	80%	90%	90%	77%	80%	1.00		
Performance (1 / Eff.) (kW/kW)	1.33	1.25	1.11	1.11	1.30	1.25	1.00		

Peak Heating Load	88.2 W/m²	28.0 Btu/hr.ft²	
Seasonal Heating Load (Tertiary Load)	415 MJ/m².yr	10.7 kWh/ft².yr	
Sizing Factor	1.50		
Electric Fuel Share	10.0%	Gas Fuel Share 90.0%	Oil Fuel Share

Boiler Maintenance

Annual Maintenance Tasks	Incidence (%)
Fire Side Inspection	75%
Water Side Inspection for Scale Buildup	100%
Inspection of Controls & Safeties	100%
Inspection of Burner	100%
Flue Gas Analysis & Burner Set-up	90%

All Electric EUI	kWh/ft².yr	10.7
	MJ/m².yr	415
Natural Gas EUI	kWh/ft².yr	14.9
	MJ/m².yr	578
Market Composite EUI	kWh/ft².yr	14.5
	MJ/m².yr	562

SPACE COOLING

A/C Plant Type

	Centrifugal Chillers		Screw	Recprocting Chillers		Gas Cooling		Total
	Standard	HE	Chillers	Open	DX	Absorptior	Engine	
System Present (%)					100.0%			100.0%
COP	4.7	5.4	4.4	3.6	2.6	0.9	1.8	
Performance (1 / COP) (kW/kW)	0.21	0.19	0.23	0.28	0.38	1.11	0.56	
Additional Refrigerant Related Information								

Control Mode

Incidence of Use	Fixed Setpoint	Reset
Chilled Water	100%	
Condenser Water	100%	

Setpoint

Chilled Water	6 °C	42.8 °F
Condenser Water	35 °C	95 °F
Supply Air	14.0 °C	57.2 °F

Peak Cooling Load	61 W/m²	19 Btu/hr.ft²	619 ft²/Ton
Seasonal Cooling Load (Tertiary Load)	99.8 MJ/m².yr	2.6 kWh/ft².yr	

Sizing Factor 1.00 — Operation (occ. period) 3000 hrs/year — Note value cannot be less than 2,900 hrs/year)

A/C Saturation (Incidence of A/C) 75.0%

Electric Fuel Share 100.0% — Gas Fuel Share

Chiller Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect Control, Safeties & Purge Unit	100%	2
Inspect Coupling, Shaft Sealing and Bearings		
Megger Motors		
Condenser Tube Cleaning		
Vibration Analysis		
Eddy Current Testing		
Spectrochemical Oil Analysis		

Cooling Tower/Air Cooled Condenser Maintenan

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspection/Clean Spray Nozzles		
Inspect/Service Fan/Fan Motors		
Megger Motors		
Inspect/Verify Operation of Controls		

All Electric EUI	kWh/ft².yr	1.0
	MJ/m².yr	40
Natural Gas EUI	kWh/ft².yr	
	MJ/m².yr	
Market Composite EUI	kWh/ft².yr	1.0
	MJ/m².yr	40

DOMESTIC HOT WATER

Service Hot Water Plant Type

Fossil Fuel SHW	Standard Boiler	Tank Heater	Tank Heater	Cnd. Boiler	Water Heater
System Present (%)	20%		60%	5%	5%
Eff./COP	75%	60%	65%	90%	90%

	Fossil	Elec. Res.	
Fuel Share	90%	10%	100%
Blended Efficiency	0.70	0.91	

Service Hot Water load (MJ/m².yr) (Tertiary Load) 157.5

Wetting Use Percentage 10%

	All Electric EUI	All Natural Gas EUI	Market Composite EUI
kWh/ft².yr	4.5	5.8	5.7
MJ/m².yr	173	225	219.8

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Medium Rise	**> 5 Units, Excluding Contract Customers**		**Northern Franchise**
Baseline			

HVAC FANS & PUMPS

SUPPLY FANS

System Design Air Flow	0.5	L/s.m²	0.10	CFM/ft²
System Static Pressure CAV	375	Pa	1.5	wg
System Static Pressure VAV		Pa		wg
Fan Efficiency	52%			
Fan Motor Efficiency	85%			
Sizing Factor	1.00			
Fan Design Load CAV	0.4	W/m²	0.04	W/ft²
Fan Design Load VAV		W/m²		W/ft²

Ventilation and Exhaust Fan Operation & Control

	Ventilation Fan		Exhaust Fan	
Control	Fixed	Variable Flow	Fixed	Variable Flow
Incidence of Use	100%		100%	
Operation	Continous	Scheduled	Continuous	Scheduled
Incidence of Use	50%	50%	100%	
Comments:				

EXHAUST FANS

Washroom Exhaust	100	L/s.washroom	212	CFM/washroom
Washroom Exhaust per gross unit are	0.6	L/s.m²	0.12	CFM/ft²
Other Exhaust (Smoking/Conference)	0.1	L/s.m²	0.02	CFM/ft²
Total Building Exhaust	0.7	L/s.m²	0.14	CFM/ft²
Exhaust System Static Pressure	250	Pa	1.0	wg
Fan Efficiency	25%			
Fan Motor Efficiency	75%			
Sizing Factor	1.0			
Exhaust Fan Connected Load	0.9	W/m²	0.09	W/ft²

AUXILIARY COOLING EQUIPMENT (Condenser Pump and Cooling Tower/Condenser Fans)

Average Condenser Fan Power Draw	0.022	kW/kW	0.08	kW/Ton
(Cooling Tower/Evap. Condenser/ Air Cooled Condenser)	1.35	W/m²	0.13	W/ft²

Condenser Pump

Pump Design Flow	0.053	L/s.KW	3.0	U.S. gpm/Ton
Pump Design Flow per unit floor area	0.003	L/s.m²	0.005	U.S. gpm/ft²
Pump Head Pressure	0.1	kPa	0.0333333	ft
Pump Efficiency	60%			
Pump Motor Efficiency	85%			
Sizing Factor	1.0			
Pump Connected Load	0.00	W/m²	0.00	W/ft²

CIRCULATING PUMP (Heating & Cooling)

Pump Design Flow @ 5 °C (10 °F) delta T	0.003	L/s.m²	0.0039	U.S. gpm/ft²	2.4	U.S. gpm/Ton
Pump Head Pressure	100	kPa	33	ft		
Pump Efficiency	60%					
Pump Motor Efficiency	85%					
Sizing Factor	1.0					
Pump Connected Load	0.5	W/m²	0.05	W/ft²		

Supply Fan Occ. Period	3900	hrs./year
Supply Fan Unocc. Period	4860	hrs./year
Supply Fan Energy Consumption	2.7	kWh/m².yr
Exhaust Fan Occ. Period	3900	hrs./year
Exhaust Fan Unocc. Period	4860	hrs./year
Exhaust Fan Energy Consumption	8.2	kWh/m².yr
Condenser Pump Energy Consumption	0.0	kWh/m².yr
Cooling Tower /Condenser Fans Energy Consumption	0.6	kWh/m².yr
Circulating Pump Yearly Operation	7000	hrs./year
Circulating Pump Energy Consumption	3.2	kWh/m².yr

Fans and Pumps Maintenance

Annual Maintenance Tasks	Incidence (%)	Frequency (years)
Inspect/Service Fans & Motors		
Inspect/Adjust Belt Tension on Fan Belts		
Inspect/Service Pump & Motors		

EUI	kWh/ft².yr	1.4
	MJ/m².yr	52.8

COMMERCIAL SECTOR BUILDING PROFILE

New BUILDINGS:	**SIZE:**	**VINTAGE:**	**REGION:**
Medium Rise	**> 5 Units, Excluding Contract Customers**		**Northern Franchise**
Baseline			

EUI SUMMARY

TOTAL ALL END-USES:	**Electricity:**	**7.5** kWh/ft².yr	**290.9** MJ/m².yr	**Gas:**	**19.0** kWh/ft².yr	**736.6** MJ/m².yr	

END USE:	kWh/ft².yr	MJ/m².yr	**END USE:**	Electricity kWh/ft².yr	Electricity MJ/m².yr	Gas kWh/ft².yr	Gas MJ/m².yr
GENERAL LIGHTING (SUITES)	0.4	16.0					
ARCHITECTURAL LIGHTING (COR	1.3	48.5	SPACE HEATING	1.1	41.5	13.4	520.1
OTHER (HIGH BAY) LIGHTING			SPACE COOLING	0.8	30.1		
OTHER PLUG LOADS	0.3	11.7	DOMESTIC HOT WATER	0.4	17.3	5.2	202.5
HVAC FANS & PUMPS	1.4	52.8	FOOD SERVICE EQUIPMENT	0.9	36.0	0.1	4.0
REFRIGERATION	0.5	20.0	MISCELLANEOUS			0.3	10.0
COMPUTER EQUIPMENT							
ELEVATORS							
OUTDOOR LIGHTING	0.4	17.0					

APPENDIX E

Measure TRC Calculations

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High-Performance Glazings

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.361	$0.441
Electricity ($/kWh)	$0.982	$0.111
Water ($/1000L)	$20.577	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr	Water (L/yr)				Nat. Gas	Elec.	Water		
1	High Performance Glazings (0.32 Btu/hr.ft2.F) - baseline building with a U value of 0.46 Btu/hr.ft2.F and a space heating EUI of 17.4 m3/m2/yr.	17.4	-	-	15.7			I	$4.4	$0	30	2	0	0	$1	5.7	$0	$8	$0	$0	$3	1.7

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.361	$0.466
Electricity ($/kWh)	$0.982	$0.103
Water ($/1000L)	$20.577	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr	Water (L/yr)				Nat. Gas	Elec.	Water		
1	High Performance Glazings (0.32 Btu/hr.ft2.F) - baseline building with a U value of 0.46 Btu/hr.ft2.F and a space heating EUI of 21.9 m3/m2/yr.	21.9	-	-	19.7			I	$4.4	$0	30	2	0	0	$1	4.5	$0	$10	$0	$0	$5	2.2
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Costs based on $5 per square foot of window area based on ACEEE and translated to floor area based on WWR of 0.28
2. Savings are 10% of space heating energy based on CEEAM simulations.
3. The service life of glazing is 30 years (BC Hydro QA Standard)
4. The analysis is based on 1 m2 of floor area

Super High-Performance Glazings

Service Region:	**Southern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.361	$0.441
Electricity ($/kWh)	$0.982	$0.111
Water ($/1000L)	$20.577	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Super High-Performance Glazings (.2 Btu/hr.ft2.F) - baseline office with a window U value of 0.46 Btu/hr.ft2.F and a space heating EUI of 14 m3/m2/yr.	14.0	-	-	11.9			I	$15.7	$0	30	2	0	0	$1	16.9	$0	$9	$0	$0	-$7	0.6
2										$0	30	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	30	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
								I		$0	30	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Service Region:	**Northern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.361	$0.466
Electricity ($/kWh)	$0.982	$0.103
Water ($/1000L)	$20.577	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Super High-Performance Glazings (.2 Btu/hr.ft2.F) - baseline office with a window U value of 0.46 Btu/hr.ft2.F and a space heating EUI of 17 m3/m2/yr.	17.0	-	-	14.5			I	$15.7	$0	30	3	0	0	$1	14.0	$0	$11	$0	$0	-$5	0.7
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Costs based on $10-15 per square foot of glazing based on Marbek database translated to floor area based on WWR of 0.35
2. Savings are 15% of space heating energy based on CEEAM simulations
3. The service life of glazing is 30 years (BC Hydro QA Standard)
4. The analysis is based on 1 m2 of floor area

Wall Insulation

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost	Customer Cost
Natural Gas ($/m^3)	$3.817	$0.441
Electricity ($/kWh)	$0.856	$0.111
Water ($/1000L)	$17.927	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Wall Insulation (R-24) - baseline wall R-12 and a space heating EUI of 12.9 m3/m2/yr.	12.9	-	-	11.8			I	$14.8	$0	20	1	0	0	$0	30.6	$0	$4	$0	$0	-$11	0.3
2										$0	20	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	20	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
								I		$0	20	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost	Customer Cost
Natural Gas ($/m^3)	$3.817	$0.466
Electricity ($/kWh)	$0.856	$0.103
Water ($/1000L)	$17.927	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Wall Insulation (R-24) - baseline wall R-12 and a space heating EUI of 15.9 m3/m2/yr.	15.9	-	-	14.5			I	$14.8	$0	20	1	0	0	$1	24.1	$0	$5	$0	$0	-$10	0.4
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Costs based on $1.38 per square foot of floor area based on Marbek database
2. Savings are 9% of space heating energy based on CEEAM simulations
3. The service life of insulation is 20 years (BC Hydro QA Standard)
4. The analysis is based on 1 m2 of floor area

Roof Insulation

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.817	$0.441
Electricity ($/kWh)	$0.856	$0.111
Water ($/1000L)	$17.927	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Roof Insulation (R-22) - baseline roof R-12 and a space heating EUI of 15.3 m3/m2/yr.	15.3	-	-	12.1			I	$10.8	$0	20	3	0	0	$1	7.6	$0	$12	$0	$0	$1	1.1
2										$0	20	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	20	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
								I		$0	20	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Roof Insulation (R-22) - baseline roof R-12 and a space heating EUI of 18.9 m3/m2/yr.	18.9	-	-	15.1			I	$10.8	$0	25	4	0	0	$2	6.5	$0	$14	$0	$0	$4	1.3
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Costs based on $1 per square foot of roof area based on Marbek database
2. Savings are 20% of space heating energy based on CEEAM simulations (single story building)
3. The service life of insulation is 20 years (BC Hydro QA Standard)
4. The analysis is based on 1 m2 of floor area

Air Sealing

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$1.830	$0.441
Electricity ($/kWh)	$0.401	$0.111
Water ($/1000L)	$8.422	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Air Sealing - highrise office with a poor envelope and a space heating EUI of 12.9 m3/m2/yr.	12.9	-	-	12.3			F	$1.1	$0	6	1	0	0	$0	3.8	$0	$1	$0	$0	$0	1.1
2										$0	6	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	6	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
								F		$0	6	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Costs based on $0.10 per square foot of floor area based on Marbek database
2. Savings are 5% of space heating energy based on CEEAM simulations
3. The service life of air sealing is 6 years (BC Hydro QA Standard)
4. The analysis is based on 1 m2 of floor area

Air Curtains

Service Region:	**Southern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.339	$0.441
Electricity ($/kWh)	$0.747	$0.111
Water ($/1000L)	$15.618	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Air curtain with rated effectiveness of 85% installed on double door - baseline: A "double door" entranceway open 4 hours per day.	6,440	-	-	1,932	-1,023		F	$2,500	$0	15	4,508	1,023	0	$2,102	1.2	$0	$15,052	$764	$0	$13,316	6.3

Service Region:	**Northern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.339	$0.400
Electricity ($/kWh)	$0.747	$0.100
Water ($/1000L)	$15.618	$1.750

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. This upgrade consists of installing an air curtain (Enershield MCS-72) on the main double doors of a retail building.
2. It is assumed that the door is open for 4 hours per day and that the air curtain has an effectiveness of 85%
3. Installed cost is $2,500 as per Enbridge input assumptions
4. The service life is estimated to be 15 years (Enbridge Gas input assumptions) .

www.enershield.ca

Vinyl Strip Curtains

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$1.587	$0.441
Electricity ($/kWh)	$0.346	$0.111
Water ($/1000L)	$7.272	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Baseline: Loading dock entranceway open 1 hour/day. Upgrade: Vinyl strip curtain installed on loading dock door.	581	-	-	232			F	$420	$0	5	349	0	0	$154	2.7	$0	$553	$0	$0	$133	1.3
2			-	-	-			I		$0	5	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.339	$0.400
Electricity ($/kWh)	$0.747	$0.100
Water ($/1000L)	$15.618	$1.750

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

This upgrade consists of installing a vinyl strip door with 100% overlap on a 12' X 12' loading dock door.
It is assumed that the door is open for one hour per day and that the strip door prevents 60% of air infiltration.
Installed cost is $420 as per supplier information and RS Means
The service life is estimated to be 5 years.

www.envirobarrier.com

Fast Moving Doors

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m³)	$2.632	$0.441
Electricity ($/kWh)	$0.585	$0.111
Water ($/1000L)	$12.234	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Baseline: A standard speed (0.2 m/s) 5m x 5m overhead door. Upgrade: High Speed (1.5m/s) 5m x 5m overhead door.	517	-	-	69	0		I	$10,500	$0	10	448	0	0	$198	53.1	$0	$1,180	$0	$0	-$9,320	0.1
2			-	-	-			I		$0	10	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m³)	$3.339	$0.400
Electricity ($/kWh)	$0.747	$0.100
Water ($/1000L)	$15.618	$1.750

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

This upgrade consists of installing JetRoll high speed fabric door on a 16' x 16' loading dock
The baseline is a rolling steel door with a standard electric operator
It is assumed that the door is open for 20 times per day, and that the fast moving door opens and closes at 1.5 m/s, while the baseline overhead steel door opens and closes at 0.2 m/s.
Installed cost is $26,500 as per supplier information.
The service life is estimated to be 10 years.

Costing information from personal communication
bcrombeen@edwardsdoors.com

L-Shaped Vestibule

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.441
Electricity ($/kWh)	$0.931	$0.111
Water ($/1000L)	$19.502	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Baseline: A double-door entranceway with both doors open for four hour per day (in a building occupied 10 hours/day). Upgrade: L-Shaped vestibule.	1,149	-	-	230			F	$7,040	$0	25	919	0	0	$405	17.4	$0	$3,805	$0	$0	-$3,235	0.5
2	Baseline: A "straight" double-door vestibule entranceway with both doors open simultaneaously for 1 hour per day (in a building occupied 10 hours/day). Upgrade: L-Shaped vestibule.	306	-	-	230			I	$0	$0	25	77	0	0	$34	0.0	$0	$317	$0	$0	$317	N/A

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.339	$0.400
Electricity ($/kWh)	$0.747	$0.100
Water ($/1000L)	$15.618	$1.750

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

This upgrade consists of installing a 10' x10' L-shaped vestibule with two entrance doors.
The measure is evaluated at full cost against a standard double door, and incrementally against a standard "straight vestibule"
It is assumed that the door is open for three hours per day, with both "straight" vestibule doors are open simultaneously for 1 hour per day.
Full Installed cost is $7,040 (RS Means), There is no incremental cost, as the incremental upgrade is a matter of alternate door placement.
The service life is estimated to be 25 years (BC Hydro QA standard).

Turnstile Doors

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.441
Electricity ($/kWh)	$0.931	$0.111
Water ($/1000L)	$19.502	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Baseline: A "double door" entranceway open 3 hours per day (in a building occupied 10 hours/day). Upgrade: Turnstile door with identical frontage dimensions.	1,149	-	-	128			F	$19,675	$0	25	1,021	0	0	$450	43.7	$0	$4,228	$0	$0	-$15,447	0.2
2	Baseline: A "double door" entranceway open 3 hours per day (in a building occupied 10 hours/day). Upgrade: Turnstile door with identical frontage dimensions.	1,149	-	-	128			I	$6,725	$0	25	1,021	0	0	$450	14.9	$0	$4,228	$0	$0	-$2,497	0.6

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.339	$0.400
Electricity ($/kWh)	$0.747	$0.100
Water ($/1000L)	$15.618	$1.750

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

This upgrade consists of installing a revolving door in place of s standard double door.
It is assumed that the door is open for three hours per day and reduces energy loss due to air infiltration to by 7/8 compared with standard balanced swinging door (Sustainability @ MIT, sustainability.mit.edu/Revolving_Door)
Incremental Installed cost is $6,725 (RS Means)
The service life is estimated to be 25 years (BC Hydro).

Condensing Boiler

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.441
Electricity ($/kWh)	$0.931	$0.111
Water ($/1000L)	$19.502	$3.050

#	Measure Description	Baseline Consumption Nat. Gas (m^3/yr)	Baseline Elec. (kWh/yr)	Baseline Water (L/yr)	Upgrade Energy Use Nat. Gas (m^3/yr)	Upgrade Elec. (kWh/yr)	Upgrade Water (L/yr)	Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings Nat. Gas (m^3/yr)	Savings Elec. (kWh/yr)	Savings Water (L/yr)	Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor Nat. Gas	Elec.	Water	Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
1	Condensing Boiler - 1,000 MBH, 94% Et (88% seasonal) - baseline standard efficiency 80% Et (76% seasonal) - 1,000 FLE hours	37,296	-	-	32,210			I	$17,778	$0	25	5,086	0	0	$2,243	7.9	$0	$21,062	$0	$0	$3,284	1.2
2	Condensing Boiler - 1,000 MBH, 94% Et (88% seasonal) - baseline standard efficiency 80% Et (76% seasonal) - 1,500 FLE hours	55,943	-	-	48,315			I	$17,778	$0	25	7,629	0	0	$3,364	5.3	$0	$31,593	$0	$0	$13,815	1.8
3	Condensing Boiler - 1,000 MBH, 94% Et (88% seasonal) - baseline standard efficiency 80% Et (76% seasonal) - 2,000 FLE hours	74,591	-	-	64,420			I	$17,778	$0	25	10,172	0	0	$4,486	4.0	$0	$42,124	$0	$0	$24,347	2.4
4	Condensing Boiler - 1,000 MBH, 94% Et (88% seasonal) - baseline near-condensing 85% Et (81% seasonal) - 1,000 FLE hours	34,993	-	-	32,210			I	$14,837	$0	25	2,784	0	0	$1,228	12.1	$0	$11,528	$0	$0	-$3,309	0.8
5	Condensing Boiler - 1,000 MBH, 94% Et (88% seasonal) - baseline near-condensing 85% Et (81% seasonal) - 1,500 FLE hours	52,490	-	-	48,315			I	$14,837	$0	25	4,175	0	0	$1,841	8.1	$0	$17,292	$0	$0	$2,455	1.2
6	Condensing Boiler - 1,000 MBH, 94% Et (88% seasonal) - baseline near-condensing 85% Et (81% seasonal) - 2,000 FLE hours	69,987	-	-	64,420			I	$14,837	$0	25	5,567	0	0	$2,455	6.0	$0	$23,056	$0	$0	$8,219	1.6

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

#	Measure Description	Baseline Consumption Nat. Gas (m^3/yr)	Baseline Elec. (kWh/yr)	Baseline Water (L/yr)	Upgrade Energy Use Nat. Gas (m^3/yr)	Upgrade Elec. (kWh/yr)	Upgrade Water (L/yr)	Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings Nat. Gas (m^3/yr)	Savings Elec. (kWh/yr)	Savings Water (L/yr)	Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor Nat. Gas	Elec.	Water	Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Boilers evaluated at 1,000, 1,500, and 2,000 full-load equivalent hours to reflect the range of operation commonly found in commercial buildings in both the Southern and Northern service regions.
2. The seasonal efficiency of the standard efficiency boiler is 76%; near-condensing, 81%; and condensing, 88% (Union Gas 2007-2009 DSM Plan, Appendix A and Terasen Gas)
3. The input capacity of the condensing boiler is approximately 12% less than the standard efficiency boiler and 6% less than the near-condensing boiler.
4. The boiler costs are based on Marbek's in-house database as follows:
   - Standard efficiency boiler at $8/MBH
   - Near-condensing at $11/MBH
   - Condensing at $25/MBH
5. The service life of a boiler is 25 years (ASHRAE Applications Handbook - 2003, Chapter 36, Table 3).

Near Condensing Boiler

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.441
Electricity ($/kWh)	$0.931	$0.111
Water ($/1000L)	$19.502	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Near-Condensing Boiler - 1,000 MBH, 85% Et (81% seasonal) - baseline standard efficiency 80% Et (76% seasonal) - 1,000 FLE hours	37,296	-	-	34,993			I	$2,941	$0	25	2,302	0	0	$1,015	2.9	$0	$9,534	$0	$0	$6,593	3.2
2	Near-Condensing Boiler - 1,000 MBH, 85% Et (81% seasonal) - baseline standard efficiency 80% Et (76% seasonal) - 1,500 FLE hours	55,943	-	-	52,490			I	$2,941	$0	25	3,453	0	0	$1,523	1.9	$0	$14,301	$0	$0	$11,360	4.9
3	Near-Condensing Boiler - 1,000 MBH, 85% Et (81% seasonal) - baseline standard efficiency 80% Et (76% seasonal) - 2,000 FLE hours	74,591	-	-	69,987			I	$2,941	$0	25	4,604	0	0	$2,031	1.4	$0	$19,069	$0	$0	$16,127	6.5

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Boilers evaluated at 1,000, 1,500, and 2,000 full-load equivalent hours to reflect the range of operation commonly found in commercial buildings in both the Southern and Northern service regions.
2. The seasonal efficiency of the standard efficiency boiler is 76%; near-condensing, 81% (Union Gas 2007-2009 DSM Plan, Appendix A and Terasen Gas)
3. The input capacity of the near-condensing boiler is approximately 6% less than the standard efficiency boiler.
4. The boiler costs are based on Marbek's in-house database as follows:
   - Standard efficiency boiler at $8/MBH
   - Near-condensing at $11/MBH
5. The service life of a boiler is 25 years (ASHRAE Applications Handbook - 2003, Chapter 36, Table 3).

Condensing Unit Heater

Service Region:	**Southern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.817	$0.441
Electricity ($/kWh)	$0.856	$0.111
Water ($/1000L)	$17.927	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Condensing UH - 160 MBH, 91% Et (89% seasonal) - baseline standard efficiency 80% Et (79% seasonal) - 1,000 FLE hours	5,741	-	-	5,096			I	$1,044	$0	20	645	0	0	$284	3.7	$0	$2,462	$0	$0	$1,418	2.4
2	Condensing UH - 160 MBH, 91% Et (89% seasonal) - baseline standard efficiency 80% Et (79% seasonal) - 1,500 FLE hours	8,611	-	-	7,644			I	$1,044	$0	20	968	0	0	$427	2.4	$0	$3,693	$0	$0	$2,649	3.5
3	Condensing UH - 160 MBH, 91% Et (89% seasonal) - baseline standard efficiency 80% Et (79% seasonal) - 2,000 FLE hours	11,481	-	-	10,191			I	$1,044	$0	20	1,290	0	0	$569	1.8	$0	$4,925	$0	$0	$3,880	4.7

Service Region:	**Northern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.648	$0.466
Electricity ($/kWh)	$0.817	$0.103
Water ($/1000L)	$17.108	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	18	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	18	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	18	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	18	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Unit heaters evaluated at 1,000, 1,500, and 2,000 full-load equivalent hours to reflect the range of operation commonly found in commercial buildings in both the Southern and Northern service regions.
2. The standard unit heater has a thermal efficiency of 80% and a seasonal efficiency of 79% (NRCan's proposed amendment to Canada's Energy Efficiency Regulation Aug 8, 2008)
3. The condensing unit heater has a thermal efficiency of 91% (Reznor Model UEAS 180) and a seasonal efficiency of 89% (Marbek estimate).
4. The input capacity of the condensing unit heater is approximately 12% less than the standard efficiency unit heater.
5. The unit heater costs are based on RS Means Mechanical Cost Data 2007 and personal communication with with Reznor as follows:
   - Standard efficiency UH with power vent - $8/MBH
   - Condensing UH - $16/MBH
6. The service life of a unit heater is 20 years (Union Gas 2007-2009 DSM Plan, Appendix A - Input Assumptions).

High-Efficiency Rooftop Unit

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m³)	$3.817	$0.441
Electricity ($/kWh)	$0.856	$0.111
Water ($/1000L)	$17.927	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m³/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m³/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m³/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	High Efficiency Rooftop Unit - 375 MBH, 83% Et (80% seasonal) - baseline standard efficiency 80% Et (73% seasonal) - 1,000 FLE hours	14,561	-	-	13,287			I	$1,875	$0	20	1,274	0	0	$562	3.3	$0	$4,864	$0	$0	$2,989	2.6
2	High Efficiency Rooftop Unit - 375 MBH, 83% Et (80% seasonal) - baseline standard efficiency 80% Et (73% seasonal) - 1,500 FLE hours	21,841	-	-	19,930			I	$1,875	$0	20	1,911	0	0	$843	2.2	$0	$7,295	$0	$0	$5,420	3.9
3	High Efficiency Rooftop Unit - 375 MBH, 83% Et (80% seasonal) - baseline standard efficiency 80% Et (73% seasonal) - 2,000 FLE hours	29,121	-	-	26,573			I	$1,875	$0	20	2,548	0	0	$1,124	1.7	$0	$9,727	$0	$0	$7,852	5.2

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m³)	$3.339	$0.466
Electricity ($/kWh)	$0.747	$0.103
Water ($/1000L)	$15.618	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m³/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m³/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m³/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Rooftops were evaluated at 1,000, 1,500, and 2,000 full-load equivalent hours to reflect the range of operation commonly found in commercial buildings in both the Southern and Northern service regions.
2. The standard rooftop unit has a thermal efficiency of 80% and a seasonal efficiency of 73%.
3. The high efficiency rooftop unit has a thermal efficiency of 83% and a seasonal efficiency of 80%.
4. The incremental cost of a modulating burner is $5/MBH (RS Means Mechanical Cost Data 2007 and personal communication with Engineered Air)
5. The service life of a rooftop unit is 20 years (Union Gas 2007-2009 DSM Plan, Appendix A - Input Assumptions).

Condensing Rooftop Unit

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.817	$0.441
Electricity ($/kWh)	$0.856	$0.111
Water ($/1000L)	$17.927	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Condensing Rooftop Unit - 375 MBH, 92% seasonal - baseline standard efficiency 80% Et (73% seasonal) - 1000 FLE hours	14,561	-	-	11,810			I	$9,375	$0	20	2,750	0	0	$1,213	7.7	$0	$10,499	$0	$0	$1,124	1.1
2	Condensing Rooftop Unit - 375 MBH, 83% Et (80% seasonal) - baseline standard efficiency 80% Et (73% seasonal) - 1,500 FLE hours	21,841	-	-	17,715			I	$9,375	$0	20	4,126	0	0	$1,819	5.2	$0	$15,749	$0	$0	$6,374	1.7
3	Condensing Rooftop Unit - 375 MBH, 83% Et (80% seasonal) - baseline standard efficiency 80% Et (73% seasonal) - 2,000 FLE hours	29,121	-	-	23,621			I	$9,375	$0	20	5,501	0	0	$2,426	3.9	$0	$20,998	$0	$0	$11,623	2.2

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.339	$0.466
Electricity ($/kWh)	$0.747	$0.103
Water ($/1000L)	$15.618	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Rooftops were evaluated at 1,000, 1,500, and 2,000 full-load equivalent hours to reflect the range of operation commonly found in commercial buildings in both the Southern and Northern service regions.
2. The standard rooftop unit has a thermal efficiency of 80% and a seasonal efficiency of 73%.
3. The condensing boiler has a seasonal efficiency of 92%.
4. The incremental cost of a condensing rooftop unit is $25/MBH based on a 100% premium over a standard unit and RS Means Mechanical Cost Data 2007
5. The service life of a rooftop unit is 20 years (Union Gas 2007-2009 DSM Plan, Appendix A - Input Assumptions).

Absorption Heat Pump

Service Region:	**Southern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.339	$0.441
Electricity ($/kWh)	$0.747	$0.111
Water ($/1000L)	$15.618	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Gas Absorption Heat Pump - 124 MBH at 105% seasonal - baseline standard efficiency boiler, 76% seasonal - 1,000 FLE hours	4,625		-	3,515			I	$2,108	$0	15	1,110	0	0	$489	4.3	$0	$3,706	$0	$0	$1,598	1.8
2	Gas Absorption Heat Pump - 124 MBH at 105% seasonal - baseline standard efficiency boiler, 76% seasonal - 1,500 FLE hours	6,937	-	-	5,272			I	$2,108	$0	15	1,665	0	0	$734	2.9	$0	$5,559	$0	$0	$3,451	2.6
3	Gas Absorption Heat Pump - 124 MBH at 105% seasonal - baseline standard efficiency boiler, 76% seasonal - 2,000 FLE hours	9,249	-	-	7,029			I	$2,108	$0	15	2,220	0	0	$979	2.2	$0	$7,412	$0	$0	$5,304	3.5

Service Region:	**Northern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.339	$0.466
Electricity ($/kWh)	$0.747	$0.103
Water ($/1000L)	$15.618	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Heat pumps were evaluated at 1,000, 1,500, and 2,000 full-load equivalent hours to reflect the range of operation commonly found in commercial buildings in both the Southern and Northern service regions.
2. The standard boiler has a thermal efficiency of 80% and a seasonal efficiency of 76%.
3. The heat pump is based on a Robur gas-fired absorption heat pump GAHP-A (heating only) with a a seasonal efficiency of 105%. (GazMetro InformaTECH Vol 22, Number 2, June 2008)
4. The incremental cost of a GAHP is $17/MBH over a standard efficiency boiler (Marbek estimate and personal communication with D-B Cooling Systems Inc)
5. The service life of a heat pump is 15 years (BC Hydro QA Standard).

Steam Plant Efficiency Measures

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$2.632	$0.441
Electricity ($/kWh)	$0.585	$0.111
Water ($/1000L)	$12.234	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Steam Plant Efficiency Measures	100		-	86.3			F	$7.25	$0	10	14	0	0	$6	1.2	$0	$36	$0	$0	$29	5.0

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.339	$0.466
Electricity ($/kWh)	$0.747	$0.103
Water ($/1000L)	$15.618	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Cost and savings based on results of Enbridge's Steam Plant Performance Test and Audit Program up to the end of 2005.
2. Analysis based on 100 m3 of gas and 13.7 % savings at a 1.2 year payback.
3. Measure life estimated to be an average of 10 years.
4. Analysis does not include electricity or water savings.

HVLS De-stratification Fans

Service Region:	Southern
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.339	$0.441
Electricity ($/kWh)	$0.747	$0.111
Water ($/1000L)	$15.618	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	HVLS De-stratification Fans - baseline is a 58,000 ft^2 warehouse with 30' ceilings and 20' heater height - London	90,250		-	72,712	1,569		F	$21,264		15	17,538	-1,569	0	$7,560	2.8	$0	$58,558	-$1,171	$0	$36,123	2.6

Service Region:	Northern
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.339	$0.466
Electricity ($/kWh)	$0.747	$0.103
Water ($/1000L)	$15.618	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	HVLS De-stratification Fans - baseline is a 58,000 ft^2 warehouse with 30' ceilings and 20' heater height - North Bay	108,845		-	91,731	1,569		F	$21,264		15	17,114	-1,569	0	$7,373	2.9	$0	$57,143	-$1,171	$0	$34,707	2.5

Notes:

1. Analysis and assumptions are based on Energy Savings Associated with De-stratification in Buildings With High Ceilings (Draft), Caneta Research Inc., October 2007.
2. Cost based on 24' three diameter fans and information provided by suppliers.
3. Savings based on 15% of space heating load
4. Service life is 15 years (Enbridge DSM input assumptions)
5. The analysis does not account for any cooling savings in the summer.

Heat Reflector Panels

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost	Customer Cost
Natural Gas ($/m^3)	$3.648	$0.441
Electricity ($/kWh)	$0.817	$0.111
Water ($/1000L)	$17.108	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Heat Reflector Panels - baseline is an apartment building with radiators and a space heating heating EUI of 16.2 m3/m2/yr.	16.2	-	-	15.7			F	$0.74	$0	18	0	0	0	$0	3.5	$0	$1.77	$0	$0	$1.03	2.4

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost	Customer Cost
Natural Gas ($/m^3)	$1.587	$0.466
Electricity ($/kWh)	$0.346	$0.103
Water ($/1000L)	$7.272	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	5	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	5	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	5	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	5	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Installed cost of approx $25/unit estimated using manufacturer retail costs (see www.novitherm.com)
2. Savings are 3% of space heating energy based on manufacturer case studies, Discussions with Union Gas personnel, and
Natural Gas Technologies Centre, 2004. Measurement and Verification of Heating Energy Savings Resulting from the Installation of Heat Reflector Panels, Site 2 report: Habitations L'Equerre, Sherbrook,
3. The service life is estimated to be 18 years (Enbridge input assumptions).
4. The analysis is based on one m2 of floor area.

Heat Recovery

Service Region:	**Southern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.339	$0.441
Electricity ($/kWh)	$0.747	$0.111
Water ($/1000L)	$15.618	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Air-To-Air Heat Recovery - 50% effectiveness, 8 hours/day	1.4	-	-	0.7			I	$2.17	$0	15	1	0	0	$0	6.9	$0	$2	$0	$0	$0	1.1
2	Air-To-Air Heat Recovery - 50% effectiveness, 16 hours/day	2.9	-	-	1.4			I	$2.17	$0	15	1	0	0	$1	3.4	$0	$5	$0	$0	$3	2.2
3	Air-To-Air Heat Recovery - 50% effectiveness, 24 hours/day	4.3	-	-	2.1			I	$2.17	$0	15	2	0	0	$1	2.3	$0	$7	$0	$0	$5	3.3

Service Region:	**Northern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.339	$0.466
Electricity ($/kWh)	$0.747	$0.103
Water ($/1000L)	$15.618	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Air-To-Air Heat Recovery - 50% effectiveness, 8 hours/day	1.9	-	-	1			I	$2.17	$0	15	1	0	0	$0	5.1	$0	$3	$0	$0	$1	1.5
2	Air-To-Air Heat Recovery - 50% effectiveness, 16 hours/day	3.9	-	-	2			I	$2.17	$0	15	2	0	0	$1	2.5	$0	$6	$0	$0	$4	3.0
3	Air-To-Air Heat Recovery - 50% effectiveness, 24 hours/day	5.8	-	-	3			I	$2.17	$0	15	3	0	0	$1	1.7	$0	$10	$0	$0	$8	4.5

Notes:

1. The measure is evaluated at 8,16, and 24 hours to reflect range of operation found in building stock.
2. Baseline is 1 cfm of exhaust with no heat recovery
3. Upgrade is a heat wheel with an average sensible heat recovery effectiveness of 50% over the heating season.
4. Service life is 15 years based on BC Hydro QA Standard for packaged equipment and Union Gas input assumptions.
5. Costs ($2.17 / cfm average for 1,000 to 8,000 cfm heat wheels) based on RS Means Mechanical Cost Data 2007 page 371.
6. Analysis based on 1 cfm and sensible heat recovery only - no cooling savings considered.

Programmable Thermostats

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.339	$0.441
Electricity ($/kWh)	$0.747	$0.111
Water ($/1000L)	$15.618	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Programmable Thermostats - baseline is a small commercial building with packaged rooftop equipment, standard thermostats, and a space heating EUI of 12.9 m3/m2/yr.	12.9	-	-	11.6			F	$1.4	$0	15	1	0	0	$1	2.4	$0	$4	$0	$0	$3	3.1
2										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
								F		$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Baseline building: 10,000 ft2, 400 ft2/ton, 5 RTUs, standard t'stats
2. Upgrade: programmable thermostats and sheduling of RTUs
3. Savings 10% of space heating (CEEAM)
4. Service life is 15 years (Pers comm, Union Gas / Enbridge input assumptions)
5. Costs based on $250-$300 provided by Union Gas
6. The analysis is based on 1 m2 of floor area

Demand Controlled Ventilation

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.339	$0.441
Electricity ($/kWh)	$0.747	$0.111
Water ($/1000L)	$15.618	$3.050

Measure Description		Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Demand Controlled Ventilation - baseline is a large office with standard mixed air control and a space heating EUI of 13/m3/m2/yr.	13.0	-	-	11.7			F	$0.9	$0.1	15	1	0	0	$1	1.7	$0	$4	$0	$0	$3	3.4

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

Measure Description		Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Baseline building: 150,000 ft2, 8 RTUs, standard mixed air control
2. Savings 10% of space heating (CEEAM)
3. Service life of DCV is 15 years (same a building automation system)
4. Costs based on supplier information and RS Means.
5. The analysis is based on 1 m2 of floor area and includes an increase in O&M for maintenance and calibration of CO2 sensors.

Demand Control Kitchen Ventilation

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.817	$0.441
Electricity ($/kWh)	$0.856	$0.111
Water ($/1000L)	$17.927	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Demand Control Kitchen Ventilation - baseline 0-4999 cfm constant volume							F	$5,000	$0	20	3,660	7,319	0	$2,428	2.1	$0	$13,972	$6,268	$0	$15,240	4.0
2	Demand Control Kitchen Ventilation - baseline 5000-9999 cfm constant volume							F	$10,000	$0	20	9,535	23,180	0	$6,783	1.5	$0	$36,399	$19,852	$0	$46,251	5.6
3	Demand Control Kitchen Ventilation - baseline 10000-15000 cfm constant volume							F	$15,000	$0	20	17,455	40,929	0	$12,250	1.2	$0	$66,632	$35,053	$0	$86,685	6.8

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Costs and savings based on Union Gas 2007-2009 DSM Plan page 48
2. Gas savings are assumed to be equivalent to ~ 30% required to heat make-up air.
3. Service life is estimated to be 20 years as per Union Gas Updated input assumptions (July 2008)
4. Costs range from approximately $1 to $2 per cfm.

Furnace Boiler Tune Ups

Service Region:	**Southern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost	Customer Cost
Natural Gas ($/m^3)	$0.754	$0.441
Electricity ($/kWh)	$0.155	$0.111
Water ($/1000L)	$3.246	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Furnace Boiler Tune Ups - baseline is a 400 m^2 retail building with two gas-fired rooftop units and a space heating EUI of 13m3/m2/yr.	13.0	-	-	12.4			F	$0.5	$0	2	1	0	0	$0	1.7	$0	$0	$0	$0	$0	1.0

Service Region:	**Northern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Baseline is a 400 m2 retail building with two gas-fired rooftop units and a space heating EUI of 13 m3/m2/yr.
2. Savings 5% of space heating
3. Service life of tune-up is estimated to be 2 years
4. The analysis is based on 1 m2 of floor area
5. Cost is $500/unit (personal communication, Union Gas)

Condensing Furnace

Service Region:	**Southern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.648	$0.441
Electricity ($/kWh)	$0.817	$0.111
Water ($/1000L)	$17.108	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Condensing Furnace - 100 MBH, 94% AFUE - baseline standard 80% AFUE - 1,000 FLE hours	3,543	-	-	3,015			I	$600	$0	18	528	0	0	$233	2.6	$0	$1,925	$0	$0	$1,325	3.2
2	Condensing Furnace - 100 MBH, 94% AFUE - baseline standard 80% AFUE - 1,500 FLE hours	5,315	-	-	4,523			I	$600	$0	18	792	0	0	$349	1.7	$0	$2,888	$0	$0	$2,288	4.8
3	Condensing Furnace - 100 MBH, 94% AFUE - baseline standard 80% AFUE - 2,000 FLE hours	7,086	-	-	6,031			I	$600	$0	18	1,055	0	0	$465	1.3	$0	$3,850	$0	$0	$3,250	6.4

Service Region:	**Northern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Furnaces evaluated at 1,000, 1,500, and 2,000 full-load equivalent hours to reflect the range of operation commonly found in commercial buildings in both the Southern and Northern service regions.
2. Costs based on scan of supplier information and RS Means.
3. Service life of 18 years based on ASHRAE/Union Gas Updated input assumptions (July 2008)

Infrared Heaters

Service Region:	**Southern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.817	$0.441
Electricity ($/kWh)	$0.856	$0.111
Water ($/1000L)	$17.927	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Infrared Heaters - 100 MBH, 80% Et - baseline standard unit heater 80% Et - 1,000 FLE hours	3,588	-	-	3,157			I	$375	$0	20	431	0	0	$190	2.0	$0	$1,644	$0	$0	$1,269	4.4
2	Infrared Heaters - 100 MBH, 80% Et - baseline standard unit heater 80% Et - 1,500 FLE hours	5,382	-	-	4,736			I	$375	$0	20	646	0	0	$285	1.3	$0	$2,465	$0	$0	$2,090	6.6
3	Infrared Heaters - 100 MBH, 80% Et - baseline standard unit heater 80% Et - 2,000 FLE hours	7,176	-	-	6,315			I	$375	$0	20	861	0	0	$380	1.0	$0	$3,287	$0	$0	$2,912	8.8

Service Region:	**Northern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.648	$0.466
Electricity ($/kWh)	$0.817	$0.103
Water ($/1000L)	$17.108	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	18	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	18	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	18	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	18	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Infrared heaters evaluated at 1,000, 1,500, and 2,000 full-load equivalent hours to reflect the range of operation commonly found in commercial buildings in both the Southern and Northern service regions.
2. The standard unit heater has a thermal efficiency of 80% and a seasonal efficiency of 79% (NRCan's amendment to Canada's Energy Efficiency Regulation Aug 8, 2008)
3. The infrared heater is tube-style with an efficiency of 80% (Union Gas).
4. Costs based on RS Means Mechanical Cost Data 2007
5. The service life is estimated to be 20 years (Union Gas Updated input assumptions (July 2008))

Solar Preheated Make-up Air

Service Region:	**Southern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.817	$0.441
Electricity ($/kWh)	$0.856	$0.111
Water ($/1000L)	$17.927	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Solar Preheated Make-up Air - baseline 1500 cfm make-up air unit at 80% efficiency and 24 hour operation	11,348	-	-	##### ###			F	$11,200	$0	20	2,066	0	0	$911	12.3	$0	$7,887	$0	$0	-$3,313	0.7

Service Region:	**Northern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.817	$0.466
Electricity ($/kWh)	$0.856	$0.103
Water ($/1000L)	$17.927	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1											20	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2											20	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3											20	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Measure analysis based on a RETSceen analysis for a warehouse application; 1500 cfm and 280 ft2 of cladding.
2. Costs are 40/ft2 of cladding (installed) based on Marbek review of REDI applications.
3. Service life based on 20 years (Marbek estimate)
4. Savings based on RETScreen simulations

Condensing Water Heater

Service Region:	**Southern**
Measure Type:	Baseload
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost	Customer Cost
Natural Gas ($/m³)	$4.104	$0.441
Electricity ($/kWh)	$0.918	$0.111
Water ($/1000L)	$19.233	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Condensing Water Heater - 150 MBH, (90% seasonal) - baseline standard efficiency 80% Et (70% seasonal) - 500 FLE hours	3,037	-	-	2,362			I	$2,447	$0	24	675	0	0	$298	8.2	$0	$2,769	$0	$0	$322	1.1
2	Condensing Water Heater - 150 MBH, (90% seasonal) - baseline standard efficiency 80% Et (70% seasonal) - 1,000 FLE hours	6,074	-	-	4,724			I	$2,447	$0	24	1,350	0	0	$595	4.1	$0	$5,539	$0	$0	$3,091	2.3
3	Condensing Water Heater - 150 MBH, (90% seasonal) - baseline standard efficiency 80% Et (70% seasonal) - 1,500 FLE hours	9,111	-	-	7,086			I	$2,447	$0	24	2,025	0	0	$893	2.7	$0	$8,308	$0	$0	$5,861	3.4
4								I		$0	24	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Service Region:	**Northern**
Measure Type:	Baseload
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost	Customer Cost
Natural Gas ($/m³)	$4.159	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Heaters were evaluated at 500, 1,000, and 1,500 equivalent full-load hours to reflect the range of operation and loads commonly found in commercial buildings.
2. The seasonal efficiency of the standard efficiency heater is 75%; and condensing heater 90% (Marbek estimate)
3. The input capacity of the condensing heater is less than the standard efficiency heater.
4. The boiler costs are based on Marbek's in-house database as follows:
   - Standard efficiency heater at $8/MBH
   - Condensing heater $25/MBH
5. The service life of a DHW boiler is 24 years. (BC Hydro QA Standard)

Condensing Tank-Type Water Heater

Service Region:	**Southern**
Measure Type:	Baseload
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost	Customer Cost
Natural Gas ($/m^3)	$3.350	$0.441
Electricity ($/kWh)	$0.747	$0.111
Water ($/1000L)	$15.618	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Condensing Tank-Type Water Heater - 150 MBH, (90% seasonal) - baseline standard efficiency 80% Et (70% seasonal) - 500 FLE hours	3,037	-	-	2,362			I	$2,000	$0	15	675	0	0	$298	6.7	$0	$2,261	$0	$0	$261	1.1
2	Condensing Storage Water Heater - 150 MBH, (90% seasonal) - baseline standard efficiency 80% Et (70% seasonal) - 1,000 FLE hours	6,074	-	-	4,724			I	$2,000	$0	15	1,350	0	0	$595	3.4	$0	$4,522	$0	$0	$2,522	2.3
3	Condensing Storage Water Heater - 150 MBH, (90% seasonal) - baseline standard efficiency 80% Et (70% seasonal) - 1,500 FLE hours	9,111	-	-	7,086			I	$2,000	$0	15	2,025	0	0	$893	2.2	$0	$6,783	$0	$0	$4,783	3.4
4								I		$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Service Region:	**Northern**
Measure Type:	Baseload
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost	Customer Cost
Natural Gas ($/m^3)	$4.159	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Heaters were evaluated at 500, 1,000, and 1,500 equivalent full-load hours to reflect the range of operation and loads commonly found in commercial buildings.
2. The seasonal efficiency of the standard efficiency heater is 75%; and condensing heater 90% (Marbek estimate)
3. The input capacity of the condensing heater is less than the standard efficiency heater.
4. The heater costs are based on Marbek's in-house database and RS Means
5. The service life of a DHW heater is 15 years. (Union Gas DSM 2006 Evaluation Report, June 2007)

Tankless Water Heater

Service Region:	**Southern**
Measure Type:	Baseload
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost	Customer Cost
Natural Gas ($/m^3)	$3.833	$0.441
Electricity ($/kWh)	$0.856	$0.111
Water ($/1000L)	$17.927	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Tankless Water Heater - 150 MBH, (81% seasonal) - baseline standard efficiency 80% Et (70% seasonal) - 500 FLE hours	3,037	-	-	2,625			I	$2,196	$0	20	412	0	0	$182	12.1	$0	$1,581	$0	$0	-$615	0.7
2	Tankless Water Heater - 150 MBH, (81% seasonal) - baseline standard efficiency 80% Et (70% seasonal) - 1,000 FLE hours	6,074	-	-	5,249			I	$2,196	$0	20	825	0	0	$364	6.0	$0	$3,161	$0	$0	$965	1.4
3	Tankless Water Heater - 150 MBH, (81% seasonal) - baseline standard efficiency 80% Et (70% seasonal) - 1,500 FLE hours	9,111	-	-	7,874			I	$2,196	$0	20	1,237	0	0	$546	4.0	$0	$4,742	$0	$0	$2,546	2.2
4								I		$0	20	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Service Region:	**Northern**
Measure Type:	Baseload
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost	Customer Cost
Natural Gas ($/m^3)	$4.159	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Heaters were evaluated at 500, 1,000, and 1,500 equivalent full-load hours to reflect the range of operation and loads commonly found in commercial buildings.
2. The seasonal efficiency of the standard efficiency heater is 70%; and tankless heater 81% (Marbek estimate)
3. The service life of a Tankless DHW heater is 20 years, tank-type 15 years. (Union Gas DSM 2006 Evaluation Report, June 2007)
4. Incremental cost of $15/MBH are based on Marbek's in-house database as follows:
   - Tank-type Heater @ approx $39/MBH (RS Means)
   - Annualized cost over lifetime (@ 10% discount rate): -$5.17 /MBH
   - Present value of annualized cost over 20 years (life of tankless heater): $44.03 /MBH
   - Tankless Heater @ approx $59/MBH (Supplier Information, Takagi)
   - Incremental cost = Tankless/MBH-Tank/MBH $14.64 /MBH

Drainwater Heat Recovery

Service Region: **Southern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.833	$0.441
Electricity ($/kWh)	$0.856	$0.111
Water ($/1000L)	$17.927	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Drainwater Heat Recovery - 10 minute shower, 1.5 times per day	216	-	-	112			I	$900	$0	20	103	0	0	$46	19.7	$0	$397	$0	$0	-$503	0.4
2	Drainwater Heat Recovery - 10 minute shower, 3 times per day	431	-	-	224			I	$900	$0	20	207	0	0	$91	9.9	$0	$793	$0	$0	-$107	0.9
3	Drainwater Heat Recovery - 10 minute shower, 4.5 times per day	647	-	-	336			I	$900	$0	20	310	0	0	$137	6.6	$0	$1,190	$0	$0	$290	1.3

Service Region: **Northern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.159	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Heat recovery was evaluated 1.5, 3 and 4.5 showers per day.
2. The heat recovery efficiency of the drain water system is 48% (NRCan)
3. The cost of the drain water system is $600 to $1,200 (RenewABILITY Energy Inc)
5. The service life is estimated to be 20 years.

Low-Flow Faucets Aerators and Showerheads

Service Region: **Southern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$2.638	$0.441
Electricity ($/kWh)	$0.585	$0.111
Water ($/1000L)	$12.234	$3.050

	Measure Description	Baseline Consumption: Nat. Gas (m^3/yr)	Baseline Consumption: Elec. (kWh/yr)	Baseline Consumption: Water (L/yr)	Upgrade Energy Use: Nat. Gas (m^3/yr)	Upgrade Energy Use: Elec. (kWh/yr	Upgrade Energy Use: Water (L/yr)	Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings: Nat. Gas (m^3/yr)	Annual Energy & Water Savings: Elec. (kWh/yr	Annual Energy & Water Savings: Water (L/yr)	Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor: Nat. Gas	Total Benefits: Elec.	Total Benefits: Water	Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
1	Low Flow Faucets (1.0 gpm) - baseline faucet 2.0 gpm for 1 min/day.	11	-	2,763	6		2,072	F	$5	$0	10	6	0	691	$5	1.1	$0	$15	$0	$8	$19	4.7
2	Low Flow Faucets (1.0 gpm) - baseline faucet 2.0 gpm for 3 min/day.	34	-	8,289	17		6,217	F	$5	$0	10	17	0	2,072	$14	0.4	$0	$45	$0	$25	$66	14.2
3	Low Flow Faucets (1.0 gpm) - baseline faucet 2.0 gpm for 5 min/day.	57	-	13,815	29		10,361	F	$5	$0	10	29	0	3,454	$23	0.2	$0	$76	$0	$42	$113	23.6
4	Low Flow Showerheads (1.25 gpm) - baseline showerhead 2.5 gpm for 5 min/day.	72	-	17,269	36		8,635	F	$20	$0	10	36	0	8,635	$42	0.5	$0	$95	$0	$106	$180	10.0
5	Low Flow Showerheads (1.25 gpm) - baseline showerhead 2.5 gpm for 10 min/day.	144	-	34,538	72		17,269	F	$20	$0	10	72	0	17,269	$84	0.2	$0	$190	$0	$211	$381	20.0
6	Low Flow Showerheads (1.25 gpm) - baseline showerhead 2.5 gpm for 15 min/day.	216	-	51,807	108		25,904	F	$20	$0	10	108	0	25,904	$127	0.2	$0	$284	$0	$317	$581	30.1

Service Region: **Northern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.159	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption: Nat. Gas (m^3/yr)	Baseline Consumption: Elec. (kWh/yr)	Baseline Consumption: Water (L/yr)	Upgrade Energy Use: Nat. Gas (m^3/yr)	Upgrade Energy Use: Elec. (kWh/yr	Upgrade Energy Use: Water (L/yr)	Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings: Nat. Gas (m^3/yr)	Annual Energy Savings: Elec. (kWh/yr	Annual Energy Savings: Water (L/yr)	Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor: Nat. Gas	Total Benefits: Elec.	Total Benefits: Water	Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Savings evaluated at 1,3, and 5 minutes/day for faucets and 5,10, and 15 minutes/day to reflect the range of diversity found in the commercial building stock.
2. Savings based on installing 1.0 gpm (50% savings) faucet aerators and 1.25 gpm (50% savings) shower heads.
3. Costs based on $5 per aerator and $20 per head as per personal communication with Water Conservation Company.
4. The service life is estimated to be 10 years. (BC Hydro QA Standard, Union Gas DSM input assumptions)

Pre-Rinse Spray Valve

Service Region:	**Southern**
Measure Type:	Baseload
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$1.585	$0.441
Electricity ($/kWh)	$0.346	$0.111
Water ($/1000L)	$7.272	$3.050

	Measure Description	Baseline Consumption			Upgrade Consumption			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Pre-Rinse Spray Valve (1.2 gpm) - baseline 3.0 gpm for 20 minutes per day	345	-	82,892	138		33,157	F	$100	$0	5	207	0	49,735	$243	0.4	$0	$328	$0	$362	$590	6.9
2	Pre-Rinse Spray Valve (1.2 gpm) - baseline 3.0 gpm for 40 minutes per day	690	-	165,783	276		66,313	F	$100	$0	5	414	0	99,470	$486	0.2	$0	$656	$0	$723	$1,279	13.8
3	Pre-Rinse Spray Valve (1.2 gpm) - baseline 3.0 gpm for 60 minutes per day	1,035		248,675	414		99,470	F	$100	$0	5	621	0	149,205	$729	0.1	$0	$984	$0	$1,085	$1,969	20.7
4	Pre-Rinse Spray Valve (1.2 gpm) - baseline 3.0 gpm for 225 minutes per day	3,880	-	927,420	2,392		383,333	F	$100	$0	5	1,487	0	544,086	$2,315	0.0	$0	$2,358	$0	$3,957	$6,215	63.1

Service Region:	**Northern**
Measure Type:	Baseload
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.159	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Measure evaluated at 20,40, and 60 minutes/day to reflect range of operation commonly found in food service operations. (see Veritec Consulting. "Region of Waterloo Pre-Rinse Spray Valve Pilot Study")
2. Measure evaluated at 225 minutes/day to reflect Union Gas input assumptions (presently under review)
3. Cost, savings, and service life assumptions based on information provided in study conducted by Veritec Consulting for the Region of Waterloo.
4. Baseline spray valve flow rate from Union Gas input assumptions

Solar Water Heating

Service Region:	**Southern**
Measure Type:	Baseload
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost	Customer Cost
Natural Gas ($/m^3)	$3.350	$0.441
Electricity ($/kWh)	$0.747	$0.111
Water ($/1000L)	$15.618	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Solar Weater Heating System - baseline standard efficiency 80% Et (70% seasonal) - 500 FLE hours	3,037	-	-	2,430			F	$9,000	$100	15	607	0	0	$168	53.6	$761	$2,035	$0	$0	-$7,726	0.2
2	Solar Weater Heating System - baseline standard efficiency 80% Et (70% seasonal) - 1,000 FLE hours	6,074	-	-	4,859			F	$9,000	$100	15	1,215	0	0	$436	20.7	$761	$4,070	$0	$0	-$5,691	0.4
3	Solar Weater Heating System - baseline standard efficiency 80% Et (70% seasonal) - 1,500 FLE hours	9,111	-	-	7,289			F	$9,000	$100	15	1,822	0	0	$704	12.8	$761	$6,105	$0	$0	-$3,656	0.6
4								F		$0	15	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Service Region:	**Northern**
Measure Type:	Baseload
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost	Customer Cost
Natural Gas ($/m^3)	$4.159	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Heating systems were evaluated at 500, 1,000, and 1,500 equivalent full-load hours to reflect the range of operation and loads commonly found in commercial buildings.
2. The seasonal efficiency of the standard efficiency heater is 75%;
3. The cost of the closed loop solar add on based on RS Means Mechanical Cost Data 2007 for a 100 gallon storage tank heater
4. The service life of a solar heating system is estimated to be the same as a storage tank heater - 15 years. (BC Hydro QA Standard)

Booster Water Heater

Service Region:	**Southern**
Measure Type:	Baseload
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.833	$0.441
Electricity ($/kWh)	$0.856	$0.111
Water ($/1000L)	$17.927	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Tankless Booster Water Heater - 75 MBH, (83% seasonal) - baseline standard efficiency 80% Et (70% seasonal) - 800 FLE hours	2,274	-	-	1,918			I	$1,200	$0	20	356	0	0	$157	7.6	$0	$1,365	$0	$0	$165	1.1
2																						

Service Region:	**Northern**
Measure Type:	Baseload
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.159	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Heaters were evaluated at 500 equivalent full-load hours to reflect the typical operation and load of a commercial dishwasher.
2. The seasonal efficiency of the standard efficiency heater is 70%; and tankless heater 83% (Marbek estimate)
3. The burner size of the tankless heater is approximately 3x larger than the standard efficiency heater.
4. The baseline cost based on RS Means, tankless costs are based on supplier information: (http://www.tanklesswaterheaters.ca/takmobtm1.html)
5. The service life of a tankless water booster water heater is assumed to be 20 years (BC Hydro QA Standard)

Commercial Cooking

Service Region: **Southern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$2.638	$0.441
Electricity ($/kWh)	$0.585	$0.111
Water ($/1000L)	$12.234	$3.050

#	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Commercial Griddle (86,100 kBtu/year) Baseline griddle: 32% efficient - High efficiency product: 40%	2,415	-	-	1,932			I	$1,150	$0	10	483	0	0	$213	5.4	$0	$1,274	$0	$0	$124	1.1
2	Commercial Broiler (115,000 - 210,000 kBtu/year) Baseline broiler: 0.808 therms/hr - High efficiency product: 0.658 therms/hr at standard duty cycles.	4,557	-	-	3,711			I	$200	$0	10	846	0	0	$373	0.5	$0	$2,232	$0	$0	$2,032	11.2
3	Commercial Oven (62,400 kBtu/year) Baseline oven: Baseline griddle: 30% efficient - High efficiency product: 40%	1,750	-	-	1,312			I	$1,600	$0	10	437	0	0	$193	8.3	$0	$1,154	$0	$0	-$446	0.7
4	Commercial Gas Fryers (75,000 kBtu/year) Baseline gas range: 35% efficient - High efficiency product: 50%	2,103	-	-	1,472			I	$1,100	$0	10	631	0	0	$278	4.0	$0	$1,665	$0	$0	$565	1.5
5	Efficient Gas Kitchen Appliances Measure	10,825	-	-	8,865			I	$ 2,450	$0	10	1,960	0	0	$864	2.8	$0	$5,171	$0	$0	$2,721	2.1

Service Region: **Northern**
Measure Type: Baseload
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$3.662	$0.400
Electricity ($/kWh)	$0.817	$0.100
Water ($/1000L)	$17.108	$1.750

#	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	18	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	18	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	18	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	18	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

Griddle

1. Griddles evaluated at 12 hours per day, 6 days per week and a duty cycle of 34% (Food Service Technology Center, 2002).
Gives baseline use is 86,100 kBtu/yr (Food Service Technology Centre, 2002)
2. The upgrade has a cooking efficiency of 40% (US ENERGYSTAR)
3. The baseline griddle unit has a cooking efficiency of 32% (US ENERGYSTAR), assumed improvements in same proportion to idling energy use.
4. The griddle costs are based on US ENERGY STAR calculator assumptions
- Standard efficiency unit $2000
- High efficiency unit: $3150
5. The service life of a griddle is 10 years.

Broiler

1. Broilers evaluated at 8 hours per day, 6 days per week and a duty cycle of 70-80% (Food Service Technology Center, 2002).
Gives baseline use is 115,000 - 210,000 kBtu/yr dependingon eqiupment type (Food Service Technology Centre, 2002)
2. The upgrade has an average energy use of 0.658 Therms/h (US ENERGYSTAR)
3. The baseline broiler has an average energy use of 0.808 Therms/h (US ENERGYSTAR)
4. The broiler costs are based on US ENERGY STAR calculator assumptions
- Standard efficiency unit $2300
- High efficiency unit: $2500
5. The service life of a broiler is 10 years (US ENERGY STAR).

Oven

1. Ovens evaluated at 8 hours per day, 6 days per week and a duty cycle of 35% (Food Service Technology Center, 2002).
Gives baseline use is 62,400 kBtu/yr for standard size ovens (standard/convection and combination) (Food Service Technology Centre, 2002)
2. The upgrade has a cooking efficiency of 40% (ENERGYSTAR)
3. The baseline oven has a cooking efficiency of 30% (ENERGYSTAR), assumed improvements in same proportion to idling energy use.
4. The oven costs are based on US ENERGY STAR calculator assumptions
- Standard efficiency unit $2800
- High efficiency unit: $4400
5. The service life of an oven is 10 years.

Fryer

1. Fryers evaluated at 12 hours per day, 6 days per week and a duty cycle of 20% (Food Service Technology Center, 2002).
Gives baseline use is 75,000 kBtu/yr for standard size fryer ("open" deep fat type) (Food Service Technology Centre, 2002)
2. The upgrade has a cooking efficiency of 50% (ENERGYSTAR)
3. The baseline oven has a cooking efficiency of 35% (ENERGYSTAR), assumed improvements in same proportion to idling energy use.
4. The oven costs are based on US ENERGY STAR calculator assumptions
- Standard efficiency unit $2200
- High efficiency unit: $3300
5. The service life of a fryer is 10 years (US ENERGY STAR).

Building Recommissioning

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$1.587	$0.441
Electricity ($/kWh)	$0.346	$0.111
Water ($/1000L)	$7.272	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Recommisioning - baseline is a large office buiding with a gas EUI of 16 m3/m2.yr and an electric EUI of 190 kWh/m2.yr	16.0	190	-	13.6	162		F	$3.8	$0	5	2	29	0	$4	0.9	$0	$4	$10	$0	$10	3.6

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. Savings based on 15% of total building energy use.
2. Costs are $0.35 per square foot based on 2004 LBNL study of retrocommissioning
3. The service life is estimated to be 5 years based on recommended cycle for recommissioning
4. The analysis is based on one m2 of floor area.

Advanced Building Automation Systems

Service Region:	**Southern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$2.632	$0.441
Electricity ($/kWh)	$0.585	$0.111
Water ($/1000L)	$12.234	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1	Advanced BAS - baseline is a large office buiding with a gas EUI of 16 m3/m2.yr and an electric EUI of 190 kWh/m2.yr	16.0	190	-	14.4	171		F	$9.7	$0	10	2	19	0	$3	3.4	$0	$4	$11	$0	$6	1.6
2										$0	10	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	10	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
								F		$0	10	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Service Region:	**Northern**
Measure Type:	Weather
Assumed Discount Rate:	10.00%
Adjustment Factor:	100.00%
Free Rider Rate:	0.00%
Resource Costs:	

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

Installation of an advanced BAS or upgrade with new front-end, automated diagnosis and new control strategies. In this analysis savings of 10% of the whole building EUI are estimated through re-institution of equipment scheduling, expanded control (lighting) and improved self-tuning control strategies.
The costs of an advanced BAS is based on $900 per control point and the and the additional of 1 point per 1,000 ft2 to provide DDC room controls (terminal devices), lighting control and augmented control of central plants and air handling systems.
The service life is estimated to be 10 years.
The analysis is based on one m2 of floor area.

High Performance New Construction

Service Region: **Southern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.441
Electricity ($/kWh)	$0.931	$0.111
Water ($/1000L)	$19.502	$3.050

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy & Water Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV O&M Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr	Water (L/yr)				Nat. Gas	Elec.	Water		
1	High Performane New Construction (25% more efficient) - baseline is a new office buiding with a gas EUI of 12 m3/m2.yr and an electric EUI of 160 kWh/m2.yr	12.0	160	-	9.0	120		I	$26.9	$0	25	3	40	0	$6	4.7	$0	$12	$37	$0	$23	1.8
2	High Performane New Construction (40% more efficient) - baseline is a newe office buiding with a gas EUI of 12 m3/m2.yr and an electric EUI of 160 kWh/m2.yr	12.0	160	-	7.2	88		I	$48.4	$0	25	5	72	0	$10	4.8	$0	$20	$67	$0	$38	1.8

Service Region: **Northern**
Measure Type: Weather
Assumed Discount Rate: 10.00%
Adjustment Factor: 100.00%
Free Rider Rate: 0.00%
Resource Costs:

	Avoided Cost (NPV)	Customer Cost
Natural Gas ($/m^3)	$4.141	$0.466
Electricity ($/kWh)	$0.931	$0.103
Water ($/1000L)	$19.502	$2.250

	Measure Description	Baseline Consumption			Upgrade Energy Use			Installed Cost F=full; I=Incr.		Incr. O&M ($/yr)	Measure Life (yrs)	Annual Energy Savings			Annual Savings ($)	Simple Payback (Yrs)	NPV Maintenance Cost ($)	Total Benefits, Not Adjusted for Free Ridership or Adjustment Factor			Adjusted Measure TRC ($)	Adjusted Benefit/Cost Ratio
		Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)	Nat. Gas (m^3/yr)	Elec. (kWh/yr)	Water (L/yr)					Nat. Gas (m^3/yr)	Elec. (kWh/yr	Water (L/yr)				Nat. Gas	Elec.	Water		
1										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
2										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
3										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A
4										$0	25	0	0	0	$0	0.0	$0	$0	$0	$0	$0	N/A

Notes:

1. New commercial construction with a performance of 25% better than current practice has incremental cost of $2.50/sqft based on 1.7% premium and $150/sqft for office buildings.
2. New commercial construction with a performance of 40% better than current practice has an incremental cost of $4.50/sqft based on 3% premium and $150/sqft for office buidings.
3. The service life is estimated to be 25 years.
4. The analysis is based on one m2 of floor area.
5. Ref: The Costs and Financial Benefits of Green Buildings: A Report of California's Sustainable Building Task Force, October 2003.

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APPENDIX F

Commercial Achievable Workshop Opportunity Profiles

Commercial Opportunity 1:
Roof Insulation

- Technology Description
  - Measure involves upgrading roof insulation to R-22 at time of re-roofing
- Discussion Sub Sector – Small Office
- Discussion "Typical" Application
  - Cost estimated at $\$1/ft^2$ (incremental)
  - Useful life of 20 years
  - Savings of up to 20% of space heating energy (depending on building characteristics)

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Commercial Opportunity 1:
Roof Insulation

- Financial & Economic Indicators
  - 6.7 yrs simple payback
  - B/C ratio = 1.1
  - Basis of assessment > Incremental
- Approximate Number of Eligible Participants
  - 16,000 roofs by 2012
  - 16,000 roofs 2013 to 2017, inclusive

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Commercial Opportunity 2: Heat Recovery Ventilators

- Technology Description
  - Measure involves installing air-to-air heat recovery equipment to pre-heat make-up air
- Discussion Sub Sector – High-rise Apartment
- Discussion "Typical" Application
  - Cost estimated at $2.17/cfm (incremental)
  - Useful life of 15 years
  - Savings of 50% of ventilation heating energy

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Commercial Opportunity 2: Heat Recovery Ventilators

- Financial & Economic Indicators
  - 6.1 yrs simple payback
  - B/C ratio = 1.1
  - Basis of assessment > Incremental
- Approximate Number of Eligible Participants
  - 200 High-rise Apartment buildings by 2012
  - 200 High-rise Apartment buildings 2013 to 2017, inclusive

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Commercial Opportunity 3: ENERGY STAR® Fryers

- Technology Description
  - Measure involves upgrading to an ENERGY STAR fryer at time of equipment turnover
- Discussion Sub Sector – Restaurant/Food Service
- Discussion "Typical" Application
  - Cost estimated at $1,100/unit (incremental)
  - Useful life of 10 years
  - Savings of 30%

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Commercial Opportunity 3: ENERGY STAR® Fryers

- Financial & Economic Indicators
  - 3.5 yrs simple payback
  - B/C ratio = 1.5
  - Basis of assessment > Incremental
- Approximate Number of Eligible Participants
  - 800 Restaurants/Food Service Buildings by 2012
  - 800 Restaurants/Food Service Buildings 2013 to 2017, inclusive

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Commercial Opportunity 4: Condensing Boilers

- Technology Description
  - Measure involves upgrading standard boiler to condensing or near-condensing boiler or at time of equipment turnover
- Discussion Sub Sector – Large Office
- Discussion “Typical” Application
  - Incremental cost estimated at $17/MBH and $3/MBH for condensing and near-condensing respectively
  - Useful life of 25 years
  - Savings of 14% and 6% of space heating energy respectively

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Commercial Opportunity 4: Condensing Boilers

- Financial & Economic Indicators
  - Condensing
    - 4.7 yrs simple payback
    - B/C ratio = 1.8
  - Near-Condensing
    - 1.7 yrs simple payback
    - B/C ratio = 4.9
  - Basis of assessment > Incremental
- Approximate Number of Eligible Participants
  - 70 Large Office Buildings by 2012
  - 70 Large Office Buildings 2013 to 2017, inclusive

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Commercial Opportunity 5: Condensing RTUs

- Technology Description
  - Measure involves upgrading rooftop unit (RTU) to condensing or high efficiency RTU or at time of equipment turnover
- Discussion Sub Sector – Retail
- Discussion "Typical" Application
  - Incremental cost estimated at $25/MBH and $5/MBH for condensing and high efficiency respectively
  - Useful life of 15 years
  - Savings of 19% and 9% of space heating energy respectively

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Commercial Opportunity 5: Condensing RTUs

- Financial & Economic Indicators
  - Condensing
    - 4.5 yrs simple payback
    - B/C ratio = 1.5
  - High Efficiency
    - 2.0 yrs simple payback
    - B/C ratio = 3.4
  - Basis of assessment > Incremental
- Approximate Number of Eligible Participants
  - 1200 Retail Buildings by 2012
  - 1200 Retail Buildings 2013 to 2017, inclusive

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Commercial Opportunity 6: Recommisioning & Advanced BAS

- Technology Description
  - Measure involves applying the retrocommissioning process to an existing building and/or installing an advanced building automation system (BAS)
- Discussion Sub Sector – Large Office
- Discussion "Typical" Application
  - Incremental cost estimated at $0.35/ft^{2}and $0.90/ft^2 for recommissioning and advanced BAS respectively
  - Useful life is 5 and 10 years respectively
  - Savings of 15% and 10% of total energy use respectively

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Commercial Opportunity 6: Recommisioning & Advanced BAS

- Financial & Economic Indicators
  - Recommisioning
    - 1.1yrs simple payback
    - B/C ratio = 3.6
  - Advanced BAS
    - 4.4 yrs simple payback
    - B/C ratio = 1.6
  - Basis of assessment > Full Cost
- Approximate Number of Eligible Participants
  - 340 Large Office Buildings by 2017

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Commercial Opportunity 7: Condensing Storage Water Heaters

- Technology Description
  - Measure involves upgrading to a condensing water heater at time of equipment turnover
- Discussion Sub Sector – Large Office
- Discussion “Typical” Application
  - Incremental cost estimated at $13/MBH
  - Useful life is 15 years
  - Savings of 24% of water heating energy

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Commercial Opportunity 7: Condensing Storage Water Heaters

- Financial & Economic Indicators
  - 3.0 yrs simple payback
  - B/C ratio = 2.3
  - Basis of assessment > Incremental
- Approximate Number of Eligible Participants
  - 110 Large Office Buildings by 2012
  - 110 Large Office Buildings 2013 to 2017, inclusive

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Commercial Opportunity 8: Advanced New Building Construction

- Technology Description
  - This measure involves new construction that is either 40% or 25% more energy efficient that current construction practices
- Discussion Sub Sector – Large Office
- Discussion “Typical” Application
  - Incremental cost estimated at $4.50/ft^2$and $2.50/ft^2$ for 40% and 25% more energy efficient respectively
  - Useful life is 25 years
  - Savings of 40% and 25% of total energy use respectively

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Commercial Opportunity 8: Advanced New Building Construction

- Financial & Economic Indicators
  - 40% more efficient
    - 6.3 yrs simple payback
    - B/C ratio = 1.8
  - 25% more efficient
    - 6.1 yrs simple payback
    - B/C ratio = 1.9
  - Basis of assessment > Incremental Cost
- Approximate Number of Eligible Participants
  - 24 Large Office Buildings by 2012
  - 26 Large Office Buildings 2013-2017, inclusive

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Natural Gas
Energy Efficiency Potential

Industrial Sector

–Final Report–

Submitted to:

Union Gas

Submitted by:

Marbek Resource Consultants Ltd.

March 24, 2009

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Note to Reader

The primary economic data for this study was compiled during the period April to June of 2008. They represented the best available at the time. However, since that time, Canada and other global economies have entered a period of unprecedented economic uncertainty that may have significant impact on the results of this study, particularly in the short term. Three elements that affect this study's results are particularly impacted by these economic changes:

- Sector growth rates
- DSM Program participation rates that are used to determine the estimates of achievable potential
- Type of DSM investment

Sector Growth Rates

Key factors underlying Union's load forecast and the study's Reference Case such as gross domestic product (GDP), energy prices, commodity prices, currency values etc. are expected to change under the current conditions. The impact of these changes, at least in the short term, is expected to be reduced industrial output accompanied by reduced consumption of natural gas. At this time, it is impossible to predict either the extent or the duration of the economic downturn and its consequent impact on natural gas consumption.

DSM Program Participation Rates

The participation rates estimated during the Achievable Potential workshops do not explicitly take into account changes in industry outlook as a result of the economic downturn. In the short term, the expected impact would be lower discretionary investment and, hence, lower program participation rates than those presented in this report. As neither the extent nor the duration of the economic downturn is known at this time, it is not possible to estimate the total reduction in program participation rates over the full study period.

Type of DSM Investment

Many of the DSM investments included in this study's results pass the economic screen on a full cost basis and can be implemented at any time over the study period. This means that even if program participation rates are reduced in the short term, there remains the possibility of recapturing some of these opportunities in later portions of the study period. However, some of the DSM investment opportunities included in the study's results occur only when existing equipment is replaced at the end of its life. This means that if program participation rates are reduced in the short term, then the opportunity to implement the energy efficient model is lost until the equipment again comes up for replacement, which in most applications will be beyond the period covered by this study.

EXECUTIVE SUMMARY

❑ Background and Objectives

Union Gas Ltd. (Union) is a natural gas utility serving almost 1.3 million customers in the residential, commercial and industrial markets. Union is a regulated utility with a franchise area spread across the Province of Ontario, including northern, southwestern and southeastern cities and towns. Union distributes approximately 13.9 billion m^3 (489.9 billion ft^3) of natural gas to its customers annually.

Since 1997, Union has delivered demand side management (DSM) programs to its customers under a mandate from the provincial regulator, the Ontario Energy Board (OEB). Union offers DSM programs to all in-franchise customer rate classes and across all sectors and the DSM savings target and budget are determined through a rate proceeding with the OEB. Over the past eleven years Union has delivered approximately 614 million m^3 of natural gas savings and over $1 billion in net Total Resource Cost (TRC) benefits.

Union has been participating in a market of increasing DSM program maturity. This market is continually evolving in its engagement with energy efficiency through growing voluntary initiatives and more stringent codes and standards. In addition, changes in the economy have started to show signs of negatively impacting the commercial and industrial marketplace in Union's Service Area.

In the DSM Generic Proceeding held in 2006, Union committed to creating an updated Market Potential Study for input into the next DSM plan. This study will support the identification of potential energy savings for Union's next multi-year plan and be part of Union's regulatory filing in the next DSM rate case.

Union has initiated this current study within the context of the conditions noted above. When completed, the results of this natural gas Efficiency Potential Study will provide a foundation that Union can use to guide the development of its longer-term DSM strategy, including new measures and targets.

In the DSM Generic Proceeding held in 2006, Union committed to creating an updated Market Potential Study for input into the next DSM plan. Union has initiated this current study within the context of the conditions noted above. When completed, the results of this Natural Gas Efficiency Potential Study will provide a foundation that Union can use to guide the development of its longer-term DSM strategy, including new measures and targets. More specifically, this includes support for Union's filing to the OEB regulatory application for the next multi-year DSM plan by:

- Estimating the achievable and economic potential for DSM measures across all applicable technologies, markets and sectors in Union's Service Area
- Giving shape to, and refining ongoing energy-efficiency work by Union in order to develop its next multi-year DSM plan, and
- Provide information that is actionable and can be easily converted to plan and program development.

❑ Scope and Organization

This study covers a 10-year study period from 2007 to 2017 and addresses the Residential, Commercial and Industrial sectors. The 2007 calendar year was selected as the Base Year as this is the most recent year for which complete customer data are available.

The study addresses the full range of natural gas efficiency measures. Results are presented for the total Union Service Area and for two service regions: The study results are disaggregated by service region due to differences in the distribution of industry sub sectors.

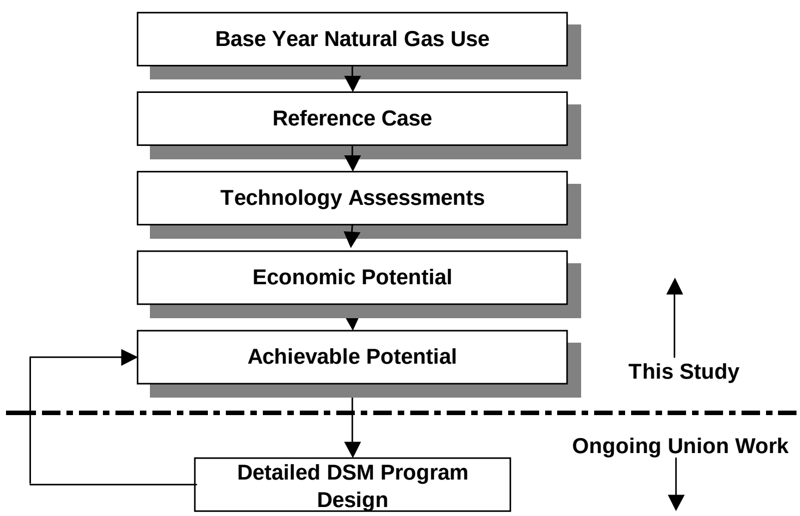
This report presents the results for Union's Industrial sector.

❑ Approach

The detailed end-use analysis of energy-efficiency opportunities in the Industrial sector employed Marbek's Industrial Energy-efficiency Model (IEEM), an in-house spreadsheet-based macro model. The model is described in further detail in Section 1.

The major steps involved in the analysis are shown in Exhibit ES1 and are discussed in greater detail in Section 1. As illustrated in Exhibit ES1, the results of this study, and in particular the estimation of Achievable Potential,[1] support Union's on-going DSM program planning; however, it should be emphasized that the estimation of Achievable Potential is not synonymous with either the setting of specific targets or with detailed program design, which are beyond the scope of this study.

Exhibit ES1: Study Approach - Major Analytical Steps



❑ Overall Study Findings

As in any study of this type, the results presented in this report are based on a large number of important assumptions. Assumptions such as those related to the current penetration of energy-efficient technologies, the rate of future growth in the province's industrial sectors and customer

[1] The proportion of savings identified that could realistically be achieved within the study period, under various program spending and market conditions.

willingness to implement new efficiency measures are particularly influential. Wherever possible, the assumptions used in this study are consistent with those used by Union and are based on best available information, which in many cases includes the professional judgement of the consultant team, Union personnel and local experts. The reader should, therefore, use the results presented in this report as best available estimates; major assumptions, information sources and caveats are noted throughout.

The study findings confirm the existence of significant cost-effective DSM potential in Union's Industrial sector. Natural gas savings from efficiency improvements within the Union Service Area would provide between 846 and 524 million m^3/year of natural gas savings by 2017 in, respectively, the Financially Unconstrained and the Static Marketing Achievable scenarios. The most significant Achievable Savings opportunities were in the actions that reduce gas usage for process heating (specifically for ovens, dryers, furnaces and kilns), boiler steam systems and plant-wide systems.

Although program costs for the Financially Unconstrained and the Static Marketing scenarios will vary depending on the specific composition of the future program portfolio, both scenarios show an evident trend towards higher future costs to achieve natural gas savings and TRC benefits.[2] This trend recognizes that savings from DSM programs tend to become more expensive over time, as the most attractive measures gain greater market penetration and only the more challenging measures remain.[3]

- Summary of Natural Gas Savings

A summary of the levels of annual natural gas consumption contained in each of the forecasts addressed by the study is presented in Exhibits ES2 and ES3, by milestone year, and discussed briefly in the paragraphs below.

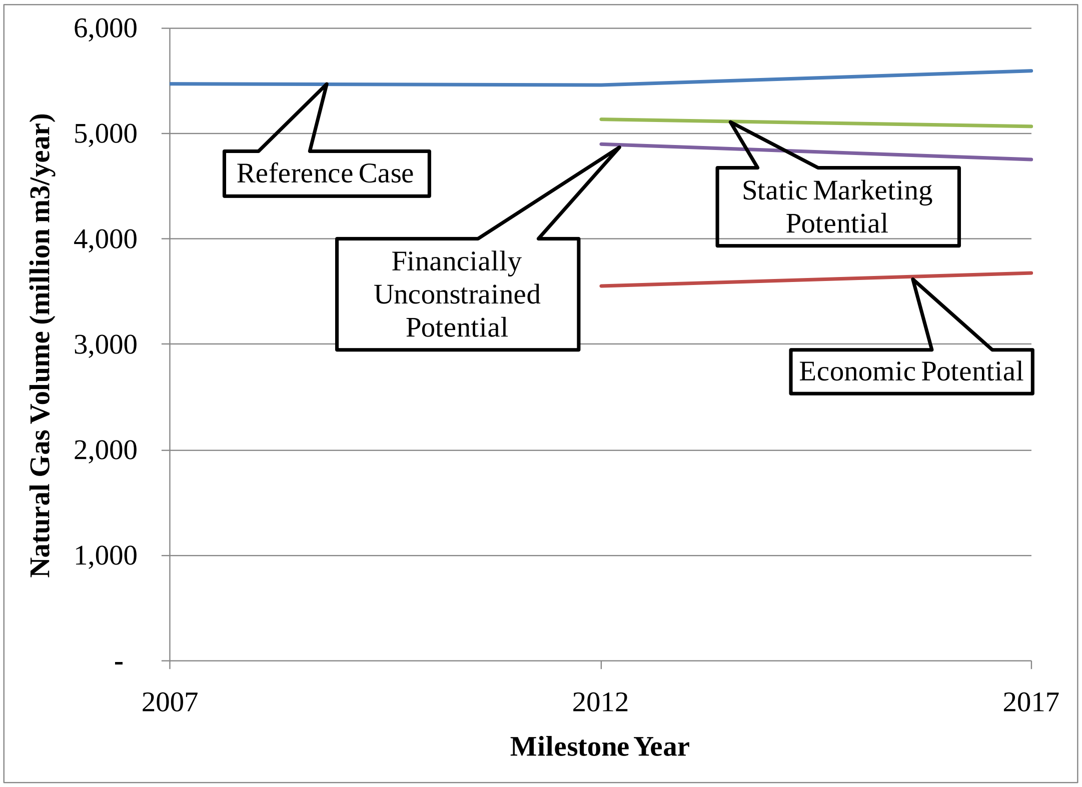
Exhibit ES2: Summary of Forecast Results for the Total Union Service Area – Annual Natural Gas Consumption and Savings, Industrial Sector (million m^3/yr.)

Annual Consumption in Industrial Sector (million m^3/yr.)					Potential Annual Savings (million m^3/yr.)		
Milestone Year	Reference Case	Economic Potential	Achievable Potential: Financially Unconstrained	Achievable Potential: Static	Economic Potential	Achievable Potential: Financially Unconstrained	Achievable Potential: Static
	(A)	(B)	(C)	(D)	(A-B)	(A-C)	(A-D)
2007	5,465	-	-	-	-	-	-
2012	5,458	3,555	4,901	5,141	1,903	557	318
2017	5,598	3,675	4,752	5,074	1,923	846	524

[2] Design of a DSM program portfolio is beyond the scope of this current study.

[3] Over time, it is also expected that some relatively new technologies, such as condensing boilers, may become less expensive as they gain greater sales volumes.

Exhibit ES3: Graphic of Forecast Results for the Total Union Service Area – Annual Natural Gas Consumption, Industrial Sector (million m^3/yr.)



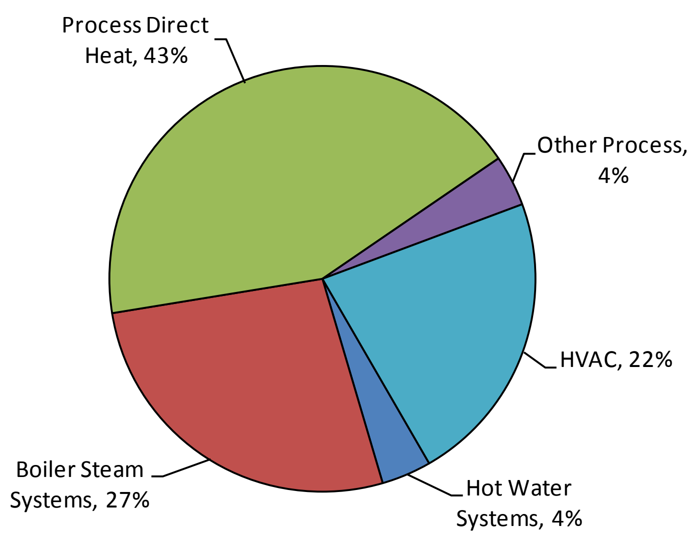
Base Year Natural Gas Use

In the Base Year of 2007, Union's Industrial sector consumed about 5,465 million m^3 of natural gas. Exhibit ES4 shows that process direct heat accounts for about 43% of total industrial natural gas use. Boiler steam systems account for about 27% of the total natural gas use, followed by heating, ventilation and cooling (HVAC) (22%) and hot water systems (4%). The remaining 4% of natural gas consumption occurs in a variety of other processes that are sub sector specific, such as using gas for steam generation in steam dryers.

Exhibit ES4: Base Year Natural Gas Use by End Use for the Total Union Service Area, Industrial Sector (1000 m^3/yr.)

Sub Sector	End Use						
	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	27,568	161,964	963,099	31,428	194,357	1,378,415	25%
Contract Chemical	20,117	408,369	331,925	74,222	171,201	1,005,834	18%
Other Chemical	741	15,034	12,220	2,732	6,303	37,030	0.7%
Contract Paper	11,344	353,887	107,431	10,380	84,175	567,218	10%
Contract Transportation and Machinery	7,827	91,046	117,313	15,868	159,278	391,332	7%
Other Transportation and Machinery	2,984	34,718	44,734	6,051	60,736	149,223	3%
Contract Petroleum Refineries	7,520	72,251	253,607	6,738	35,873	375,989	7%
Contract Mining	64,023	80,029	112,041	16,006	48,017	320,117	6%
Other Mining	5	6	9	1	4	25	0.0004%
Contract Food and Beverage	20,142	120,397	69,212	15,585	26,436	251,771	5%
Other Food and Beverage	4,463	26,680	15,337	3,454	5,858	55,793	1%
Contract Non-Metallic Mineral	5,598	33,477	198,345	10,581	31,910	279,911	5%
Miscellaneous Industrial	33,945	75,984	127,031	17,690	398,131	652,781	12%
Total	206,277	1,473,842	2,352,303	210,736	1,222,280	5,465,438	
%	4%	27%	43%	4%	22%		

Note: Totals may not add to 100% due to rounding.



Roughly 25% of the natural gas consumption in the Industrial sector is used by the Contract Primary Metal sub sector. The Contract Chemical sub sector uses about 18%, followed by Miscellaneous Industrial (12%), and Contract Paper (10%). The Southern service region accounts for nearly 70% of the industrial natural gas consumption in the total Union Service Area.

Reference Case

In the absence of new Union DSM initiatives, the study estimates that natural gas consumption in Union's Industrial sector will grow from 5,465 million m^3 in 2007 to about 5,598 million m^3 by 2017. This represents an overall growth of about 2.4% in the period and compares very closely with Union's load forecast, which also included consideration of the impacts of "natural conservation."

Economic Potential Forecast

Under the conditions of the Economic Potential Forecast,[4] the study estimated that natural gas consumption in Union's Industrial sector would decline from the Base Year levels of 5,465 million m^3 to about 3,675 million m^3 by 2017. Annual savings in 2017 relative to the Reference Case are 1,923 million m^3, or about 34%.

Achievable Potential

As noted above, the Achievable Potential is the proportion of the economic natural gas savings that could practically be achieved within the study period under various program spending and marketing conditions.

Under the conditions defined by the Financially Unconstrained scenario, total Industrial sector natural gas savings in 2017 are estimated to be approximately 846 million m^3/year. This represents a savings of approximately 15%, relative to the Reference Case, and is equal to approximately 44% of the savings identified in the Economic Potential Forecast.

The most significant opportunities for natural gas savings in this scenario are technologies that reduce gas usage for process heating, specifically ovens, dryers, kilns and furnaces. Implementation of energy-efficiency measures in boiler steam systems is also a significant opportunity. Measures that improve the total plant (referred to as system wide) energy efficiency are the third most significant opportunity area.

Under the conditions defined by the Static Marketing scenario, total Industrial sector natural gas savings in 2017 are estimated to be approximately 524 million m^3/yr. This represents a savings of approximately 9%, relative to the Reference Case and is equal to approximately 27% of the savings identified in the Economic Potential Forecast.

Similar to the Financially Unconstrained scenario, the most significant opportunities for natural gas savings are technologies and measures applicable to process heating, boiler steam systems and system wide (or plant wide).

[4] The level of natural gas consumption that would occur if all equipment and systems were upgraded to the level that is cost effective. In this study, "cost effective" means that the technology upgrade passes the measure TRC test.

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1. INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

Union Gas Ltd. (Union) is a natural gas utility serving almost 1.3 million customers in the residential, commercial and industrial markets. Union is a regulated utility with a franchise area spread across the Province of Ontario including northern, southwestern and southeastern cities and towns. Union distributes approximately 13.9 billion m^3 (489.9 billion ft^3) of natural gas to its customers annually.

Since 1997, Union has delivered demand side management (DSM) programs to its customers under a mandate from the provincial regulator, the Ontario Energy Board (OEB). Union offers DSM programs to all in-franchise customer rate classes and across all sectors and the DSM savings target and budget are determined through a rate proceeding with the OEB. Over the past eleven years Union has delivered approximately 614 million m^3 of natural gas savings and over $1 billion in net Total Resource Cost (TRC) benefits.

Union has been participating in a market of increasing DSM program maturity. This market is continually evolving in its engagement with energy efficiency through growing voluntary initiatives and more stringent codes and standards. In addition, changes in the economy have started to show signs of negatively impacting the commercial and industrial marketplace in Union's Service Area.

In the DSM Generic Proceeding held in 2006, Union committed to creating an updated Market Potential Study for input into the next DSM plan. This study will support the identification of potential energy savings for Union's next multi-year plan and be part of Union's regulatory filing in the next DSM rate case.

Union has initiated this current study within the context of the conditions noted above. When completed, the results of this natural gas Efficiency Potential Study will provide a foundation that Union can use to guide the development of its longer-term DSM strategy, including new measures and targets. More specifically, this includes support for Union's filing to the OEB regulatory application for the next multi-year DSM plan by:

- Estimating the achievable and economic potential for DSM measures across all applicable technologies, markets and sectors in Union's Service Area.

- Giving shape to, and refining, ongoing energy-efficiency work by Union in order to develop its next multi-year DSM plan.

- Provide information that is actionable and can be easily converted to plan and program development.

1.2 STUDY SCOPE

The scope of this study is summarized below.

Sector Coverage: The study addresses three sectors: Residential, Commercial and Industrial.

Geographical Coverage: The study results are presented for the total Union Service Area and for two service regions: Southern and Northern. The southern region of Union's system extends through Southwestern Ontario from Windsor to just west of Toronto. The Northern region of Union's system extends throughout Northern Ontario from the Manitoba border to the North Bay/Muskoka area and across Eastern Ontario from Port Hope to Cornwall. The study results are disaggregated by service region due to differences in building stock and weather conditions (heating degree days).

Study Period: This study covers a 10-year period. The Base Year is the calendar year 2007, with milestone periods at five-year increments: 2012 and 2017. The Base Year of 2007 was selected, as this was the most recent calendar year for which complete customer data were available.

Technologies: The study addresses the full range of natural gas energy-efficiency measures. All the measures that were assessed in the study are summarised in Exhibit 1.1. In consultation with Union, some measures were combined, such as boiler right sizing and load management. Two measures, first generation super boiler and computational fluid dynamic (CFD) modeling, were screened out end excluded from the study. First generation super boilers are an emerging technology and its application and potential market take up is considered to be too uncertain, and potentially very limited, for inclusion in the potential analysis. CFD is a tool to identify improvement projects and the resulting measures are captured by existing measures. Inclusion of CFD would result in double counting the savings. More detailed description of the measures and the technologies included in the measures are provided in Section 4.

1.2.1 Data Caveat

As in any study of this type, the results presented in this report are based on a large number of important assumptions. Assumptions such as those related to the current penetration of energy-efficient technologies, the rate of future growth in Union's industrial load and customer willingness to implement new energy-efficiency measures are particularly influential.

Wherever possible, the assumptions used in this study are consistent with those used by Union and are based on best available information, which in many cases includes the professional judgment of the consultant team, Union personnel and/or local experts. The reader should use the results presented in this report as best available estimates; major assumptions, information sources and caveats are noted throughout.

Exhibit 1.1: Industrial Energy-Efficiency Technologies

End Use	Energy Management Measure List
System	Integrated control system
	Sub-metering
Boilers, Steam and Hot Water Systems	Economizer
	Blowdown heat recovery
	Boiler combustion air preheat
	Process heat recovery to pre-heat make-up water
	Condensing boiler
	First generation super boilers
	Direct contact hot water heaters
	Boiler right sizing and load management
	High-efficiency burners
	Insulation
	Advanced boiler controls
	Blowdown control
	Boiler water treatment
	Boiler maintenance
	Minimize deaerator vent losses
	Condensate return
	Steam trap survey and repair
	Instantaneous steam generation
Process Direct Heat (Furnaces / Kilns / Ovens / Dryers)	Exhaust gas heat recovery
	High-efficiency burners and burner controls
	Oxy-gas direct impingement heating for steel annealing
	Insulation
	Advanced heating and process control
	High-efficiency ovens
	High-efficiency dryers
	High-efficiency kilns
	High-efficiency furnaces
	Air curtains
Other Process	Pollution control measures
	Computational fluid dynamic modeling
	Hydrogen atmospheres for steel batch coil annealing
	Process Heat Recovery
HVAC	Radiant heaters
	Automated temperature control
	Solar walls
	Ventilation heat recovery & optimization
	Warehouse loading dock seals
	Air curtains
	Air compressor heat recovery
	Destratification fans

1.3 DEFINITIONS[5]

This study employs numerous terms that are unique to analyses such as this one and consequently it is important to ensure that readers have a clear understanding of what each term means when applied to this study. Below is a brief description of some of the most important terms.

Base Year Natural Gas Use The Base Year of 2007 is the starting point for the analysis. It provides a detailed description of "where" and "how" natural gas is currently used in the Industrial sector. A bottom up profile of energy use patterns and market shares of energy-using technologies was calibrated to actual Union customer billing data.

Reference Case Forecast The Reference Case is a projection of natural gas consumption to 2017, in the absence of any new Union DSM market interventions after 2007. It is the baseline against which the scenarios of energy savings are calculated. The Reference case forecast incorporates an estimation of "natural conservation," namely, changes in end-use efficiency over the study period that are projected to occur in the absence of new market interventions. The Reference Case, therefore, provides the point of comparison for the calculation of opportunities associated with each of the subsequent scenarios that are assessed within this study.

Measure Total Resource Cost The measure TRC calculates the net present value of energy and water savings that result from an investment in an efficiency technology or measure. The measure TRC is equal to its full or incremental capital cost (depending on application) plus any change (positive or negative) in the combined annual energy and equipment operating and maintenance (O&M) costs. This calculation includes, among others, the following inputs: the avoided natural gas, electricity and water supply costs, the life of the technology and the selected discount rate, which in this analysis has been set at 10%.

The measure TRC test is the primary determinant of whether a measure is included in the economic potential forecast.

Milestone Years The Base Year is the calendar year 2007, and the milestone years are defined at five-year increments: 2012 and 2017.

[5] A Glossary is provided in Section 9.

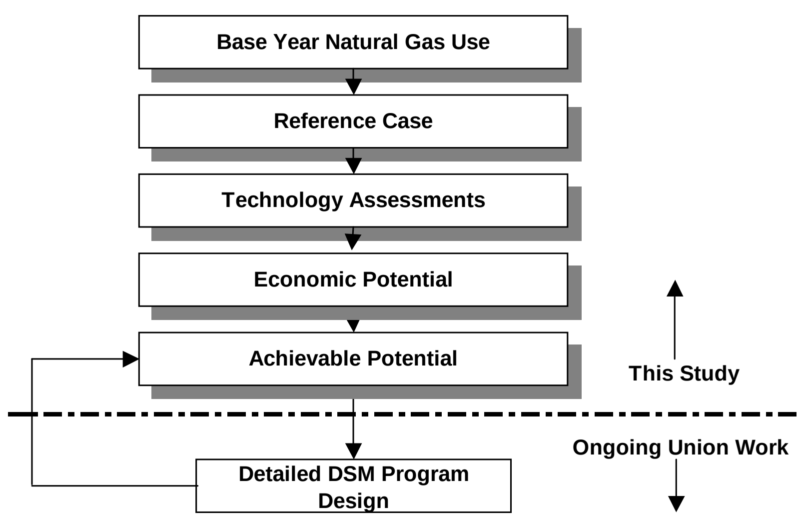
Economic Potential Forecast The Economic Potential Forecast is the level of natural consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective from Union's perspective. All the energy-efficiency technologies and measures that have a positive measure TRC are incorporated into the Economic Potential Forecast. These technologies and measures are applied at either natural stock turnover rates or at designated years for immediate application.

Achievable Potential The Achievable Potential is the proportion of the natural gas savings identified in the Economic Potential Forecast that could realistically be achieved, given no other market barriers, within the study period. Achievable Potential recognizes that it is difficult to induce customers to purchase and install all of the efficiency technologies that meet the criteria defined by the Economic Potential Forecast.

1.4 APPROACH

To meet the objectives outlined above, the study was conducted within an iterative process that involved a number of well-defined steps. At the completion of each step, the client reviewed the results and, as applicable, revisions were identified and incorporated into the interim results. The study then progressed to the next step. A summary of the steps is presented in Exhibit 1.2 and briefly discussed below.

Exhibit 1.2: Major Study Steps



Step 1: Develop Profile of Base Year Natural Gas Use

- Compile and analyze available data on Union's existing industrial facilities including customer billing data and information from customer surveys, etc.
- Divide industrial facilities into Union service regions and sub sectors and compile actual Union billing data for each
- Develop detailed technical profiles of natural gas use in the existing facilities within each sub sector

- Undertake computer simulations of energy use in the existing facilities, generate model results by sub sector, end use and service region, and compare these with actual billing data and data from Marbek's in-house database
- Calibrate model results using actual Union billing data
- The output of Step 1 forms Section 2 of this report.

Step 2: Develop Reference Case Forecast for the Study period

- Compile and analyze data on forecast growth in output for each major sub sector
- Compile data on "natural" changes in equipment efficiency levels and/or practices. (For definition of "natural conservation," see above under Section 1.3: "Reference Case Forecast")
- Define sector model inputs and create forecasts of energy use for each of the milestone years
- Compare sector model results with Union's forecast for the period
- The output of Step 2 forms Section 3 of this report.

Step 3: Develop and Assess Energy-efficiency Upgrade Options

- Develop list of energy-efficiency measures in consultation with Union
- Compile detailed cost and performance data for each measure
- Assess the energy and economic impacts of implementing the energy-efficiency upgrade options in place of the baseline technologies employed in the Reference Case
- Determine the measure TRC for each upgrade option
- The output of this task forms Section 4 of this report.

Step 4: Estimate Economic Energy Savings Potential

- Compile utility economic data on the forecast cost of new natural gas supply
- Screen the identified energy-efficiency upgrade options from Step 3 against the utility economic data
- Identify the combinations of energy-efficiency upgrade options and sub sectors where the measure TRC is positive
- Apply the economically attractive efficiency measures from Step 3 within the energy use simulation model developed previously for each industrial sub sector
- Compare the energy consumption levels when all economic efficiency measures are used with the Reference Case consumption levels and calculate the energy savings
- The output of this task forms Section 5 of this report.

Step 5: Estimate Achievable Energy Savings Potential

- "Bundle" the energy saving opportunities identified in the Economic Potential Forecast into a set of Actions
- Create "Action Profiles" for each of the identified Actions that provide a "high-level" rationale and direction, including target technologies and sub markets as well as key barriers and a broad intervention strategy
- Review historical achievable program results and prepare preliminary Action Assessment Worksheets
- Conduct Achievable Potential workshops involving utility and consultant team personnel, selected trade allies and technology and market experts to reach general agreement on a range of achievable potential based on different funding scenarios
- The output of this task forms Section 6 of this report.

1.5 ANALYTICAL MODELS

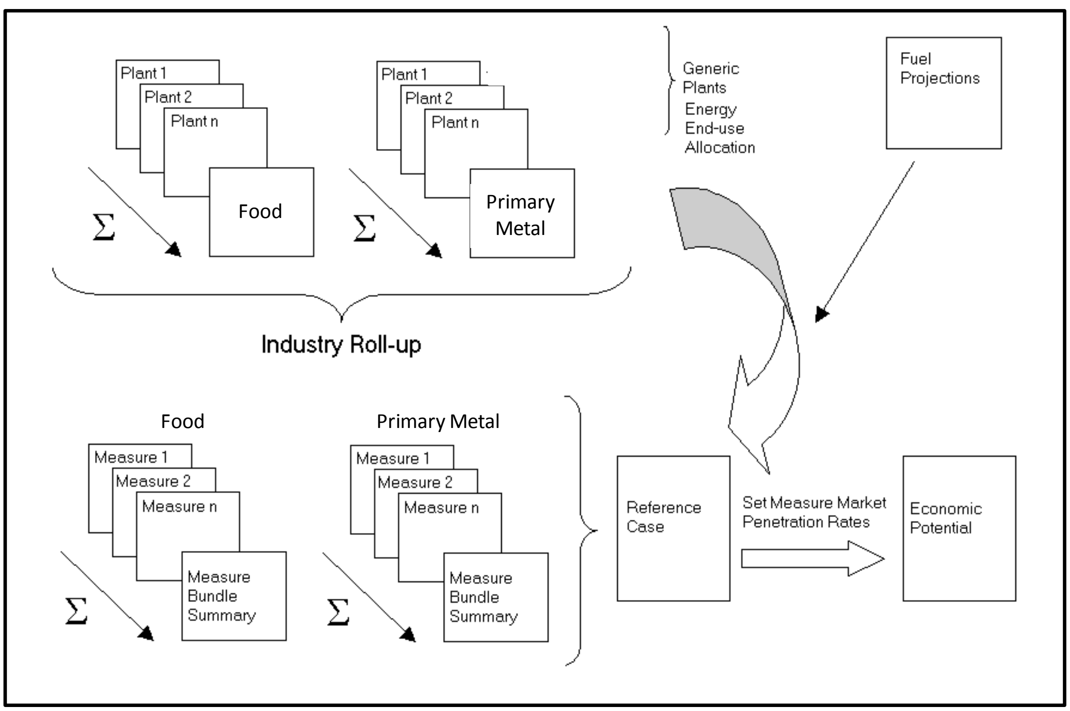
The analysis of the Industrial sector employed Marbek's Industrial Energy Efficiency Model (IEEM)[6]. The model is built in a spreadsheet format and is organized by major industrial sub sector and major end use. The sub sectors and end uses are described in detail in Section 2.

The model addresses each sub sector by defining a "generic" plant for the sub sector as a whole. Exhibit 1.3 illustrates how the model combines sub sector, end use, efficiency measures and fuel share data to generate the energy use forecasts used in the study.

The generic plant construct within the model is used to define an energy consumption profile representative of a "typical" or archetype plant within a given industry sub sector (or a specific type of plant within a given sub sector if there are substantial process differences). The generic plant is a composite of energy use patterns, energy intensities and consumption levels within the particular target sub sector. The candidate energy management measures are applied to the generic plant to model energy savings potential.

Marbek's existing stock of generic industrial plants was used as a starting point for the analysis. The model was customized to the specific Union industrial customer base, based on reports provided by Union, a literature research and the study team's extensive work in Ontario's industrial facilities.

Exhibit 1.3: Industry Energy Efficiency Model (IEEM) Diagram



[6] All input assumptions that are not otherwise referenced are from the Marbek internal database.

1.6 THIS REPORT

This report addresses the Industrial sector and provides a summary of the results to date. This initial report is presented in the following sections.

- Section 2 presents a profile of Base Year natural gas use in Union's Service Area, including a discussion of the major steps involved and the data sources that were employed.
- Section 3 presents the Industrial sector Reference Case for the study period 2007 to 2017.
- Section 4 provides a financial and economic assessment of the identified Industrial sector energy-efficiency measures.
- Section 5 presents the Industrial sector Economic Potential Forecast for the study period 2007 to 2017.
- Section 6 presents the estimated range of Achievable Potential for natural gas savings, under differing scenarios, for the study period 2007 to 2017.
- Section 7 presents high level conclusions.
- Section 8 presents a listing of major references.

2. BASE YEAR NATURAL GAS USE

2.1 INTRODUCTION

This section presents a description of natural gas use in Union's Industrial sector in the Base Year of 2007. Drawing on the best available data, this section presents total natural gas consumption in Union's Industrial sector, together with an estimate of how that consumption is distributed by service region, sub sector, end use and technology.

The remainder of this section outlines the steps involved in preparing the profile of Base Year natural gas use and presents a summary of the results. The discussion is organized into the following subsections:

- Segmentation of Industrial sector facilities
- Union industrial Base Year sales data
- End-use profile of natural gas consumption
- Summary of Base Year model results.

2.2 SEGMENTATION OF INDUSTRIAL FACILITIES

The first step in the Base Year calibration required segmenting the industrial accounts into sub sectors. To facilitate the analysis of energy-efficiency options in later stages of this analysis, the accounts were grouped such that the natural gas using processes and technologies were approximately similar within each sub sector.

A summary of the Industrial sub sectors used in this study is provided in Exhibit 2.1. Exhibit 2.1 also shows the Union sub sector customer groups that are included in each of the defined Industrial sub sectors.

It was also agreed that the primary study focus would be on the large, contract sub sectors (see Section 2.2.2 below for definition). The modelled output from these sub sectors was used to derive results for the remaining sub sectors defined in Exhibit 2.1. The derived results were based on the proportional natural gas consumption by each sub sector.

Exhibit 2.1: Industrial Sub Sectors and Union Sub sector Descriptions

Study Sub sectors	Union Sub sectors Included
Contract Primary Metal	Steel & Non-Ferrous Smelting (Contract)
Contract Paper	Pulp & Paper (Contract)
Contract Transportation and Machinery	Auto (Contract)
Other Transportation and Machinery	Heavy Mfg/Assembly Light Mfg/Assembly
Contract Chemical	Chemical (Contract)
Other Chemical	Chemical/Petro Processing
Contract Food and Beverage	Food & Beverage (Contract)
Other Food and Beverage	Food & Beverage Processing
Contract Mining (Except oil and gas)	Mining (Contract)
Other Mining (Except oil and gas)	Industrial Mines Aggregate Processing / Mfg.
Contract Non-Metallic Mineral	Glass (Contract) Cement (Contract) Lime (Contract) Building Products (Contract)
Contract Petroleum Refineries	Refinery (Contract)
Miscellaneous Industrial	Greenhouse (Contract) Miscellaneous (Contract) Recycling (Contract) Industrial Building / Other Metal Fabrication (Contract) Textiles and Apparel Wood & Paper Mfg (small / medium) Marketers / Producers (Contract) Asphalt (Contract) Smelting / Casting / Refining SME Agriculture (Contract) Farm / Agriculture Building Farm / Agriculture Other Farm / Agriculture Pump Farm / Agriculture Drying

Selected additional information elaborating on the definition of the sub sectors shown in Exhibit 2.1, such as NAICS classification and definition of “contract” sub sectors, is provided below.

2.2.1 Sub Sector Classification

Classification of the study sub sectors is based on the North American Industry Classification System (NAICS). The eight core sub sectors modelled in the study and their associated NAICS codes and descriptions are summarized in Exhibit 2.2.

Exhibit 2.2: Industrial Sub Sectors and Associated NAICS Codes and Descriptions

NAICS	NAICS Description
331	Primary Metal Manufacturing
322	Paper Manufacturing
336 & 333	Transportation Equipment Manufacturing & Machinery Manufacturing
325	Chemical Manufacturing
311 & 312	Food Manufacturing & Beverage and Tobacco Product Manufacturing
212	Mining (except Oil and Gas)
32411	Petroleum Refineries
327	Non-metallic Mineral Product Manufacturing

2.2.2 Contract Sub Sectors

Union divides its industrial customers into large volume users and small and medium volume users. The large volume users are referred to as “Contract” market customers by Union; the small and medium volume users are referred to as “Other” in this study. For example, “Contract Chemical” refers to the all the large volume users (referred to by Union as Contract market) in the NAICS sub sector 325 – Chemical Manufacturing; the “Other Chemical” sub sector refers to all the small and medium volume customers in the same NAICS sub sector.

2.2.3 Electric Power Generation

The Electric Power Generation sub sector includes the Union Gas sub sectors of Hydro (in the Contract market), and Independent Power Producers. This sub sector is not included in the current scope of the assessment, and Union Gas will assess the energy efficiency potential in this sector separately, or as part of an extension of the study scope.

2.3 UNION CUSTOMER BASE YEAR SALES DATA

Once agreement was reached on the selection and definition of the Industrial sub sectors shown in Exhibit 2.1, Union compiled a summary of its total 2007 customer sales, segmented into the selected sub sectors. The original billing data included natural gas consumption as feedstock and for on-site cogeneration. Sub sectors for which cogeneration and/or feedstock comprise a large portion of total gas consumption include:[7]

- Chemical Manufacturing (32%)
- Petroleum Refining (55%)
- Transportation Equipment and Machinery Manufacturing (5%)
- Food and Beverage Manufacturing (37%).

As natural gas use for cogeneration and feedstock are outside the scope of this study, these consumption volumes were subtracted from the sub sector totals addressed by this study.[8] The resulting Base Year natural gas consumption in each service area by sub sector and total Industrial sector is summarised in Exhibit 2.3.

Exhibit 2.3: Base Year Industrial Natural Gas Use, by Service Region

Sub Sector	Gas Consumption (1000 m^3)			Percentage of Total (%)
	Northern	Southern	Total	
Contract Primary Metal	398,032	980,383	1,378,415	25%
Contract Chemical	256,247	749,587	1,005,834	18%
Other Chemical	2,310	34,720	37,030	0.7%
Contract Paper	537,762	29,456	567,218	10%
Contract Transportation and Machinery	10,593	380,739	391,332	7%
Other Transportation and Machinery	1,411	147,811	149,223	3%
Contract Petroleum Refineries	-	375,989	375,989	7%
Contract Mining	307,752	12,365	320,117	6%
Other Mining	-	25	25	0.0004%
Contract Food and Beverage	39,603	212,168	251,771	5%
Other Food and Beverage	2,527	53,266	55,793	1%
Contract Non-Metallic Mineral	21,239	258,672	279,911	5%
Miscellaneous Industrial	76,363	576,418	652,781	12%
Total	1,653,839	3,811,599	5,465,438	100%
Percentage	30%	70%		

[7] An assessment of data obtained at the completion of this study indicated that up to about 42% of the Base Year natural gas consumption in the Contract Primary Metal sub sector could be considered as feedstock. It was not feasible to include the data in the study at this late stage of the study. The implication is that the energy efficiency potential in the Contract Primary Metal sub sector might be overstated.

[8] It was assumed that all cogeneration occurs within the Contract sub sectors.

2.4 END-USE PROFILE OF NATURAL GAS CONSUMPTION

The next step involved the development of a profile that shows how the natural gas use presented in Exhibit 2.3 is distributed among the major end uses that were defined for this study, namely:

- Hot Water Systems
- Boilers and Steam Systems
- Process Direct Heat
- Other Process
- HVAC.

The following discussion provides a brief description of each end use and, to the extent that data permit, provides highlights on the Base Year conditions.

2.4.1 Hot Water Systems

This end use includes all hot water boilers, water heaters and hot water distribution systems. The boilers/heaters and hot water distribution system are considered as one end use because any energy-efficiency measures applied to the distribution system will result in a reduction in gas consumption at the boilers/heaters. For boiler population and vintage see the discussion below under the boilers and steam system end use.

2.4.2 Boiler steam systems

Similar to the hot water systems, this end use includes all steam boilers, steam distribution systems and condensate return systems. The boilers and steam distribution systems are considered as one end use because any energy-efficiency measures that are applied to the distribution system will result in a reduction in gas consumption at the boilers.

In 2005, the Union Service Area included about 2,080 boilers in steam plants in the Industrial and institutional sectors.[9] Assuming at least 70% of the boilers are in the Industrial sector, the estimated population of large, steam boilers in the Union Service Area is approximately 1,500 units.

Although detailed data on the distribution of Ontario industrial boilers by size is not available, the results of similar work in the U.S. is expected to be at least indicative of conditions within Ontario's Industrial sector. Exhibit 2.4 provides a profile of the U.S. steam and hot water boiler population by size.

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[9] Griffin, B. *The Enbridge "Steam Saver" Program – Steam Boiler Plant Efficiency-Update to Year End, 2005*. 2006. www.steamingahead.org/library/enbridge05.pdf. (Latest publically available report).

Exhibit 2.4: Profile of Size Distribution of Boilers in U.S.[10]

Boiler Size		Percentage of Total
[BHP]	**[MMBTU/hr]**	
<300	<10	55%
300-1500	10-50	29%
1500-3000	50-100	8%
3000-7500	100-250	5%
>7500	>250	3%

Although detailed data on the age of Ontario's steam boilers is not available, the same U.S. data noted above indicates that the vintage profile for boilers larger than 300 BHP is that 7% are less than 10 years old and 76% are more than 30 years old. Based on the age of Ontario's industry it is expected that a similar vintage profile would be applicable to Ontario's heavy industry, such as Primary Metal, Chemical, Paper, Petroleum Refineries and Mining, while the lighter manufacturing industry in Ontario's profile will have a larger percentage of newer boilers. Larger boilers tend to be primarily steam boilers, while smaller boilers include a larger share of hot water boilers.

2.4.3 Process Direct Heat

This end use includes the processes where natural gas is directly applied to heat product, unlike the steam and hot water system end uses where the heat energy from natural gas combustion is transferred indirectly through a medium, such as steam or water. Specific technologies included in the process direct heat end use are ovens, dryers, kilns and furnaces.

Similar to the boiler population, a large portion of the process direct end-use equipment population is relatively old. This is especially true for large equipment in the large, energy-intensive industrial facilities

2.4.4 Other Process

This end use includes all other process specific technologies, which are sub sector specific, and include, for example, chemical evaporators.

2.4.5 Heating, Ventilation and Air Conditioning (HVAC)

The heating, ventilation and air conditioning (HVAC) end use includes technologies where natural gas is used in HVAC processes for both comfort, such as space heating during winter months, and process, such as ventilation of paint booths or welding booths, and air supply for greenhouses.

[10] Energy and Environmental Analysis, Inc. *Characterization of the U.S. Industrial Commercial Boiler Population*, Oakridge National Laboratory, 2005.

2.4.6 Data Sources

The Base Year end use profiles were developed based on an extensive literature review and the project team's experience in the sub sectors. More specifically, the distribution of natural gas use by end use within each sub sector was determined mainly with data from the following sources:

- CIEEDAC (provides annual national energy usage per sector for Canada)
- Office of Industrial Technology (reports end-use data for sectors in the U.S.)
- U.S. Department of Energy – Energy Efficiency and Renewable Energy (provides energy use profiles for energy-intensive industries for the U.S.)
- U.S. Manufacturing Energy Consumption Survey (reports annual energy usage per end use for sectors in the U.S., U.S. Department of Energy). Data that was primarily U.S. plant specific was adjusted for Ontario based on the seasonal gas usage of Union customers.

2.5 SUMMARY OF BASE YEAR MODEL RESULTS

This sub section provides a summary of results of the Base Year model. The results are presented in Exhibits 2.5 to 2.7. The exhibits show the distribution of Base Year natural gas use by sub sector and end use for the total Union Service Area in volumetric and percentage units.

The detailed breakdown of the Base Year natural gas consumption by service region is presented in Appendix A.

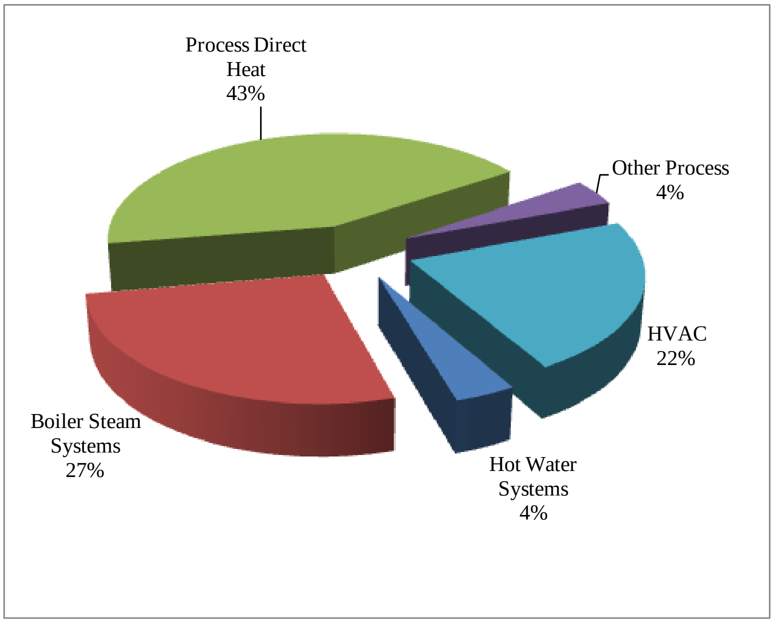
Exhibit 2.5: Base Year (2007) Natural Gas Consumption by Sub Sector and End Use for the Total Service Area (1000 of m^3/yr.)

Sub Sector	End Use						
	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	27,568	161,964	963,099	31,428	194,357	1,378,415	25%
Contract Chemical	20,117	408,369	331,925	74,222	171,201	1,005,834	18%
Other Chemical	741	15,034	12,220	2,732	6,303	37,030	0.7%
Contract Paper	11,344	353,887	107,431	10,380	84,175	567,218	10%
Contract Transportation and Machinery	7,827	91,046	117,313	15,868	159,278	391,332	7%
Other Transportation and Machinery	2,984	34,718	44,734	6,051	60,736	149,223	3%
Contract Petroleum Refineries	7,520	72,251	253,607	6,738	35,873	375,989	7%
Contract Mining	64,023	80,029	112,041	16,006	48,017	320,117	6%
Other Mining	5	6	9	1	4	25	0.0004%
Contract Food and Beverage	20,142	120,397	69,212	15,585	26,436	251,771	5%
Other Food and Beverage	4,463	26,680	15,337	3,454	5,858	55,793	1%
Contract Non-Metallic Mineral	5,598	33,477	198,345	10,581	31,910	279,911	5%
Miscellaneous Industrial	33,945	75,984	127,031	17,690	398,131	652,781	12%
Total	206,277	1,473,842	2,352,303	210,736	1,222,280	5,465,438	
%	4%	27%	43%	4%	22%		100%

Exhibit 2.6: Base Year (2007) Natural Gas Consumption as Percentages by End Use and Sub Sector for the Total Service Area

Sub Sector	Total Consumption (1000 m^3)	End Use					
		Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total
Primary Metal	1,378,415	2%	12%	70%	2%	14%	100%
Chemical	1,042,864	2%	41%	33%	7%	17%	100%
Paper	567,218	2%	62%	19%	2%	15%	100%
Transportation and Machinery	540,554	2%	23%	30%	4%	41%	100%
Petroleum Refineries	375,989	2%	19%	67%	2%	10%	100%
Mining	320,141	20%	25%	35%	5%	15%	100%
Food and Beverage	307,563	8%	48%	27%	6%	11%	100%
Non-metallic Mineral	279,911	2%	12%	71%	4%	11%	100%
Miscellaneous Industry	652,781	5%	12%	19%	3%	61%	100%
Overall	5,465,438	4%	27%	43%	4%	22%	100%

Exhibit 2.7: Base Year (2007) Natural Gas Consumption by End Use for the Total Service Area (1000 of m^3/yr.)



2.5.1 Interpretation of Results

Selected highlights of the information presented in Exhibits 2.5 to 2.7 are presented below.

Sub Sectors

The total annual industrial natural gas consumption for the 2007 Base Year (exclusive of cogeneration and feedstock gas consumption) was 5,465 million m^3.

Approximately 53% of the total natural gas is consumed by three sub sectors: Contract Primary Metal, Contract Chemical and Contract Paper.

Total natural gas consumption by the Contract sub sectors account for 82% of the total Base Year gas consumption and is equal to 4,571 million m^3.

End Use

Direct process heating in ovens, dryers, kilns and furnaces accounts for the largest share (43%) of industrial natural gas use, followed by steam generation in boiler steam systems (27%) and HVAC (22%). Hot water (4%) and Other Processes (4%) account for the remaining natural gas consumption.

The subsectors accounting for the largest share of natural gas in the three major end uses are:

- Contract Chemical and Contract Paper, which accounts for 52% (762 million m^3) of gas use in the boiler steam system end use.

- Contract Primary Metal, which accounts for 43% (963 million m^3) of gas use in the process direct heat (which includes furnaces, kilns, dryers and ovens) end use.

- Miscellaneous Industrial, which accounts for 22% (398 million m^3) in the HVAC end use.

3. REFERENCE CASE FORECAST

3.1 INTRODUCTION

This section presents the Industrial sector Reference Case forecast for the study period 2007 to 2017. The Reference Case estimates the expected level of natural gas consumption that would occur over the study period in the absence of new Union DSM initiatives. The Reference Case, therefore, provides the point of comparison for the calculation of opportunities associated with each of the subsequent scenarios that are assessed within this study.

The discussion is presented within the following sub sections:

- Expected growth rates, by sub sector
- Summary of model results
- Interpretation of results.

3.2 EXPECTED GROWTH RATES, BY SUB SECTOR

The Reference Case is based on Union's load forecast, which is informed by data obtained directly from the large volume industrial users. This data provides an understanding of the expected industry changes during the study period, such as new plants or plant closures, process changes, projected production growth and changes to fuel shares. It also includes planned major energy-efficiency projects and, as a result, captures "natural conservation" impacts.

Union's load forecast and growth rates for each of the industry sub sectors were determined for the period 2007 to 2012. However, the Union forecast does not extend beyond 2012; consequently, in the absence of specific data, the 2007 to 2012 growth rates for each sub sector were held constant to the end of the study period. Exhibit 3.1 provides a summary of natural gas growth rates that are forecast for the sub sectors and service regions addressed by this study. To undertake the modeling for the total region a weighted average growth rate was determined for each sub sector, based on the proportional gas consumption by the Southern and Northern regions. Exhibit 3.1 presents the weighted average for the total service regions over the two milestone periods. The growth rates are used in the model to determine the Reference Case gas consumption by sub sector and milestone year.

As illustrated in Exhibit 3.1, industrial natural gas consumption is forecast to decrease by a sales-weighted average of about 0.13% from 2007 to 2012 for the total Union Service Area. As also illustrated in Exhibit 3.1, there is a significant regional difference in the expected rates. The rate of increase during the period 2012 to 2017 is estimated to be about 2.6%; this result incorporates the continuation of the 2007-2012 sub sector growth rates in combination with the forecast consumption volumes in each service region.

Exhibit 3.1: Reference Case Forecast Natural Gas Consumption Growth Rates for Milestone Periods Compared to Base Year 2007

Sub Sector	Milestone Percent Growth (2007 – 2012)		Weighted Avg. Percent Growth (2007-2012)	Weighted Avg. Percent Growth (2012-2017)
	Northern	Southern		
Primary Metal	13.3%	4.0%	6.7%	6.9%
Chemical	35.3%	1.5%	9.9%	11.8%
Paper	-27.9%	5.8%	-26.1%	-25.4%
Transportation and Machinery	4.9%	-15.5%	-15.1%	-15.0%
Petroleum Refineries	0.0%	4.3%	4.3%	4.3%
Mining	-0.4%	-21.8%	-1.2%	-1.0%
Food and Beverage	66.6%	-15.5%	-4.2%	4.1%
Non-metallic Mineral	20.9%	1.3%	2.8%	3.0%
Miscellaneous Industry	-49.5%	9.9%	3.0%	6.5%
Overall	-0.7%	0.1%	-0.13%	2.6%

3.3 "NATURAL" CHANGES AFFECTING NATURAL GAS CONSUMPTION

The Reference Case recognizes that, even in the absence of DSM market interventions, there will be "natural" changes[11] in natural gas consumption patterns over the study period. Specific impacts and trends that are applicable to the industrial end uses are discussed below according to:

- Regulation of industrial GHG emissions
- Changes affecting industrial end uses.

3.3.1 Regulation of Industrial GHG Emissions

The Federal government issued the final Regulatory Framework for Air Emissions in April 2007, which laid out the broad design of the regulations for industrial emissions of both greenhouse gases (GHG) and air pollutants.[12] Natural gas combustion contributes to GHG emissions and one can expect the regulation to impact natural gas consumption in the regulated sub sectors. Highlights are provided below related to affected sub sectors, reduction targets and timing.

❑ Sub Sectors

The regulatory framework for industrial GHG emissions proposes that the following sub sectors be covered by the regulations:

- Electricity generation produced by combustion
- Oil and gas (including oil sands, upstream oil and gas, natural gas pipelines and petroleum refining)

[11] "Natural changes" refer to those changes that are expected in the absence of any Union programming.

[12] Environment Canada. *Turning the Corner: Regulatory Framework for Industrial Greenhouse Gas Emissions*, 2008, www.ec.gc.ca/doc/virage-corner/2008-03/541_eng.htm.

- Pulp and paper
- Iron and steel
- Iron ore pelletizing
- Smelting and refining (including base metals smelting, aluminum and alumina, and ilmenite (titanium) smelting)
- Cement
- Lime
- Potash
- Chemicals and fertilizer.

❑ Emission Reduction Targets

The proposed targets to be achieved by the Industrial sub sectors include:

- All covered Industrial sectors will be required to reduce their emissions intensity from 2006 levels by 18% by 2010, with 2% continuous improvement every year after that.
- The target will be applied at the facility, sector or corporate level, as determined after consultations with each sector.
- Fixed process emissions will receive a 0% target. The definition of fixed process emissions will be based on technical feasibility.
- To provide incentives to adopt the best available technologies for new facilities, whose first year of operation is 2004 or later, a target based on a cleaner fuel standard will be applied.
- There will be an incentive until 2018 for facilities to be built "carbon-capture ready."
- A special incentive will be provided through the target structure for high-efficiency cogeneration.

❑ Timing

The following expected timeframe to legislate the regulation is provided by Environment Canada:

- Draft regulation to be published in the *Canada Gazette* for public comment in fall 2008.
- Final regulations approved and published in *Canada Gazette* in fall 2009. Regulations to come into force on January 1, 2010.

❑ Summary & Implications for this Study

As illustrated by the above listing, most of the sub sectors addressed by this study will be affected by this regulation when it comes into effect. Moreover, the proposed regulation of GHG emissions from large industrial sources has the potential to have a significant impact on industrial natural gas consumption over the study period. However, at this point in time it is not possible to accurately predict the eventual direction or magnitude of GHG regulation. On the one hand, it is expected that regulated sub sectors would increase their overall investment in energy efficiency; on the other hand, GHG emission regulations would also promote a shift away from GHG intensive fuels, such as oil and coal, to less GHG intensive fuels, such as natural gas.

3.3.2 Other Influences Affecting Industrial End Uses

In addition to the potential broad impacts from the proposed regulation of industrial emissions of GHG and other air pollutants, other influences related to the age of the installed equipment and naturally occurring improvements in equipment efficiency are also expected to affect natural gas use over the study period. To the extent that data permit, a brief discussion of key influences is presented below for each of the major end uses addressed by this study, namely:

- Boiler Steam and Hot Water Systems
- Process Direct Heat
- Process Specific
- HVAC
- Plant and System Integration Measures.

❑ Boiler Steam and Hot Water Systems

As noted previously in Section 2, Ontario industry has a large population of boilers at a very advanced age; consequently, it is expected that many of the boilers will be replaced or decommissioned during the next decade. Replacing these aged boilers with new ones will result in reduced energy use, due to the advances in boiler efficiency that have occurred over the past 40 years. However, in the absence of "drivers" such as GHG emission regulation, or further DSM support, it is expected that efficiency improvements will continue at a modest pace. More specifically:

- Data applicable to programs offered in Ontario provides insight in the participation rates of boiler and steam system energy-efficiency measures in the Industrial sector when supported by a program.[13] According to a 2006 analysis, only 32% of identified energy-efficiency projects with a payback period of less than 1.2 years were implemented. In the absence of a DSM program one would expect a significantly lower participation rate of the energy-efficiency measures.

- Most of the opportunities identified by energy assessments in Ontario programs include: economizers and heat recovery, combustion improvements, capital projects (such as new boilers) and steam distribution and condensate return improvements. These are generally the first type of projects to be addressed and one can expect more natural change associated with the measures compared to other measures, such as insulation and chemical boiler water treatment.

- A large portion of the steam and hot water systems would be of the same vintage as the boilers. Lack of maintenance and poorly designed systems provide a significant opportunity. Without DSM intervention, one can expect very limited natural change due to various barriers, such as a lack of internal technical resources and expertise, organizational changes, lack of an energy management structure, etc.

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[13] Griffin, B. *The Enbridge "Steam Saver" Program – Steam Boiler Plant Efficiency-Update to Year End, 2005*. 2006. www.steamingahead.org/library/enbridge05.pdf (Latest publically available report).

- Process Direct Heat (Furnaces, Kilns, Ovens and Dryers)

Similar to the boiler population, a large portion of the process direct end-use equipment population, which includes furnaces, kilns, ovens and dryers, is relatively old. This is especially true for large equipment in the large, energy-intensive industrial facilities. Similar observations and trends discussed above for boiler systems are applicable to process direct heat, and include:

- Large population of relatively old stock. Replacement of equipment with more efficient equipment at the end of life would increase natural change in gas consumption. Experience in the Industrial sector has indicated that replacement of process direct heating equipment occurs at a much slower pace compared to boilers.

- Limited implementation of energy-efficiency measures in the absence of a DSM program. With increased natural gas prices and price volatility, the focus on energy-efficiency measures is expected to increase.

- Implementation of energy-efficiency measures is constrained by a number of barriers, such as lack of internal resources and technical expertise, organizational changes, lack of an energy management structure, etc.

- Other Process

It is expected that the proposed Federal GHG emission regulation (see 3.3.1 above) will influence natural gas consumption and increase energy efficiency in regulated sub sectors.

As described above, similar observations in terms of vintage and trends are applicable to the process specific equipment for the process direct end use in Section 3.3.2.

- HVAC

Currently, unitary air conditioning units (19 kW to 73 kW) sold in Canada are regulated by Canada's Energy Efficiency Regulations and are required to meet minimum efficiency levels as specified in the Canadian Standards Association's CSA C746-98, Performance Standard for Rating Large Air Conditioners and Heat Pumps. (These regulations are currently under review.) In accordance with commitments made under the Montreal Protocol, the use of HCFC-22 as the refrigerant in unitary air-conditioning units will be phased out in new equipment by 2010.[14]

Replacing older air conditioning units at the end of life with newer more efficient models will result in increased energy efficiency. Due to the smaller sizes and lower capital cost, small- and medium-size HVAC units tend to be replaced more frequently when compared with boilers and other large thermal equipment. Large HVAC units are much more

[14] Natural Resources Canada. Office of Energy Efficiency. *High-Efficiency Unitary Air-Conditioning Units (19 to 73 kW)*, 2006. http://oee.rncan.gc.ca/industrial/equipment/heating/index.cfm?attr=24.

expensive to replace and, therefore, a large percentage of the existing units are of an older vintage and may require replacement during the next 10 years.

- Plant and System Integration Measures

Plant or system measures are generally not executed by facilities, unless they are supported by a DSM program. Many large, energy-intensive industrial facilities already have some form of integrated control systems and sub-metering. To upgrade these systems to more modern and efficient systems can be expensive and the systems generally need to be installed during a shut down. The implementation of these measures is expected to be limited in the absence of a DSM program.

3.4 SUMMARY OF MODEL RESULTS

This section presents a summary of the model results in the following exhibits:

- Exhibit 3.2 presents a summary of the results for the total Union Service Area, by milestone year and service region.
- Exhibits 3.3 and 3.4 present the results for the total service region, by end use and milestone year.

A detailed breakdown of the Reference Case results by service region is presented in Appendix B.

Exhibit 3.2: Reference Case Forecast Natural Gas Consumption by Milestone Year ($1000\ m^3$)

Sub Sector	Contract / SME		Northern Region			Southern Region			All Regions		
	% North	% South	2007	2012	2017	2007	2012	2017	2007	2012	2017
Contract Primary Metal	100%	100%	398,032	450,983	510,978	980,383	1,020,039	1,061,300	1,378,415	1,471,022	1,572,278
Contract Chemical	99%	96%	256,247	346,763	469,253	749,587	761,091	772,771	1,005,834	1,107,854	1,242,023
Other Chemical	1%	4%	2,310	3,126	4,230	34,720	35,253	35,794	37,030	38,379	40,024
Contract Paper	100%	100%	537,762	387,867	279,754	29,456	31,156	32,954	567,218	419,023	312,708
Contract Transportation and Machinery	88%	72%	10,593	11,107	11,646	380,739	321,547	271,557	391,332	332,653	283,202
Other Transportation and Machinery	12%	28%	1,411	1,480	1,552	147,811	124,831	105,424	149,223	126,311	106,976
Contract Petroleum Refineries	100%	100%	-	-	-	375,989	392,187	409,082	375,989	392,187	409,082
Contract Mining	100%	100%	307,752	306,571	305,394	12,365	9,671	7,564	320,117	316,242	312,958
Other Mining	0%	0.20%	-	-	-	25	19	15	25	19	15
Contract Food and Beverage	94%	80%	39,603	65,980	109,927	212,168	179,350	151,608	251,771	245,330	261,535
Other Food and Beverage	6%	20%	2,527	4,210	7,014	53,266	45,027	38,062	55,793	49,236	45,076
Contract Non-Metallic Mineral	100%	100%	21,239	25,670	31,026	258,672	261,940	265,249	279,911	287,610	296,275
Miscellaneous Industrial	100%	100%	76,363	38,563	19,475	576,418	633,692	696,656	652,781	672,255	716,131
Total			1,653,839	1,642,320	1,750,247	3,811,599	3,815,802	3,848,036	5,465,438	5,458,123	5,598,284

Selected highlights of the information presented in Exhibits 3.2 relevant to service region:

- Over the 10-year Reference Case period, natural gas consumption in the Southern service region is expected to increase by 36 million m^3/yr. (1.0%), while the Northern service region's gas consumption is expected to increase by 96 million m^3/year (5.8%) relative to the Base Year.

- Growth in natural gas usage in the Southern service region is driven mainly by the Contract Primary Metal and Miscellaneous Industrial sub sectors. Most of the reduction in natural gas consumption in this service region can be ascribed to the Transportation and Machinery (both Contract and Other) and Food and Beverage (both Contract and Other) sub sectors.

- Growth in natural gas usage in the Northern service region is driven mainly by the Contract Primary Metal and Contract Chemical sub sectors. Most of the reduction in natural gas consumption in this service region can be ascribed to the Contract Paper sub sector.

Exhibit 3.3: Reference Case Forecast Natural Gas Consumption by End Use for Milestone Year 2012 – Total Service Region (1000 m^3)

Sub Sector	End Use						
	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	29,420	172,845	1,027,803	33,539	207,414	1,471,022	27%
Contract Chemical	22,157	449,789	365,592	81,750	188,566	1,107,854	20%
Other Chemical	768	15,582	12,665	2,832	6,532	38,379	0.70%
Contract Paper	8,380	261,429	79,363	7,668	62,183	419,023	8%
Contract Transportation and Machinery	6,653	77,394	99,722	13,489	135,395	332,653	6.09%
Other Transportation and Machinery	2,526	29,387	37,865	5,122	51,411	126,311	2.31%
Contract Petroleum Refineries	7,844	75,363	264,532	7,029	37,419	392,187	7%
Contract Mining	63,248	79,060	110,685	15,812	47,436	316,242	6%
Other Mining	4	5	7	1	3	19	0%
Contract Food and Beverage	19,626	117,317	67,441	15,186	25,760	245,330	4.5%
Other Food and Beverage	3,939	23,545	13,535	3,048	5,170	49,236	0.90%
Contract Non-Metallic Mineral	5,752	34,398	203,801	10,872	32,788	287,610	5.3%
Miscellaneous Industrial	34,957	78,251	130,821	18,218	410,008	672,255	12.3%
Total	205,276	1,414,365	2,413,832	214,566	1,210,085	5,458,123	100%
%	4%	26%	44%	4%	22%		

Exhibit 3.4: Reference Case Forecast Natural Gas Consumption by End Use for Milestone Year 2017 – Total Service Region (1000 m^3)

Sub Sector	End Use						
	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	31,446	184,743	1,098,551	35,848	221,691	1,572,278	28%
Contract Chemical	24,840	504,261	409,868	91,651	211,403	1,242,023	22%
Other Chemical	800	16,250	13,208	2,953	6,812	40,024	0.71%
Contract Paper	6,254	195,099	59,227	5,723	46,406	312,708	6%
Contract Transportation and Machinery	5,664	65,889	84,898	11,483	115,268	283,202	5.06%
Other Transportation and Machinery	2,140	24,889	32,069	4,338	43,541	106,976	1.91%
Contract Petroleum Refineries	8,182	78,610	275,928	7,332	39,031	409,082	7%
Contract Mining	62,592	78,239	109,535	15,648	46,944	312,958	6%
Other Mining	3	4	5	1	2	15	0%
Contract Food and Beverage	20,923	125,066	71,896	16,189	27,461	261,535	4.7%
Other Food and Beverage	3,606	21,555	12,391	2,790	4,733	45,076	0.81%
Contract Non-Metallic Mineral	5,926	35,435	209,941	11,199	33,775	296,275	5.3%
Miscellaneous Industrial	37,239	83,358	139,359	19,407	436,768	716,131	12.8%
Total	209,614	1,413,397	2,516,876	224,562	1,233,836	5,598,284	100%
%	4%	25%	45%	4%	22%		

Selected highlights of the information presented in Exhibits 3.3 and 3.4 are presented below.

Sub Sectors

- Overall, the results of the Reference Case forecast show that natural gas use increases by about 2.4%, or 133 million m^3/yr., from 2007 to 2017.

- A significant increase in annual natural gas consumption occurs in the Contract Primary Metal and Contract Chemical sub sectors, which increase respectively by 194 million m^3/yr. and 236 million m^3/yr. from 2007 to 2017. Other sub sectors that show an increase in natural gas consumption from 2007 to 2017 are the Other Chemical, Contract Petroleum Refineries, Contract Food and Beverage, Contract Non-metallic Mineral and Miscellaneous Industrial sub sectors.

- The most significant decrease in annual gas consumption during the period 2007 to 2017 occurs in the Contract Paper (reduction of 254 million m^3/yr.) and Contract Transportation and Machinery (108 million m^3/yr.) sub sectors.

End Use

- In 2007, direct process heating in ovens, dryers, kilns and furnaces accounted for the largest share (43%) of industrial natural gas use, and this share is increased to 45% in 2017; boiler steam systems' share of 27% in 2007 decreases to 25% in 2017, while the share of gas consumption by the other end uses remains relatively unchanged.

4. ENERGY-EFFICIENCY MEASURES

4.1 INTRODUCTION

This section identifies and assesses the financial and economic attractiveness of the selected energy-efficiency measures for the Industrial sector. The discussion is organized and presented as follows:

- Methodology
- Summary of energy-efficiency results
- Description of energy-efficiency technologies and measures.

4.2 METHODOLOGY

The following steps were employed to assess the energy-efficiency measures:

- Select candidate energy-efficiency measures
- Establish technical performance for each measure within a range of applicable load sizes and/or service region conditions (e.g., degree days)
- Establish the capital, installation and equipment operating costs for each measure
- Calculate the simple payback from the customer's perspective
- Calculate the measure TRC
- Calculate the benefit/cost ratio.

A brief discussion of each step is outlined below.

Step 1: Select Candidate Measures

The candidate measures were selected in close collaboration with Union personnel based on a combination of a literature review and the previous experience of both the consultants and Union personnel. The selected measures are considered to be technically proven and commercially available, even if only at an early stage of market entry. Technology costs, which will be addressed in this section, were not a factor in this initial selection of candidate technologies.

Step 2: Establish Technical Performance

Marbek's in-house database of measures formed the basis for the performance characteristics of the measures. The database was developed from secondary sources and input from specialists in the industrial sector. The database has been used and reviewed in many studies. The database information was updated for existing and new measures from available secondary sources, including the experience and on-going research work of study team members and from equipment suppliers. References are provided for performance characteristics where specific sources are relevant, while non-referenced performance characteristics are from the Marbek database.

Step 3: Establish Capital, Installation and Operating Costs for Each Measure

Information on the cost of implementing each measure was also compiled from secondary sources, including the experience and on-going research work of study team members. As applicable, both the incremental and full cost of each measure was estimated. Marbek's database of measures was used as the basis and was updated for this study. References are provided for costs where specific sources are relevant, while non-referenced costs are from the Marbek database.

The incremental cost is applicable when a measure is installed in a new facility, or at the end of its useful life in an existing facility. In this case, incremental cost is defined as the difference between the energy-efficiency measure and the "baseline" technology. The full cost is applicable when an operating piece of equipment is replaced with a more efficient model prior to the end of its useful life.

In both cases, the costs and savings are annualized, based on the number of years of equipment life and the discount rate. The discount rate in this study is 10% and is based on data provided by Union, which is based on the latest load forecast input assumptions. The costs incorporate applicable changes in annual equipment-specific O&M costs. All costs are expressed in constant (2008) dollars.

Step 4: Calculate Simple Payback

The simple payback is generated to show the customer's financial perspective. Simple payback is "a measure of the length of time required for the cumulative savings from a project to recover its initial investment cost and other accrued costs, without taking into account the time value of money. The simple payback period is usually measured from the service date of the project."[15] The cost of the measure (incremental or full, as appropriate) is divided by the expected annual savings and the answer is given in years**.**

The following equation illustrates how this calculation is applied to a situation where an upgrade has a higher upfront cost than the baseline technology, but lower ongoing operating costs:

$$\text{Payback}_{\text{(years)}} = (\text{CostUpgr} - \text{CostBase})/(\text{AnnBase} - \text{AnnUpgr})$$

where:

CostUpgr	= initial capital cost of the upgrade measure ($)
CostBase	= initial capital cost of the baseline measure ($)
AnnUpgr	= ongoing operating cost of the upgrade ($/yr.)
AnnBase	= ongoing operating savings of the base ($/yr.)

[15] Fuller, S.K. & Petersen, S.R. National Institute of Standards Technology. *Life Cycle Costing Manual for the Federal Energy Management Program - Handbook 135*, 1996.

Step 5: Calculate the Measure Total Resource Cost (TRC)

The measure TRC calculates the net present value of energy and water savings that result from an investment in an efficiency measure. The measure TRC is equal to its full or incremental capital cost (depending on application) plus any change (positive or negative) in the combined annual energy and equipment O&M costs. This calculation includes, among others, the following inputs: the avoided natural gas, electricity and water supply costs, the life of the technology and the selected discount rate, which in this analysis has been set at 10%.

A technology or measure with a positive TRC value is included in subsequent phases of the analysis, which consists of the economic and achievable potential scenarios. A measure with a negative TRC value is not economically attractive and is therefore not included in subsequent stages of the analysis.

It should be noted that the measure TRC provides an initial screen of the technical options. Considerations such as program delivery costs, free riders and incentives are incorporated in later detailed program design stages, which are beyond the scope of this study.

Step 6: Calculate Benefit/Cost Ratio

The measure benefit/cost ratio indicates the relative attractiveness of the measures. It is defined as the net present value of benefits (i.e., energy and water savings over the measure's life) divided by the net present value of the incremental cost of the measure relative to the baseline technology (i.e., the equipment's capital and equipment-specific O&M costs) over its life. If a measure has a benefit/cost ratio in excess of 1.0, it means that the measure's benefits outweigh its costs. Such a measure would be included in subsequent stages of the analysis. A measure with a benefit/cost ratio that is well in excess of 1.0 (e.g., 3.0) is particularly attractive. Conversely, if a measure has a benefit/cost ratio of less than one, its costs outweigh its benefits. Such a measure would not be included in subsequent stages of the analysis.

4.2.1 Energy Costs

The financial and economic results presented in this section are based on the following:

- Avoided supply cost of natural gas
- Avoided supply cost of electricity and water
- Customer energy prices.

A brief discussion of each is provided below.

Avoided Supply Cost of Natural Gas

Natural gas avoided supply costs were provided by Union. The data provided were segmented into base load and weather-sensitive rates and their resulting net present values (NPVs). The rates were forecast for a 30-year timespan. The avoided supply costs also incorporate a GHG adder that accounts for carbon dioxide emissions resulting from natural gas consumption. A cost of $15/tonne CO_2e (per tonne of CO_2 equivalent) is employed until 2012 and the price is increased to $20 /tonne CO_2e starting in 2013.

An emissions coefficient of 0.001903 tonnes CO_2e/m^3 (1,903 g CO_2e/m^3) is used in this analysis.[16] The resulting avoided supply costs for natural gas are shown in Exhibit 4.1. The avoided supply cost is used in the TRC calculation (see description above under Section 4.2, Step 5).

Exhibit 4.1: Natural Gas – Avoided Supply Costs

Year	Base Load		Weather Sensitive	
	Gas Rates ($/m³)	NPV ($/m³)	Gas Rates ($/m³)	NPV ($/m³)
1	0.39898	0.39898	0.40143	0.40143
2	0.38189	0.74614	0.38823	0.75436
3	0.36510	1.04787	0.36231	1.05378
4	0.37148	1.32698	0.36864	1.33075
5	0.37799	1.58515	0.37510	1.58694
6	0.39425	1.82995	0.39130	1.82991
7	0.40101	2.05631	0.39800	2.05457
8	0.40790	2.26562	0.40483	2.26231
9	0.41492	2.45919	0.41179	2.45442
10	0.42207	2.63818	0.41889	2.63207
11	0.42936	2.80372	0.42611	2.79635
12	0.43678	2.95681	0.43348	2.94828
13	0.44435	3.09839	0.44098	3.08879
14	0.45206	3.22934	0.44863	3.21874
15	0.45992	3.35045	0.45642	3.33893
16	0.46793	3.46247	0.46436	3.45010
17	0.47608	3.56608	0.47245	3.55292
18	0.48440	3.66191	0.48070	3.64802
19	0.49287	3.75056	0.48910	3.73599
20	0.50150	3.83256	0.49766	3.81736
21	0.51030	3.90841	0.50639	3.89263
22	0.51927	3.97858	0.51528	3.96226
23	0.52840	4.04349	0.52433	4.02668
24	0.53771	4.10354	0.53357	4.08626
25	0.54719	4.15910	0.54297	4.14139
26	0.55686	4.21049	0.55256	4.19239
27	0.56671	4.25804	0.56232	4.23957
28	0.57674	4.30204	0.57228	4.28322
29	0.58697	4.34274	0.58242	4.32361
30	0.59739	4.38040	0.59275	4.36098

[16] Based on emission factors and Global Warming Potentials (GWPs) presented by Environment Canada in *Greenhouse Gas Sources and Sinks in Canada: National - Inventory Report 1990-2005*, p. 23 and 583, 2007.

Avoided Supply Cost of Electricity and Water

The study team undertook a review of the potential related water and electricity savings. The review concluded that these additional savings were minimal, relative to the magnitude of the natural gas savings and, consequently, would not affect the results presented in this section. The results presented in this section, therefore, refer only to natural gas savings.

Customer Energy Prices

The customer energy prices used in this analysis are presented in Exhibit 4.2. These values are used in the calculation of customer payback periods that are presented in later sections of this report. The natural gas prices shown are based on July 2008 rate schedules.

Exhibit 4.2: Customer Energy Prices

Service Region	Nat. Gas[17] ($/m^3)
Northern Service Region	0.540
Southern Service Region	0.458

4.3 SUMMARY OF ENERGY-EFFICIENCY SCREENING RESULTS

A summary of the screening results for the energy-efficiency measures is presented in Exhibit 4.3. Due to the number of measures assessed for each sub sector, the results shown are for the measures applied to large technology in the Chemical sub sector. The results for the small- and medium-size technologies in the Chemical sub sector are presented in Appendix D, together with the measure TRC calculations for the remaining sub sectors. All the measures had a positive TRC in at least one sub sector for the large technology size. This means that all the measures passed the TRC screening and were included in the study. It should be noted that the following measures listed in Exhibits 1.1 and 4.4 were not assessed: first generation super boilers, computational fluid dynamic modelling, and process integration and pinch analysis. The reasons for the exclusion of these measures are described in the respective descriptions in Section 4.4.

The measures are grouped by end use and measures that apply to the total plant's natural gas use are grouped under the system end use. System end-use measures are those measures that do not apply to only one specific end use, such as boilers and steam systems, but apply to all end uses. For example, by controlling many end uses, an integrated control system would result in energy savings relative to the plant's total energy.

[17] Natural gas rates are approximate estimates based on Union rates (as of July 1, 2008) in each service region.

Exhibit 4.3: Summary of Measure TRC Screening Results - Example for Chemical Sub Sector, Medium Technology Energy-efficiency Options

End Use	Measure	Full/ Incremental	Net Measure TRC	Simple Payback Period (Years)	Benefit / Cost Ratio
System	Integrated control system	F	$ 7,895,530	0.1	45.3
	Sub-metering	F	$ 6,026,885	0.4	16.5
Boiler, Steam & Hot Water Systems	Economizer	F	$ 235,022	1.8	4.5
	Blowdown heat recovery	F	$ 88,954	3.4	2.4
	Boiler combustion air preheat	F	$ 131,864	4.4	1.7
	Process heat recovery to preheat make-up water	F	$ 294,079	3.0	2.8
	Condensing boiler	I	$ 688,500	0.8	11.0
	Direct contact hot water heaters	I	$ 804,906	0.1	N/A
	Boiler right sizing and load management	I	$ 809,906	0.1	N/A
	High-efficiency burners	F	$ 278,669	2.3	3.8
	Insulation	F	$ 285,489	0.9	7.3
	Advanced boiler controls	F	$ 110,952	3.3	2.3
	Blowdown control	F	$ 1,220	8.9	1.0
	Boiler water treatment	F	$ 22,412	3.2	1.8
	Boiler maintenance	F	$ 107,189	0.4	3.2
	Minimize deaerator vent losses	F	$ 76,954	4.2	2.0
	Condensate return	F	$ 46,251	6.1	1.4
	Steam trap survey and repair	F	$ 46,089	1.1	2.3
	Instantaneous steam generation	I	$ 936,275	0.6	17.6
Process Heating (Furnaces/ Kilns/ Ovens/ Dryers)	Exhaust gas heat recovery	F	$ 1,170,870	0.9	7.6
	High-efficiency burners and burner controls	F	$ 964,941	0.6	16.1
	Insulation	F	$ 398,957	0.8	8.9
	Advanced heating and process controls	F	$ 751,307	1.1	6.1
	High-efficiency ovens	I	$ 1,119,729	0.8	10.7
	High-efficiency dryers	I	$ 1,119,729	0.8	10.7
	High-efficiency kilns	I	$ 1,325,517	0.7	12.5
	High-efficiency furnaces	I	$ 1,325,517	0.7	12.5
	Air curtains	F	$ 1,436,897	0.6	14.5
Other Process	Pollution control measures	I	$ 772,269	1.1	4.0
	High-efficiency furnaces	F	$ 2,364,557	0.9	8.1
	Process heat recovery	F	$ 912,627	2.3	3.1
HVAC	Radiant heaters	F	$ 107,635	3.8	2.2
	Automated temperature control	F	$ 82,112	2.5	3.3
	Solar walls	F	-$ 71,311	14.2	0.6
	Ventilation & heat recovery optimization	F	$ 42,868	5.9	1.5
	Warehouse loading dock seals	F	-$ 107	6.2	1.0
	Air curtains	F	$ 11,037	5.1	1.5
	Air compressor heat recovery	F	$ 60,676	4.0	2.1
	Destratification fans	F	$ 31,511	4.2	2.0

4.4 DESCRIPTION OF ENERGY-EFFICIENCY TECHNOLOGIES AND MEASURES

This sub section provides a brief description of each of the energy-efficiency technologies and measures that are included in this study, as listed in Exhibit 4.4.

Exhibit 4.4: Energy-efficiency Technologies and Measures - Industrial Sector

System • Integrated control system • Sub-metering ***Boiler, Steam, and Hot Water Systems*** • Economizer • Blowdown heat recovery • Boiler combustion air preheat • Process heat recovery to preheat make-up water • Condensing boiler • First generation super boilers • Direct contact hot water heaters • Boiler right sizing and load management • High-efficiency burner • Insulation • Advanced boiler controls including air/fuel mix control • Blowdown control • Boiler water treatment • Boiler maintenance • Minimize deaerator vent losses • Condensate return • Steam trap survey and repair • Instantaneous steam generation	***Process Direct Heat (Furnaces / Kilns / Ovens / Dryers)*** • Exhaust gas heat recovery • High-efficiency burner and burner controls (including. oxy-gas direct impingement heating for steel annealing) • Insulation • Advanced heating and process control • High-efficiency ovens • High-efficiency dryers • High-efficiency kilns • High-efficiency furnaces • Air curtains ***Other Process*** • Pollution control measures • Computational fluid dynamic modeling • Hydrogen atmospheres for steel batch coil annealing • Process heat recovery • Process integration and pinch analysis ***HVAC*** • Radiant heaters • Automated temperature control • Solar walls • Ventilation heat recovery and optimization • Warehouse loading dock seals • Air curtains • Air compressor heat recovery • Destratification fans

The discussion is organized and presented in the following subsections:

- System
- Boiler, Steam, and Hot Water Systems
- Process Direct Heat (furnaces/kilns/ovens/dryers)
- Other Process
- HVAC.

Each option is discussed below, with a brief description of the technology, savings relative to the baseline, typical installed costs, applicability and co-benefits. The descriptions are measure specific and do not indicate the interactive effects of measures. For example, the typical measure savings indicates the savings if it is implemented as a stand-alone measure. When these measures are implemented together then these typical savings are not additive, but there is a cascading effect of reduced savings potential resulting from a reduced volume of gas usage subsequent to implementing a measure. The remaining potential to implement the measures is indicated and, unless a specific reference is provided, is based on the consulting team’s experience.

4.4.1 System[18]

System-level measure bundles are efficiency upgrade options that span several energy end uses, and are therefore applied against the entire generic plant's energy consumption. Each measure bundle was modified as appropriate in term of savings, operating times, implementation costs, etc., to suit the generic plant type to which it was applied. The following measures were identified and assessed:

- Integrated control system
- Sub-metering.

Integrated Control System

Assumptions used for Analysis	
Sub Sectors	Medium and large industry
Typical Measure Size/Specification	Applied to medium / large facility
Typical Measure Costs	$165,000 to $500,000
Typical Measure Savings	8% in natural gas use[19]
Useful Measure Life	10 years

Traditionally, control systems have been implemented as separate entities, each with its own infrastructure, installer and service. This can result in control systems that, as a whole, are not utilized to their maximum potential. Applications of advanced, automated control and energy management systems in varying development stages can be found in all Industrial sectors. However, there is still a large potential to implement control and management systems, as more modern systems enter the market continuously.

Process control systems depend on information at many stages of the processes. The information of the sensors is used in control systems to adapt the process conditions, based on mathematical (rule-based) or neural networks and "fuzzy logic" models of the industrial process. Neural network-based control systems have successfully been used in the cement (kilns), food (baking), non-ferrous metals (alumina, zinc), pulp and paper (paper stock, lime kiln), petroleum refineries (process, site) and steel industries (EAFs, rolling mills). New energy management systems that use artificial intelligence, fuzzy logic (neural network), or rule-based systems mimic the "best" controller, using monitoring data and learning from previous experiences.

[18] Unless otherwise noted, measure assumptions provided in this section are from Marbek's in-house database, which is compiled from a number of sources including previous and on-going studies, facility energy audits and surveys.

[19] Ernest, Orlando. Lawrence Berkley National Laboratory and the American Council for an Energy Efficient Economy (ACEEE). Emerging Energy-Efficient Industrial Technologies, 2000, report reference number: LBNL 46990.

Sub-Metering

Assumptions used for Analysis	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Applied to small / medium / large facility
Typical Measure Costs	$200,000 to $1,000,000
Typical Measure Savings	5%
Useful Measure Life	15 years

Sub-metering systems measure the amount of energy used by a plant and in particular certain portions of the plant where major utility loads are known. The use of sub-metering can be beneficial as part of a control system or an energy management plan. Well-placed sub-meters provide utility usage information for specific processes or plant areas, which can help in the identification of potential areas of improvement within. Data obtained from meters are only beneficial for demand-side management if it is interpreted and used in a DSM system or energy management framework, including monitoring and targeting strategies. Also, the closer the meter is to the end user, the more likely it is he/she will be held accountable, which can lead to further savings. Sub-meters tend to be less common in medium and small facilities, and more common in large energy-intensive facilities, but a large potential to use the data in energy management still exists in large industry.

4.4.2 Boiler, Steam, and Hot Water Systems[20]

Efficiency measure bundles applicable to boilers, steam systems and hot water systems include all the efficiency upgrade measures that improve the efficiency, or reduce the energy use, in these end uses. The energy reduction of a measure is compared to a standard efficiency water tube boiler (for medium and large boilers) or a standard efficiency fire tube boiler (for small boilers) without the measure. The following measures were identified and assessed:

- Economizer
- Blowdown heat recovery
- Boiler combustion air preheat
- Process heat recovery to preheat make-up water
- Condensing boiler
- First generation super boilers
- Direct contact hot water heaters
- Boiler right sizing and load management
- High-efficiency burner
- Insulation
- Advanced boiler controls including air/fuel mix control
- Blowdown control
- Boiler water treatment
- Boiler maintenance

[20] Unless otherwise noted, measure assumptions provided in this section are from Marbek's in-house database, which is compiled from a number of sources including previous and on-going studies, facility energy audits and surveys.

- Minimize deaerator vent losses
- Condensate return
- Steam trap survey and repair
- Instantaneous steam generation.

Economizer

Assumptions used for Analysis[21]	
Sub Sectors	Medium and large industry
Typical Measure Size/Specification	Application: 110 to 460 BHP boiler
Typical Measure Costs	$27,000 to $350,000
Typical Measure Savings	4%
Useful Measure Life	20 years

An economizer is a heat exchanger that is designed to use heat from hot boiler flue gases to preheat water. Economizers are often used on large utility steam boilers to preheat the feedwater using recovered stack heat. The same principle can be applied to smaller heating boilers where there is a nearby demand for hot water. These installations have become more economical as energy prices have risen and smaller, lighter and more durable economizers have been developed. A condensing economizer improves the effectiveness of reclaiming flue gas heat by cooling the flue gas below the dewpoint. The condensing economizer thus recovers both the sensible heat from the flue gas and the latent heat from the moisture that condenses. The condensate is highly corrosive and requires measures to ensure that it does not enter the boiler. New boilers generally include economizers, while a large percentage of existing boilers has the potential to be retrofitted with an economizer.

Blowdown Heat Recovery

Assumptions used for Analysis[22]	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Application: 50 to 460 BHP boiler
Typical Measure Costs	$23,000 to $200,000
Typical Measure Savings	2%
Useful Measure Life	20 years

The boiler blowdown process involves the periodic or continuous removal of water from a boiler to remove accumulated dissolved solids and/or sludge. During the process, water is discharged from the boiler to avoid the negative impacts of dissolved solids or impurities on boiler efficiency and maintenance. However, boiler blowdown wastes energy because the blowndown liquid is at about the same temperature as the steam produced. Much of this heat can be recovered by routing the blowndown liquid through a heat exchanger that preheats the boiler's make-up water. The recovered heat can be used

[21] Cameron Veitch of Combustion and Energy Systems Ltd. Telephone call to author, August 7, 2008.

[22] Natural Resources Canada. Office of Energy Efficiency. *Energy Efficient Boilers.* www.oee.nrcan.gc.ca/industrial/equipment/boilers.

to preheat boiler make-up water before it enters the deaerator, and for low-pressure steam to heat water inside the deaerator, which reduces the cost to run the deaerator and improves overall boiler efficiency. Blowdown heat recovery is more prevalent at larger boilers in large energy-intensive facilities, but it is believed that the market penetration of the measure is still relatively small, based on consultant experience.

Boiler Combustion Air Preheat

Assumptions used for Analysis[23,24]	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Application: 50 to 460 BHP boiler
Typical Measure Costs	$50,000 to $500,000
Typical Measure Savings	5%
Useful Measure Life	15 years

Combustion air preheaters are similar to economizers in that they transfer energy from the flue gases back into the system. In these devices, however, the energy is transferred to the incoming combustion air. The efficiency benefit is roughly 1% for every 40°F increase in the combustion air temperature. Changes in combustion air temperature directly affect the amount of combustion air supplied to the boiler and may increase or decrease the excess air. (See below under the advanced boiler control measure for a discussion on air-fuel ration control.) Preheating boiler combustion air has a relatively low market penetration rate on existing boilers.

Process Heat Recovery to Preheat Makeup Water

Assumptions used for Analysis	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Application: 50 to 460 BHP boiler
Typical Measure Costs	$70,000 to $400,000
Typical Measure Savings	6%
Useful Measure Life	20 years

Recovered process heat can be a good source of energy to preheat boiler make-up water. Waste heat can be captured from a clean waste stream that normally goes into the atmosphere or down the drain and used to heat the make-up water before it is sent to the boiler. Implementation of many potential opportunities is restricted due to factors such as the distance between the process and the boiler, the available heat in the in the process stream, the volume of the process stream and the consistency of the heat generation. Implementation of the measure is not widely practiced, especially in small- and medium-sized facilities. Consequently, a significant potential remains.

[23] U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy. *Improving Steam System Performance: A Sourcebook for Industry*, 2004.

[24] Industrial Technologies Program. U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy. *Energy Tips – Process Heating – Tip Sheet 1.*

Condensing Boiler

Assumptions used for Analysis[25]	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Application: 50 to 460 BHP boiler
Typical Measure Costs	$120,000 to $3,500,000
Typical Measure Savings	10%
Useful Measure Life	20 years

High-efficiency condensing boilers feature advanced heat exchanger designs and materials that extract more heat from the flue gases before they are exhausted. The temperature of the flue gases is reduced to the point where the water vapour produced during combustion condenses back into liquid form, releasing the latent heat, which improves energy efficiency.

Modern condensing boilers have energy efficiencies of 90% to 96%, compared with new conventional non-condensing models with energy efficiencies up to 85%. Many boilers over 20 years old typically operate at overall water-to-steam boiler efficiencies of less than 70%, making them good candidates for upgrading or replacement. A number of natural gas-fired condensing boilers are available, but very few oil-burning models are on the market. Installing new boilers generally occurs only at the end of the life of existing boilers or when expansion occurs.

First generation super boilers

First generation super boilers are an emerging technology. Based on consultation to define the Achievable Potential, it was concluded that the potential future market take up of the measure is too uncertain, and potentially limited, to be included in this study.

Direct Contact Hot Water Heaters

Assumptions used for Analysis	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Application: 24 to 430 BHP heater
Typical Measure Costs	$75,000 to $2,750,000
Typical Measure Savings	10%
Useful Measure Life	20 years

In direct contact hot water heaters the combustion gas is in direct contact with the water and there is no heat transfer medium between the gas and the water. An example is where incoming water flows downward through a vertical column filled with stainless steel packing rings. As cold water comes into direct contact with rising hot combustion air from a gas burner, a very rapid heat transfer occurs, absorbing the heat energy into the water. Compared to heat exchanger type water heaters, direct contact heaters are more efficient because they eliminate the performance reductions caused by heat losses via the

[25] Natural Resources Canada. Office of Energy Efficiency. *Energy Efficient Boilers: Boiler Savings.* www.oee.nrcan.gc.ca/industrial/equipment/boilers.

heat transfer medium and by fouling of the heat exchange surfaces and the associated energy losses. However, efficiency can be greatly reduced by high return fluid temperatures.[26] Direct contact hot water heaters are most often installed when an existing water heater needs to be replaced due to its age and associated increased maintenance requirements. The market penetration of the technology is relatively small and a significant potential exists to increase the market penetration.

Boiler Right Sizing and Load Management

Assumptions used for Analysis[27,28]	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Application: 50 to 460 BHP boiler
Typical Measure Costs	$70,000 to $2,700,000
Typical Measure Savings	10%
Useful Measure Life	20 years

An oversized boiler will turn on and off more often than a boiler that has been properly matched to the demand, which may result in boiler short-cycling losses. If the boiler is instead left on standby, short-cycling losses will be avoided but energy will be wasted in keeping the boiler on standby. Rather than sizing a boiler to meet the highest possible load, fuel savings can be achieved by adding a smaller boiler, sized to meet the plant's average loads, or by re-engineering the power plant to consist of multiple small boilers. Multiple small boilers offer reliability and flexibility to operators to follow load swings without over-firing and short cycling. Load management also helps to reduce load variation. As this measure is normally an end-of-life option there should be no incremental costs to right size a boiler, but a benefit exists by purchasing a smaller boiler. The market penetration of the measure is relatively small and depends on the replacement rate of existing boilers and installation of new boilers.

High-efficiency Burners

Assumptions used for Analysis	
Sub Sectors	Small, medium, and large industry
Typical Measure Size/Specification	Application: 50 to 460 BHP boiler
Typical Measure Costs	$48,000 to $400,000
Typical Measure Savings	5%
Useful Measure Life	20 years

Due to differing temperature requirements and wide range of boiler models, a wide variety of burners are available and burner technology is continuously improving. Improvement in boiler burner efficiency is mainly associated with optimum combustion efficiency and improving the heat profile inside the combustion chamber. The efficiency

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[26] CADDET Energy Efficiency. *Ultra-high Efficiency Direct Contact Water Heater.* www.caddet.org.

[27] Industrial Technologies Program. U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy. *Minimize Boiler Short Cycling Losses – Tipsheet*, 2006.

[28] U.S. Environmental Protection Agency. *Wise Rules for Industrial Efficiency: a Toolkit for Estimating Energy Savings and Greenhouse Gas Emissions*, 2003.

of boiler burners is closely linked with the boiler controls regulating the fuel-to-air ratio. For example, inefficient fuel-to-air ratio control will reduce the efficiency of the burner.

Insulation

Assumptions used for Analysis	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Steam pipe: 100 ft (25psi) to 1,000 ft (100psi)
Typical Measure Costs	\$20,000 to \$150,000[29]
Typical Measure Savings	5%
Useful Measure Life	15 years

Insulation increases the amount of energy available for end uses by decreasing the amount of heat lost from the distribution system. Insulation removed during maintenance is often not replaced, and older insulation deteriorates with time. To improve the energy efficiency of the system, regular insulation surveys assist in identifying areas with insufficient insulation. A significant amount of facilities do not have regular insulation surveys.

Advanced Boiler Controls

Assumptions used for Analysis	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Application: 50 to 460 BHP boiler
Typical Measure Costs	\$40,000 to \$200,000
Typical Measure Savings	3%
Useful Measure Life	15 years

An alternative to complex linkage designs, modern burners are increasingly using servomotors with parallel positioning to independently control the quantities of fuel and air delivered to the burner head. Controls without linkages allow for easy tune-ups and minor adjustments, while eliminating hysteresis, or lack of retraceability, and provide accurate point-to-point control. These controls provide consistent performance and repeatability as the burner adjusts to different firing rates. Variable frequency drives (VFDs) can also be used to more accurately control the air supply.

Other technologies included in combustion controls are metered control, cross limited control and oxygen and carbon monoxide trim controls. Advanced boiler controls are generally one of the first energy-efficiency measures a facility will implement to improve boiler energy efficiency. Although the measure has achieved a substantial market share, a large market still remains.

[29] U.S. Environmental Protection Agency. *Wise Rules for Industrial Efficiency: a Toolkit for Estimating Energy Savings and Greenhouse Gas Emissions.* 1998. (1998 cost escalated to 2008 cost).

Blowdown Control

Assumptions used for Analysis	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Application: 50 to 460 BHP boiler
Typical Measure Costs	$35,000 to $120,000
Typical Measure Savings	1%
Useful Measure Life	20 years

Boiler water must be blown down periodically to prevent scale from forming on boiler tubes. This process can be wasteful if too much is lost to blowdown. Automatic blowdown controls measure and respond to boiler water conductivity and acidity to ensure that only the right amount of blowdown water is used. Although automatic blowdown control is becoming a standard practice for new boilers, a large percentage of existing boilers do not have automated control.

Boiler Water Treatment

Assumptions used for Analysis[30]	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Application: 50 to 460 BHP boiler
Typical Measure Costs	$10,000 to $50,000
Typical Measure Savings	1%
Useful Measure Life	10 years

Properly conditioning boiler water can increase the efficiency of the boiler as well as extend the boiler's life. Some of the technologies that are employed to remove undesirable impurities from the water supply include reverse osmosis, electrodialysis and electrodialysis with current reversal. These are all known as membrane processes. Reverse osmosis uses semi-permeable membranes that let water through but block the passage of salts. In electrodialysis, the salts dissolved in the water are forced to move through cation-selective and anion-selective membranes, removing the ion concentration. Proper boiler water treatment is a relatively common practice, especially for larger boilers.

[30] U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy. *A Consumer's Guide to EE and RE: Industry Plant Managers & Engineers - Steam Boilers.* www.eere.energy.gov/consumer/industry/steam.html#opp2.

Boiler Maintenance

Assumptions used for Analysis	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Application: 50 to 460 BHP boiler
Typical Measure Costs	(equipment-specific O&M) $8,000 to $30,000
Typical Measure Savings	5%
Useful Measure Life	5 years

An upgraded boiler maintenance program, including optimizing the air-to-fuel ratio, burner maintenance and tube cleaning, can save about 2% of a facility's total energy use with an average simple payback of five months. Periodic measurement of flue gas oxygen, carbon monoxide, opacity and temperature provides the fundamental data required for a boiler tune-up.

A typical tune-up might include a reduction of excess air (and thereby excess oxygen, O2), boiler tube cleaning and recalibration of boiler controls. A comprehensive tune-up with precision testing equipment to detect and correct excess air losses, smoking, unburned fuel losses, sooting and high stack temperatures, can result in boiler fuel savings as high as 20%, while typical savings are in the order of about 8% boiler fuel usage.

Boiler maintenance programs are a relatively common practice, especially for large boilers and in energy-intensive industries.

Minimize Deaerator Vent Losses

Assumptions used for Analysis[31,32]	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Application: 50 to 460 BHP boiler
Typical Measure Costs	$35,000 to $150,000
Typical Measure Savings	2%
Useful Measure Life	20 years

A deaerator works to remove dissolved oxygen from boiler feedwater and must vent this oxygen, and any other non-condensable gases that were removed, into the atmosphere. A very small percentage of steam will also be venting when the gases are vented. The amount of steam vented should be minimized through proper operation and controls.

If the deaerator is operated at very high pressures, this may cause excessive venting of steam to the atmosphere. Instead, the deaerator tank should be operated to meet water chemistry requirements for oxygen and carbon dioxide rather than simply using pressure

[31] U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy Industrial Technologies Program. *Energy Tips – Steam – Tip sheet #18 deaerators.*

[32] U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy. *A Consumer's Guide to EE and RE: Industry Plant Managers & Engineers - Steam Boilers*. www.eere.energy.gov/consumer/industry/steam.html#opp2.

and temperature as a guide. This measure has been implemented on a relatively limited scale.

Condensate Return

Assumptions used for Analysis[33]	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Application: 50 to 460 BHP boiler
Typical Measure Costs	$40,000 to $350,000
Typical Measure Savings	2%
Useful Measure Life	20 years

The primary purpose of an effective condensate recovery system is to make the most effective use of all remaining steam and condensate energy after process use. Condensate (water or condensed steam) reduces the quality of the steam but is too high in value to simply discard. Maximizing the amount of condensate that is returned to the boiler can save both energy and water treatment chemicals. The value of the condensate varies with its pressure and temperature, which depends on the operating pressure of the steam system. If boiler feedwater is 60°F, and the condensate is 212ºF, then each pound of condensate contains at least 162 BTUs; if the boiler is operating at 80% efficiency, then it represents 190 BTUs. Condensate under pressure and above 212ºF can be flashed to steam for additional energy value/recovery.

The feasibility of returning condensate to the boiler depends on the distance the condensate needs to be piped to the boiler, and the volume of the condensate. Longer distances and smaller volumes negatively affect the feasibility of returning the condensate. Condensate return has achieved a relatively significant market penetration, but a substantial number of boiler steam systems still do not include condensate return systems.

Steam Trap Survey and Repair

Assumptions used for Analysis[34]	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Application: 50 to 460 BHP boiler
Typical Measure Costs	$20,000 to $200,000
Typical Measure Savings	4%
Useful Measure Life	3 years

Steam traps are important to the performance of both end-use equipment and the distribution system. Traps provide for condensate removal with little or no steam loss. If the traps do not function properly, excess steam will flow through the end-use device or the condensate will back up into it. Excess steam loss will lead to costly operation while

[33] U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy. *A Consumer's Guide to EE and RE: Industry Plant Managers & Engineers - Steam Boilers*. www.eere.energy.gov/consumer/industry/steam.html#opp2.

[34] U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy. *A Consumer's Guide to EE and RE: Industry Plant Managers & Engineers - Steam Boilers*. www.eere.energy.gov/consumer/industry/steam.html#opp2.

condensate backup will promote poor performance and may lead to water hammer. Traps can also remove non-condensable gases that reduce heat exchanger effectiveness. Regular steam trap surveys are an important measure to identify faulty steam traps and steam leaks. Repairing the steam leaks and faulty steam traps will minimize steam losses and improve system efficiency.

Steam trap surveys and repair is generally one of the first energy-efficiency measures implemented by plants and the measure is implemented by a large segment of the Industrial sector.

Instantaneous Steam Generation

Assumptions used for Analysis[35,36]	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Application: 50 to 460 BHP boiler
Typical Measure Costs	$120,000 to $3,500,000
Typical Measure Savings	15%
Useful Measure Life	15 years

When a boiler is too big, boiler short-cycling losses may occur, as an oversized boiler will turn on and off more often than a boiler that has been properly matched to the demand. Every time the boiler turns on, extra energy is required to heat it back up to steady state. Conversely, a boiler left on standby will avoid the extra energy used to heat back up to steady state, but will waste energy while it is in standby. Instantaneous steam generators do not need to be left on standby and do not require a large amount of energy to reach steady state performance. The relatively small water content of a coil-type steam generator, for example, enables it to go from cold start-up to full steam output in approximately 5 minutes. Instantaneous steam generation systems can also be beneficial when full modulation, high-output turndown ratios or rapid start-ups are required. A large market potential exist for instantaneous steam generators.

[35] Clark, Larry S. *Coil-Type Steam Generator*s. 2001 Retrieved June 27, 2008 from www.vaporpower.com/media/FeaturebyLarryClark.pdf.

[36] Clark, Larry S. *Coil-Type Steam Generators for Heating Plant Applications*. 1999. Retrieved June 27, 2008 from www.vaporpower.com/media/HPAC_Art.pdf

4.4.3 Process Direct Heat (Furnaces / Kilns / Ovens / Dryers) [37]

Efficiency measure bundles applicable to process direct heat (furnaces/kilns/ovens/dryers) end use include all the efficiency upgrade measures that improve the efficiency or reduce the energy use applicable to the end use. The energy reduction of a measure is compared to the most common, standard efficiency technology available, without the measure. The following measures were identified and assessed:

- Exhaust gas heat recovery
- High-efficiency burner and burner controls (including oxy-gas direct impingement heating for steel annealing)
- Insulation
- Advanced heating and process control
- High-efficiency ovens
- High-efficiency dryers
- High-efficiency kilns
- High-efficiency furnaces
- Air curtains

Exhaust Gas Heat Recovery

Assumptions used for Analysis [38]	
Sub Sectors	All
Typical Measure Size/Specification	Applicable to: 2 to 100 MMBTU/h units (K/F/O/D)*
Typical Measure Costs	$30,000 to $900,000
Typical Measure Savings	15%
Useful Measure Life	15 years

* K/F/O/D: Kilns/Furnaces/Ovens/Dryers

Exhaust gas heat recovery increases efficiency because it extracts energy from the exhaust gases and recycles it back to the process. Significant efficiency improvements can be made on furnaces, kilns, dryers and ovens, even if they are already operating with properly tuned ratio and temperature controls.

For lower and medium temperature applications, heat recovery from flue gas can be used to preheat oven burners, or heat other media such as make-up air, feed product or ventilation make-up air. The energy saved in heat recovered from the flue gas is related to the temperature difference between the flue gas and the heated medium, and the savings depend upon finding applications where heat recovery is economic and improves the process. Heat or enthalpy wheels are used at a number of facilities to recover the heat. The actual energy savings and costs depend on the heat wheel implemented.

[37] Unless otherwise noted, measure assumptions provided in this section are from Marbek's in-house database, which is compiled from a number of sources including previous and on-going studies, facility energy audits and surveys.

[38] U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy. *Improving Process Heating System Performance: A Sourcebook for Industry*. 2004.

New heat recovery technologies continue to be developed, such as heat wheels with a desiccant core to recover energy, which can operate with low-grade heat in more robust environments. Opportunities vary by sub sector. For example, in the Food sub sector, recovered flue gas can be used to provide heat at the dough-rising stage, or to provide hot water for other processes. Payback periods for heat recovery systems in medium- to low-temperature application, such as ovens and dryers, range between 2.5 and four years, and are dependent on the type of technology implemented and the application of the recovered heat.[39]

For high-temperature applications there are mainly four widely used methods: direct heat recovery to the product; using a recuperator to transfer heat from the outgoing exhaust gas to the incoming combustion air, while keeping the two streams from mixing; using a regenerator to store thermal energy for future use; and using a waste heat boiler.

Exhaust gas heat recovery is not very common in process direct heat applications and, therefore, a large market potential for the measure exists.

High-efficiency Burners

Assumptions used for Analysis[40]	
Sub Sectors	All
Typical Measure Size/Specification	Applicable to: 2 to 100 MMBTU/h units (K/F/O/D)*
Typical Measure Costs	$15,000 to $500,000
Typical Measure Savings	10%
Useful Measure Life	20 years

* K/F/O/D: Kilns/Furnaces/Ovens/Dryers

Due to differing temperature requirements and applications, a wide variety of burners are available. Burner technology is also continuously improving. Efficient burner technology generally recovers heat from the flue gas and includes recuperative and regenerative style burners. These burners are more efficient at higher-temperature applications. Advancements over the past five years include the commercialization of self-recuperative and self-regenerative burners that use staged combustion to achieve flameless combustion. This results in more uniform heating, lower peak flame temperatures, improved efficiency and lower NO_x emissions.

There are numerous other types of high-temperature burner technologies that improve on previous technologies. Examples include rotary burners, dilute oxygen combustion (DOC) systems, oscillating combustion and low-NO_x burners with a vacuum-swing-adsorption (VSA) oxygen system, referred to as air-oxygen/fuel burner. More specifically:

- Rotary burners control gas pressure to ensure the desired fuel-to-air ratio.

[39] Ernest, Orlando. Lawrence Berkley National Laboratory. *Energy Efficiency Improvement and Cost Saving Opportunities for the Vehicle Assembly Industry*. 2003. Report reference number: LBNL 50939.

[40] U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy. *Improving Process Heating System Performance: A Sourcebook for Industry*. 2004.

- Dilute oxygen combustion relies on the rapid and complete mixing of fuel and oxygen jets with hot furnaces gases containing low levels of oxygen.
- Oscillating combustion systems use a valve to oscillate the fuel flow rate to the burner. Oscillation creates successive fuel-rich and fuel-lean zones within the flame. Heat transfer to the load is increased due to more luminous fuel rich-zones and the break up of the thermal boundary layer, which shortens heat-up times.
- Air-oxygen/fuel burners use an innovative air-oxy-natural gas burner that achieves high productivity and energy efficiency with low NO_X emissions.

Modern burners are increasingly using servomotors with parallel positioning to independently control the quantities of fuel and air delivered to the burner head. These controls provide consistent performance and repeatability as the burner adjusts to different firing rates. Alternatives to electronic controls are burners with a single drive or jackshaft.[41]

Examples of advanced burner technologies include radiation stabilized burners (RSB), forced internal recirculation (FIR) burners and the low-swirl burners (LSB). More specifically:

- The RSB is a fully pre-mixed, semi-radiant, surface stabilized burner, developed to provide high thermal efficiency and very low emission of NO_x and CO in industrial boilers and process heaters.

- The FIR burner aims to reduce emissions while maintaining the boiler efficiency. The FIR burner operates with pre-mixed sub-stoichiometric combustion and significant internal recirculation of partial combustion products. Both the RSB and FIR burners are available commercially.

- The LSB is being developed to achieve ultra-low NO_x emissions and increase system efficiency. The burner system combines a low-swirl flame stabilization method with internal flue gas recirculation. It is also being optimized to utilize partially reformed natural gas.

In addition to the high-efficiency burners discussed above, the use of oxy-gas is one of the major efficiency improvements applicable to high-temperature applications, such as furnaces and kilns. Replacing air with oxygen eliminates the need to heat and process large volumes of nitrogen present in air. This reduces energy use and enables a reduction in equipment size. In many industrial activities, air quality regulations drive the demand for high efficiency but low emissions (NO_x, CO) in the combustion process. NO_x formation is reduced by reducing the amount of nitrogen in contact with oxygen at high flame temperatures.

Oxy-fuel burners are used throughout industry, including the steel and glass sectors. The high velocities of the gases in the burner ensure that the fuel is completely combusted at a lower temperature zone of the flame. An earlier case study in the metal casting industry

[41] U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy. Industrial Technologies Program. *Energy Tips – Steam – Upgrading Boilers to High-efficiency Burners.*

reviewed the installation of an oxy-fuel melting furnace in an iron foundry. The furnace achieved a reduction in energy use, an improvement in operational costs and had a lower initial investment cost than a conventional electric furnace.[42]

The use of oxy-gas direct flame impingement (DFI) is specifically applicable to stainless steel annealing. DFI is based on a large number of small oxy-fuel burners that are positioned in rows close to the steel strip in order to realize oxy-fuel flames that are directly impinging the strips. Production capacity increases after the installation of the DFI oxy-gas unit and improves the energy efficiency.[43]

Insulation

Assumptions used for Analysis[44]	
Sub Sectors	All
Typical Measure Size/Specification	Applicable to: 2 to 100 MMBTU/h units (K/F/O/D)*
Typical Measure Costs	$8,000 to $250,000
Typical Measure Savings	5%
Useful Measure Life	15 years

* K/F/O/D: Kilns/Furnaces/Ovens/Dryers

Heat loss can cause significant reduction in process heating efficiency. Insulation of equipment and pipes increases the amount of energy available for end uses by decreasing the amount of heat lost from the system. New refractory fiber material with low thermal conductivity and heat storage can produce significant improvements in efficiency. Typical applications include furnace covers, installing fiber liner between the standard refractory lining and the shell wall or installing ceramic fiber liner over the present refractory liner. Replacing standard refractory linings with vacuum-formed refractory fiber insulation can also improve efficiency. It is reported that installing a furnace with refractory fiber liners can improve thermal efficiency of the heating process by up to 50%.[45]

Insulation removed during maintenance is often not replaced, and older insulation deteriorates with time. To improve the energy efficiency of the system, regular insulation surveys assist in identifying areas with insufficient insulation. A significant amount of facilities do not have regular insulation surveys.

42 Ernest, Orlando. Lawrence Berkley National Laboratory and the American Council for an Energy Efficient Economy (ACEEE). Emerging Energy-Efficient Industrial Technologies. 2000. Report reference number: LBNL 46990.

43 Gas, L. *State-of-the-art Oxyfuel Solutions for Reheating and Annealing Furnaces in Steel Industry*. 2007. Presentation retrieved www.linde-gas.com/rebox.

44 U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy; *Improving Process Heating System Performance: A Sourcebook for Industry,* 2004.

45 U.S. Environmental Protection Agency; *Wise Rules for Industrial Efficiency: a Toolkit for Estimating Energy Savings and Greenhouse Gas Emissions*, 1998.

Advanced Heating and Process Control

Assumptions used for Analysis[46]	
Sub Sectors	Medium and large industry
Typical Measure Size/Specification	Applicable to: 2 to 100 MMBTU/h units (K/F/O/D)*
Typical Measure Costs	$100,000 to $500,000
Typical Measure Savings	10%
Useful Measure Life	15 years

* K/F/O/D: Kilns/Furnaces/Ovens/Dryers

Advanced heating and process controls refer to opportunities to reduce energy losses by improving control systems that govern aspects such as material handling, heat storage and turndown. These also include process thermal optimization measures. Energy losses that are generally attributable to system operation during periods of low throughput are addressed. Some advanced controls use a programmed heating temperature setting for part load operation; they also monitor and control exhaust gas oxygen as well as unburned hydrocarbon and carbon monoxide emissions. Advanced heating and process controls are often one of the first energy-efficiency measures a facility will implement to improve energy efficiency. Although the measure has achieved a substantial market penetration, a large market still remains.

High-efficiency Ovens

Assumptions used for Analysis	
Sub Sectors	Paper, Chemical, Transportation and Machinery, Non-metallic Mineral, Miscellaneous, Food and Beverage
Typical Measure Size/Specification	Applicable to: 2 to 100 MMBTU/h ovens
Typical Measure Costs	Incremental cost: $18,000 to $1,000,000
Typical Measure Savings	12%
Useful Measure Life	20 years

Specific to: Paper, Chemical, Transportation and Machinery, Non-metallic Mineral, Miscellaneous

Infrared (IR) ovens use less energy than convection ovens because they heat the parts directly. Unlike convection ovens, they do not heat the air. IR ovens may also be used as a booster oven where final curing requires convection heating. Production rates may increase significantly when an IR oven replaces a convection oven. IR ovens can either replace existing convection ovens or be an addition to an existing one.

Natural gas savings were reported where an IR oven was used as a booster oven. Production speed increases of up to 50% were also reported. A simple payback period of 2.5 years is reported for the installation of an IR oven as a booster oven.[47] In cases where

[46] U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy. *Improving Process Heating System Performance: A Sourcebook for Industry*. 2004.

[47] U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy, Industrial Technology Program. *Infrared oven saves energy, lifts production at a metal finishing plant.* 2004.

IR ovens replaced convection ovens, reported simple payback periods ranged between 10 months and 3.5 years.[48]

Airflow in convection ovens is important to ensure uniform distribution of heated air, which improves product quality and optimizes the volume of heated air required. In medium- to low-temperature applications, some energy-efficient units incorporate internal recycling of airflow to optimize airflow distribution. Air heat seals at the entrance and exit of units limit heat loss with airflow. (See also Air Curtains measure.)

Heat recovery from flue gas can be used to preheat oven burners, or heat other media like make-up air or product. (See also the Flue Gas Heat Recovery measure.)

Specific to: Transportation and Machinery

Research relevant to paint ovens includes developing paints or coatings that cure faster, or requires less energy to cure. Powder slurry coats are an example of a newer type of paint that requires less energy. The application of powder slurry coats does not require the base coat to be heated to high temperatures, with the result that energy is saved in the drying process. A wet-on-wet painting process eliminates the baking process between the two coats of paint; Honda and Toyota have used this process at their facilities since 1998.

Specific to: Food and Beverage Sub Sector

A wide range of oven sizes and designs are used in the Food and Beverage sub sector. Advances in oven energy efficiency are primarily related to improved control systems, improved combustion efficiency, reduced energy losses and reclaiming heat from exhaust gas. (See also the Exhaust Gas Heat Recovery and High-efficiency Burners measures.) Actual energy use and efficiencies also vary widely depending on oven type and application.[49]

Reducing the speed of the recirculation fan and reducing the exhaust rate can minimize the energy loss when the oven is in standby mode, which maintains the temperature of the oven, for example, when the door is open.

The reported average payback period for eight heat recovery projects at various international locations is four years.[50] The inclusion of improved burners, control systems and insulation would further decrease the payback period.

As an end-of-life measure, the implementation of high-efficiency ovens is dependent on the turnover rate of existing ovens and the need for new ovens.

[48] Ernest, Orlando. Lawrence Berkley National Laboratory. *Energy Efficiency Improvement and Cost Saving Opportunities for the Vehicle Assembly Industry*. 2003. Report reference number: LBNL 50939.

[49] U.S. Gas Research Institute – Energy Utilization Centre: Research Collaboration Program. *Food Processing Technology Project – Phase 1*. 2003.

[50] Ernest, Orlando. Lawrence Berkley National Laboratory and the American Council for an Energy Efficient Economy (ACEEE). Emerging Energy-Efficient Industrial Technologies. 2000. Report reference number: LBNL 46990.

High-efficiency Dryers

Assumptions used for Analysis	
Sub Sectors	Food and Beverage, Chemical, Paper, Miscellaneous
Typical Measure Size/Specification	Applicable to: 2 to 100 MMBTU/h ovens
Typical Measure Costs	$18,000 to $1,000,000
Typical Measure Savings	12%
Useful Measure Life	20 years

A large variety of dryers, ranging in size and design, are used in the Food, Chemical, Paper and Miscellaneous sectors. Besides the design of dryers, advances in energy efficiency include improving control systems, improving combustion efficiency, reducing energy losses and reclaiming heat from exhaust gas. (See also the Gas Exhaust Heat Recovery, High-efficiency Burners and Advanced Heating and Process Control measures.)

Advanced drying technology usually aims to improve the heat transfer between the combustion gas and the product, for example the pulsed fluidized bed dryer, helix dryer and the pulse combustion flash dryer. The pulsed fluidized bed dryer uses a periodic hot air supply and has a wide range of applications. The helix dryer is a cylindrical chamber with a centrally located hollow column through which hot gas is supplied to the helical trays. The pulse combustion flash dryer uses intermittent combustion of fuel, which generates intensive pressure, velocity and temperature waves. The helix dryer must still be proven on a commercial scale, while the other two technologies are available for commercial applications. Energy use and efficiencies also vary widely depending on dryer type and application.[51]

Replacing a steam system with direct-fired systems can save a significant amount of natural gas. One example is the implementation of a direct-fired gas system to dry barley in a malting plant; pre-drying stages or multiple drying stages can increase the production rate and reduce the natural gas consumption per production unit.

The implementation of high-efficiency dryers is dependent on the turnover rate of existing dryers and the need for new dryers.

[51] U.S. Gas Research Institute – Energy Utilization Centre: Research Collaboration Program. *Food Processing Technology Project – Phase 1*. 2003.

High-efficiency Kilns

Assumptions used for Analysis	
Sub Sectors	Non-metallic Mineral
Typical Measure Size/Specification	Applicable to: 20 to 100 MMBTU/h furnaces
Typical Measure Costs	$100,000 to $1,000,000
Typical Measure Savings	14%
Useful Measure Life	20 years

Roller kilns, using rapid firing technology, are more efficient than conventional tunnel kilns in the clay and ceramic industries. In the rapid firing process, the clay is prepared dry and the reduced water content results in reduced heating times. Roller kilns are successfully used in Europe and the U.S. Current kilns may have single or double layer designs and are well suited for ceramic products, but may be less suited for larger capacity brick kilns. Energy performance can be improved by heat recovery from the flue gases and retrofitting or installing improved insulation with low thermal mass materials (LTM). A simple payback period of 3.2 years is reported for the installation of a roller kiln in the place of a tunnel kiln, and relatively high fuel savings are reported when tunnel kilns are replaced with roller kilns and improved LTM insulation.[52]

Suppliers of roller kilns are developing multi-layer kilns, which will increase production rates and reduce the rate of energy usage per production unit. Additional fuel savings will be associated with improved heat recovery, burner design and control systems. (See also the Gas Exhaust Heat Recovery, High-efficiency Burners and Advanced Heating and Process Control measures.)

Similar to high-efficiency ovens and dryers, the implementation of high-efficiency kilns is dependent on the turnover rate of existing kilns and the need for new kilns. The lifespan of kilns are relatively longer than ovens and dryers, and a large percentage of older kilns (compared to ovens and dryers) are present in some sectors.

High-efficiency Furnaces

Assumptions used for Analysis	
Sub Sectors	Primary Metal, Transportation and Machinery and Non-metallic Mineral (medium and large facilities)
Typical Measure Size/Specification	Applicable to: 20 to 100 MMBTU/h furnaces
Typical Measure Costs	Incremental cost: $100,000 to $1,000,000
Typical Measure Savings	14%
Useful Measure Life	20 years

The main advances in furnaces are related to combustion control, waste-heat recovery and better design. Preheating combustion air using high-velocity burners, pulse firing, recuperators or regenerative burners can improve the heat transfer of the combustion

[52] Ernest, Orlando. Lawrence Berkley National Laboratory and the American Council for an Energy Efficient Economy (ACEEE). Emerging Energy-Efficient Industrial Technologies.2000. Report reference number: LBNL 46990.

system. Specific improvements are usually applicable to specific furnaces. (See also the High-efficiency Burners measure profile.)

Advanced furnace design includes highly preheated combustion air system with/without oxygen enrichment.[53] Porous wall radiation barrier (PWRB) heating mantles reportedly results in a heat-transfer rate in the 1,800°F to 2,400°F range that is two to four times greater than conventional gas-fired mantles.[54] Improvement in insulation material will reduce heat losses from the furnace shell. Research to develop new composite materials for insulation is undertaken at the Lawrence Berkley National Laboratory and is expected to contribute to the overall efficiency of furnaces.[55]

Specific to: Primary Metal and Transportation and Machinery Sectors

Recycled aluminum production uses 90% less energy than primary aluminum production. Several new technologies have emerged that help to improve the recovery or processing of scrap, or reduce energy use in the preparing and melting of scrap. Examples include a decoating kiln (the IDEX™), which reported a relatively high reduction in kiln energy use, and a new melt design that preheats and decoats the scrap in a dry hearth furnace and then melts the scrap in a closed well furnace.

Specific to: Non-Metallic Mineral Sector

State-of-the-art furnace technology in glass production uses a higher percentage of recycled glass, also called cullet. Glass manufactured in North America contains on average 20% cullet, while European container glass manufacturers sometimes use 80% cullet. Increasing cullet use by 10% reduces fuel use by approximately 2.5%.

Increasing the cullet percentage in glass containers requires more effective and efficient waste glass collection. The reported simple payback period for furnaces with 100% cullet percentage and cullet preheating is two years. Energy efficiency can be further improved by batch cullet preheating and by recovering the flue gas heat. Cullet preheaters have been under development since 1980 and commercial applications can be found in Europe, while development projects are ongoing in the U.S.

Similar to high-efficiency ovens, dryers and kilns, the implementation of high-efficiency furnaces is dependent on the turnover rate of existing furnaces and the need for new furnaces. The lifespan of furnaces is relatively longer than ovens and dryers, and a large percentage of older furnaces (compared to ovens and dryers) are present in some sectors.

[53] U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy. Industrial Technologies Program. *Development of a highly preheated combustion air system with/without oxygen enrichment*. 2004.

[54] U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy. *Combustion Fact Sheet: Innovative energy-efficient high-temperature gas-fired furnace*. 2001.

[55] U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy. *Industrial Material for the Future Project Fact Sheet: Advanced nanoporous composite materials for industrial heating application*s. 2002.

Air Curtains

Assumptions used for Analysis[56,57]	
Sub Sectors	Small and medium industrial facilities
Typical Measure Size/Specification	Applicable to: 2 to 20 MMBTU/h units (O/D)*
Typical Measure Costs	$15,000 to $100,000
Typical Measure Savings	15%
Useful Measure Life	20 years

* O/D: Ovens/Dryers

Air heat seals at continuous oven and dryer entrances and exits limit heat loss with airflow. Air curtains are generally not applicable to batch operations. Air curtains are not usually technically feasible at high-temperature processes, such as kilns and furnaces, due to the process lay out, the high-temperature differential and if the processes operate as batch processes.

In a typical application, a heat seal draws hot interior air and compresses it in scroll fans. Centrifugal fans are used to create an air curtain at oven and dryer openings. When used on oven/dryer openings, air curtains are normally installed horizontally over the opening and angled slightly inward to contain the hot air. Air heat seals can be installed as a retrofit or a new installation.

Air curtains are not very common in industrial plants.

4.4.4 Other Process

Other process efficiency measures include all the upgrade measures that improve efficiency or reduce the energy use applicable to specific processes in sub sectors. The energy reduction of a measure is compared to the most common, standard efficiency technology available, without the measure. The following measures were identified and assessed:

- Pollution control measures
- Computational fluid dynamic modeling
- Hydrogen atmospheres for steel batch coil annealing
- Process heat recovery
- Process integration and pinch analysis.

Specific information about the measure was retrieved from in-house Marbek data, unless otherwise specified.

56 Hank Specialty Equipment. *Air Curtains*. www.hankinspecialty.com/aircurtain.html.

57 Miniveil Air Systems. *Air Curtain Usage*. www.miniveil.com/uses.html.

Pollution Control Measures

Assumptions used for Analysis	
Sub Sectors	Medium and large industry
Typical Measure Size/Specification	Applicable to: 5,000 to 500,000 scfm
Typical Measure Costs	Incremental cost: $80,000 to $1,000,000[58]
Typical Measure Savings	10%
Useful Measure Life	20 years

Regenerative thermal oxidizers (RTOs) are generally used as a pollution control mechanism to destroy volatile organic compounds (VOCs) and are assumed to be the baseline technology. RTOs use high temperatures to incinerate and destroy VOCs. Regenerative catalytic oxidizers (RCOs) use a catalyst to enable the RCO to operate at a lower temperature than the RTO. RCOs provide the same level of VOC destruction efficiency as RTOs, but offer lower natural gas consumption. Large energy-intensive industries in sub sectors that are subject to emission regulations are more inclined to have energy-efficient pollution control measures but the market penetration of the measure is still relatively limited.

Computational Fluid Dynamic (CFD) modeling

CFD modeling is used as a tool to identify energy savings opportunities and does not generate savings *per se*. The opportunities identified are captured by the other measures and, if CFD modeling were included, it would result in a double counting of the savings. CFD modeling was therefore excluded from the study.

Hydrogen Atmospheres for Steel Batch Coil Annealing

Assumptions used for Analysis[59,60]	
Sub Sectors	Miscellaneous
Typical Measure Size/Specification	Applicable to: 20 to 100 MMBTU/h process units
Typical Measure Costs	$250,000 to $2,000,000
Typical Measure Savings	30%
Useful Measure Life	15 years

The modernization of existing HN batch anneal facilities to H_2 operation can range from simply retrofitting equipment to the safe use of pure H_2 as the process atmosphere, to a full conversion to state-of-the-art high-performance hydrogen technology. Increasing throughput is generally the primary reason to upgrade, but cost savings also result from reduced consumables and labour, increased product quality and yield and the capability to produce higher profit margin grades.

[58] U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy. *Air Pollution Control Technology Fact Sheet*. EPA-425/F-03-021.

[59] Brooks, R. *California Style: All New, All Hydrogen*. 2001. RAD-CON, Inc. www.rad-con.com/pdf/California%20Style.pdf.

[60] Gasse, W. *Benefits of converting HN batch annealing to hydrogen*. 2002. Retrieved June 27, 2008 from www.allbusiness.com/primary-metal-manufacturing/iron-steel-mills-ferroalloy/344606-1.html.

Hydrogen has a thermal conductivity approximately seven times greater and a density of one-fourteenth that of nitrogen. Upgrading the batch anneal equipment to H_2 capability provides an overall improvement in heat transfer of the process atmosphere itself and allows the further increase in convective heat transfer through increasing process atmosphere recirculation flow rates.

As a result, the required thermal uniformity within the coil (Delta temperature, or the difference between the hot exterior and the coldest position in the core of the coil) is achieved within a shorter period of time, meaning equivalent micro-structural and mechanical properties uniformity is achieved with higher throughput and reduced utilities consumption. As H_2 is much more efficient in transferring heat into the body of the coil, overheating of coil exterior surfaces is greatly reduced or eliminated entirely, resulting in increased yield of prime material. Superior mechanical properties are also made possible by the ability to realize reduced Delta temperature than can be achieved with old HN equipment. Modernization can increase heating throughput by 50% to 200% relative to the old HN operation, depending upon the recirculated process atmosphere flow generated by the base motor and impeller and the fuel gas consumption rating of the furnace.

Based on information from Ontario suppliers, the implementation of hydrogen atmospheres is relatively mature and close to half of the potential market has been captured.

Process Heat Recovery

Assumptions used for Analysis	
Sub Sectors	All
Typical Measure Size/Specification	Applicable to: 2 to 100 MMBTU/h process units
Typical Measure Costs	$30,000 to $1,000,000
Typical Measure Savings	15%
Useful Measure Life	15 years

Process heat recovery includes the use of waste heat from industrial processes to heat other processes or utility streams. A wide range of heat recovery opportunities exists, including heat transfer between a heat source and a heat sink, where the heat sink and heat source could be either gas, liquid or solid. The feasibility of process heat recovery opportunities depend in large part on the quality of the heat, the distance between the heat source and heat sink, potential cross contamination of product, properties of the process stream (such as corrosiveness), the flow rates of the streams and the fluctuation in the flow rates. Although the concept of process heat recovery is very mature, its participation rate in industry is still relatively low.

Process Integration and Pinch Analysis

Process integration and pinch analysis are used as tools to identify energy savings opportunities and do not generate savings *per se*. The opportunities identified are captured by the other measures and, if process integration and pinch analysis were included, it would result in a double counting of the savings. This measure was therefore excluded from the study.

4.4.5 HVAC[61]

Efficiency measure bundles applicable to the heating, ventilation and air conditioning (HVAC) end use include all the upgrade measures that improve the efficiency, or reduce the energy use applicable to the end use. The energy reduction of a measure is compared to the most common, standard efficiency technologies, without the applicable measure. The following measures were identified and assessed:

- Radiant heaters
- Automated temperature control
- Solar walls
- Ventilation heat recovery and optimization
- Warehouse loading dock seals
- Air curtains
- Air compressor heat recovery
- Destratification fans.

Radiant Heaters

Assumptions used for Analysis	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Applied to small, medium and large facilities
Typical Measure Costs	$30,000 to $200,000
Typical Measure Savings	25%
Useful Measure Life	20 years

Radiant heating equipment is designed to provide comfort heating through the application of radiant heat transfer. Radiant heaters work by emitting heated infrared rays, which are absorbed by objects, such as floors, equipment or people. Infrared heat rays do not warm the air, although the air immediately surrounding the "heated" objects is warmed by the increase in temperature of those objects. These systems are very efficient compared to convection type heaters and can use significantly less natural gas than a natural gas-fired convection heating system. Radiant heating technology is mature and data indicated that close to one-third of the potential market is already captured.[62]

61 Unless otherwise noted, measure assumptions provided in this section are from Marbek's in-house database, which is compiled from a number of sources including previous and on-going studies, facility energy audits and surveys.

62 Zulfiqar A. *An Insight Into The Union Gas Industrial Segment*. Union Gas Report, 2007.

Automated Temperature Control

Assumptions used for Analysis	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	N/A
Typical Measure Costs	$12,000 to $70,000
Typical Measure Savings	15%
Useful Measure Life	20 years

Automatic temperature controls allow the temperature in different areas to be varied according to a schedule, in order to save energy during times when a space need not be heated or cooled as much. These controls may also prevent individuals from manually changing the temperature settings. Automated temperature controls for comfort heating are relatively common in industrial plants and have reportedly achieved close to 50% market penetration.[63]

Solar Walls

Assumptions used for Analysis[64]	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	500 watts/square meter[65]
Typical Measure Costs	$100,000 - $250,000
Typical Measure Savings	15%[66]
Useful Measure Life	20[67]

Solar walls use solar energy to preheat outside air before it is introduced into a plant. The warmed air can be distributed as is, further heated in a building's primary heating system or used as combustion air for industrial furnaces. Because the air going into the system is already warm, less energy is needed to heat it further.

Solar walls are typically made of dark metal cladding, usually unglazed corrugated aluminum, which is mounted over a south-facing wall. Sunlight hitting the cladding warms the air near its surface, which is then drawn through thousands of small perforations in the cladding into a narrow space between the wall and the building. The heated air rises to an overhanging canopy plenum where it is drawn into the facility by fans and dampers. A solar wall is virtually maintenance free, with no liquids or moving parts other than the ventilation system fans. Solar walls have achieved little market penetration in Ontario industrial facilities.

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[63] Zulfiqar A. *Industrial Usage and Energy Efficiency Study: Top Line Results*. Union Gas Report, 2006.

[64] Natural Resources Canada. *Solar Air Heating*. 2007. www.canren.gc.ca/prod_serv/index.asp?CaId=137&PgId=742.

[65] Conserval Engineering. *Solar Air Heating and Ventilation with SolarWall Systems*. Retrieved May 20, 2008 from http://solarwall.com/en/products/solarwall-air-heating.php.

[66] Ibid.

[67] Ibid.

Ventilation Heat Recovery and Optimization

Assumptions used for Analysis	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	12,000 cfm
Typical Measure Costs	$25,000 to $150,000
Typical Measure Savings	17%
Useful Measure Life	20 years

Two types of heat recovery and optimization technologies are included in the measure: BKM reverse flow heat recovery system and heat wheels.

A BKM reverse flow heat recovery system is an air-to-air heat exchanger that collects the thermal energy in air that is exhausted from a facility and uses it to preheat fresh make-up air that is brought in to replace the exhausted air. These units use two heat sinks, which are alternately used to either heat the incoming air, or cool the exhaust air, and switch roles every 70 seconds.

An enthalpy wheel, or heat wheel, is a type of energy recovery ventilator that uses a rotating energy exchanger in the form of a cylinder. The cylinder is packed with a heat transfer medium with many small air passages, or flutes, that run parallel to the direction of airflow. In a typical installation, the wheel is positioned in a duct system such that it is divided into two half moon sections. Stale air from the conditioned space is exhausted through one half, while outdoor air is drawn through the other half in a counter flow pattern. At the same time, the wheel is rotated slowly. Sensible heat is transferred as the metallic substrate picks up and stores heat from the hot air stream and gives it up to the cold one. Latent heat is transferred as the medium condenses moisture from the air stream that has the higher humidity ratio.

This energy-efficiency measure has achieved a relatively small market penetration and a significant potential for a higher participation rate exists.

Warehouse Loading Dock Seals

Assumptions used for Analysis[68]	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	N/A
Typical Measure Costs	$10,000 to $40,000
Typical Measure Savings	5%
Useful Measure Life	10 years

Warehouse loading dock seals provide a barrier between the back of a docked truck and the edges of the loading dock opening. An improper seal may result in drafts and a loss of heat from the warehouse. Although this measure is easy to implement, it is a relatively neglected efficiency area with a large potential for market penetration.

[68] Bondor Manufacturing Company. *Foam Truck Dock Seals*. www.bondorseals.com/more_info/dock_seals_all_types/foam_truck_dock_seals/foam_truck_dock_seals.htm.

Air Curtains

Assumptions used for Analysis	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	2 to 8 Standard loading dock doors
Typical Measure Costs	$13,000 to $40,000
Typical Measure Savings	5%
Useful Measure Life	15 years

Open loading dock doors may lose a large amount of heat between the time they are opened and when a truck is docked. An air curtain at the loading dock door acts as a thermal barrier, lowering the amount of energy lost through the opening. Air curtains work by generating a jet of high-velocity air that separates the two sides of the jet, forming a screen or curtain. The air curtain should be activated as soon as the loading dock door is opened and then stopped once it is closed in order to conserve energy. Air curtains can either be heated or unheated, depending on the application requirement. Although air curtain technology is a very mature technology, its reported market penetration is very small.[69]

Air Compressor Heat Recovery

Assumptions used for Analysis	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	N/A
Typical Measure Costs	$18,000 to $100,000
Typical Measure Savings	15% of heating costs
Useful Measure Life	20 years

Typically, the warm exhaust gas produced by plant air compressors is discharged outside the building. Using this exhaust during winter to replace outside make-up air can significantly reduce the cold make-up air supply. Installing a duct that joins the compressor gas exhaust to the existing plant air distribution system ensures that the warm air is distributed evenly through the plant. During summer months the exhaust gas from the compressors will still need to be vented to outside the building. Although this measure is very mature, its reported market penetration is very small.[70]

[69] Zulfiqar A. *Industrial Usage and Energy Efficiency Study: Top Line Results*. Union Gas Report, 2006.

[70] Zulfiqar A. *An Insight Into The Union Gas Industrial Segment*. Union Gas Report, 2007.

Destratification Fans

Assumptions used for Analysis[71,72]	
Sub Sectors	Small, medium and large industry
Typical Measure Size/Specification	Applied to small, medium and large plants
Typical Measure Costs	$10,000 to $60,000
Typical Measure Savings	8%
Useful Measure Life	20 years

The air temperature in large, high ceiling storage rooms can become stratified (i.e., air is layered at different temperatures at different levels). Destratification fans are high-volume, low-speed fans that mix the air and eliminate stratified layers of temperature in large spaces. These types of fans use a comparable amount of energy as conventional, small ceiling fans, but since fewer fans are required, the total energy required is reduced. High-volume, low-speed destratification fans have been on the market for a number of years and are at the early stages of market penetration.

4.5 TECHNOLOGY DATA AND INFORMATION AS INPUT FOR ECONOMIC AND ACHIEVABLE POTENTIAL FORECASTS

The technology data and information presented in this section was used as input data in the measure TRC assessment, described above in Sections 4.2 and 4.3. The detailed results of the TRC input assumptions and results are provided in Appendix D. The measures that have a positive TRC are included in the Economic Potential and Achievable Potential assessment, which are discussed in Sections 5 and 6. As discussed under Section 4.3 all the measures had a positive TRC in at least one sub sector for the large technology size. It should be noted that the following measures listed in Exhibits 1.1 and 4.4 were not assessed: first generation super boilers, computational fluid dynamic modelling, and process integration and pinch analysis. The reasons for the exclusion of these measures are described in the respective descriptions in Section 4.4.

[71] Big Ass Fans. www.bigassfans.com/howitworks.php.

[72] Envira-North Systems. *Destratification Fans*. www.enviranorth.com.

5. ECONOMIC POTENTIAL FORECAST

5.1 INTRODUCTION

This section presents the Industrial sector Economic Potential Forecast for the study period (2007 to 2017). The Economic Potential Forecast estimates the level of natural gas consumption that would occur if all process equipment and building envelopes were upgraded to the level that is cost effective. In this study, "cost effective" means that the technology upgrade passes the measure total resource cost (TRC) test, as discussed previously in Section 4.2.

The discussion in this section is organized into the following subsections:

- Major modeling tasks
- Technologies included in Economic Potential Forecast
- Presentation of results
- Interpretation of results.

5.2 MAJOR MODELING TASKS

By comparing the results of the Industrial sector Economic Potential Forecast with the Reference Case, it is possible to determine the aggregate level of potential natural gas savings within the Industrial sector, as well as identify which specific sub sectors, end uses and technologies provide the most significant opportunities for savings.

To develop the Industrial sector Economic Potential Forecast, the following tasks were completed:

- The measure TRC results for each of the energy-efficiency upgrades and equipment sizes (small, medium, large) presented in Exhibit 4.3 were reviewed.

- Technology upgrades that had positive measure TRC results were selected for inclusion either on a "full cost" basis for retrofit measures, or an "incremental" basis for end-of-life measures. Technical upgrades passing the measure TRC test on a "full cost" basis were implemented in the first forecast year. Those upgrades that passed the measure TRC test on an "incremental" basis were introduced as the existing stock reached the end of its useful life.

- Energy use within each of the sub sectors was modelled with the same energy models used to generate the Reference Case. However, for this forecast, the remaining standard efficiency technologies included in the Reference Case were replaced with the most efficient "technology upgrade option" that passed the measure TRC test.

- When multiple measures passed the economic screen and were applicable to a given end use, the first measure selected was the one that provided the largest energy savings. This typically meant that equipment replacement (e.g., a high-efficiency boiler) was applied first in the model, followed by retrofit measures (e.g., boiler control, economizers, heat recovery, etc).

5.3 TECHNOLOGIES INCLUDED IN ECONOMIC POTENTIAL FORECAST

Exhibit 5.1 (below) provides a listing of the technologies selected for inclusion in this forecast. In each case, the exhibit shows the following:

- End use affected
- Upgrade measure(s) selected
- Sub sector(s) to which the measures were applied
- Rate at which the measures were introduced into the stock i.e., immediate or new installations or end-of-life replacement.

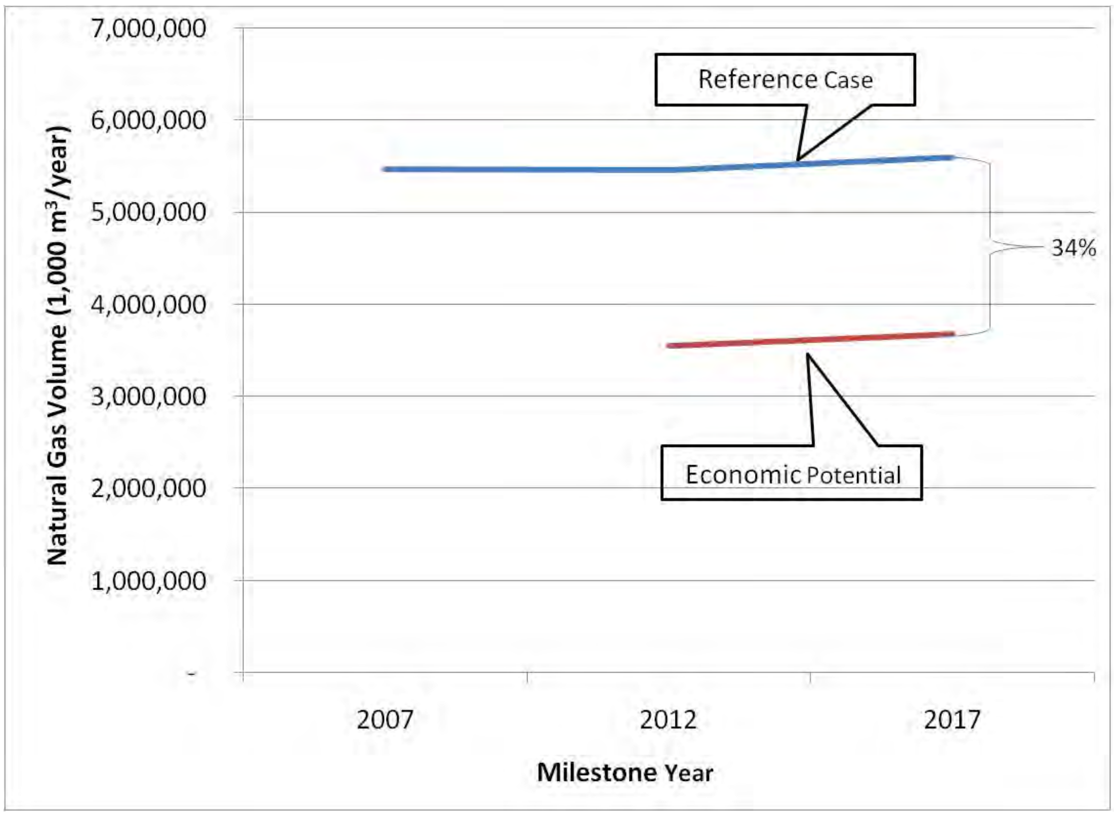
Exhibit 5.1: Technologies Included in Economic Potential Scenario Chemical Sub Sector

End Use	Measure	Applicability to Sub Sector	Rate of Introduction
System	Integrated control system	All	Immediate
	Sub-metering	All	Immediate
Hot Water Systems and Boilers Steam Systems	Economizer	All	Immediate
	Blowdown heat recovery	All	Immediate
	Boiler combustion air preheat	All	Immediate
	Process heat recovery to preheat make-up water	All	Immediate
	Condensing boiler	All	End-of-life/ New
	Direct contact hot water heaters	All	End-of-life/ New
	Boiler right sizing and load management	All	End-of-life/ New
	High-efficiency burners	All	Immediate
	Insulation	All	Immediate
	Advanced boiler controls	All	Immediate
	Blowdown control	All	Immediate
	Boiler water treatment	All	Immediate
	Boiler maintenance	All	Immediate
	Condensate return	All	Immediate
	Steam trap survey and repair	All	Immediate
	Instantaneous steam generation	All	Immediate
Process Heat (Furnace/ Kilns/ Ovens/ Dryers)	Exhaust gas heat recovery	All	Immediate
	High-efficiency burners and burner controls	All	Immediate
	Insulation	All	Immediate
	Advanced heating and process controls	All	Immediate
	High-efficiency ovens	Paper, Chemical, Transport & Machinery, Non-metallic Mineral, Misc., Food & Beverage	End-of-life/ New
	High-efficiency dryers	Paper, Chemical, Misc., Food & Beverage	End-of-life/ New
	High-efficiency kilns	Non-metallic Mineral	End-of-life/ New
	High-efficiency furnaces	Primary Metal, Transportation & Machinery, Non-metallic Mineral	End-of-life/ New
	Air curtains	All	Immediate
Other Process	Pollution control measures	Transportation & Machinery, Misc.	End-of-life/ New
	Hydrogen atmospheres for steel batch coil annealing	Misc.	Immediate
	Process Heat Recovery	All	Immediate
HVAC	Radiant heaters	All	Immediate
	Automated temperature control	All	Immediate
	Solar walls	All	Immediate
	Warehouse loading dock seals	All	Immediate
	Air curtains	All	Immediate
	Air compressor heat recovery	All	Immediate
	Destratification fans	All	Immediate

5.4 PRESENTATION OF RESULTS

Exhibit 5.2 compares the Reference Case and Economic Potential Forecast levels of industrial energy consumption. As illustrated, under the Reference Case industrial natural gas consumption would grow from the Base Year level of approximately 5,465 million m^3/year to 5,598 million m^3/year by 2017. This contrasts with the Economic Potential Forecast in which natural gas consumption would decrease to approximately 3,674 million m^3/year, a difference of approximately 1,924 million m^3/year, or 34% by 2017.

Exhibit 5.2: Reference Case versus Economic Potential - Natural Gas Consumption for the Total Union Gas Service Area (1000 m3/yr.)



5.4.1 Natural Gas Savings

Further detail on the total potential natural gas savings provided by the Economic Potential Forecast is provided in the following exhibits:

- Exhibits 5.3 and 5.4 present the results by sub sector, end use and milestone year for the total Union Gas Service Area.
- Exhibit 5.5 graphically presents the forecasted results in 2017 by sub sector and end use for the total Union Gas Service Area.

A detailed breakdown of the Economic Potential results by service region is presented in Appendix C.

Exhibit 5.3: Natural Gas Savings by Sub Sector and End Use for the Total Union Service Area in Milestone Year 2012 (1000 m^3/yr.)

Sub Sector	End Use							
	System	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal[73]	89,821	3,941	35,772	298,984	2,754	68,586	499,857	26%
Contract Chemical	76,884	3,339	100,384	97,179	9,011	66,722	353,519	19%
Other Chemical	693	30	905	876	81	601	3,187	0.2%
Contract Paper	25,007	1,232	59,602	20,533	824	20,622	127,820	7%
Contract Transportation and Machinery	27,783	1,357	24,369	32,283	1,898	55,312	143,002	8%
Other Transportation and Machinery	3,702	181	3,247	4,301	253	7,370	19,053	1.0%
Contract Petroleum Refineries	23,225	1,003	15,596	73,476	560	12,217	126,078	6.6%
Contract Mining	21,841	9,877	19,158	38,343	1,261	15,036	105,517	6%
Contract Food and Beverage	30,071	3,742	34,429	21,832	1,915	10,167	102,156	5%
Other Food and Beverage	1,919	239	2,197	1,393	122	649	6,518	0.3%
Contract Non-Metallic Mineral	19,862	891	8,347	86,400	1,215	10,966	127,681	7%
Miscellaneous Industrial	73,007	5,905	20,346	46,391	2,097	141,150	288,896	15%
Total	393,815	31,738	324,351	721,991	21,991	409,398	499,857	100%
Percentage of Total	21%	2%	17%	38%	1%	22%		

73 As highlighted in Section 2.3, an assessment of data obtained at the completion of this study indicated that up to about 42% of the Base Year natural gas consumption in the Contract Primary Metal sub sector could be considered as feedstock. It was not feasible to include the data in the study at this late stage of the study. The implication is that the energy efficiency potential in the Contract Primary Metal sub sector might be overstated.

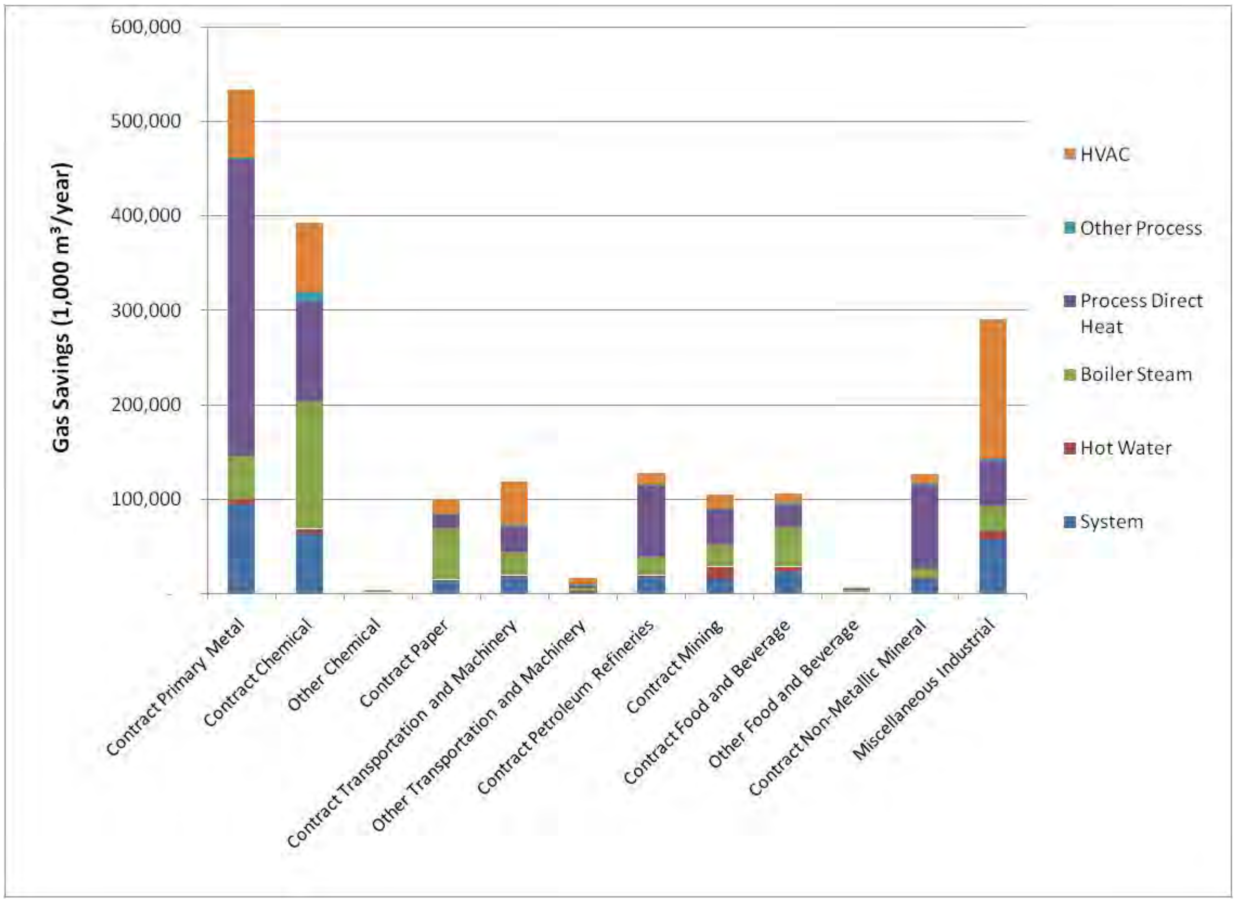
Exhibit 5.4: Natural Gas Savings by Sub Sector and End Use for the Total Union Service Area in Milestone Year 2017 (1000 m^3/yr.)

Sub Sector	End Use							
	System	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	94,745	5,428	46,092	312,941	2,901	72,090	534,197	28%
Contract Chemical	63,733	4,721	134,508	106,478	9,948	73,407	392,796	20%
Other Chemical	687	43	1,212	960	90	662	3,653	0.2%
Contract Paper	13,809	1,162	53,732	15,011	607	15,133	99,455	5%
Contract Transportation and Machinery	17,508	1,423	24,547	26,972	1,593	46,028	118,071	6%
Other Transportation and Machinery	2,271	190	3,271	3,594	212	6,133	15,670	0.8%
Contract Petroleum Refineries	17,924	1,362	19,601	75,035	575	12,529	127,026	6.6%
Contract Mining	16,023	12,212	22,692	37,343	1,230	14,628	104,128	5%
Contract Food and Beverage	23,303	4,782	42,424	22,376	1,969	10,405	105,259	5%
Other Food and Beverage	910	305	2,707	1,428	126	664	6,140	0.3%
Contract Non-Metallic Mineral	15,168	1,150	10,292	87,681	1,236	11,110	126,638	7%
Miscellaneous Industrial	57,899	7,743	25,658	48,681	2,210	147,826	290,017	15%
Total	323,980	40,521	386,738	738,500	22,697	410,615	1,923,051	100%
Percentage of Total	17%	2%	20%	38%	1%	21%		

The results presented in the preceding exhibits highlight the following observation applicable to the savings by milestone year:

- Approximately 100% of the identified savings in 2017 were economically feasible by 2012. This is because most of the measures are cost effective at full cost, i.e., it is economically attractive to implement them before the equipment they affect or replace has reached the end of its useful life. Under the Economic Potential Forecast, they would therefore be implemented in the first milestone year.

Exhibit 5.5: Natural Gas Savings by Sub Sector and End Use for the Total Union Service Area in Milestone Year 2017 (1000 m^3/yr.)



Highlights of the results presented in the preceding exhibits are summarized below:

Savings by End Use

- Process direct heat (38%) and boiler steam system (20%) measures account for the largest share of the identified savings in 2017 for the total Union Service Area, followed by HVAC (21%).

Savings by Sub Sector

- Among modelled sub sectors in the Southern service region, the largest percentage of the identified savings in 2017 are in Contract Primary Metal (27%), Contract Chemical (19%) and Miscellaneous (21%).

- In the Northern service region, the Contract Primary Metal (30%) and Contract Chemical (25%) sub sectors again account for the largest share of the identified savings in 2017, followed by Contract Mining (18%) and Contract Paper (15%).

Savings by Service Region

As indicated above, the detailed Economic Potential Forecast results for the northern and southern service regions are presented in Appendix C.

- The Southern service region represents approximately 69% of the identified savings in 2017. This is to be expected given the larger volume of natural gas consumed by the Industrial sector in this service region.

5.5.1 Caveats on Interpretation of Results

A systems approach was used to model the energy impacts of the efficiency upgrades presented in the preceding section. In the absence of a systems approach, there would be double counting of savings and an accurate assessment of the total contribution of the energy-efficient upgrades would not be possible.

For example, advanced boiler controls reduce boiler natural gas use, as does the installation of high-efficiency burners. On its own, each measure will reduce overall boiler heating energy use. However, the two savings are not additive. The order in which some upgrades are introduced is also important. In this study, the approach has been to select and model the impact of measures that reduce the load for a given end use (e.g., boiler right sizing and load management) and then to introduce measures that meet the remaining load more efficiently (e.g., high-efficiency burner).

The above approach means that where there is interaction between measures that affect the same end use, the savings for those individual measures are reduced. As appropriate, this issue is addressed in the Achievable Potential section of this report.

6. ACHIEVABLE POTENTIAL FORECAST

6.1 INTRODUCTION

This section presents the Industrial sector Achievable Potential natural gas savings for the study period (2007 to 2017). The Achievable Potential is defined as the proportion of the gross savings identified in the Economic Potential Forecast that could realistically be achieved within the study period.

The discussion is organized into the following sub sections:

- Description of Achievable Potential
- Approach to the Estimation of Achievable Potential
- Achievable Potential Workshop Organization
- Achievable Potential Workshop Results
- Achievable Potential Results
- Summary and Interpretation of Results.

6.2 DESCRIPTION OF ACHIEVABLE POTENTIAL

Achievable Potential recognizes that it is difficult to induce all customers to purchase and install all of the energy-efficiency measures that meet the criteria defined by the Economic Potential Forecast presented in the preceding section.

Exhibit 6.1 illustrates the level of natural gas consumption estimated in the Achievable Potential scenarios. As illustrated in Exhibit 6.1, reductions in natural gas consumption under Achievable Potential are "banded" by the two forecasts presented in previous sections, namely the Reference Case and the Economic Potential Forecast.

Exhibit 6.1: Illustration of Achievable Potential versus Reference Case and Economic Potential Forecasts

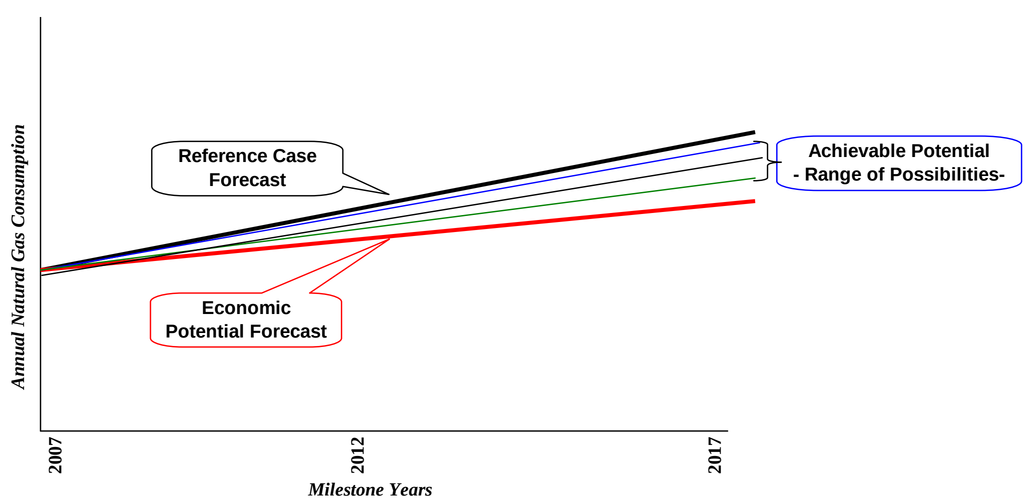


Exhibit 6.1 shows that future natural gas consumption under the Reference Case is greater than in any of the Achievable Potential forecasts. This is because the Reference Case represents a "worst case" situation in which there are no additional utility market interventions and hence no additional natural gas savings beyond those that occur "naturally."

Exhibit 6.1 also shows that future natural gas consumption under the Achievable Potential is greater than in the Economic Potential Forecast. This is because the Economic Potential Forecast assumes that efficient new technologies fully penetrate the market as soon as it is cost effective to do so. However, the Achievable Potential recognizes that under "real world" conditions, the rate at which customers are likely to implement energy-efficiency measures will be influenced by market constraints and, as a result, implementation will occur more slowly than under the assumptions employed in the Economic Potential Forecast.

Exhibit 6.2 illustrates some of the types of market constraints that often affect customer implementation of energy-efficiency measures.

Exhibit 6.2: Illustration of "Typical" Market Constraints Affecting Energy-efficiency (EE) Implementation

Category	Barrier
Price Signals	• No monetization of externalities • Tax and subsidies that affect the playing field between EE and the fuels being displaced
Customer EE Awareness	• Awareness that EE opportunities and products exist • Awareness of benefits – cost and co-benefits • Customers' technical ability to assess the options
Product and Service Availability	• Local or national product availability • Existence of a viable infrastructure of trade allies • Vendor or trade ally awareness of the efficiency options and their understanding of the technical issues
Financing of EE Measures	• Access to appropriate financing • Size of required EE investment vs. asset base • Payback ratio – actual vs. required
Transaction Costs	• Level of effort/hassle required to become informed, select products, choose contractor(s) and install
Perceived Risk/Reward	• Level of perceived risk that the EE product may not perform as promised • Level of positive external/personal recognition for "doing the right thing" by installing the EE measure(s)
Split Incentive/Motivation	• Level to which the incentives of the agent charged with purchasing the EE are aligned with those of the person(s) that would benefit
Regulatory	• Codes or standards that prohibit implementation of innovative EE technologies • Level of EE performance that is required in codes or standards

The Achievable Potential scenarios shown in Exhibit 6.1 are presented as a range. This recognizes not only that any estimate of Achievable Potential over a 10-year period is necessarily subject to uncertainty but also that there are different types and levels of potential DSM program intervention. Government and utility DSM program experience throughout North America has shown that energy-efficiency market barriers can be addressed and customer willingness to accept and purchase energy-efficient products can be positively influenced by a variety of potential DSM market intervention strategies, such as those noted below in Exhibit 6.3.

The same body of DSM program experience also recognizes that there are limits to a utility's scope of influence. It recognizes that some markets or sub markets may be so price sensitive or constrained by market barriers beyond the influence of utility DSM programs that they will only fully act if forced to by legal or other legislative means. It also recognizes that there are practical constraints related to the pace that existing inefficient equipment can be replaced by new, more efficient models or that existing building stock can be retrofitted to new energy performance levels. In addition, the design and implementation of DSM market interventions, such as those noted in Exhibit 6.3, require staff and financial resources. Under "real world" conditions these resources are also subject to constraints.

Exhibit 6.3: "Illustration" of Potential DSM Market Intervention Strategies[74]

Strategy Type	Description
Alliances	• Vertical integration of market between upstream and downstream market actors (i.e., forming a relationship between contractors and suppliers)
Audit	• An assessment of a building's energy efficiency made by a trained inspector
Contractor Certification	• An assurance that a given contractor is knowledgeable about the product or service, verified through training and/or testing
Demonstration	• Providing demonstrations of the use/performance of energy-efficient technologies to market actors
Design Assistance	• Providing recommendations on building or product design.
Financing	• Providing loans to finance the acquisition of a product or service.
Financial Incentives (and Rebates)	• Per measure dollars provided to market participants (generally either end users or distribution channel members) to encourage energy conservation measure installation
Information	• Passive provision of information to market participants
Linking Vendors & Customers	• Providing customer contacts to contractors, or contractor/vendor contacts to customers
Non-Financial Incentives	• Products, changes in procedures or administrative consolidation to encourage product or service provision
Promotion	• Active advertising and information made available to the market
Sales Training	• Providing sales, marketing and/or technical training about products or services to individuals responsible for selling it
Standards, Labelling	• Setting specific standard levels for energy-efficient technologies • Labelling those technologies accurately for easy consumer/contractor recognition
Technical Information	• Provision of technical information on energy-efficient products or services
Technical Support	• Providing answers to technical questions from market actors about energy-efficient products/services after installation
Technical Training	• Providing training to trade allies so that they better understand new or existing practices or procedures
Testing Protocols & Standards	• Standardization of testing protocols for installation and repair
Third Party Verification	• Inspection and verification provided by an unbiased party on the results of an inspection to insure correct product or service performance

Source: American Council for an Energy Efficient Economy (ACEEE) Proceedings: 2001.

[74] As in the preceding Exhibit, the strategies shown in Exhibit 6.3 are not necessarily exhaustive; rather, they illustrate the types of options that may be available to DSM program planners.

6.3 APPROACH TO THE ESTIMATION OF ACHIEVABLE POTENTIAL

Consistent with the description outlined above, this study approached the estimation of Achievable Potential by preparing a number of future scenarios, each representing differing assumptions related to the level of DSM program investment over the study period.

In consultation with Union personnel, the study identified two Achievable Potential scenarios to be assessed in this final stage of the study.[75] They are:

- A financially unconstrained DSM investment scenario
- A financially constrained DSM investment scenario, based on the maintenance of historic Union DSM program funding levels.

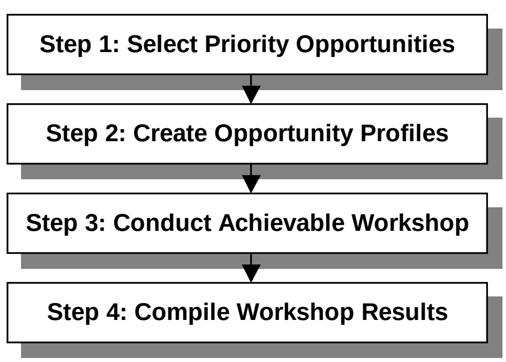
Development of the assumptions employed in each of the above scenarios was based on a combination of Union's own DSM program experience and the results of a one-day workshop involving Union DSM personnel, trade allies and consultant team members.

The workshop results were particularly valuable in generating the DSM investment scenarios; consequently, a brief description of the workshop organization and results is provided in the following sections.

6.4 ACHIEVABLE POTENTIAL WORKSHOP ORGANIZATION

The design and implementation of the Achievable Potential workshop was organized into four steps. A schematic showing the major steps is shown in Exhibit 6.4 and each step is briefly discussed below.

Exhibit 6.4: Approach to Achievable Potential Workshop



Step 1: Select Priority Opportunities

The first step was to review the energy saving opportunities identified in the Economic Potential Forecast and to select a set of those opportunities for discussion in the Achievable Potential workshop. The amount of time available in the Achievable Potential workshop for the discussion

[75] It should be emphasized that the estimation of Achievable Potential scenarios is not synonymous with either the setting of specific program targets or with program design. While both are closely linked to the discussion of Achievable Potential, they involve more detailed analysis that is beyond the scope of this study.

of energy-efficiency opportunities was limited. Consequently, the number of opportunities selected for discussion in the workshop was limited to seven, which prior experience had shown to be about the maximum allowable within the available timeframe.

Exhibit 6.5 shows the six energy-efficiency measures and the one assessment opportunity (namely process integration and pinch analysis) selected for inclusion in the workshop discussions. Selection of the opportunities was based on a qualitative application of criteria that were intended to ensure that the workshop discussions would include:

- Technologies and measures that represent a significant share of the potential energy savings identified in the Economic Potential Forecast
- Review of conditions in a variety of sub markets
- Inclusion of new products or markets where little prior DSM experience existed
- Tools that can be used to increase participation rates of energy-efficiency opportunities.

Exhibit 6.5: Industrial Sector Opportunity Areas

Opportunity Area	Title	Approximate % of Economic Savings Potential
I1	Steam Trap Survey & Repair	3.6%
I2	High-efficiency Burners & Burner Controls	4.8%
I3	High-efficiency Ovens	4.8%
I4	Economizer	2.8%
I5	Process Heat Recovery	7.0%
I6	First Generation Super Boilers	N/A
I7	Process Integration and Pinch Analysis	N/A
	Total	23%

Step 2: Create Opportunity Profiles

Brief profiles were prepared for each Opportunity selected in Step 1. The profiles, which were used to introduce the workshop discussion of each opportunity and can be found in Appendix E, provided the following information:

- **Technology description**, e.g., regular steam trap survey and repair of faulty steam traps

- **Sub sector and service region**, e.g. applicable to all industrial sub sectors, because all sub sectors have steam distribution systems

- **Selection of a "Typical" application** for discussion purposes

- **Financial and economic indicators for the "Typical" application**, e.g., installed cost, useful life, annual energy savings simple payback, benefit/cost ratio, basis of assessment (incremental versus full cost)

Exhibit 6.6 (overleaf) lists the steps employed in developing the estimated participation rates.

Exhibit 6.6: Workshop Process for Estimating Participation Rates

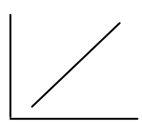
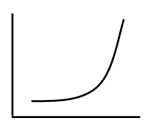
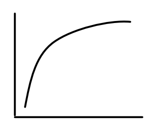
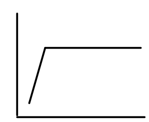
The steps involved were as follows:

The participation rate for the Aggressive Marketing scenario in 2017 was estimated.

The shape of the adoption curve was selected for the Aggressive Marketing scenario. Rather than seek consensus on the specific values to be employed in each of the intervening years, workshop participants selected one of four curve shapes that best matched their view of the appropriate "ramp-up" rate for each opportunity (see below).

The preceding process was repeated for the Static Marketing scenario.

Once participation rates had been established for the specific technology, sub sector and service region selected for the Opportunity discussion, the workshop participants provided guidelines to the consultants for extrapolating the discussion results to the other sub sectors and service regions included in the Opportunity, but not discussed in detail during the workshop

Curve A	Curve B	Curve C	Curve D
			

Curve A represents a steady increase in the expected participation rate over the 10-year study period

Curve B represents a relatively slow participation rate during the first half of the 10-year study period followed by a rapid growth in participation during the second half of the 10-year study period

Curve C represents a rapid initial participation rate followed by a relatively slow growth in participation during the remainder of the 10-year study period

Curve D represents a very rapid initial participation rate that results in virtual full saturation of the applicable market during the first milestone period of the 10-year study period.

Step 4: Compile Workshop Results

This step involved aggregating the results of the seven Opportunities discussed during the workshop and extrapolating the results of the remaining Opportunities that were identified in the Economic Potential Forecast but not discussed during the workshop.

6.5 ACHIEVABLE POTENTIAL WORKSHOP RESULTS

The following discussion provides a summary of the workshop results for each of the Industrial sector Opportunities noted previously in Exhibit 6.5. In each case, the following information is provided:

- Brief description of the Opportunity and the specific "typical" application selected for the workshop discussion
  - Highlights from the workshop discussions related to:
    - Constraints & Challenges
    - Potential Strategies and Partners
    - Incentive Sensitivity
- Summary of the estimated participation rates under the Aggressive and Static Marketing scenarios for the selected sub sector
    - Shape of Adoption Curve selected by the workshop participants
- Summary of major assumptions employed by the consultants for extrapolating the workshop results to other sub sectors.

6.5.1 I1 - Steam Trap Survey & Repair

- ❑ **Description**

- If the traps do not function properly, excess steam will flow through the end-use device or the condensate will back up into it
- Traps provide for condensate removal with little or no steam loss
- For discussion purposes the workshop focused on full cost (retrofit) applications in the Food sub sector (small, medium and large).

- ❑ **Discussion Highlights**

Constraints & Challenges

- There are two components to this measure: the audit/assessment and the replacement. Consideration needs to be given to decide how much of the cost assigned to this measure is for the assessment and how much is for the actual repairs, as the audit might be done every three years, but the replacement is not likely to happen as frequently.
- The main impediment to having this measure implemented is the cost of paying for the actual survey of the steam traps.
- The willingness to do the surveys is increasing, but it is difficult to convince plants to actually do the repairs. Experience indicates that the audit may identify the same faults, but the repairs are not done. There might be a technical reason why the repairs are not done, but it is often due to a lack of internal resources.
- Maintenance is stretched thin and generally only major repairs are done. If steam traps are not considered a top priority, then repairs might not be undertaken.

- Plant culture is more imposing than plant size in deciding whether or not to implement this measure.
- Other technologies might begin to replace this measure. For example high-pressure water could be returned to tanks.
- Large customers have more steam pressure, so they have higher losses, but still do not perform the repairs.

Potential Strategies and Partners

- Similar to the air leaks problem, if this measure is promoted as part of a repair program, rather than a one-off repair, it is more successful.
- Feedback is needed for how the plant runs when this repair is made and when nothing is done. For example, installing a thermocouple on the steam vent can identify how much energy is being lost to steam venting.
- Looking at the cumulative effect of all of the small leaks can help to increase the value of performing this measure.
- Savings are often compared to total sales, but are more appropriately/ effectively compared to profit.
- There are two parts to deciding whether to perform this measure, payback period and total capital cost.
- In promoting the program, need to talk to not only the plant manager, but also the maintenance manager.
- The programs that are most successful include a link to implementation and are not limited to the audit. For example, a facility needs to implement all measures that meet certain criteria in order to receive the incentive for the audit portion. However, this link might also discourage some plants from performing the audit, which would be detrimental, as it is very useful to have the audit performed.
- A need for more specialized people to identify opportunities was expressed.

Incentive Sensitivity

- This measure is very sensitive to incentive levels.
- Incentives would have to be rather large in order to increase the uptake of this measure (at least 30%). At 10%, there would not be many new plants implementing this measure. The offer of 30% will provide an opportunity to communicate with the facility, but it is important to target the right audience.
- Incentives have less effect on sectors with higher pressures because the losses are much higher as well.

❑ Participation Rates

Workshop participants concluded that, under the conditions represented by the Aggressive Marketing scenario, a participation rate of 20% to 30% of the remaining eligible plants could be achieved in the Food sub sector by 2017. It was also decided that a steadily increasing curve, curve A, represents the most likely adoption profile.

Under the more modest market conditions represented by the Static Marketing scenario, it was estimated that participation rate would be lower, at about 5% to 15% of the remaining eligible plants. A similar adoption curve would be followed in this case.

- **Participation Rates in Remaining Sub Sectors**

Based on the workshop discussions, it was estimated that participation rates would be slightly higher in the Primary Metal, Chemical, Paper, and Petroleum Refinery sub sectors, but approximately the same in all other sub sectors.

6.5.2 I2 - High-efficiency Burners and Burner Controls

- **Description**

- Efficient burner technology based on design and power injection to optimize fuel-air ratio throughout firing range
- Boiler controls include linkage-less controls and servomotors to independently control the fuel and air, and combustion control based on flue gas monitoring
- For discussion purposes the workshop focused on full cost (retrofit) applications in the Food sub sector (small, medium and large).

- **Discussion Highlights**

Constraints & Challenges

- Savings claims might not always be realistic and in plants where the demand is constant, controls may not have significant savings potential
- Many linkage-less controls options are available, each with different savings potential and compatibility issues
- Engineering costs might have to be included to verify expected achievable savings.
- It is not often that this measure is considered, mainly due to uncertainty related to results
- Even if all eligible sites implement this measure, the total savings might not be anywhere near the estimated total because of the variability of boiler conditions
- Some sites might implement a linkage-less control system, regardless of whether or not that is what they need, because that is all that is available.

Potential Strategies and Partners

- Customers might be receptive to early stage guidance. There are many claims about potential savings, but there is limited evidence. It is possible that the burner is not physically able to do what the controls are set to
- Linkage-less controls should not be recommended without first doing a detailed assessment. There might also be better options available, depending on the boiler
- Because this measure is very site specific, this measure would not work on its own, but could be included in a package of possible measures that would be evaluated on a site-by-site basis.

Incentive Sensitivity

- Meters are somewhat sensitive to incentives, but controls and replacements are not
- Knowledge is more important than incentive in this case because the payback period is already very short. It was proposed that a Union program should inform clients of the availability of higher-efficiency boilers and controls.

- **Participation Rates**

There is more potential for replacing controls than there is for replacing the actual burner. There would also be higher uptake on larger boilers than on smaller boilers.

Workshop participants concluded that, under the conditions represented by the Aggressive Marketing scenario, a participation rate in the range of 80% of the remaining eligible plants could be achieved in the Food sub sector by 2017. It was also decided that curve D, which represents a very rapid initial participation rate that results in virtual full saturation of the applicable market during the first milestone period of the 10-year study period, represents the most likely adoption profile.

For smaller boilers, the uptake for controls was estimated to be only about 50% to 70% of the remaining eligible plants over 10 years, and only about 10% to 15% of the remaining eligible plants for oxygen-trim systems, under the Aggressive Marketing scenario.

Under the more modest market conditions represented by the Static Marketing scenario, it was estimated that the participation rate would be much lower, at about 25% of the remaining eligible plants. Curve C, which represents a rapid initial participation rate followed by a relatively slow growth in participation during the remainder of the 10-year study period, was selected as the most likely adoption profile.

- **Participation Rates in Remaining Sub Sectors**

Based on the workshop discussions, it was estimated that participation rates would be slightly lower in the Primary Metal sub sectors, and almost non-existent in Petroleum Refineries, but approximately the same in all other sub sectors.

6.5.3 I3 - High-efficiency Ovens

- **Description**

- Advances in oven energy efficiency are primarily related to improved control systems, improved combustion efficiency, reduced energy losses, optimize uniform heating and reclaiming heat from exhaust gas
- For discussion purposes the workshop focused on full cost (retrofit) applications in the Food sub sector (small, medium and large).

- **Discussion Highlights**

Constraints & Challenges

- It is very unlikely that there would be many, if any, end-of-life replacements in the next 10 years. To fully replace an oven would normally require that the plant be shut down during the replacement. The general practice is to make as many retrofits as possible before a complete replacement
- One of the barriers to installation would be the fact that changing the oven would affect the production process. Also, food ovens, in general, have little room for improvement because of the nature of the process

- Most improvements that could be made would be process and not equipment improvements
- A high level of understanding of the process is required before changes can be made.

Potential Strategies and Partners

- One may be able to make a business case for the replacement of an oven by also considering savings from increased productivity. Energy savings are generally the minor part of the decision making
- Participants indicated that there is significantly more room for improvement in upgrading furnaces compared to ovens
- Higher-temperature ovens have a much greater opportunity for improvement. Once again, retrofits would be done, but not normally replacements
- There might be more potential in small continuous ovens, as there has not been much pressure to upgrade.

Incentive Sensitivity

- Plants are either new and in good shape, or so old that there is high risk with changing the process and there might also be a chance that the plant will close. Having an incentive might open the door for discussion, but will not significantly affect the decision. This makes this measure somewhat insensitive to incentives.

❑ **Participation Rates**

In the food and beverage industry, there are not likely to be many replacements but there is a potential for retrofits.

❑ **Participation Rates in Remaining Sub Sectors**

There might be more opportunities for replacement in industries with paint ovens. About half of the existing market is already high-efficiency (paint ovens), while ovens in the automotive and the rubber and plastic industries have room for improvement.

6.5.4 I4 - Economizer

❑ **Description**

- Heat exchanger that is designed to use heat from hot boiler flue gases to preheat water
- A condensing economizer improves the effectiveness of reclaiming flue gas heat by cooling the flue gas below the dew point
- For discussion purposes, the workshop focused on full cost (retrofit) applications in the Food sub sector (small, medium and large).

❑ **Discussion Highlights**

Constraints & Challenges

- Need to have a heat sink to transfer the recuperated heat

- Water treatment can result in a very high pH, which may corrode the economizer
- Average life of both standard and condensing economizers is about 10 years. There might be some backlash in a few years if there is a high failure rate of the units due to corrosion
- Large civil work may be required for the installation of a condensing economizer as it can be very heavy and may require large reinforcements. This may increase the costs significantly
- Mostly applicable to medium and large boilers. Less applicable to HVAC boilers.

Potential Strategies and Partners

- Economizers have become more economical as energy prices have risen and smaller, lighter and more durable economizers have been developed
- There is significant interest in moving from standard to condensing economizers.

Incentive Sensitivity

- Economizer projects with a long payback period would make this measure somewhat sensitive to incentive levels.

- ❑ **Participation Rates**

Workshop participants concluded that, under the conditions represented by the Aggressive Marketing scenario, a participation rate of about 75% of the remaining eligible pool of participants in the Food sub sector could be obtained by 2017. Adoption profile curve B was selected, which represents a relatively slow participation rate during the first half of the 10-year study period followed by a rapid growth in participation during the second half of the 10-year study period.

Under the more modest market conditions represented by the Static Marketing scenario, it was estimated that the participation rate would be lower, at about 35% of the remaining eligible market. A similar adoption curve would be followed in this case.

- ❑ **Participation Rates in Remaining Sub Sectors**

Based on the workshop discussions, it was decided that participation rates would be approximately the same across all Industrial sub sectors.

6.5.5 I5 - Process Heat Recovery

- ❑ **Description**

- The use of waste heat from industrial processes (heat source) to heat other processes, or utility streams (heat sink)
- Depends on quality of the heat (high- or low-grade heat), the distance between the heat source and heat sink, potential cross contamination of product, properties of the process stream (such as corrosiveness), the flow rates of the streams and the fluctuation in the flow rates

- For discussion purposes, the workshop focused on full cost (retrofit) applications in the Chemical sub sector (small, medium and large).

Discussion Highlights

Constraints & Challenges

- The practical potential and feasibility of heat recovery is very dependent on the type of heat source and heat sink, and there is a big difference between air-to-air and fluid-to-fluid heat recovery. The latter has much higher potential
- General constraints include contamination; corrosion and space availability
- Constraints for low-grade heat opportunities include payback period and finding a good heat sink
- It is not always easy to make the business case for heat recovery projects. One may have to model the process in order to determine the possible benefits and one may also require meters to quantify the potential
- Plants may not have the technical capability to initiate or assess heat recovery projects
- Plants may lack knowledge of the types of heat exchangers available and the technical feasibility of the heat exchangers
- Human and capital resource constraints were identified as a constraint.

Potential Strategies and Partners

- A need was identified to have qualified engineering firms undertaking these projects. The concern was expressed that the available firms provide too many options and may not target low-grade heat.
- It was observed that the main project drivers are generally not savings, but rather increased comfort (especially for low-grade heat)
- Other opportunities could be in latent heat recovery (3- to 6-year payback), poly-socks and HVAC makeup air

Incentive Sensitivity

- Low-grade heat opportunities are incentive sensitive, but increasing the incentive will not necessarily increase the market take-up proportionally.

- **Participation Rates**

Workshop participants concluded that, under the conditions represented by the Aggressive Marketing scenario, a participation rate of an additional 30% to 40% of the eligible sites could be achieved in the Chemical sub sector by 2017. It was also decided that a steadily increasing curve, curve A, represents the most likely adoption profile.

Under the more modest market conditions represented by the Static Marketing scenario, it was estimated that the participation rate would be slightly lower, at about 15% to 20% for high-grade heat projects, and 10% for low-grade heat projects. A similar adoption curve would be followed in both of these cases.

- **Participation Rates in Remaining Sub Sectors**

Based on the workshop discussions, it was decided that for high-grade heat projects participation rates would be slightly higher in the Primary Metal and Mining sub sectors and lower in the Paper, Transportation and Machinery and Food and Beverage sub sectors. For low-grade heat projects, participation rates would be slightly higher in the Transportation and Machinery and Food and Beverage sub-sectors, and non-existent in Non-Metallic Mineral and Miscellaneous Industry subsectors.

6.5.6 I6 - First Generation Super Boilers

- **Description**

- Two-stage fire tube design and a transport membrane condenser and compact air heater
- Also includes compact convective zones with intensive heat transfer and a staged/intercooled combustion system for ultra-low emissions
- Currently in the early stages of commercialization
- For discussion purposes, the workshop focused on incremental cost (end-of-life) applications in the Food sub sector (small, medium and large).

- **Discussion Highlights**

Constraints & Challenges

- One constraint to the implementation of this technology is whether or not the plant employs a boiler operating engineer. Some plants may not be willing/ able to install a large boiler because that would require having an operating engineer
- This technology is very expensive relative to the existing technology and very high risk. Competing technologies would restrict the uptake of this measure
- Good potential program target because the benefit-cost ratio is good, but the payback period is very long
- The efficiency of this boiler is comparable to a boiler with a condensing economizer
- Cogeneration might also compete with this technology.

Potential Strategies and Partners

- This technology is to be included in the study as an advanced technology opportunity, and should not be included as a measure.

Incentive Sensitivity

- Boiler will most likely only be installed as part of a demonstration project.

- **Participation Rates**

Other than a potential demonstration project, there is not likely to be a boiler installed in any sub sector.

6.5.7 I7 - Process Integration and Pinch Analysis

- **Description**

- Systematic and methodical techniques for designing a process and/or appropriate heat exchanger network to optimize industrial processes involving heat transfer between either process streams or between a utility stream and a process stream
- Pinch analysis involves calculating thermodynamically attainable energy targets for a given process and then identifying how to achieve them
- For discussion purposes the workshop focused on full cost (retrofit) applications in the Food sub sector (large).

- **Discussion Highlights**

Constraints & Challenges

- The opportunities identified are generally good, but it takes a long time before projects are actually implemented
- Delegates regarded pinch analysis as overly complicated and expensive
- There is insufficient expertise in Ontario to perform pinch and process integration analysis
- Pinch analysis is generally not suitable for smaller plants. The same result could be attained by simply listing the heat supplies and sinks and matching them up. Process integration might be more applicable.

Potential Strategies and Partners

- Need to identify local expertise that is able to perform these studies more efficiently and for less
- These measures should be lumped in with measurement and targeting.

- Participation Rates

Workshop participants concluded that, under the conditions represented by the Aggressive Marketing scenario, a participation rate up to 75% of the remaining eligible plants could be achieved in the Food sub sector by 2017. Small and medium plants would have lower take-up rates than larger plants. It was also decided that a steadily increasing curve, curve A, represents the most likely adoption profile.

Under the more modest market conditions represented by the Static Marketing scenario, it was estimated that the participation rate would be much lower, at about 25% of the remaining eligible plants. A similar adoption curve would be followed in this case.

- **Participation Rates in Remaining Sub Sectors**

  Based on the workshop discussions, it was decided that participation rates would be slightly higher in the Primary Metal, Chemical and Mining sub sectors and lower in the Transportation and Machinery and Non-Metallic Mineral sub sectors. It was estimated that little or no opportunity remains in the Petroleum Refinery or Paper sub sectors as these industries have already performed process integration in their plants.

6.5.8 Extrapolated Participation Rates for Remaining Opportunities

As noted previously, the workshop results were used as a reference point. This knowledge was combined with follow-up discussions with some of the workshop participants and consultant experience to estimate participation rates for the remaining energy-efficiency opportunities that are contained in the Economic Potential Forecast. The extrapolated participation rates are summarized in Exhibits 6.8 and 6.15, which are presented in Section 6.6.

6.6 ACHIEVABLE POTENTIAL DSM INVESTMENT SCENARIO RESULTS

Consistent with the description presented earlier in this section, the Achievable Potential results are presented as a range, which is defined by the following two scenarios:

- A “Financially Unconstrained” scenario, in which potential is limited by market constraints but not by program budget.

- A “Static Marketing” scenario, in which potential is limited by market constraints as well as DSM program budgets that are approximately similar to current Union levels (although the specific programs and technologies addressed would not necessarily be the same).

In order to facilitate the modeling of the Achievable Potential scenario, measures were grouped in “bundles.” In the Industrial sector, most programs are not offered on a measure-by-measure basis, but rather on a system or custom basis. Fifteen bundles were created to group measures together that logically fall into the same custom type of projects. The 15 bundles provide a manageable data set to be modeled and provide the level of accuracy required for the study to simulate typical concept program subsets. The bundles are listed in Exhibit 6.7.

Exhibit 6.7: Measure Bundles

End Use	Bundle	Measure
System	1	Sub-metering
	2	Integrated control system
Hot Water Systems and Boiler Steam Systems	3	Process heat recovery to preheat make-up water
		Boiler combustion air preheat
		Minimize deaerator vent losses
		Blowdown heat recovery
		Blowdown control
		Boiler water treatment
		High-efficiency burners
		Advanced boiler controls
		Economizer
	4	Boiler right sizing and load management
	5	Steam trap survey and repair
	6	Condensate return
	7	Insulation
	8	Boiler maintenance
	9	Condensing boiler
		Direct contact hot water heaters
		Instantaneous steam generation
Process Heat (Furnace/ Kilns/ Ovens/ Dryers)	10	Exhaust gas heat recovery
		High-efficiency burners and burner controls
		Insulation
		Advanced heating and process controls
		Air curtains
	11	High-efficiency ovens
		High-efficiency dryers
		High-efficiency kilns
		High-efficiency Furnaces
Other Process	12	Process heat recovery
	13	Pollution control measures
		Hydrogen atmospheres for steel batch coil annealing
HVAC	14	Radiant heaters
		Automated temperature control
		Solar walls
		Warehouse loading dock seals
		Air curtains
		Air compressor heat recovery
		Destratification fans
	15	Ventilation & heat recovery optimization

The results of each achievable scenario are presented below.

6.6.2 Financially Unconstrained DSM Investment Scenario

The financially unconstrained investment scenario provides an overview of the level of potential natural gas savings that could be achieved if a comprehensive portfolio of DSM programs was launched without any constraint on the availability of program funding. This scenario is based largely on the results of the Aggressive Marketing scenario that was explored during the Achievable Potential workshop.

Although the results of this scenario are not constrained by program funding, the results do incorporate consideration of the market constraints identified during the Achievable Potential workshop (see Exhibit 6.2), such as product and service availability, customer transaction costs, etc.

This scenario, therefore, provides a 'high level' estimate of the upper level of natural gas savings that could be achieved by Union's industrial customers over the nine-year period beginning in 2009 and ending in 2017. It also provides Union's industrial DSM program personnel with a view of the relative potential contribution of individual sub sectors, end uses, technologies and service regions.

Major Assumptions: Financially Unconstrained Scenario

- All measures that pass the measure TRC screen are included
- No program financial limit is set, except that all measures must continue to pass the measure TRC screen
- Participation rates are constrained by the market barriers noted in the workshop
- Participation rates for measures discussed in the workshop are employed directly and are shown in Exhibit 6.8
- Participation rates for the remaining measures are extrapolated from the workshop results and/or consultant experience and are shown in Exhibit 6.8

Fixed program costs (e.g., advertising, training workshops, contractor certification, etc.) and incentive costs are included for each measure. The levels selected for the scenario are summarized in Exhibit 6.9. In each case, the values shown draw on theworkshop results and recent Union DSM program experience.

Exhibit 6.8: Participation Rates for Financially Unconstrained Scenario

Workshop Reference Number	Upgrade Technology/Measure	Participation Rates in 2017 (% of eligible)			Adoption Curve Shape	Notes
		Small	Medium	Large		
	Integrated control system	28-88%	28-88%	35-95%	C	Based on workshop ref. I2
	Sub-metering	60%	60%	60%	C	Based on workshop ref. I2
I4	Economizer	86%	87%	90%	B	Based on workshop ref. I4
	Blowdown heat recovery	34-37%	39-42%	45-48%	B	Based on workshop ref. I4
	Boiler combustion air preheat	0-3%	0-27%	22-72%	B	Based on workshop ref. I5
	Process heat recovery to preheat make-up water	15%	17%	21%	A	Based on workshop ref. I1
	Condensing boiler	25-28%	25-28%	20-25%	B	Based on workshop ref. I5
	Direct contact hot water heaters	20%	20%	0%	A	Based on workshop ref. I1
	Boiler right sizing and load management	58-60%	60%	63%	A	Based on consultant experience
	High-efficiency burners	80-99%	82-100%	85-100%	C	Based on workshop ref. I2
	Insulation (boiler system)	80%	80%	85%	A	Based on workshop ref. I1
	Advanced boiler controls	70-80%	73-90%	82-96%	C	Based on workshop ref. I2
	Blowdown control	16%	16%	26%	A	Based on workshop ref. I1
	Boiler water treatment	69-74%	72-80%	79-84%	A	Based on workshop ref. I1
	Boiler maintenance	82%	87%	98%	A	Based on workshop ref. I1
	Minimize deaerator vent losses	82%	87%	98%	B	Based on workshop ref. I4
	Condensate return	58%	60%	62%	A	Based on workshop ref. I1
I1	Steam trap survey and repair	75%	80%	85%	A	Based on workshop ref. I1
	Instantaneous steam generation	89%	69%	0%	C	Based on consultant experience
	Exhaust gas heat recovery	52-74%	55-76%	60-82%	A	Based on workshop ref. I1
I2	High-efficiency burners and burner controls	64-72%	70-82%	74-84%	C	Based on workshop ref. I2
	Insulation (process heat system)	85%	85%	85%	A	Based on workshop ref. I1
	Advanced heating and process controls	50-60%	52-62%	55-64%	C	Based on workshop ref. I2
I3	High-efficiency ovens	51-62%	36-67%	58-72%	C	Based on workshop ref. I3
	High-efficiency dryers	51-62%	36-67%	58-72%	C	Based on workshop ref. I3
	High-efficiency kilns	0-50%	0-53%	0-56%	C	Based on workshop ref. I3
	High-efficiency furnaces	0-50%	0-53%	0-56%	C	Based on workshop ref. I3
	Air curtains (process heat system)	5%	6%	7%	C	Based on consultant experience
	Pollution control measures	0-20%	0-20%	0-36%	C	Based on consultant experience
	Hydrogen atmospheres for steel batch coil annealing	0-59%	0-63%	0%	A	Based on workshop ref. I5
I5	Process heat recovery	57-79%	60-81%	65-87%	A	Based on workshop ref. I5
	Radiant heaters	49%	51%	54%	A	Based on workshop ref. I5
	Automated temperature control	60%	60%	60%	C	Based on workshop ref. I2
	Solar walls	0%	2%	2-4%	A	Based on consultant experience
	Ventilation & heat recovery optimization	34-44%	46-47%	49%	B	Based on consultant experience
	Warehouse loading dock seals	60%	60%	60%	A	Based on workshop ref. I1
	Air curtains (HVAC)	81%	81%	81%	A	Based on workshop ref. I1
	Air compressor heat recovery	22-25%	24-27%	25-29%	A	Based on workshop ref. I5
	Destratification fans	15%	15%	20%	C	Based on consultant experience

Exhibit 6.9: Summary of Program Cost Assumptions – Financially Unconstrained Scenario[76]

End Use	Bundle	Fixed Program Costs ($/yr.)	Incentive Level *(% of installed cost)*	Payback After Incentive (yrs)
System	1	105,000	5.0%	0.5
	2	60,000	15.0%	0.2
Boilers	3	120,000	22.5%	1.6
	4	40,000	N/A-Fixed Incentive	0.04
	5	50,000	30.0%	0.6
	6	30,000	30.0%	3.1
	7	30,000	15.0%	0.6
	8	30,000	N/A-Fixed Incentive	0.3
	9	60,000	9.6%	0.3
Process Heat	10	130,000	15.0%	0.7
	11	180,000	15.0%	0.7
Other Process	12	30,000	15.0%	1.0
	13	70,000	11.0%	0.6
HVAC	14	95,000	11.1%	3.2
	15	30,000	10.0%	4.6

Results: Financially Unconstrained Scenario

Under the conditions defined by the financially unconstrained scenario, total Industrial sector natural gas savings in 2017 are estimated to be approximately 846 million m^3/yr. This represents a saving of approximately 15%, relative to the Reference Case, and is equal to approximately 44% of the savings identified in the Economic Potential Forecast. Further detail is provided in the following exhibits:

- Exhibit 6.10 shows total natural gas savings by service region and milestone year
- Exhibit 6.11 shows total natural gas savings by sub sector and milestone year for the total Union Service Area
- Exhibit 6.12 shows total natural gas savings by end use and milestone year for the total Union Service Area
- Exhibit 6.13 shows total natural gas savings by sub sector and end use for 2017 for the total Union Service Area
- Exhibit 6.14 shows annual natural gas savings for the year 2017 by technology, together with the estimated program costs and TRC benefits for the total Union Service Area. (**Note**: the values shown in Exhibit 6.14 are for the single year 2017 only; consequently, they do not add to the same values shown in the preceding exhibits.)

[76] Fixed program costs and incentive levels were provided by Union based on workshop results and current experience. Where fixed program costs apply to a bundle of measures, costs are distributed among the measures weighted by total savings potential.

Exhibit 6.10: Natural Gas Savings by Service Region and Milestone Year, Financially Unconstrained Scenario (1000 m3/yr.)

Milestone Year	Southern Region	Northern Region	Total	% Savings Relative to Ref Case
	1000 m^3/yr.			
2012	394,898	162,208	557,106	10.2%
2017	583,749	262,425	846,175	15.1%
% Savings 2017 Re: Reference Case	15%	15%	15%	
% Savings 2017 Re: Total	69%	31%	100%	

Exhibit 6.11: Natural Gas Savings by Sub Sector and Milestone Year for the Total Union Service Area, Financially Unconstrained Scenario (1000 m3/yr.)

Sub-Sector	Milestone Year		% Savings 2017	
	2012	2017	Re: Ref Case	Re: Total
	1000 m^3/yr.			
Contract Primary Metal[77]	168,588	254,331	16.2%	30.1%
Contract Chemical	99,433	173,877	14.0%	20.5%
Other Chemical	3,445	5,603	14.0%	0.7%
Contract Paper	37,445	45,808	14.6%	5.4%
Contract Transportation and Machinery	32,041	40,531	14.3%	4.8%
Other Transportation and Machinery	12,166	15,310	14.3%	1.8%
Contract Petroleum Refineries	42,346	63,350	15.5%	7.5%
Contract Mining	30,342	45,752	14.6%	5.4%
Contract Food and Beverage	23,439	39,067	14.9%	4.6%
Other Food and Beverage	4,704	6,733	14.9%	0.8%
Contract Non-Metallic Mineral	37,957	55,028	18.6%	6.5%
Miscellaneous Industrial	65,201	100,785	14.1%	11.9%
Total	557,106	846,175	15.1%	100.0%

[77] As highlighted in Section 2.3, an assessment of data obtained at the completion of this study indicated that up to about 42% of the Base Year natural gas consumption in the Contract Primary Metal sub sector could be considered as feedstock. It was not feasible to include the data in the study at this late stage of the study. The implication is that the energy efficiency potential in the Contract Primary Metal sub sector might be overstated.

Exhibit 6.12: Natural Gas Savings by End Use and Milestone Year for the Total Union Service Area, Financially Unconstrained Scenario (1000 m^3/yr.)

End Use	Milestone Year		% Savings 2017	
	2012	2017	Re: Ref Case	Re: Total
	1000 m^3/yr.			
Systems	132,034	177,973	3.2%	21.0%
Hot Water Systems	8,747	12,001	5.7%	1.4%
Boiler Steam Systems	93,324	178,706	12.6%	21.1%
Process Heat	235,829	347,413	13.8%	41.1%
Other Process	6,067	12,176	5.4%	1.4%
HVAC	81,105	117,906	9.6%	13.9%
Total	557,106	846,175	15.1%	100.0%

Exhibit 6.13: Annual Natural Gas Savings by Sub Sector and End Use for 2017 for the Total Union Service Area, Financially Unconstrained Scenario (1000 m3/yr.)

Sub Sector	End Use							
	Systems	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	51,328	1,562	21,102	157,238	2,045	21,056	254,331	30.1%
Contract Chemical	38,821	1,306	61,082	46,845	5,229	20,593	173,877	20.5%
Other Chemical	1,251	42	1,968	1,510	168	664	5,603	0.7%
Contract Paper	9,774	329	23,979	6,943	360	4,422	45,808	5.4%
Contract Transportation and Machinery	8,943	364	9,586	10,881	668	10,089	40,531	4.8%
Other Transportation and Machinery	3,378	138	3,621	4,110	252	3,811	15,310	1.8%
Contract Petroleum Refineries	12,597	401	8,944	37,272	373	3,765	63,350	7.5%
Contract Mining	10,092	3,520	10,261	16,548	951	4,381	45,752	5.4%
Contract Food and Beverage	8,259	1,354	18,235	7,751	734	2,735	39,067	4.6%
Other Food and Beverage	1,423	233	3,143	1,336	126	471	6,733	0.8%
Contract Non-Metallic Mineral	9,494	331	4,632	36,830	508	3,233	55,028	6.5%
Miscellaneous Industrial	22,614	2,421	12,154	20,150	760	42,687	100,785	11.9%
Total	177,973	12,001	178,706	347,413	12,176	117,906	846,175	
%	21%	1%	21%	41%	1%	14%		

Exhibit 6.14: Annual Natural Gas Savings by Technology for One Year of Program Activity (2017) for the Total Union Service Area, Financially Unconstrained Scenario

End Use	Bundle	Aggressive Achievable Potential 2017		Program Costs 2017	Program Costs per Unit Savings and TRC	
		Natural Gas Savings (1000 m^3/yr.)	TRC Benefits ('000 $)	('000 $)	Per Natural Gas Savings ($/$m^3$)	Per TRC Benefits ($/$)
System wide	1	1,327	4,168	120	0.09	0.03
	2	433	1,173	65	0.15	0.06
Boiler	3	4,411	11,315	500	0.11	0.04
	4	5,009	12,294	79	0.02	0.01
	5	3,142	1,311	185	0.06	0.14
	6	603	2,044	259	0.43	0.13
	7	3,606	3,697	58	0.02	0.02
	8	261	330	41	0.16	0.13
	9	975	18,442	1,301	1.33	0.07
Process	10	8,433	42,504	736	0.09	0.02
	11	1,627	7,789	419	0.26	0.05
Other	12	1,112	3,837	99	0.09	0.03
	13	12	327	87	7.45	0.27
HVAC	14	3,956	16,434	1,966	0.50	0.12
	15	8,873	20,554	2,207	0.25	0.11
Weighted Average					0.19	0.06

6.6.2 Static Marketing Scenario

The Static Marketing scenario is based largely on the results of the Static Marketing scenario that was explored during the Achievable Potential workshop. Consequently, it incorporates consideration of both market constraints and DSM program budget limitations, which are “roughly” consistent with current Union levels.

This scenario, therefore, provides a ‘high level’ estimate of the level of natural gas savings that could be achieved by Union’s industrial customers over the nine-year period beginning in 2009 and ending in 2017, assuming present levels of program activity and a somewhat different mix of programs. It also provides Union’s industrial DSM program personnel with a view of the relative potential contribution of individual sub sectors, end uses, technologies and service regions.

Major Assumptions: Static Marketing Scenario

- All measures that pass the measure TRC screen are included
- No program financial limit is set, except that all measures must continue to pass the measure TRC screen
- Participation rates are constrained by the market barriers noted in the workshop
- Participation rates for measures discussed in the workshop are employed directly and are shown in Exhibit 6.15
- Participation rates for the remaining measures are extrapolated from the workshop results and/or consultant experience and are shown in Exhibit 6.14

- Fixed program costs (e.g., advertising, training workshops, contractor certification, etc.) and incentive costs are included for each measure. The levels selected for the scenario are summarized in Exhibit 6.16. In each case the values shown draw on the workshop results and recent Union DSM program experience.

Exhibit 6.15: Participation Rates for Static Marketing Scenario

Workshop Reference Number	Upgrade Technology/Measure	Participation Rates in 2017 (% of eligible)			Adoption Curve Shape	Notes
		Small	Medium	Large		
	Sub-metering	40-60%	7-11%	40%	C	Based on workshop ref. I2
	Integrated control system	26-86%	17-77%	30-90%	C	Based on workshop ref. I2
	Process heat recovery to preheat make-up water	10-15%	8%	16-17%	A	Based on workshop ref. I1
	Boiler combustion air preheat	0-3%	0-17%	21-71%	B	Based on workshop ref. I5
	Minimize deaerator vent losses	82%	62%	94%	B	Based on workshop ref. I4
	Blowdown heat recovery	30-34%	32-35%	39-42%	B	Based on workshop ref. I4
	Blowdown control	13-16%	11%	19%	A	Based on workshop ref. I1
	Boiler water treatment	63-69%	64-72%	77-82%	A	Based on workshop ref. I1
	High-efficiency burners	25-96%	17-87%	29-100%	C	Based on workshop ref. I2
	Advanced boiler controls	45-70%	46-70%	68-90%	C	Based on workshop ref. I2
I4	Economizer	71-86%	54%	80%	B	Based on workshop ref. I4
	Boiler right sizing and load management	40-60%	23%	45%	A	Based on consultant experience
I1	Steam trap survey and repair	60-75%	45-48%	70-75%	A	Based on workshop ref. I1
	Condensate return	40-58%	29%	44%	A	Based on workshop ref. I1
	Insulation	75-80%	54%	75%	A	Based on workshop ref. I1
	Boiler maintenance	72-82%	87%	98%	A	Based on workshop ref. I1
	Condensing boiler	15-28%	6-7%	10-15%	B	Based on workshop ref. I5
	Direct contact hot water heaters	15-20%	3-6%	0%	A	Based on workshop ref. I1
	Instantaneous steam generation	82-89%	54%	0%	C	Based on consultant experience
	Exhaust gas heat recovery	37-54%	35-41%	45-62%	A	Based on workshop ref. I1
I2	High-efficiency burners and burner controls	39-64%	30-52%	49-64%	C	Based on workshop ref. I2
	Insulation	75-85%	49%	85%	A	Based on workshop ref. I1
	Advanced heating and process controls	30-50%	26-36%	35-44%	C	Based on workshop ref. I2
	Air curtains	4-5%	4%	6%	C	Based on consultant experience
I3	High-efficiency ovens	49-60%	32-42%	56-70%	C	Based on workshop ref. I3
	High-efficiency dryers	49-60%	32-42%	56-70%	C	Based on workshop ref. I3
	High-efficiency kilns	0-44%	0-24%	0-50%	C	Based on workshop ref. I3
	High-efficiency furnaces	0-50%	0-32%	0-58%	C	Based on workshop ref. I3
I5	Process heat recovery	42-59%	29-33%	50-67%	A	Based on workshop ref. I5
	Pollution control measures	0-10%	0%	0-26%	C	Based on consultant experience
	Hydrogen atmospheres for steel batch coil annealing	0-59%	0-28%	0%	A	Based on workshop ref. I5
	Radiant heaters	37-49%	31%	42%	A	Based on workshop ref. I5
	Automated temperature control	53-60%	42%	53%	C	Based on workshop ref. I2
	Solar walls	0%	1%	1-3%	A	Based on consultant experience
	Warehouse loading dock seals	57-60%	47%	57%	A	Based on workshop ref. I1
	Air curtains	78-81%	67%	78%	A	Based on workshop ref. I1
	Air compressor heat recovery	19-25%	9-12%	22-26%	A	Based on workshop ref. I5
	Destratification fans	10-15%	4-5%	15%	C	Based on consultant experience
	Ventilation & heat recovery optimization	34-44%	46-47%	49%	B	Based on consultant experience

Exhibit 6.16: Summary of Program Cost Assumptions

End Use	Bundle	Fixed Program Costs ($/yr.)	Incentive Level (% of installed cost)	Payback After Incentive (yrs)
System wide	1	35,000	3.0%	0.6
	2	20,000	10.0%	0.1
Boiler	3	70,000	15.0%	1.8
	4	20,000	N/A-Fixed Incentive	0.04
	5	35,000	12.0%	0.8
	6	20,000	15.0%	3.8
	7	10,000	15.0%	0.6
	8	20,000	N/A-Fixed Incentive	0.3
	9	30,000	4.8%	0.3
Process	10	50,000	7.9%	0.7
	11	60,000	4.7%	0.8
Other	12	20,000	4.3%	1.2
	13	40,000	3.2%	0.6
HVAC	14	50,000	5.0%	3.4
	15	20,000	5.0%	4.8

Results: Static Marketing Scenario

Using the assumptions listed above the market penetration rates were determined for each measure by sub sector. The market penetration rates were used in the model to estimate the natural gas savings for the Static Marketing scenario. Under the conditions defined by the Static Marketing scenario, total Industrial sector natural gas savings in 2017 are estimated to be approximately 524 million m^3/yr. This represents a saving of approximately 9%, relative to the Reference Case, and is equal to approximately 27% of the savings identified in the Economic Potential Forecast. Further detail is provided in the following exhibits:

- Exhibit 6.17 shows total natural gas savings by service region and milestone year
- Exhibit 6.18 shows total natural gas savings by sub sector and milestone year for the total Union Service Area
- Exhibit 6.19 shows total natural gas savings by end use and milestone year for the total Union Service Area
- Exhibit 6.20 shows total natural gas savings by sub sector and end use for 2017 for the total Union Service Area
- Exhibit 6.21 shows annual natural gas savings for the year 2017 by technology, together with the estimated program costs and TRC benefits for the total Union Service Area. (**Note**: the values shown in Exhibit 6.21 are for the single year 2017 only; consequently, they do not add to the same values shown in the preceding exhibits.)

Exhibit 6.17: Natural Gas Savings by Service Region and Milestone Year, Static Marketing Scenario (1000 m^3/yr.)

Milestone Year	Southern Region	Northern Region	Total	% Savings Relative to Ref Case
	1000 m^3/year			
2012	218,983	98,593	317,576	5.8%
2017	357,258	167,079	524,337	9.4%
% Savings 2017 Re: Reference Case	9%	10%	9%	
% Savings 2017 Re: Total	68%	32%	100%	

Exhibit 6.18: Natural Gas Savings by Sub Sector and Milestone Year for the Total Union Service Area, Static Marketing Scenario (1000 m^3/yr.)

Sub-Sector	Milestone Year		% Savings 2017	
	2012	2017	Re: Ref Case	Re: Total
	1000 m^3/year			
Contract Primary Metal	91,880	162,563	10.3%	31.0%
Contract Chemical	56,226	103,098	8.3%	19.7%
Other Chemical	1,948	3,322	8.3%	0.6%
Contract Paper	29,611	35,029	11.2%	6.7%
Contract Transportation and Machinery	18,152	23,949	8.5%	4.6%
Other Transportation and Machinery	6,892	9,047	8.5%	1.7%
Contract Petroleum Refineries	23,292	40,165	9.8%	7.7%
Contract Mining	17,646	28,135	9.0%	5.4%
Contract Food and Beverage	12,414	21,857	8.4%	4.2%
Other Food and Beverage	2,491	3,767	8.4%	0.7%
Contract Non-Metallic Mineral	20,140	35,135	11.9%	6.7%
Miscellaneous Industrial	36,884	58,269	8.1%	11.1%
Total	317,576	524,337	9.4%	100.0%

Exhibit 6.19: Natural Gas Savings by End Use and Milestone Year for the Total Union Service Area, Static Marketing Scenario (1000 m^3/yr.)

End Use	Milestone Year		% Savings 2017	
	2012	2017	Re: Ref Case	Re: Total
	1000 m^3/year			
Systems	88,406	118,008	2.1%	22.5%
Hot Water Systems	4,428	6,489	3.1%	1.2%
Boiler Steam Systems	50,771	99,410	7.0%	19.0%
Process Heat	116,421	220,899	8.8%	42.1%
Other Process	3,416	7,108	3.2%	1.4%
HVAC	54,134	72,423	5.9%	13.8%
Total	317,576	524,337	9.4%	100.0%

Exhibit 6.20: Annual Natural Gas Savings by Sub Sector and End Use for 2017 for the Total Union Service Area, Static Marketing Scenario (1000 m^3/yr.)

Sub Sector		End Use						
	Systems	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	34,448	914	11,652	102,974	1,335	11,241	162,563	31.0%
Contract Chemical	25,486	758	35,475	27,210	2,993	11,175	103,098	19.7%
Other Chemical	821	24	1,143	877	96	360	3,322	0.6%
Contract Paper	6,417	191	13,905	4,041	207	10,269	35,029	6.7%
Contract Transportation and Machinery	5,923	172	4,850	6,458	383	6,163	23,949	4.6%
Other Transportation and Machinery	2,237	65	1,832	2,440	145	2,328	9,047	1.7%
Contract Petroleum Refineries	8,205	242	5,380	24,162	217	1,960	40,165	7.7%
Contract Mining	6,747	2,042	6,014	10,434	581	2,318	28,135	5.4%
Contract Food and Beverage	5,470	634	8,787	5,105	396	1,465	21,857	4.2%
Other Food and Beverage	943	109	1,514	880	68	253	3,767	0.7%
Contract Non-Metallic Mineral	6,334	189	2,704	23,907	274	1,726	35,135	6.7%
Miscellaneous Industrial	14,977	1,148	6,153	12,412	414	23,165	58,269	11.1%
Total	118,008	6,489	99,410	220,899	7,108	72,423	524,337	
%	23%	1%	19%	42%	1%	14%		

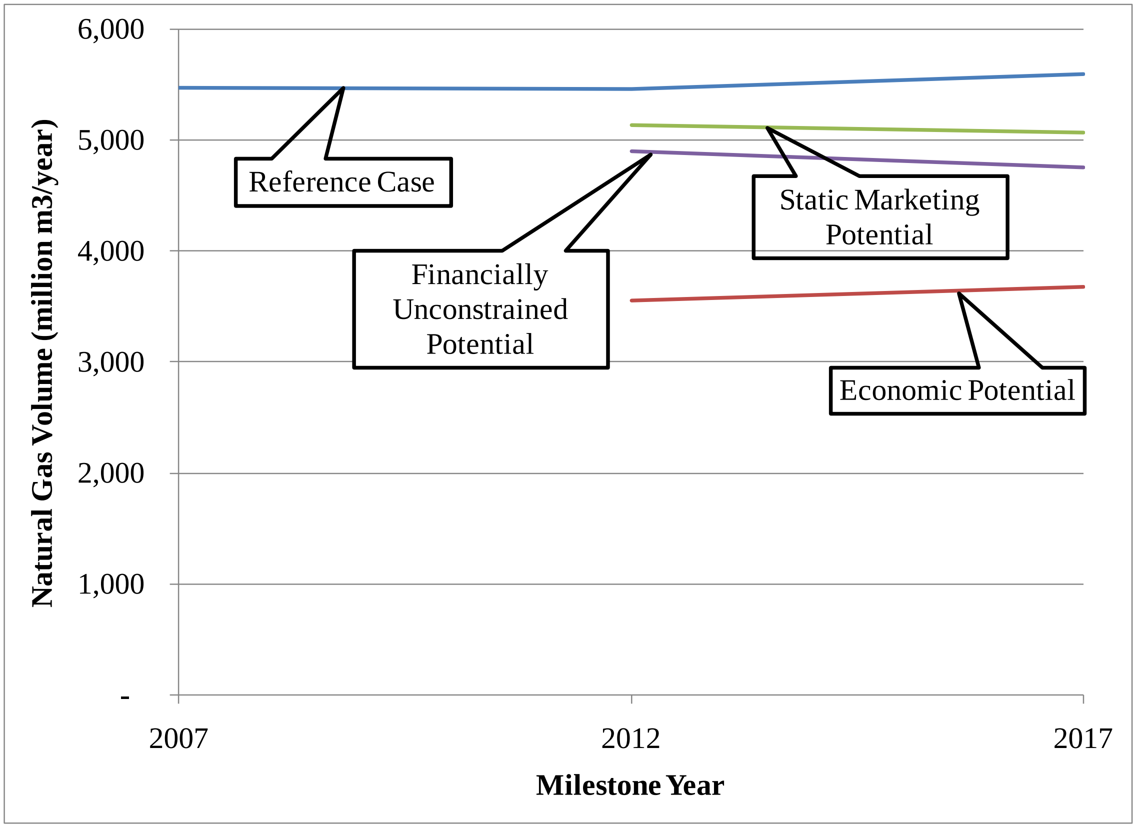
Exhibit 6.21: Annual Natural Gas Savings by Technology for One Year of Program Activity (2017) for the Total Union Service Area, Static Marketing Scenario

End Use	Bundle	Static Achievable Potential 2017		Program Costs 2017	Program Costs per Unit Savings and TRC	
		Natural Gas Savings (1000 m^3/yr.)	TRC Benefits ('000 $)	('000 $)	Per Natural Gas Savings ($/m^3)	Per TRC Benefits ($/$)
System wide	1	814	2,557	41	0.05	0.02
	2	355	961	23	0.06	0.02
Boiler	3	2,406	6,172	207	0.09	0.03
	4	2,270	5,572	26	0.01	0.005
	5	2,144	895	72	0.03	0.08
	6	255	864	68	0.27	0.08
	7	2,763	2,833	32	0.01	0.01
	8	110	140	22	0.20	0.16
	9	609	11,508	408	0.67	0.04
Process	10	4,516	22,760	189	0.04	0.01
	11	14,452	69,163	706	0.05	0.01
Other	12	657	2,270	32	0.05	0.01
	13	47	1,296	47	1.01	0.04
HVAC	14	2,214	9,196	534	0.24	0.06
	15	6,360	14,732	800	0.13	0.05
Weighted Average					0.08	0.02

6.7 SUMMARY AND INTERPRETATION OF RESULTS

Exhibit 6.22 provides a summary of the achievable natural gas savings under the Static Marketing and Financially Unconstrained scenarios presented in the preceding section. Results are shown relative to the Reference Case and Economic Potential Forecasts.

Exhibit 6.22: Achievable Potential versus Reference Case and Economic Potential Forecasts, for the Total Union Service Area



Further highlights are provided below.

The Financially Unconstrained Scenario

- Under the conditions defined by the Financially Unconstrained scenario, total Industrial sector natural gas savings in 2017 are estimated to be approximately 846 million m^3/yr. This represents a saving of approximately 15%, relative to the Reference Case and is equal to approximately 44% of the savings identified in the Economic Potential Forecast.

- The most significant opportunities for natural gas savings in this scenario are technologies that reduce gas usage for process heating, specifically ovens, dryers, kilns and furnaces. Implementation of energy-efficiency measures in boiler steam systems is also a significant opportunity. Implementation of measures to improve the total plant (referred to as system wide) energy efficiency is the third most significant opportunity area.

- Program costs per m^3 of natural gas savings in this scenario range widely by measure, from approximately $0.02 for bundles four and seven (both are bundles that apply to boiler steam systems), to $7.45 for bundle 13, which applies to process specific (referred to as "other") end use.

- Program costs per dollar of TRC benefit also show a wide range, from approximately $0.01 for bundle 4 to almost $ 0.27 for bundle 13.

- Weighted averages for the whole group of measures show 2017 program costs of approximately $0.19/$m^3$ of natural gas savings and approximately $0.06/TRC dollar. These values are approximately two to three times higher than Union's current program results.[78]

The Static Marketing Scenario

- Under the conditions defined by the Static Marketing scenario, total Industrial sector natural gas savings in 2017 are estimated to be approximately 524 million m^3/yr. This represents a saving of approximately 9%, relative to the Reference Case and is equal to approximately 27% of the savings identified in the Economic Potential Forecast.

- Similar to the Financially Unconstrained scenario, the most significant opportunities for natural gas savings are technologies and measures applicable to process heating, boiler steam systems and system wide (or plant wide).

- Program costs per m^3 of natural gas savings also range widely by measure in the Static Marketing scenario, from approximately $0.01 for bundles four and seven, to $1.01 for bundle 13.

- Program costs per dollar of TRC benefit show a similar wide range, from approximately $0.005 for bundle four to $0.16 for bundle eight.

- Weighted averages for the whole group of measures included in the Static Marketing scenario show 2017 program costs of approximately $0.08/$m^3$ of natural gas savings and approximately $0.02/TRC dollar. These values are relatively similar to Union's current program results.

[78] Union's audited results for its 2006 industrial DSM programs show that program spending of $3,500,000 achieved natural gas savings of 53,000,000 m^3 and TRC net benefits of $102,900,000. Expressed as a ratio, one dollar of program spending generated approximately 15.1 m^3 (approximately $0.07/$m^3$) of annual natural gas savings and just over $29 of TRC net benefits (approximately $0.03/TRC$).

7. CONCLUSIONS

This study has confirmed the existence of significant cost-effective DSM potential within all sub sectors of Union's Industrial sector. In fact, the levels of identified annual achievable potential savings are in the same order of magnitude as those captured in Union's 2007 program. However, the cost of achieving the identified savings is increasing.

Although the weighted average program cost values presented for both the Financially Unconstrained and Static Marketing scenarios will vary depending on the specific composition of the future program portfolio, both scenarios show an evident trend towards higher future costs to achieve natural gas savings and TRC benefits.[79] This trend recognizes that savings from DSM programs tend to become more expensive with time as the most attractive measures gain greater market penetration and only the more challenging measures remain.[80]

7.1 ADDITIONAL OBSERVATIONS

In addition to the preceding conclusions, three additional observations warrant note as they may affect future program strategies. They include:

- ***Rate of measure implementation has a large effect on overall savings:*** For measures that pass the TRC screen on an incremental cost basis, low participation rates in early milestone years create a significant "lost opportunity." This is particularly relevant to the replacement of equipment with a very long life, which is applicable to most industrial technologies and measures. The gap between Economic Potential and Achievable Potential savings presented in this study is due in large part to this significant lost opportunity that occurs in early milestone years.

- ***Bundling of measures to develop program concepts has an impact on the achievable potential and program development:*** To model the achievable potential scenario measures were grouped into bundles that are manageable within the scope and budget of the project. The results in Chapter 6 provide an indicative savings potential based on the specific set of bundles. Bundles with different combinations of measures will prioritize the measures in a different order from lowest to highest program cost per TRC benefit. In defining and developing specific programs it will be important to interpret the Achievable Potential by assessing individual measures within the context of the Economic Potential and the measure TRC results.

[79] Design of a DSM program portfolio is beyond the scope of this current study.

[80] Over time, it is also expected that some relatively new technologies may become less expensive as they gain greater sales volumes.

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9. GLOSSARY

achievable potential
The Achievable Potential is the proportion of the natural gas savings identified in the Economic Potential Forecast that could realistically be achieved within the study period. Achievable Potential recognizes that it is difficult to induce customers to purchase and install all of the efficiency technologies that meet the criteria defined by the Economic Potential Forecast.

avoided cost
The unit cost of acquiring the next resource to meet demand, which is used as a measure for evaluating individual demand-side and supply-side options. In the context of this study “avoided cost” is the capital expenditure offset by Union Gas DSM activities (i.e., the cost of having to buy natural gas on the open market, contract for long-term supply, and/or build and run new storage/transmission facilities).

base year
The Base Year is the year to which all potentials will be compared. It provides a detailed description of “where” and “how” natural gas is currently used in each sector. For this study, it is the calendar year 2007. The modelled base year energy use is calibrated against Union’s actual sales for 2007.

benefit/cost ratio
The measure benefit/cost ratio indicates the relative attractiveness of the measures. A measure that has a benefit/cost ratio in excess of 1.0 has benefits which outweigh its costs. Similarly, a measure with a benefit/cost ratio that is well in excess of one (e.g., 3.0) means that it is very attractive. A measure with a benefit/cost ratio of less than 1.0 has costs which outweigh its benefits.

building envelope
The material separation between the interior and the exterior environments of a building. The building envelope serves as the outer shell to protect the indoor environment as well as to facilitate its climate control.

co-generation
The simultaneous production of electric or mechanical energy and useful heat energy from a single fuel source.

combustion efficiency
The ratio of energy released during combustion to the potential chemical energy available in the fuel.

demand-side management (DSM)
Actions that modify customer demand for natural gas and that can defer the need for additional new supply.

discount rate
The interest rate used in calculating the present value of expected yearly benefits and costs.

economic efficiency
Allocation of human and natural resources in a way that results in the greatest net economic benefit, regardless of how benefits and costs are distributed within society.

economic potential forecast
The economic potential forecast is an estimate of the level of natural gas consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective from society's perspective. All of the energy-efficiency technologies and measures that have a positive measure TRC are incorporated into the economic potential forecast. These technologies and measures are applied at either natural stock turnover rates or at designated years for immediate application.

effective measure life (EML)
The estimate median number of years that the measures installed under a program are still in place and operable. EML incorporates field conditions, obsolescence, building remodelling, renovation, demolition and occupancy changes.

energy audit
An on-site inspection and cataloguing of energy using equipment/buildings, energy consumption and the related end-uses. The purpose is to provide information to the customer and the utility. Audits are useful for load research, for DSM program design and for identification of specific energy savings projects.

energy conservation
Activities by energy users that result in a reduction of the energy used to provide services. Energy conservation can include a wide variety of behavioural or operational changes that result in energy savings. For the purpose of this study, only energy savings achieved through physical or hardware installations are considered.

energy intensity
The ratio of energy consumed per application or end use. For example, gigajoules per square metre of heated office space per day, or gigajoules per tonne of aluminum produced. All else being equal, energy intensity increases as energy efficiency decreases.

emerging technologies
New energy-conserving technologies that are not yet market-ready, but may be market-ready over next 5 to 10 years. This category includes technologies that could be accelerated into the market during that period through targeted financial or technical support.

end use
The final application or final use to which energy is applied. End use is often used interchangeably with energy service.

energy savings
The savings that result from efficient technologies or activities. In this document, the term "energy" refers specifically to energy derived from natural gas unless otherwise noted.

energy service
An amenity or service supplied jointly by energy and other components/equipment such as buildings and heating equipment. Examples of energy services include residential space heating, commercial cooking, aluminum smelting and public transit. The same energy service can frequently be supplied with different mixes of equipment and energy.

energy use index (EUI)
End use energy consumption divided by a specific parameter of production (e.g., MJ/m^2., MJ/unit).

environmental credit/environmental penalty
An increment or decrement to the cost of a resource or set of resources, to reflect the overall level of its/their environmental impact, relative to another resource or set of resources.

financial incentive
Certain financial features in the utility's DSM programs designed to motivate customer participation. They may include features designed to reduce a customer's net cash outlay, pay-back period or cost of finance to participate.

fuel share
The proportion of requirements for a specific service met using a certain fuel. For example, a natural gas fuel share of 90% for space heating in commercial large office sub sector implies that 90% of the sub sector floor space is heated using natural gas. Similarly, a 90% natural gas fuel share in single family detached homes means that 90% of the space heating requirements for that dwelling type are met by natural gas.

gigajoule
One billion joules or one thousand megajoules.

interactive effects
In the context of natural gas use, interactive effects refer to the increase in gas consumed by heating equipment required to offset a decrease in "waste" heat generated by more efficient electrical fixtures or appliances after retrofit or replacement.

joule
The basic unit of energy. In physical terms, equal to the work required to move a mass of one Newton a distance of one metre.

kilowatt (kW)
One thousand watts; the most common unit of measurement of electric power. (The amount of energy transferred at a rate of one kilowatt for one hour is equal to one kilowatt hour.)

kilowatt hour (kWh)
The most common unit of measurement of electric energy. One kilowatt hour represents the power of one thousand watts for a period of one hour.

load forecast
An estimate of expected natural gas requirements that have to be met by the utility in future years.

load research
Research to disaggregate and analyze patterns of natural gas consumption by various sub sectors and end-uses. Load Research supports the development of the load forecast and the design of demand-side management programs.

measure total resource cost (TRC)
The Measure TRC is the net present value of energy savings that result from an investment in a energy efficiency measure. The Measure TRC is equal to its full or incremental capital cost (depending on application) plus any change (positive or negative) in the combined annual energy and equipment-specific operating & maintenance costs. This calculation includes among others, the following inputs: the avoided natural gas and electricity supply costs; the life of the measure; and the selected discount rate.

megajoule
One million joules.

natural conservation
The future change in energy intensity that is expected to occur in the absence of utility DSM programs.

non-participant test (NPT)
A test measuring what happens to rates due to changes in utility revenues and operating costs caused by a program. Rates will go down if the avoided cost is greater than the sum of the revenue lost plus the program costs. This test indicates the direction and magnitude of the expected change in rate levels.

operating and maintenance cost (O&M cost)
The cost refers to the operating and maintenance costs associated with running the specific equipment. It is also referred to as equipment-specific O&M cost.

rate
Generically refers to a utility's rate structure.

rate structure
The formulae used by a utility to calculate charges for the use of natural gas or electricity.

reference case forecast
An estimate of the expected level of natural gas consumption that would occur over the study period in the absence of any new utility DSM market interventions after 2008. It is the baseline against which the scenarios of energy savings are calculated. The Reference Case forecast incorporates an estimation of "natural conservation," namely, changes in end-use efficiency over the study period that are projected to occur in the absence of new market interventions by the utility.

saturation
The portion of floor area that receives a specific energy service. For example, a saturation of 86% for space cooling in the Large Office sub sector means that 86% of the sub sector floor space is cooled (regardless of fuel used to provide that cooling).

seasonal efficiency
The ratio of delivered useful energy relative to the input potential fuel energy determined over a full heating season (or year).

sector
A group of customers having a common type of economic activity. Union Gas divides its customers into three principal sectors: Residential, Commercial and Industrial. Sectors are further divided into sub sectors. For example, “Large Offices” is a sub sector of the Commercial sector.

service area
The portion of the Province of Ontario that receives service from Union Gas. Union Gas’ service area is spread across the Province of Ontario including northern, southwestern and southeastern cities and towns.

service region
For the purposes of this study, the total Union Gas service area is divided into two service regions. They are the Northern Region and Southern Region.

simple payback
The simple payback is generated to show the customer’s financial perspective. Simple payback is a measure of the length of time required for the cumulative savings from a project to recover its initial investment cost and other accrued costs, without taking into account the time value of money.

static marketing scenario
The Static Marketing scenario incorporates consideration of both market constraints and DSM program budget limitations, which are “roughly” consistent with current Union levels. It provides a ‘high level’ estimate of the level of natural gas savings that could be achieved by Union’s industrial customers over the nine-year period beginning in 2009 and ending in 2017, assuming present levels of program activity and a somewhat different mix of programs.

strategic conservation
Utility action to reduce the total natural gas demand. Strategic conservation is natural gas conservation induced by utility programs.

strategic load growth
Utility action to increase (annual) total natural gas demand for specific end uses.

sub sectors
A classification of customers within a sector by common features. Residential sub sectors are by type of home (SFD, duplex, apartment, etc.). Commercial sub sectors are generally by type of

commercial service (office, retail, warehouse, etc.). Industrial sub sectors are by product type (pulp and paper, solid wood products, chemicals, etc.).

supply curves
A curve illustrating the amount of energy available at an appropriate screened price in ascending order of cost.

Total Resource Cost (TRC) Test
A test that compares the total costs of energy efficiency investments, including natural gas conservation programs, to the social cost of natural gas. Un-priced environmental and social costs may be accounted for by changing the cost of either the investment under consideration or the total cost of natural gas in such a way that relative un-priced impacts are reflected. It is used in designing and evaluating programs that are developed from the Energy Efficiency Potential study's results.

utility cost
The total financial cost incurred by the utility to acquire energy resources. For DSM, the costs include all utility program costs, including incentive costs.

watt
The basic unit of measurement of power.

Natural Gas
Energy Efficiency Potential

Industrial Sector

–Appendices–

Submitted to:

Union Gas

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APPENDIX A

Regional Base Year Natural Gas Consumption Profiles

Appendix A-1

Base Year (2007) Natural Gas Consumption by Sub Sector for Northern Service Region (1000 of m^3/yr.)

Sub Sector	End Use						
	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	7,961	46,769	278,105	9,075	56,123	398,032	24%
Contract Chemical	5,125	104,036	84,562	18,909	43,615	256,247	15%
Other Chemical	46	938	762	170	393	2,310	0.14%
Contract Paper	10,755	335,510	101,852	9,841	79,804	537,762	33%
Contract Transportation and Machinery	212	2,464	3,175	430	4,311	10,593	0.64%
Other Transportation and Machinery	28	328	423	57	574	1,411	0.09%
Contract Petroleum Refineries	-	-	-	-	-	-	0%
Contract Mining	61,550	76,938	107,713	15,388	46,163	307,752	19%
Other Mining	-	-	-	-	-	-	0%
Contract Food and Beverage	3,168	18,938	10,887	2,451	4,158	39,603	2.4%
Other Food and Beverage	202	1,208	695	156	265	2,527	0.15%
Contract Non-Metallic Mineral	425	2,540	15,050	803	2,421	21,239	1.3%
Miscellaneous Industrial	3,971	8,889	14,860	2,069	46,574	76,363	4.6%
Total	93,444	598,559	618,085	59,350	284,402	1,653,839	
%	6%	36%	37%	4%	17%		

Appendix A-2

Base Year (2007) Natural Gas Consumption by Sub Sector for Southern Service Region (1000 of m^3/yr.)

Sub Sector	End Use						
	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	19,608	115,195	684,993	22,353	138,234	980,383	26%
Contract Chemical	14,992	304,332	247,364	55,313	127,586	749,587	20%
Other Chemical	694	14,096	11,458	2,562	5,910	34,720	0.9%
Contract Paper	589	18,378	5,579	539	4,371	29,456	0.8%
Contract Transportation and Machinery	7,615	88,582	114,137	15,438	154,967	380,739	10%
Other Transportation and Machinery	2,956	34,389	44,311	5,994	60,162	147,811	4%
Contract Petroleum Refineries	7,520	72,251	253,607	6,738	35,873	375,989	10%
Contract Mining	2,473	3,091	4,328	618	1,855	12,365	0.3%
Other Mining	5	6	9	1	4	25	0.001%
Contract Food and Beverage	16,973	101,459	58,325	13,133	22,278	212,168	6%
Other Food and Beverage	4,261	25,472	14,643	3,297	5,593	53,266	1.4%
Contract Non-Metallic Mineral	5,173	30,937	183,295	9,778	29,489	258,672	7%
Miscellaneous Industrial	29,974	67,095	112,171	15,621	351,558	576,418	15%
Total	112,833	875,283	1,734,218	151,386	937,878	3,811,599	
%	3%	23%	45%	4%	25%		

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APPENDIX B

Regional Reference Case Forecast Natural Gas Consumption Profiles

Appendix B-1

Reference Case Forecast Natural Gas Consumption by End Use for Milestone Year 2012 – Northern Service Region (1000 m^3)

Sub Sector	End Use						
	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	9,020	52,991	315,102	10,282	63,589	450,983	27%
Contract Chemical	6,935	140,786	114,432	25,588	59,022	346,763	21%
Other Chemical	63	1,269	1,032	231	532	3,126	0.19%
Contract Paper	7,757	241,990	73,462	7,098	57,560	387,867	24%
Contract Transportation and Machinery	222	2,584	3,330	450	4,521	11,107	0.68%
Other Transportation and Machinery	30	344	444	60	602	1,480	0.09%
Contract Petroleum Refineries	-	-	-	-	-	-	0%
Contract Mining	61,314	76,643	107,300	15,329	45,986	306,571	19%
Other Mining	-	-	-	-	-	-	0%
Contract Food and Beverage	5,278	31,552	18,138	4,084	6,928	65,980	4.0%
Other Food and Beverage	337	2,013	1,157	261	442	4,210	0.26%
Contract Non-Metallic Mineral	513	3,070	18,190	970	2,926	25,670	1.6%
Miscellaneous Industrial	2,005	4,489	7,504	1,045	23,520	38,563	2.3%
Total	93,475	557,731	660,090	65,398	265,627	1,642,320	100%
%	6%	34%	40%	4%	16%		

Appendix B-2

Reference Case Forecast Natural Gas Consumption by End Use for Milestone Year 2017 – Northern Service Region (1000 m^3)

Sub Sector	End Use						
	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	10,220	60,040	357,020	11,650	72,048	510,978	29%
Contract Chemical	9,385	190,517	154,853	34,627	79,871	469,253	27%
Other Chemical	85	1,717	1,396	312	720	4,230	0.24%
Contract Paper	5,595	174,538	52,985	5,119	41,515	279,754	16%
Contract Transportation and Machinery	233	2,709	3,491	472	4,740	11,646	0.67%
Other Transportation and Machinery	31	361	465	63	632	1,552	0.09%
Contract Petroleum Refineries	-	-	-	-	-	-	0%
Contract Mining	61,079	76,348	106,888	15,270	45,809	305,394	17%
Other Mining	-	-	-	-	-	-	0%
Contract Food and Beverage	8,794	52,567	30,219	6,805	11,542	109,927	6.3%
Other Food and Beverage	561	3,354	1,928	434	736	7,014	0.40%
Contract Non-Metallic Mineral	621	3,711	21,985	1,173	3,537	31,026	1.8%
Miscellaneous Industrial	1,013	2,267	3,790	528	11,878	19,475	1.1%
Total	97,615	568,130	735,021	76,453	273,028	1,750,247	100%
%	6%	32%	42%	4%	16%		

Appendix B-3

Reference Case Forecast Natural Gas Consumption by End Use for Milestone Year 2012 – Southern Service Region (1000 m^3)

Sub Sector	End Use						
	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	20,401	119,855	712,702	23,257	143,826	1,020,039	27%
Contract Chemical	15,222	309,003	251,160	56,162	129,544	761,091	20%
Other Chemical	705	14,313	11,633	2,601	6,000	35,253	0.92%
Contract Paper	623	19,438	5,901	570	4,624	31,156	1%
Contract Transportation and Machinery	6,431	74,810	96,393	13,038	130,875	321,547	8.43%
Other Transportation and Machinery	2,497	29,043	37,422	5,062	50,808	124,831	3.27%
Contract Petroleum Refineries	7,844	75,363	264,532	7,029	37,419	392,187	10%
Contract Mining	1,934	2,418	3,385	484	1,451	9,671	0%
Other Mining	4	5	7	1	3	19	0%
Contract Food and Beverage	14,348	85,765	49,303	11,102	18,832	179,350	4.7%
Other Food and Beverage	3,602	21,532	12,378	2,787	4,728	45,027	1.18%
Contract Non-Metallic Mineral	5,239	31,328	185,611	9,901	29,861	261,940	6.9%
Miscellaneous Industrial	32,952	73,762	123,316	17,173	386,489	633,692	16.6%
Total	111,801	856,634	1,753,742	149,167	944,458	3,815,802	100%
%	3%	22%	46%	4%	25%		

Appendix B-4

Reference Case Forecast Natural Gas Consumption by End Use for Milestone Year 2017 – Southern Service Region (1000 m^3)

Sub Sector	End Use						
	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	21,226	124,703	741,530	24,198	149,643	1,061,300	28%
Contract Chemical	15,455	313,745	255,014	57,024	131,532	772,771	20%
Other Chemical	716	14,532	11,812	2,641	6,092	35,794	0.93%
Contract Paper	659	20,560	6,242	603	4,890	32,954	1%
Contract Transportation and Machinery	5,431	63,179	81,407	11,011	110,528	271,557	7.06%
Other Transportation and Machinery	2,108	24,528	31,604	4,275	42,909	105,424	2.74%
Contract Petroleum Refineries	8,182	78,610	275,928	7,332	39,031	409,082	11%
Contract Mining	1,513	1,891	2,647	378	1,135	7,564	0%
Other Mining	3	4	5	1	2	15	0%
Contract Food and Beverage	12,129	72,499	41,677	9,385	15,919	151,608	3.9%
Other Food and Beverage	3,045	18,201	10,463	2,356	3,996	38,062	0.99%
Contract Non-Metallic Mineral	5,305	31,724	187,956	10,026	30,238	265,249	6.9%
Miscellaneous Industrial	36,226	81,091	135,569	18,879	424,891	696,656	18.1%
Total	111,998	845,267	1,781,855	148,109	960,807	3,848,036	100%
%	3%	22%	46%	4%	25%		

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APPENDIX C

Regional Natural Gas Savings Profiles

Appendix C-1

Natural Gas Savings by Sub Sector and End Use for the Northern Service Region in Milestone Year 2012 (1000 m3/yr.)

Sub Sector	End Use							
	System	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	27,537	1,214	10,967	91,662	844	21,027	153,251	28%
Contract Chemical	23,469	1,028	30,642	29,664	2,751	20,367	107,921	20%
Other Chemical	212	9	276	267	25	184	973	0.2%
Contract Paper	23,148	1,150	55,170	19,007	763	19,088	118,326	22%
Contract Transportation and Machinery	762	38	668	885	52	1,517	3,922	1%
Other Transportation and Machinery	102	5	89	118	7	202	523	0.1%
Contract Mining	21,172	9,681	18,571	37,168	1,223	14,576	102,390	19%
Contract Food and Beverage	7,165	904	8,204	5,202	456	2,423	24,354	5%
Other Food and Beverage	457	58	523	332	29	155	1,554	0.3%
Contract Non-Metallic Mineral	1,773	80	745	7,712	108	979	11,397	2%
Miscellaneous Industrial	4,188	343	1,167	2,661	120	8,097	16,577	3%
Total	109,984	14,512	127,024	194,678	6,379	88,613	541,189	100%
Percentage of Total	20%	3%	23%	36%	1%	16%		

Note: Totals may not add to 100% due to rounding.

Appendix C-2

Natural Gas Savings by Sub Sector and End Use for the Northern Service Region in Milestone Year 2017 (1000 m^3/yr.)

Sub Sector	End Use							
	System	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	30,792	1,807	14,979	101,703	943	23,429	173,653	30%
Contract Chemical	23,538	1,787	49,676	39,324	3,674	27,111	145,110	25%
Other Chemical	254	16	448	354	33	244	1,350	0.2%
Contract Paper	12,354	1,066	48,070	13,429	543	13,539	89,000	15%
Contract Transportation and Machinery	592	49	830	912	54	1,557	3,995	1%
Other Transportation and Machinery	77	7	111	122	7	207	530	0.1%
Contract Petroleum Refineries	-	-	-	-	-	-	-	0.0%
Contract Mining	15,635	12,228	22,143	36,439	1,200	14,274	101,918	18%
Other Mining	-	-	-	-	-	-	-	0%
Contract Food and Beverage	8,888	1,874	16,181	8,534	751	3,968	40,196	7%
Other Food and Beverage	347	120	1,032	545	48	253	2,345	0.4%
Contract Non-Metallic Mineral	1,588	124	1,078	9,182	129	1,163	13,265	2%
Miscellaneous Industrial	1,575	216	698	1,324	60	4,020	7,893	1%
Total	95,638	19,294	155,246	211,869	7,442	89,766	579,255	100%
Percentage of Total	17%	3%	27%	37%	1%	15%		

Note: Totals may not add to 100% due to rounding.

Appendix C-3

Natural Gas Savings by Sub Sector and End Use for the Southern Service Region in Milestone Year 2012 (1000 m^3/yr.)

Sub Sector	End Use							
	System	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	62,284	2,746	24,805	207,322	1,910	47,559	346,625	25%
Contract Chemical	53,415	2,341	69,742	67,515	6,260	46,355	245,628	18%
Other Chemical	481	21	629	609	56	418	2,214	0.2%
Contract Paper	1,859	92	4,432	1,527	61	1,533	9,505	1%
Contract Transportation and Machinery	27,021	1,339	23,700	31,397	1,846	53,795	139,099	10%
Other Transportation and Machinery	3,600	178	3,158	4,183	246	7,168	18,533	1.4%
Contract Petroleum Refineries	23,225	1,008	15,596	73,476	560	12,217	126,082	9.3%
Contract Mining	669	306	587	1,175	39	461	3,236	0%
Contract Food and Beverage	22,906	2,890	26,225	16,629	1,459	7,744	77,854	6%
Other Food and Beverage	1,462	184	1,673	1,061	93	494	4,967	0.4%
Contract Non-Metallic Mineral	18,090	821	7,602	78,688	1,106	9,988	116,294	9%
Miscellaneous Industrial	68,819	5,644	19,179	43,730	1,976	133,053	272,401	20%
Total	283,831	17,570	197,327	527,313	15,613	320,785	1,362,440	100%
Percentage of Total	21%	1%	14%	39%	1%	24%		

Note: Totals may not add to 100% due to rounding.

Appendix C-4

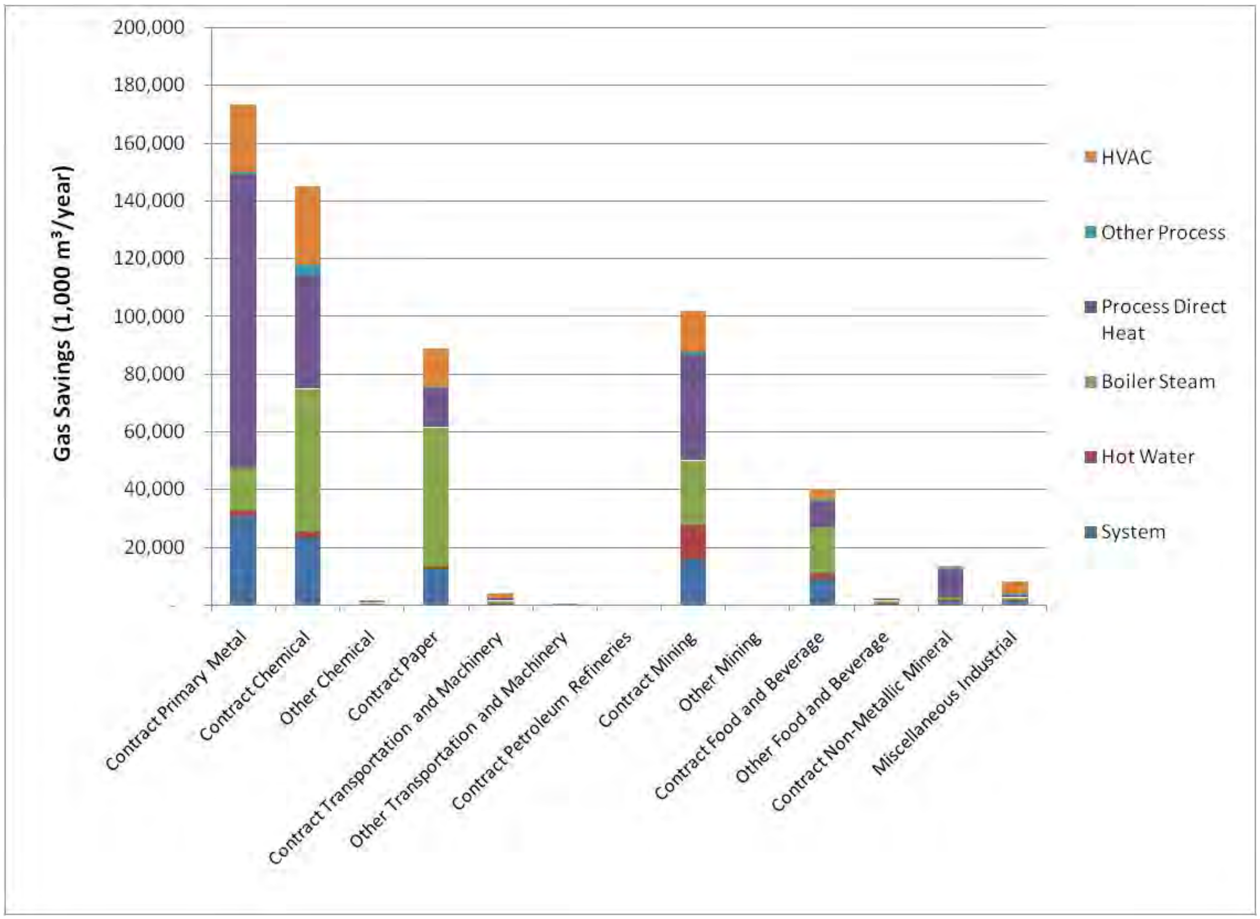
Natural Gas Savings by Sub Sector and End Use for the Southern Service Region in Milestone Year 2017 (1000 m^3/yr.)

Sub Sector	End Use							
	System	Hot Water Systems	Boiler Steam Systems	Process Direct Heat	Other Process	HVAC	Total	
Contract Primary Metal	63,954	3,754	31,112	211,237	1,958	48,662	360,678	27%
Contract Chemical	40,195	3,052	84,832	67,154	6,274	46,297	247,804	19%
Other Chemical	433	28	765	605	57	417	2,305	0.2%
Contract Paper	1,455	126	5,663	1,582	64	1,595	10,484	1%
Contract Transportation and Machinery	16,916	1,413	23,716	26,060	1,539	44,471	114,116	9%
Other Transportation and Machinery	2,194	188	3,160	3,472	205	5,925	15,145	1.1%
Contract Petroleum Refineries	17,924	13,418	68,801	1,994	3,062	12,529	117,728	8.8%
Contract Mining	388	303	550	904	30	354	2,529	0%
Other Mining	-	-	-	-	-	-	-	0%
Contract Food and Beverage	14,415	3,039	26,244	13,842	1,218	6,437	65,194	5%
Other Food and Beverage	563	194	1,674	883	78	411	3,803	0.3%
Contract Non-Metallic Mineral	13,579	1,057	9,214	78,499	1,106	9,947	113,403	8%
Miscellaneous Industrial	56,325	7,740	24,960	47,357	2,150	143,806	282,338	21%
Total	228,342	34,312	280,692	453,591	17,741	320,850	1,335,527	100%
Percentage of Total	17%	3%	21%	34%	1%	24%		

Note: Totals may not add to 100% due to rounding.

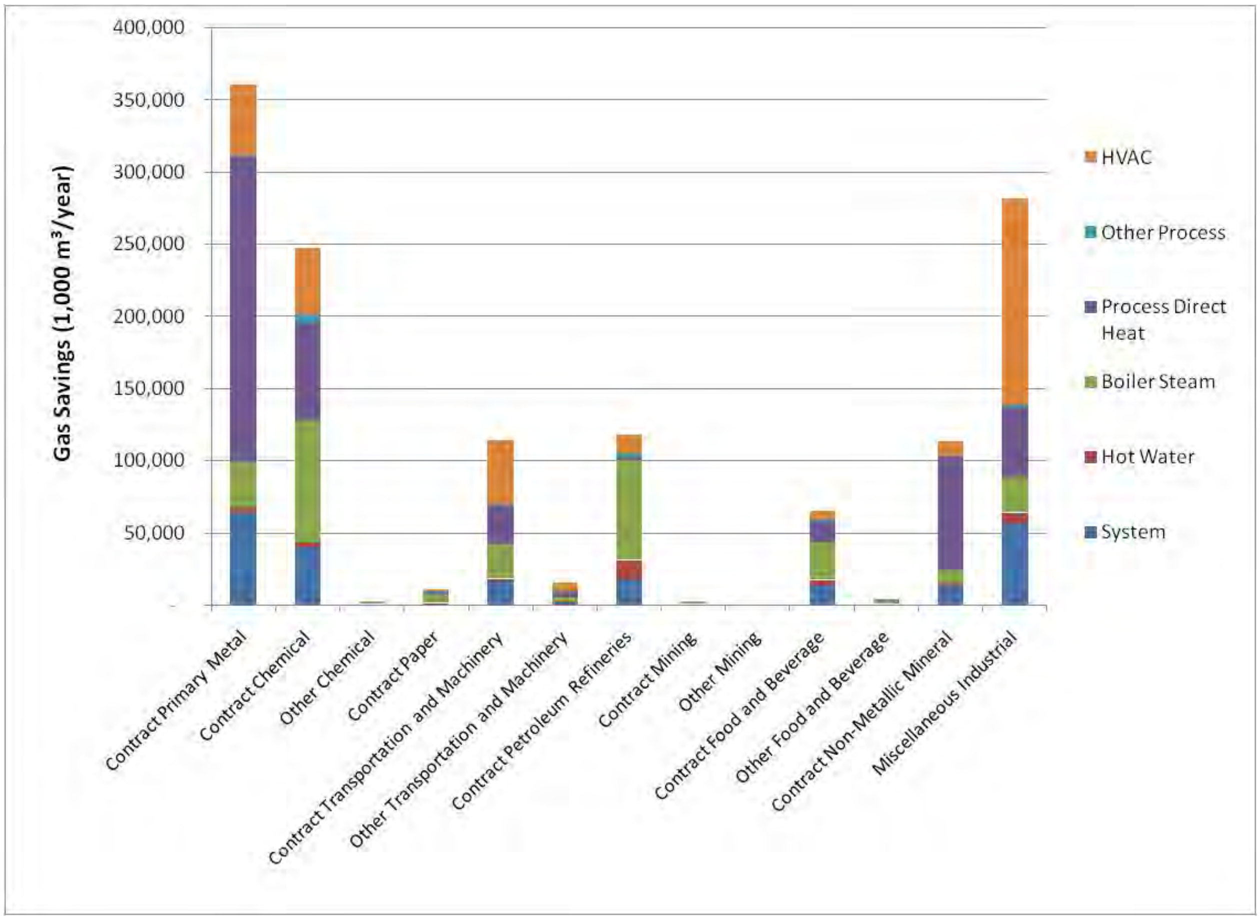
Appendix C-5

Natural Gas Savings by Sub Sector and End Use for the Northern Service Region in Milestone Year 2017 (1000 m^3/yr.)



Appendix C-6:

Natural Gas Savings by Sub Sector and End Use for the Southern Service Region in Milestone Year 2017 (1000 m^3/yr.)



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APPENDIX D

Industrial Sector Measure TRC Calculations

Appendix D-1

Industrial Sector TRC Calculations – Chemical

End Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
System	Medium	Integrated control system	$ 165,000	$ 13,200	N/A	Now	121,650	3,227,638	$ 7,895,530	0.1	45.3
		Sub-metering	$ 330,000	$ 33,000	$ 3,300	Now	76,031	2,017,274	$ 6,026,885	0.4	16.5
Boiler	Small (200 BHP)	Economizer	$ 27,000	$ 3,000	$ 1,000	Now	1,239	32,886	$ 81,164.60	2.5	3.1
		Blowdown heat recovery	$ 23,000	$ 2,000	$ 1,000	Now	620	16,443	$ 26,326	4.5	1.8
		Boiler combustion air preheat	$ 50,000	$ 10,000	$ 2,000	Now	1,549	41,108	$ 55,512	4.2	1.7
		Process heat recovery to preheat makeup water	$ 70,000	$ 8,000	$ 1,500	Now	1,859	49,329	$ 88,747	4.2	2.0
		Condensing boiler	$ 120,000	$ 20,000	$ 1,000	EOL	3,099	82,216	$ 250,682	1.9	6.2
		Direct contact hot water heaters	$ 75,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 329,736	0.1	N/A
		Boiler right sizing and load management	$ 70,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 334,736	0.0	N/A
		High efficiency burners	$ 48,000	$ 6,000	$ -	Now	1,549	41,108	$ 95,598	3.2	2.8
		Insulation	$ 20,000	$ 1,500	$ 150	Now	1,549	41,108	$ 108,083	1.3	5.8
		Advanced boiler controls	$ 40,000	$ 1,200	$ 150	Now	930	24,665	$ 36,093	4.1	1.9
		Blowdown control	$ 35,000	$ 3,500	$ 600	Now	310	8,222	-$ 13,689	14.1	0.7
		Boiler water treatment	$ 10,000	$ 2,000	$ 500	Now	310	8,222	$ 5,493	4.3	1.4
		Boiler maintenance	$ -	$ -	$ 8,000	Now	1,549	41,108	$ 31,489	0.9	2.0
		Minimize deaerator vent losses	$ 35,000	$ 3,500	$ 600	Now	620	16,443	$ 16,231	6.4	1.4
		Condensate return	$ 40,000	$ 8,000	$ 700	Now	620	16,443	$ 5,880	8.0	1.1
		Steam trap survey and repair	$ 20,000	$ 1,000	$ -	Now	1,239	32,886	$ 11,628	1.6	1.6
		Instantaneous Steam Generation	$ 120,000	$ 20,000	$ 1,000	EOL	4,648	123,323	$ 344,565	1.2	8.2
	Medium (450 BHP)	Economizer	$ 55,000	$ 4,400	$ 1,000	Now	3,137	83,243	$ 235,022	1.8	4.5
		Blowdown heat recovery	$ 50,000	$ 4,000	$ 1,000	Now	1,569	41,622	$ 88,954	3.4	2.4
		Boiler combustion air preheat	$ 140,000	$ 21,000	$ 5,000	Now	3,922	104,054	$ 131,864	4.4	1.7
		Process heat recovery to preheat makeup water	$ 130,000	$ 15,000	$ 1,800	Now	4,706	124,865	$ 294,079	3.0	2.8
		Condensing boiler	$ 180,000	$ 15,000	$ 2,800	EOL	7,844	208,108	$ 688,500	0.8	11.0
		Direct contact hot water heaters	$ 130,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 804,906	0.1	N/A
		Boiler right sizing and load management	$ 125,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 809,906	0.1	N/A
		High efficiency burners	$ 90,000	$ 10,000	$ -	Now	3,922	104,054	$ 278,669	2.3	3.8
		Insulation	$ 35,000	$ 2,800	$ 1,000	Now	3,922	104,054	$ 285,489	0.9	7.3
		Advanced boiler controls	$ 75,000	$ 6,500	$ 800	Now	2,353	62,432	$ 110,952	3.3	2.3
		Blowdown control	$ 60,000	$ 6,000	$ 1,000	Now	784	20,811	$ 1,220	8.9	1.0
		Boiler water treatment	$ 20,000	$ 3,500	$ 1,000	Now	784	20,811	$ 22,412	3.2	1.8
		Boiler maintenance	$ -	$ -	$ 13,000	Now	3,922	104,054	$ 107,189	0.4	3.2
		Minimize deaerator vent losses	$ 60,000	$ 6,000	$ 1,000	Now	1,569	41,622	$ 76,954	4.2	2.0
		Condensate return	$ 80,000	$ 15,000	$ 1,200	Now	1,569	41,622	$ 46,251	6.1	1.4
		Steam trap survey and repair	$ 35,000	$ 1,500	$ -	Now	3,137	83,243	$ 46,089	1.1	2.3
		Instantaneous Steam Generation	$ 180,000	$ 28,000	$ 1,500	EOL	11,765	312,162	$ 936,275	0.6	17.6
	Large (3,000 BHP)	Economizer	$ 350,000	$ 40,000	$ 2,000	Now	32,536	863,263	$ 2,734,525	1.1	7.7
		Blowdown heat recovery	$ 200,000	$ 25,000	$ 5,000	Now	16,268	431,632	$ 1,303,208	1.3	5.9
		Boiler combustion air preheat	$ 500,000	$ 60,000	$ 7,000	Now	40,670	1,079,079	$ 2,818,259	1.3	5.6
		Process heat recovery to preheat makeup water	$ 400,000	$ 50,000	$ 5,000	Now	48,805	1,294,895	$ 4,219,760	0.9	9.6
		Boiler right sizing and load management	$ 2,700,000	$ 150,000	-$ 10,000	EOL	81,341	2,158,158	$ 8,039,015	0.0	N/A
		High efficiency burners	$ 400,000	$ 60,000	$ -	Now	40,670	1,079,079	$ 3,466,940	1.0	8.5
		Insulation	$ 150,000	$ 30,000	$ 1,500	Now	40,670	1,079,079	$ 3,240,092	0.4	17.9
		Advanced boiler controls	$ 200,000	$ 40,000	$ 3,000	Now	24,402	647,448	$ 1,796,082	0.9	7.8
		Blowdown control	$ 120,000	$ 12,000	$ 2,000	Now	8,134	215,816	$ 636,361	1.5	5.3
		Boiler water treatment	$ 50,000	$ 8,000	$ 3,000	Now	8,134	215,816	$ 463,416	0.7	7.1
		Boiler maintenance	$ -	$ -	$ 30,000	Now	40,670	1,079,079	$ 1,508,925	0.1	14.3
		Minimize deaerator vent losses	$ 150,000	$ 15,000	$ 2,000	Now	16,268	431,632	$ 1,388,749	1.0	8.6
		Condensate return	$ 350,000	$ 80,000	$ 10,000	Now	16,268	431,632	$ 1,055,640	2.6	3.0
		Steam trap survey and repair	$ 200,000	$ 30,000	$ -	Now	32,536	863,263	$ 626,482	0.6	3.7

End Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m^3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
Process Direct Heat	Small (2 MMBTU)	Exhaust gas heat recovery	$ 30,000	$ 5,000	$ 1,000	Now	1,421	37,699	$ 77,277	2.5	2.8
		High-efficiency burners and burner controls	$ 15,000	$ 2,000	$ -	Now	947	25,133	$ 74,461	1.6	5.4
		Insulation	$ 8,000	$ 500	$ 300	Now	474	12,566	$ 29,179	1.8	3.7
		High-efficiency ovens	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		High-efficiency dryers	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		Air curtains	$ 15,000	$ 2,000	$ 1,000	Now	1,421	37,699	$ 111,679	1.2	5.4
	Medium (20 MMBTU)	Exhaust gas heat recovery	$ 120,000	$ 35,000	$ 3,000	Now	15,985	424,112	$ 1,170,870	0.9	7.6
		High-efficiency burners and burner controls	$ 60,000	$ 4,000	$ -	Now	10,657	282,741	$ 964,941	0.6	16.1
		Insulation	$ 40,000	$ 3,000	$ 1,000	Now	5,328	141,371	$ 398,957	0.8	8.9
		Advanced heating and process controls	$ 100,000	$ 25,000	$ 3,000	Now	10,657	282,741	$ 751,307	1.1	6.1
		High-efficiency ovens	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High-efficiency dryers	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High-efficiency kilns	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		High-efficiency furnaces	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		Air curtains	$ 80,000	$ 18,000	$ 1,000	Now	15,985	424,112	$ 1,436,897	0.6	14.5
	Large (100 MMBTU)	Exhaust gas heat recovery	$ 900,000	$ 180,000	$ 10,000	Now	124,326	3,298,649	$ 9,333,733	0.8	9.1
		High-efficiency burners and burner controls	$ 500,000	$ 80,000	$ 5,000	Now	82,884	2,199,099	$ 7,380,303	0.7	12.9
		Insulation	$ 250,000	$ 30,000	$ 2,000	Now	41,442	1,099,550	$ 3,201,386	0.6	11.8
		Advanced heating and process controls	$ 500,000	$ 6,500	$ 8,000	Now	82,884	2,199,099	$ 6,425,848	0.6	12.3
		High-efficiency ovens	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High-efficiency dryers	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High-efficiency kilns	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
		High-efficiency furnaces	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
Other Process	Medium (20 MMTBU)	Pollution control measures	$ 80,000	$ 6,400	$ 20,000	Now	10,657	282,741	$ 772,269	1.1	4.0
		Hydrogen atmospheres for steel batch coil annealing	$ 250,000	$ 60,000	$ 3,000	Now	31,970	848,224	$ 2,364,557	0.9	8.1
		Process heat recovery	$ 300,000	$ 60,000	$ 10,000	Now	15,985	424,112	$ 912,627	2.3	3.1
	Large (100 MMBTU)	Pollution control measures	$ 1,000,000	$ 80,000	$ 125,000	Now	82,884	2,199,099	$ 5,858,675	1.5	3.7
		Hydrogen atmospheres for steel batch coil annealing	$ 2,000,000	$ 160,000	$ 10,000	Now	248,652	6,597,298	$ 18,743,528	0.8	9.4
		Process heat recovery	$ 1,000,000	$ 150,000	$ 25,000	Now	124,326	3,298,649	$ 9,149,642	0.9	7.8
HVAC	Small (0.8 MMBTU)	Radiant heaters	$ 30,000	$ 4,000	$ 1,000	Now	813	21,560	$ 35,946	4.5	1.8
		Automated temperature control	$ 12,000	$ 960	$ 500	Now	488	12,936	$ 29,859	2.8	2.7
		Solar walls	$ 100,000	$ 8,000	$ -	Now	488	12,936	-$ 60,924	20.3	0.4
		Ventilation & heat recovery optimization	$ 25,000	$ 1,600	$ 200	Now	553	14,661	$ 25,050	4.6	1.9
		Warehouse loading dock seals	$ 10,000	$ 5,000	$ 500	Now	163	4,312	-$ 7,286	12.2	0.6
		Air curtains	$ 13,000	$ 2,000	$ 500	Now	163	4,312	-$ 5,091	12.2	0.7
		Air compressor heat recovery	$ 18,000	$ 2,500	$ 500	Now	488	12,936	$ 22,319	4.4	1.9
		Destratification fans	$ 10,000	$ 800	$ -	Now	260	6,899	$ 14,307	3.8	2.3
	Medium (2 MMBTU)	Radiant heaters	$ 70,000	$ 10,000	$ 1,000	Now	2,031	53,899	$ 107,635	3.8	2.2
		Automated temperature control	$ 29,000	$ 2,320	$ 500	Now	1,219	32,340	$ 82,112	2.5	3.3
		Solar walls	$ 175,000	$ 14,000	$ -	Now	1,219	32,340	-$ 71,311	14.2	0.6
		Ventilation & heat recovery optimization	$ 70,000	$ 12,000	$ 1,000	Now	1,381	36,652	$ 42,868	5.9	1.5
		Warehouse loading dock seals	$ 20,000	$ 4,000	$ 500	Now	406	10,780	-$ 107	6.2	1.0
		Air curtains	$ 18,000	$ 1,440	$ 500	Now	406	10,780	$ 11,037	5.1	1.5
		Air compressor heat recovery	$ 45,000	$ 3,500	$ 1,000	Now	1,219	32,340	$ 60,676	4.0	2.1
		Destratification fans	$ 25,000	$ 2,000	$ 500	Now	650	17,248	$ 31,511	4.2	2.0
	Large (5 MMBTU)	Radiant heaters	$ 200,000	$ 20,000	$ 5,000	Now	5,079	134,749	$ 227,804	4.5	1.9
		Automated temperature control	$ 70,000	$ 5,600	$ 1,000	Now	3,047	80,849	$ 210,110	2.4	3.5
		Solar walls	$ 250,000	$ 20,000	$ -	Now	3,047	80,849	$ 24,223	8.1	1.1
		Ventilation & heat recovery optimization	$ 150,000	$ 15,000	$ 1,000	Now	3,454	91,629	$ 159,939	4.5	1.9
		Warehouse loading dock seals	$ 40,000	$ 8,000	$ 1,000	Now	1,016	26,950	$ 13,269	4.9	1.2
		Air curtains	$ 40,000	$ 7,000	$ 1,000	Now	1,016	26,950	$ 31,095	4.8	1.6
		Air compressor heat recovery	$ 100,000	$ 10,000	$ 2,000	Now	3,047	80,849	$ 167,196	3.6	2.3
		Destratification fans	$ 60,000	$ 4,800	$ 2,000	Now	1,625	43,120	$ 75,092	4.3	1.9

Appendix D-2

Industrial Sector TRC Calculation – Food & Beverage

End Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
System	Medium	Integrated control system	$ 165,000	$ 13,200	N/A	Now	64,000	1,698,063	$ 4,069,396	0.3	23.8
		Sub-metering	$ 330,000	$ 33,000	$ 3,300	Now	40,000	1,061,289	$ 2,986,829	0.8	8.7
Boiler	Small (200 BHP)	Economizer	$ 27,000	$ 3,000	$ 1,000	Now	1,239	32,886	$ 81,164.60	2.5	3.1
		Blowdown heat recovery	$ 23,000	$ 2,000	$ 1,000	Now	620	16,443	$ 26,326	4.5	1.8
		Boiler combustion air preheat	$ 50,000	$ 10,000	$ 2,000	Now	1,549	41,108	$ 55,512	4.2	1.7
		Process heat recovery to preheat makeup water	$ 70,000	$ 8,000	$ 1,500	Now	1,859	49,329	$ 88,747	4.2	2.0
		Condensing boiler	$ 120,000	$ 20,000	$ 1,000	EOL	3,099	82,216	$ 250,682	1.9	6.2
		Direct contact hot water heaters	$ 75,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 329,736	0.1	N/A
		Boiler right sizing and load management	$ 70,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 334,736	0.0	N/A
		High efficiency burners	$ 48,000	$ 6,000	$ -	Now	1,549	41,108	$ 95,598	3.2	2.8
		Insulation	$ 20,000	$ 1,500	$ 150	Now	1,549	41,108	$ 108,083	1.3	5.8
		Advanced boiler controls	$ 40,000	$ 1,200	$ 150	Now	930	24,665	$ 36,093	4.1	1.9
		Blowdown control	$ 35,000	$ 3,500	$ 600	Now	310	8,222	-$ 13,689	14.1	0.7
		Boiler water treatment	$ 10,000	$ 2,000	$ 500	Now	310	8,222	$ 5,493	4.3	1.4
		Boiler maintenance	$ -	$ -	$ 8,000	Now	1,549	41,108	$ 31,489	0.9	2.0
		Minimize deaerator vent losses	$ 35,000	$ 3,500	$ 600	Now	620	16,443	$ 16,231	6.4	1.4
		Condensate return	$ 40,000	$ 8,000	$ 700	Now	620	16,443	$ 5,880	8.0	1.1
		Steam trap survey and repair	$ 20,000	$ 1,000	$ -	Now	1,239	32,886	$ 11,628	1.6	1.6
		Instantaneous Steam Generation	$ 120,000	$ 20,000	$ 1,000	EOL	4,648	123,323	$ 344,565	1.2	8.2
	Medium (450 BHP)	Economizer	$ 55,000	$ 4,400	$ 1,000	Now	3,137	83,243	$ 235,022	1.8	4.5
		Blowdown heat recovery	$ 50,000	$ 4,000	$ 1,000	Now	1,569	41,622	$ 88,954	3.4	2.4
		Boiler combustion air preheat	$ 140,000	$ 21,000	$ 5,000	Now	3,922	104,054	$ 131,864	4.4	1.7
		Process heat recovery to preheat makeup water	$ 130,000	$ 15,000	$ 1,800	Now	4,706	124,865	$ 294,079	3.0	2.8
		Condensing boiler	$ 180,000	$ 15,000	$ 2,800	EOL	7,844	208,108	$ 688,500	0.8	11.0
		Direct contact hot water heaters	$ 130,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 804,906	0.1	N/A
		Boiler right sizing and load management	$ 125,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 809,906	0.1	N/A
		High efficiency burners	$ 90,000	$ 10,000	$ -	Now	3,922	104,054	$ 278,669	2.3	3.8
		Insulation	$ 35,000	$ 2,800	$ 1,000	Now	3,922	104,054	$ 285,489	0.9	7.3
		Advanced boiler controls	$ 75,000	$ 6,500	$ 800	Now	2,353	62,432	$ 110,952	3.3	2.3
		Blowdown control	$ 60,000	$ 6,000	$ 1,000	Now	784	20,811	$ 1,220	8.9	1.0
		Boiler water treatment	$ 20,000	$ 3,500	$ 1,000	Now	784	20,811	$ 22,412	3.2	1.8
		Boiler maintenance	$ -	$ -	$ 13,000	Now	3,922	104,054	$ 107,189	0.4	3.2
		Minimize deaerator vent losses	$ 60,000	$ 6,000	$ 1,000	Now	1,569	41,622	$ 76,954	4.2	2.0
		Condensate return	$ 80,000	$ 15,000	$ 1,200	Now	1,569	41,622	$ 46,251	6.1	1.4
		Steam trap survey and repair	$ 35,000	$ 1,500	$ -	Now	3,137	83,243	$ 46,089	1.1	2.3
		Instantaneous Steam Generation	$ 180,000	$ 28,000	$ 1,500	EOL	11,765	312,162	$ 936,275	0.6	17.6
	Large (3,000 BHP)	Economizer	$ 350,000	$ 40,000	$ 2,000	Now	32,536	863,263	$ 2,734,525	1.1	7.7
		Blowdown heat recovery	$ 200,000	$ 25,000	$ 5,000	Now	16,268	431,632	$ 1,303,208	1.3	5.9
		Boiler combustion air preheat	$ 500,000	$ 60,000	$ 7,000	Now	40,670	1,079,079	$ 2,818,259	1.3	5.6
		Process heat recovery to preheat makeup water	$ 400,000	$ 50,000	$ 5,000	Now	48,805	1,294,895	$ 4,219,760	0.9	9.6
		Boiler right sizing and load management	$ 2,700,000	$ 150,000	-$ 10,000	EOL	81,341	2,158,158	$ 8,039,015	0.0	N/A
		High efficiency burners	$ 400,000	$ 60,000	$ -	Now	40,670	1,079,079	$ 3,466,940	1.0	8.5
		Insulation	$ 150,000	$ 30,000	$ 1,500	Now	40,670	1,079,079	$ 3,240,092	0.4	17.9
		Advanced boiler controls	$ 200,000	$ 40,000	$ 3,000	Now	24,402	647,448	$ 1,796,082	0.9	7.8
		Blowdown control	$ 120,000	$ 12,000	$ 2,000	Now	8,134	215,816	$ 636,361	1.5	5.3
		Boiler water treatment	$ 50,000	$ 8,000	$ 3,000	Now	8,134	215,816	$ 463,416	0.7	7.1
		Boiler maintenance	$ -	$ -	$ 30,000	Now	40,670	1,079,079	$ 1,508,925	0.1	14.3
		Minimize deaerator vent losses	$ 150,000	$ 15,000	$ 2,000	Now	16,268	431,632	$ 1,388,749	1.0	8.6
		Condensate return	$ 350,000	$ 80,000	$ 10,000	Now	16,268	431,632	$ 1,055,640	2.6	3.0
		Steam trap survey and repair	$ 200,000	$ 30,000	$ -	Now	32,536	863,263	$ 626,482	0.6	3.7

End-Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m^3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
Process Direct Heat	Small (2 MMBTU)	Exhaust gas heat recovery	$ 30,000	$ 5,000	$ 1,000	Now	1,421	37,699	$ 77,277	2.5	2.8
		High-efficiency burners and burner controls	$ 15,000	$ 2,000	$ -	Now	947	25,133	$ 74,461	1.6	5.4
		Insulation	$ 8,000	$ 500	$ 300	Now	474	12,566	$ 29,179	1.8	3.7
		High-efficiency ovens	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		High-efficiency dryers	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		Air curtains	$ 15,000	$ 2,000	$ 1,000	Now	1,421	37,699	$ 111,679	1.2	5.4
	Medium (20 MMBTU)	Exhaust gas heat recovery	$ 120,000	$ 35,000	$ 3,000	Now	15,985	424,112	$ 1,170,870	0.9	7.6
		High-efficiency burners and burner controls	$ 60,000	$ 4,000	$ -	Now	10,657	282,741	$ 964,941	0.6	16.1
		Insulation	$ 40,000	$ 3,000	$ 1,000	Now	5,328	141,371	$ 398,957	0.8	8.9
		Advanced heating and process controls	$ 100,000	$ 25,000	$ 3,000	Now	10,657	282,741	$ 751,307	1.1	6.1
		High-efficiency ovens	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High-efficiency dryers	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High-efficiency kilns	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		High-efficiency furnaces	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		Air curtains	$ 80,000	$ 18,000	$ 1,000	Now	15,985	424,112	$ 1,436,897	0.6	14.5
	Large (100 MMBTU)	Exhaust gas heat recovery	$ 900,000	$ 180,000	$ 10,000	Now	124,326	3,298,649	$ 9,333,733	0.8	9.1
		High-efficiency burners and burner controls	$ 500,000	$ 80,000	$ 5,000	Now	82,884	2,199,099	$ 7,380,303	0.7	12.9
		Insulation	$ 250,000	$ 30,000	$ 2,000	Now	41,442	1,099,550	$ 3,201,386	0.6	11.8
		Advanced heating and process controls	$ 500,000	$ 6,500	$ 8,000	Now	82,884	2,199,099	$ 6,425,848	0.6	12.3
		High-efficiency ovens	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High-efficiency dryers	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High-efficiency kilns	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
		High-efficiency furnaces	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
Other Process	Medium (20 MMTBU)	Pollution control measures	$ 80,000	$ 6,400	$ 20,000	Now	10,657	282,741	$ 772,269	1.1	4.0
		Hydrogen atmospheres for steel batch coil annealing	$ 250,000	$ 60,000	$ 3,000	Now	31,970	848,224	$ 2,364,557	0.9	8.1
		Process heat recovery	$ 300,000	$ 60,000	$ 10,000	Now	15,985	424,112	$ 912,627	2.3	3.1
	Large (100 MMBTU)	Pollution control measures	$ 1,000,000	$ 80,000	$ 125,000	Now	82,884	2,199,099	$ 5,858,675	1.5	3.7
		Hydrogen atmospheres for steel batch coil annealing	$ 2,000,000	$ 160,000	$ 10,000	Now	248,652	6,597,298	$ 18,743,528	0.8	9.4
		Process heat recovery	$ 1,000,000	$ 150,000	$ 25,000	Now	124,326	3,298,649	$ 9,149,642	0.9	7.8
HVAC	Small (0.8 MMBTU)	Radiant heaters	$ 30,000	$ 4,000	$ 1,000	Now	813	21,560	$ 35,946	4.5	1.8
		Automated temperature control	$ 12,000	$ 960	$ 500	Now	488	12,936	$ 29,859	2.8	2.7
		Solar walls	$ 100,000	$ 8,000	$ -	Now	488	12,936	-$ 60,924	20.3	0.4
		Ventilation & heat recovery optimization	$ 25,000	$ 1,600	$ 200	Now	553	14,661	$ 25,050	4.6	1.9
		Warehouse loading dock seals	$ 10,000	$ 5,000	$ 500	Now	163	4,312	-$ 7,286	12.2	0.6
		Air curtains	$ 13,000	$ 2,000	$ 500	Now	163	4,312	-$ 5,091	12.2	0.7
		Air compressor heat recovery	$ 18,000	$ 2,500	$ 500	Now	488	12,936	$ 22,319	4.4	1.9
		Destratification fans	$ 10,000	$ 800	$ -	Now	260	6,899	$ 14,307	3.8	2.3
	Medium (2 MMBTU)	Radiant heaters	$ 70,000	$ 10,000	$ 1,000	Now	2,031	53,899	$ 107,635	3.8	2.2
		Automated temperature control	$ 29,000	$ 2,320	$ 500	Now	1,219	32,340	$ 82,112	2.5	3.3
		Solar walls	$ 175,000	$ 14,000	$ -	Now	1,219	32,340	-$ 71,311	14.2	0.6
		Ventilation & heat recovery optimization	$ 70,000	$ 12,000	$ 1,000	Now	1,381	36,652	$ 42,868	5.9	1.5
		Warehouse loading dock seals	$ 20,000	$ 4,000	$ 500	Now	406	10,780	-$ 107	6.2	1.0
		Air curtains	$ 18,000	$ 1,440	$ 500	Now	406	10,780	$ 11,037	5.1	1.5
		Air compressor heat recovery	$ 45,000	$ 3,500	$ 1,000	Now	1,219	32,340	$ 60,676	4.0	2.1
		Destratification fans	$ 25,000	$ 2,000	$ 500	Now	650	17,248	$ 31,511	4.2	2.0
	Large (5 MMBTU)	Radiant heaters	$ 200,000	$ 20,000	$ 5,000	Now	5,079	134,749	$ 227,804	4.5	1.9
		Automated temperature control	$ 70,000	$ 5,600	$ 1,000	Now	3,047	80,849	$ 210,110	2.4	3.5
		Solar walls	$ 250,000	$ 20,000	$ -	Now	3,047	80,849	$ 24,223	8.1	1.1
		Ventilation & heat recovery optimization	$ 150,000	$ 15,000	$ 1,000	Now	3,454	91,629	$ 159,939	4.5	1.9
		Warehouse loading dock seals	$ 40,000	$ 8,000	$ 1,000	Now	1,016	26,950	$ 13,269	4.9	1.2
		Air curtains	$ 40,000	$ 7,000	$ 1,000	Now	1,016	26,950	$ 31,095	4.8	1.6
		Air compressor heat recovery	$ 100,000	$ 10,000	$ 2,000	Now	3,047	80,849	$ 167,196	3.6	2.3
		Destratification fans	$ 60,000	$ 4,800	$ 2,000	Now	1,625	43,120	$ 75,092	4.3	1.9

Appendix D-3

Industrial Sector TRC Calculation – Mineral Processing

End Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
System	Medium	Integrated control system	$ 165,000	$ 13,200	N/A	Now	64,000	1,698,063	$ 4,069,396	0.3	23.8
		Sub-metering	$ 330,000	$ 33,000	$ 3,300	Now	40,000	1,061,289	$ 2,986,829	0.8	8.7
Boiler	Small (200 BHP)	Economizer	$ 27,000	$ 3,000	$ 1,000	Now	1,239	32,886	$ 81,164.60	2.5	3.1
		Blowdown heat recovery	$ 23,000	$ 2,000	$ 1,000	Now	620	16,443	$ 26,326	4.5	1.8
		Boiler combustion air preheat	$ 50,000	$ 10,000	$ 2,000	Now	1,549	41,108	$ 55,512	4.2	1.7
		Process heat recovery to preheat makeup water	$ 70,000	$ 8,000	$ 1,500	Now	1,859	49,329	$ 88,747	4.2	2.0
		Condensing boiler	$ 120,000	$ 20,000	$ 1,000	EOL	3,099	82,216	$ 250,682	1.9	6.2
		Direct contact hot water heaters	$ 75,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 329,736	0.1	N/A
		Boiler right sizing and load management	$ 70,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 334,736	0.0	N/A
		High efficiency burners	$ 48,000	$ 6,000	$ -	Now	1,549	41,108	$ 95,598	3.2	2.8
		Insulation	$ 20,000	$ 1,500	$ 150	Now	1,549	41,108	$ 108,083	1.3	5.8
		Advanced boiler controls	$ 40,000	$ 1,200	$ 150	Now	930	24,665	$ 36,093	4.1	1.9
		Blowdown control	$ 35,000	$ 3,500	$ 600	Now	310	8,222	-$ 13,689	14.1	0.7
		Boiler water treatment	$ 10,000	$ 2,000	$ 500	Now	310	8,222	$ 5,493	4.3	1.4
		Boiler maintenance	$ -	$ -	$ 8,000	Now	1,549	41,108	$ 31,489	0.9	2.0
		Minimize deaerator vent losses	$ 35,000	$ 3,500	$ 600	Now	620	16,443	$ 16,231	6.4	1.4
		Condensate return	$ 40,000	$ 8,000	$ 700	Now	620	16,443	$ 5,880	8.0	1.1
		Steam trap survey and repair	$ 20,000	$ 1,000	$ -	Now	1,239	32,886	$ 11,628	1.6	1.6
		Instantaneous Steam Generation	$ 120,000	$ 20,000	$ 1,000	EOL	4,648	123,323	$ 344,565	1.2	8.2
	Medium (450 BHP)	Economizer	$ 55,000	$ 4,400	$ 1,000	Now	3,137	83,243	$ 235,022	1.8	4.5
		Blowdown heat recovery	$ 50,000	$ 4,000	$ 1,000	Now	1,569	41,622	$ 88,954	3.4	2.4
		Boiler combustion air preheat	$ 140,000	$ 21,000	$ 5,000	Now	3,922	104,054	$ 131,864	4.4	1.7
		Process heat recovery to preheat makeup water	$ 130,000	$ 15,000	$ 1,800	Now	4,706	124,865	$ 294,079	3.0	2.8
		Condensing boiler	$ 180,000	$ 15,000	$ 2,800	EOL	7,844	208,108	$ 688,500	0.8	11.0
		Direct contact hot water heaters	$ 130,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 804,906	0.1	N/A
		Boiler right sizing and load management	$ 125,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 809,906	0.1	N/A
		High efficiency burners	$ 90,000	$ 10,000	$ -	Now	3,922	104,054	$ 278,669	2.3	3.8
		Insulation	$ 35,000	$ 2,800	$ 1,000	Now	3,922	104,054	$ 285,489	0.9	7.3
		Advanced boiler controls	$ 75,000	$ 6,500	$ 800	Now	2,353	62,432	$ 110,952	3.3	2.3
		Blowdown control	$ 60,000	$ 6,000	$ 1,000	Now	784	20,811	$ 1,220	8.9	1.0
		Boiler water treatment	$ 20,000	$ 3,500	$ 1,000	Now	784	20,811	$ 22,412	3.2	1.8
		Boiler maintenance	$ -	$ -	$ 13,000	Now	3,922	104,054	$ 107,189	0.4	3.2
		Minimize deaerator vent losses	$ 60,000	$ 6,000	$ 1,000	Now	1,569	41,622	$ 76,954	4.2	2.0
		Condensate return	$ 80,000	$ 15,000	$ 1,200	Now	1,569	41,622	$ 46,251	6.1	1.4
		Steam trap survey and repair	$ 35,000	$ 1,500	$ -	Now	3,137	83,243	$ 46,089	1.1	2.3
		Instantaneous Steam Generation	$ 180,000	$ 28,000	$ 1,500	EOL	11,765	312,162	$ 936,275	0.6	17.6
	Large (3,000 BHP)	Economizer	$ 350,000	$ 40,000	$ 2,000	Now	32,536	863,263	$ 2,734,525	1.1	7.7
		Blowdown heat recovery	$ 200,000	$ 25,000	$ 5,000	Now	16,268	431,632	$ 1,303,208	1.3	5.9
		Boiler combustion air preheat	$ 500,000	$ 60,000	$ 7,000	Now	40,670	1,079,079	$ 2,818,259	1.3	5.6
		Process heat recovery to preheat makeup water	$ 400,000	$ 50,000	$ 5,000	Now	48,805	1,294,895	$ 4,219,760	0.9	9.6
		Boiler right sizing and load management	$ 2,700,000	$ 150,000	-$ 10,000	EOL	81,341	2,158,158	$ 8,039,015	0.0	N/A
		High efficiency burners	$ 400,000	$ 60,000	$ -	Now	40,670	1,079,079	$ 3,466,940	1.0	8.5
		Insulation	$ 150,000	$ 30,000	$ 1,500	Now	40,670	1,079,079	$ 3,240,092	0.4	17.9
		Advanced boiler controls	$ 200,000	$ 40,000	$ 3,000	Now	24,402	647,448	$ 1,796,082	0.9	7.8
		Blowdown control	$ 120,000	$ 12,000	$ 2,000	Now	8,134	215,816	$ 636,361	1.5	5.3
		Boiler water treatment	$ 50,000	$ 8,000	$ 3,000	Now	8,134	215,816	$ 463,416	0.7	7.1
		Boiler maintenance	$ -	$ -	$ 30,000	Now	40,670	1,079,079	$ 1,508,925	0.1	14.3
		Minimize deaerator vent losses	$ 150,000	$ 15,000	$ 2,000	Now	16,268	431,632	$ 1,388,749	1.0	8.6
		Condensate return	$ 350,000	$ 80,000	$ 10,000	Now	16,268	431,632	$ 1,055,640	2.6	3.0
		Steam trap survey and repair	$ 200,000	$ 30,000	$ -	Now	32,536	863,263	$ 626,482	0.6	3.7

End Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m^3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
Process Direct Heat	Small (2 MMBTU)	Exhaust gas heat recovery	$ 30,000	$ 5,000	$ 1,000	Now	1,421	37,699	$ 77,277	2.5	2.8
		High-efficiency burners and burner controls	$ 15,000	$ 2,000	$ -	Now	947	25,133	$ 74,461	1.6	5.4
		Insulation	$ 8,000	$ 500	$ 300	Now	474	12,566	$ 29,179	1.8	3.7
		High-efficiency ovens	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		High-efficiency dryers	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		Air curtains	$ 15,000	$ 2,000	$ 1,000	Now	1,421	37,699	$ 111,679	1.2	5.4
	Medium (20 MMBTU)	Exhaust gas heat recovery	$ 120,000	$ 35,000	$ 3,000	Now	15,985	424,112	$ 1,170,870	0.9	7.6
		High-efficiency burners and burner controls	$ 60,000	$ 4,000	$ -	Now	10,657	282,741	$ 964,941	0.6	16.1
		Insulation	$ 40,000	$ 3,000	$ 1,000	Now	5,328	141,371	$ 398,957	0.8	8.9
		Advanced heating and process controls	$ 100,000	$ 25,000	$ 3,000	Now	10,657	282,741	$ 751,307	1.1	6.1
		High-efficiency ovens	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High-efficiency dryers	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High-efficiency kilns	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		High-efficiency furnaces	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		Air curtains	$ 80,000	$ 18,000	$ 1,000	Now	15,985	424,112	$ 1,436,897	0.6	14.5
	Large (100 MMBTU)	Exhaust gas heat recovery	$ 900,000	$ 180,000	$ 10,000	Now	124,326	3,298,649	$ 9,333,733	0.8	9.1
		High-efficiency burners and burner controls	$ 500,000	$ 80,000	$ 5,000	Now	82,884	2,199,099	$ 7,380,303	0.7	12.9
		Insulation	$ 250,000	$ 30,000	$ 2,000	Now	41,442	1,099,550	$ 3,201,386	0.6	11.8
		Advanced heating and process controls	$ 500,000	$ 6,500	$ 8,000	Now	82,884	2,199,099	$ 6,425,848	0.6	12.3
		High-efficiency ovens	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High-efficiency dryers	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High-efficiency kilns	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
		High-efficiency furnaces	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
Other Process	Medium (20 MMTBU)	Pollution control measures	$ 80,000	$ 6,400	$ 20,000	Now	10,657	282,741	$ 772,269	1.1	4.0
		Hydrogen atmospheres for steel batch coil annealing	$ 250,000	$ 60,000	$ 3,000	Now	31,970	848,224	$ 2,364,557	0.9	8.1
		Process heat recovery	$ 300,000	$ 60,000	$ 10,000	Now	15,985	424,112	$ 912,627	2.3	3.1
	Large (100 MMBTU)	Pollution control measures	$ 1,000,000	$ 80,000	$ 125,000	Now	82,884	2,199,099	$ 5,858,675	1.5	3.7
		Hydrogen atmospheres for steel batch coil annealing	$ 2,000,000	$ 160,000	$ 10,000	Now	248,652	6,597,298	$ 18,743,528	0.8	9.4
		Process heat recovery	$ 1,000,000	$ 150,000	$ 25,000	Now	124,326	3,298,649	$ 9,149,642	0.9	7.8
HVAC	Small (0.8 MMBTU)	Radiant heaters	$ 30,000	$ 4,000	$ 1,000	Now	813	21,560	$ 35,946	4.5	1.8
		Automated temperature control	$ 12,000	$ 960	$ 500	Now	488	12,936	$ 29,859	2.8	2.7
		Solar walls	$ 100,000	$ 8,000	$ -	Now	488	12,936	-$ 60,924	20.3	0.4
		Ventilation & heat recovery optimization	$ 25,000	$ 1,600	$ 200	Now	553	14,661	$ 25,050	4.6	1.9
		Warehouse loading dock seals	$ 10,000	$ 5,000	$ 500	Now	163	4,312	-$ 7,286	12.2	0.6
		Air curtains	$ 13,000	$ 2,000	$ 500	Now	163	4,312	-$ 5,091	12.2	0.7
		Air compressor heat recovery	$ 18,000	$ 2,500	$ 500	Now	488	12,936	$ 22,319	4.4	1.9
		Destratification fans	$ 10,000	$ 800	$ -	Now	260	6,899	$ 14,307	3.8	2.3
	Medium (2 MMBTU)	Radiant heaters	$ 70,000	$ 10,000	$ 1,000	Now	2,031	53,899	$ 107,635	3.8	2.2
		Automated temperature control	$ 29,000	$ 2,320	$ 500	Now	1,219	32,340	$ 82,112	2.5	3.3
		Solar walls	$ 175,000	$ 14,000	$ -	Now	1,219	32,340	-$ 71,311	14.2	0.6
		Ventilation & heat recovery optimization	$ 70,000	$ 12,000	$ 1,000	Now	1,381	36,652	$ 42,868	5.9	1.5
		Warehouse loading dock seals	$ 20,000	$ 4,000	$ 500	Now	406	10,780	-$ 107	6.2	1.0
		Air curtains	$ 18,000	$ 1,440	$ 500	Now	406	10,780	$ 11,037	5.1	1.5
		Air compressor heat recovery	$ 45,000	$ 3,500	$ 1,000	Now	1,219	32,340	$ 60,676	4.0	2.1
		Destratification fans	$ 25,000	$ 2,000	$ 500	Now	650	17,248	$ 31,511	4.2	2.0
	Large (5 MMBTU)	Radiant heaters	$ 200,000	$ 20,000	$ 5,000	Now	5,079	134,749	$ 227,804	4.5	1.9
		Automated temperature control	$ 70,000	$ 5,600	$ 1,000	Now	3,047	80,849	$ 210,110	2.4	3.5
		Solar walls	$ 250,000	$ 20,000	$ -	Now	3,047	80,849	$ 24,223	8.1	1.1
		Ventilation & heat recovery optimization	$ 150,000	$ 15,000	$ 1,000	Now	3,454	91,629	$ 159,939	4.5	1.9
		Warehouse loading dock seals	$ 40,000	$ 8,000	$ 1,000	Now	1,016	26,950	$ 13,269	4.9	1.2
		Air curtains	$ 40,000	$ 7,000	$ 1,000	Now	1,016	26,950	$ 31,095	4.8	1.6
		Air compressor heat recovery	$ 100,000	$ 10,000	$ 2,000	Now	3,047	80,849	$ 167,196	3.6	2.3
		Destratification fans	$ 60,000	$ 4,800	$ 2,000	Now	1,625	43,120	$ 75,092	4.3	1.9

Appendix D-4

Industrial Sector TRC Calculation – Mining

End Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
System	Medium	Integrated control system	$ 165,000	$ 13,200	N/A	Now	70,641	1,874,258	$ 4,510,137	0.2	26.3
		Sub-metering	$ 330,000	$ 33,000	$ 3,300	Now	44,150	1,171,411	$ 3,337,020	0.8	9.6
Boiler	Small (200 BHP)	Economizer	$ 27,000	$ 3,000	$ 1,000	Now	1,239	32,886	$ 81,164.60	2.5	3.1
		Blowdown heat recovery	$ 23,000	$ 2,000	$ 1,000	Now	620	16,443	$ 26,326	4.5	1.8
		Boiler combustion air preheat	$ 50,000	$ 10,000	$ 2,000	Now	1,549	41,108	$ 55,512	4.2	1.7
		Process heat recovery to preheat makeup water	$ 70,000	$ 8,000	$ 1,500	Now	1,859	49,329	$ 88,747	4.2	2.0
		Condensing boiler	$ 120,000	$ 20,000	$ 1,000	EOL	3,099	82,216	$ 250,682	1.9	6.2
		Direct contact hot water heaters	$ 75,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 329,736	0.1	N/A
		Boiler right sizing and load management	$ 70,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 334,736	0.0	N/A
		High efficiency burners	$ 48,000	$ 6,000	$ -	Now	1,549	41,108	$ 95,598	3.2	2.8
		Insulation	$ 20,000	$ 1,500	$ 150	Now	1,549	41,108	$ 108,083	1.3	5.8
		Advanced boiler controls	$ 40,000	$ 1,200	$ 150	Now	930	24,665	$ 36,093	4.1	1.9
		Blowdown control	$ 35,000	$ 3,500	$ 600	Now	310	8,222	-$ 13,689	14.1	0.7
		Boiler water treatment	$ 10,000	$ 2,000	$ 500	Now	310	8,222	$ 5,493	4.3	1.4
		Boiler maintenance	$ -	$ -	$ 8,000	Now	1,549	41,108	$ 31,489	0.9	2.0
		Minimize deaerator vent losses	$ 35,000	$ 3,500	$ 600	Now	620	16,443	$ 16,231	6.4	1.4
		Condensate return	$ 40,000	$ 8,000	$ 700	Now	620	16,443	$ 5,880	8.0	1.1
		Steam trap survey and repair	$ 20,000	$ 1,000	$ -	Now	1,239	32,886	$ 11,628	1.6	1.6
		Instantaneous Steam Generation	$ 120,000	$ 20,000	$ 1,000	EOL	4,648	123,323	$ 344,565	1.2	8.2
	Medium (450 BHP)	Economizer	$ 55,000	$ 4,400	$ 1,000	Now	3,137	83,243	$ 235,022	1.8	4.5
		Blowdown heat recovery	$ 50,000	$ 4,000	$ 1,000	Now	1,569	41,622	$ 88,954	3.4	2.4
		Boiler combustion air preheat	$ 140,000	$ 21,000	$ 5,000	Now	3,922	104,054	$ 131,864	4.4	1.7
		Process heat recovery to preheat makeup water	$ 130,000	$ 15,000	$ 1,800	Now	4,706	124,865	$ 294,079	3.0	2.8
		Condensing boiler	$ 180,000	$ 15,000	$ 2,800	EOL	7,844	208,108	$ 688,500	0.8	11.0
		Direct contact hot water heaters	$ 130,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 804,906	0.1	N/A
		Boiler right sizing and load management	$ 125,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 809,906	0.1	N/A
		High efficiency burners	$ 90,000	$ 10,000	$ -	Now	3,922	104,054	$ 278,669	2.3	3.8
		Insulation	$ 35,000	$ 2,800	$ 1,000	Now	3,922	104,054	$ 285,489	0.9	7.3
		Advanced boiler controls	$ 75,000	$ 6,500	$ 800	Now	2,353	62,432	$ 110,952	3.3	2.3
		Blowdown control	$ 60,000	$ 6,000	$ 1,000	Now	784	20,811	$ 1,220	8.9	1.0
		Boiler water treatment	$ 20,000	$ 3,500	$ 1,000	Now	784	20,811	$ 22,412	3.2	1.8
		Boiler maintenance	$ -	$ -	$ 13,000	Now	3,922	104,054	$ 107,189	0.4	3.2
		Minimize deaerator vent losses	$ 60,000	$ 6,000	$ 1,000	Now	1,569	41,622	$ 76,954	4.2	2.0
		Condensate return	$ 80,000	$ 15,000	$ 1,200	Now	1,569	41,622	$ 46,251	6.1	1.4
		Steam trap survey and repair	$ 35,000	$ 1,500	$ -	Now	3,137	83,243	$ 46,089	1.1	2.3
		Instantaneous Steam Generation	$ 180,000	$ 28,000	$ 1,500	EOL	11,765	312,162	$ 936,275	0.6	17.6
	Large (3,000 BHP)	Economizer	$ 350,000	$ 40,000	$ 2,000	Now	32,536	863,263	$ 2,734,525	1.1	7.7
		Blowdown heat recovery	$ 200,000	$ 25,000	$ 5,000	Now	16,268	431,632	$ 1,303,208	1.3	5.9
		Boiler combustion air preheat	$ 500,000	$ 60,000	$ 7,000	Now	40,670	1,079,079	$ 2,818,259	1.3	5.6
		Process heat recovery to preheat makeup water	$ 400,000	$ 50,000	$ 5,000	Now	48,805	1,294,895	$ 4,219,760	0.9	9.6
		Boiler right sizing and load management	$ 2,700,000	$ 150,000	-$ 10,000	EOL	81,341	2,158,158	$ 8,039,015	0.0	N/A
		High efficiency burners	$ 400,000	$ 60,000	$ -	Now	40,670	1,079,079	$ 3,466,940	1.0	8.5
		Insulation	$ 150,000	$ 30,000	$ 1,500	Now	40,670	1,079,079	$ 3,240,092	0.4	17.9
		Advanced boiler controls	$ 200,000	$ 40,000	$ 3,000	Now	24,402	647,448	$ 1,796,082	0.9	7.8
		Blowdown control	$ 120,000	$ 12,000	$ 2,000	Now	8,134	215,816	$ 636,361	1.5	5.3
		Boiler water treatment	$ 50,000	$ 8,000	$ 3,000	Now	8,134	215,816	$ 463,416	0.7	7.1
		Boiler maintenance	$ -	$ -	$ 30,000	Now	40,670	1,079,079	$ 1,508,925	0.1	14.3
		Minimize deaerator vent losses	$ 150,000	$ 15,000	$ 2,000	Now	16,268	431,632	$ 1,388,749	1.0	8.6
		Condensate return	$ 350,000	$ 80,000	$ 10,000	Now	16,268	431,632	$ 1,055,640	2.6	3.0
		Steam trap survey and repair	$ 200,000	$ 30,000	$ -	Now	32,536	863,263	$ 626,482	0.6	3.7

End Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m^3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
Process Direct Heat	Small (2 MMBTU)	Exhaust gas heat recovery	$ 30,000	$ 5,000	$ 1,000	Now	1,421	37,699	$ 77,277	2.5	2.8
		High-efficiency burners and burner controls	$ 15,000	$ 2,000	$ -	Now	947	25,133	$ 74,461	1.6	5.4
		Insulation	$ 8,000	$ 500	$ 300	Now	474	12,566	$ 29,179	1.8	3.7
		High-efficiency ovens	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		High-efficiency dryers	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		Air curtains	$ 15,000	$ 2,000	$ 1,000	Now	1,421	37,699	$ 111,679	1.2	5.4
	Medium (20 MMBTU)	Exhaust gas heat recovery	$ 120,000	$ 35,000	$ 3,000	Now	15,985	424,112	$ 1,170,870	0.9	7.6
		High-efficiency burners and burner controls	$ 60,000	$ 4,000	$ -	Now	10,657	282,741	$ 964,941	0.6	16.1
		Insulation	$ 40,000	$ 3,000	$ 1,000	Now	5,328	141,371	$ 398,957	0.8	8.9
		Advanced heating and process controls	$ 100,000	$ 25,000	$ 3,000	Now	10,657	282,741	$ 751,307	1.1	6.1
		High-efficiency ovens	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High-efficiency dryers	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High-efficiency kilns	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		High-efficiency furnaces	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		Air curtains	$ 80,000	$ 18,000	$ 1,000	Now	15,985	424,112	$ 1,436,897	0.6	14.5
	Large (100 MMBTU)	Exhaust gas heat recovery	$ 900,000	$ 180,000	$ 10,000	Now	124,326	3,298,649	$ 9,333,733	0.8	9.1
		High-efficiency burners and burner controls	$ 500,000	$ 80,000	$ 5,000	Now	82,884	2,199,099	$ 7,380,303	0.7	12.9
		Insulation	$ 250,000	$ 30,000	$ 2,000	Now	41,442	1,099,550	$ 3,201,386	0.6	11.8
		Advanced heating and process controls	$ 500,000	$ 6,500	$ 8,000	Now	82,884	2,199,099	$ 6,425,848	0.6	12.3
		High-efficiency ovens	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High-efficiency dryers	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High-efficiency kilns	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
		High-efficiency furnaces	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
Other Process	Medium (20 MMTBU)	Pollution control measures	$ 80,000	$ 6,400	$ 20,000	Now	10,657	282,741	$ 772,269	1.1	4.0
		Hydrogen atmospheres for steel batch coil annealing	$ 250,000	$ 60,000	$ 3,000	Now	31,970	848,224	$ 2,364,557	0.9	8.1
		Process heat recovery	$ 300,000	$ 60,000	$ 10,000	Now	15,985	424,112	$ 912,627	2.3	3.1
	Large (100 MMBTU)	Pollution control measures	$ 1,000,000	$ 80,000	$ 125,000	Now	82,884	2,199,099	$ 5,858,675	1.5	3.7
		Hydrogen atmospheres for steel batch coil annealing	$ 2,000,000	$ 160,000	$ 10,000	Now	248,652	6,597,298	$ 18,743,528	0.8	9.4
		Process heat recovery	$ 1,000,000	$ 150,000	$ 25,000	Now	124,326	3,298,649	$ 9,149,642	0.9	7.8
HVAC	Small (0.8 MMBTU)	Radiant heaters	$ 30,000	$ 4,000	$ 1,000	Now	813	21,560	$ 35,946	4.5	1.8
		Automated temperature control	$ 12,000	$ 960	$ 500	Now	488	12,936	$ 29,859	2.8	2.7
		Solar walls	$ 100,000	$ 8,000	$ -	Now	488	12,936	-$ 60,924	20.3	0.4
		Ventilation & heat recovery optimization	$ 25,000	$ 1,600	$ 200	Now	553	14,661	$ 25,050	4.6	1.9
		Warehouse loading dock seals	$ 10,000	$ 5,000	$ 500	Now	163	4,312	-$ 7,286	12.2	0.6
		Air curtains	$ 13,000	$ 2,000	$ 500	Now	163	4,312	-$ 5,091	12.2	0.7
		Air compressor heat recovery	$ 18,000	$ 2,500	$ 500	Now	488	12,936	$ 22,319	4.4	1.9
		Destratification fans	$ 10,000	$ 800	$ -	Now	260	6,899	$ 14,307	3.8	2.3
	Medium (2 MMBTU)	Radiant heaters	$ 70,000	$ 10,000	$ 1,000	Now	2,031	53,899	$ 107,635	3.8	2.2
		Automated temperature control	$ 29,000	$ 2,320	$ 500	Now	1,219	32,340	$ 82,112	2.5	3.3
		Solar walls	$ 175,000	$ 14,000	$ -	Now	1,219	32,340	-$ 71,311	14.2	0.6
		Ventilation & heat recovery optimization	$ 70,000	$ 12,000	$ 1,000	Now	1,381	36,652	$ 42,868	5.9	1.5
		Warehouse loading dock seals	$ 20,000	$ 4,000	$ 500	Now	406	10,780	-$ 107	6.2	1.0
		Air curtains	$ 18,000	$ 1,440	$ 500	Now	406	10,780	$ 11,037	5.1	1.5
		Air compressor heat recovery	$ 45,000	$ 3,500	$ 1,000	Now	1,219	32,340	$ 60,676	4.0	2.1
		Destratification fans	$ 25,000	$ 2,000	$ 500	Now	650	17,248	$ 31,511	4.2	2.0
	Large (5 MMBTU)	Radiant heaters	$ 200,000	$ 20,000	$ 5,000	Now	5,079	134,749	$ 227,804	4.5	1.9
		Automated temperature control	$ 70,000	$ 5,600	$ 1,000	Now	3,047	80,849	$ 210,110	2.4	3.5
		Solar walls	$ 250,000	$ 20,000	$ -	Now	3,047	80,849	$ 24,223	8.1	1.1
		Ventilation & heat recovery optimization	$ 150,000	$ 15,000	$ 1,000	Now	3,454	91,629	$ 159,939	4.5	1.9
		Warehouse loading dock seals	$ 40,000	$ 8,000	$ 1,000	Now	1,016	26,950	$ 13,269	4.9	1.2
		Air curtains	$ 40,000	$ 7,000	$ 1,000	Now	1,016	26,950	$ 31,095	4.8	1.6
		Air compressor heat recovery	$ 100,000	$ 10,000	$ 2,000	Now	3,047	80,849	$ 167,196	3.6	2.3
		Destratification fans	$ 60,000	$ 4,800	$ 2,000	Now	1,625	43,120	$ 75,092	4.3	1.9

Appendix D-5

Industrial Sector TRC Calculation – Miscellaneous Industry

End Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
System	Medium	Integrated control system	$ 165,000	$ 13,200	N/A	Now	96,000	2,547,095	$ 6,193,195	0.2	35.8
		Sub-metering	$ 330,000	$ 33,000	$ 3,300	Now	60,000	1,591,934	$ 4,674,294	0.6	13.0
Boiler	Small (200 BHP)	Economizer	$ 27,000	$ 3,000	$ 1,000	Now	1,239	32,886	$ 81,164.60	2.5	3.1
		Blowdown heat recovery	$ 23,000	$ 2,000	$ 1,000	Now	620	16,443	$ 26,326	4.5	1.8
		Boiler combustion air preheat	$ 50,000	$ 10,000	$ 2,000	Now	1,549	41,108	$ 55,512	4.2	1.7
		Process heat recovery to preheat makeup water	$ 70,000	$ 8,000	$ 1,500	Now	1,859	49,329	$ 88,747	4.2	2.0
		Condensing boiler	$ 120,000	$ 20,000	$ 1,000	EOL	3,099	82,216	$ 250,682	1.9	6.2
		Direct contact hot water heaters	$ 75,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 329,736	0.1	N/A
		Boiler right sizing and load management	$ 70,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 334,736	0.0	N/A
		High efficiency burners	$ 48,000	$ 6,000	$ -	Now	1,549	41,108	$ 95,598	3.2	2.8
		Insulation	$ 20,000	$ 1,500	$ 150	Now	1,549	41,108	$ 108,083	1.3	5.8
		Advanced boiler controls	$ 40,000	$ 1,200	$ 150	Now	930	24,665	$ 36,093	4.1	1.9
		Blowdown control	$ 35,000	$ 3,500	$ 600	Now	310	8,222	-$ 13,689	14.1	0.7
		Boiler water treatment	$ 10,000	$ 2,000	$ 500	Now	310	8,222	$ 5,493	4.3	1.4
		Boiler maintenance	$ -	$ -	$ 8,000	Now	1,549	41,108	$ 31,489	0.9	2.0
		Minimize deaerator vent losses	$ 35,000	$ 3,500	$ 600	Now	620	16,443	$ 16,231	6.4	1.4
		Condensate return	$ 40,000	$ 8,000	$ 700	Now	620	16,443	$ 5,880	8.0	1.1
		Steam trap survey and repair	$ 20,000	$ 1,000	$ -	Now	1,239	32,886	$ 11,628	1.6	1.6
		Instantaneous Steam Generation	$ 120,000	$ 20,000	$ 1,000	EOL	4,648	123,323	$ 344,565	1.2	8.2
	Medium (450 BHP)	Economizer	$ 55,000	$ 4,400	$ 1,000	Now	3,137	83,243	$ 235,022	1.8	4.5
		Blowdown heat recovery	$ 50,000	$ 4,000	$ 1,000	Now	1,569	41,622	$ 88,954	3.4	2.4
		Boiler combustion air preheat	$ 140,000	$ 21,000	$ 5,000	Now	3,922	104,054	$ 131,864	4.4	1.7
		Process heat recovery to preheat makeup water	$ 130,000	$ 15,000	$ 1,800	Now	4,706	124,865	$ 294,079	3.0	2.8
		Condensing boiler	$ 180,000	$ 15,000	$ 2,800	EOL	7,844	208,108	$ 688,500	0.8	11.0
		Direct contact hot water heaters	$ 130,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 804,906	0.1	N/A
		Boiler right sizing and load management	$ 125,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 809,906	0.1	N/A
		High efficiency burners	$ 90,000	$ 10,000	$ -	Now	3,922	104,054	$ 278,669	2.3	3.8
		Insulation	$ 35,000	$ 2,800	$ 1,000	Now	3,922	104,054	$ 285,489	0.9	7.3
		Advanced boiler controls	$ 75,000	$ 6,500	$ 800	Now	2,353	62,432	$ 110,952	3.3	2.3
		Blowdown control	$ 60,000	$ 6,000	$ 1,000	Now	784	20,811	$ 1,220	8.9	1.0
		Boiler water treatment	$ 20,000	$ 3,500	$ 1,000	Now	784	20,811	$ 22,412	3.2	1.8
		Boiler maintenance	$ -	$ -	$ 13,000	Now	3,922	104,054	$ 107,189	0.4	3.2
		Minimize deaerator vent losses	$ 60,000	$ 6,000	$ 1,000	Now	1,569	41,622	$ 76,954	4.2	2.0
		Condensate return	$ 80,000	$ 15,000	$ 1,200	Now	1,569	41,622	$ 46,251	6.1	1.4
		Steam trap survey and repair	$ 35,000	$ 1,500	$ -	Now	3,137	83,243	$ 46,089	1.1	2.3
		Instantaneous Steam Generation	$ 180,000	$ 28,000	$ 1,500	EOL	11,765	312,162	$ 936,275	0.6	17.6
	Large (3,000 BHP)	Economizer	$ 350,000	$ 40,000	$ 2,000	Now	32,536	863,263	$ 2,734,525	1.1	7.7
		Blowdown heat recovery	$ 200,000	$ 25,000	$ 5,000	Now	16,268	431,632	$ 1,303,208	1.3	5.9
		Boiler combustion air preheat	$ 500,000	$ 60,000	$ 7,000	Now	40,670	1,079,079	$ 2,818,259	1.3	5.6
		Process heat recovery to preheat makeup water	$ 400,000	$ 50,000	$ 5,000	Now	48,805	1,294,895	$ 4,219,760	0.9	9.6
		Boiler right sizing and load management	$ 2,700,000	$ 150,000	-$ 10,000	EOL	81,341	2,158,158	$ 8,039,015	0.0	N/A
		High efficiency burners	$ 400,000	$ 60,000	$ -	Now	40,670	1,079,079	$ 3,466,940	1.0	8.5
		Insulation	$ 150,000	$ 30,000	$ 1,500	Now	40,670	1,079,079	$ 3,240,092	0.4	17.9
		Advanced boiler controls	$ 200,000	$ 40,000	$ 3,000	Now	24,402	647,448	$ 1,796,082	0.9	7.8
		Blowdown control	$ 120,000	$ 12,000	$ 2,000	Now	8,134	215,816	$ 636,361	1.5	5.3
		Boiler water treatment	$ 50,000	$ 8,000	$ 3,000	Now	8,134	215,816	$ 463,416	0.7	7.1
		Boiler maintenance	$ -	$ -	$ 30,000	Now	40,670	1,079,079	$ 1,508,925	0.1	14.3
		Minimize deaerator vent losses	$ 150,000	$ 15,000	$ 2,000	Now	16,268	431,632	$ 1,388,749	1.0	8.6
		Condensate return	$ 350,000	$ 80,000	$ 10,000	Now	16,268	431,632	$ 1,055,640	2.6	3.0
		Steam trap survey and repair	$ 200,000	$ 30,000	$ -	Now	32,536	863,263	$ 626,482	0.6	3.7

End Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m^3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
Process Direct Heat	Small (2 MMBTU)	Exhaust gas heat recovery	$ 30,000	$ 5,000	$ 1,000	Now	1,421	37,699	$ 77,277	2.5	2.8
		High-efficiency burners and burner controls	$ 15,000	$ 2,000	$ -	Now	947	25,133	$ 74,461	1.6	5.4
		Insulation	$ 8,000	$ 500	$ 300	Now	474	12,566	$ 29,179	1.8	3.7
		High-efficiency ovens	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		High-efficiency dryers	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		Air curtains	$ 15,000	$ 2,000	$ 1,000	Now	1,421	37,699	$ 111,679	1.2	5.4
	Medium (20 MMBTU)	Exhaust gas heat recovery	$ 120,000	$ 35,000	$ 3,000	Now	15,985	424,112	$ 1,170,870	0.9	7.6
		High-efficiency burners and burner controls	$ 60,000	$ 4,000	$ -	Now	10,657	282,741	$ 964,941	0.6	16.1
		Insulation	$ 40,000	$ 3,000	$ 1,000	Now	5,328	141,371	$ 398,957	0.8	8.9
		Advanced heating and process controls	$ 100,000	$ 25,000	$ 3,000	Now	10,657	282,741	$ 751,307	1.1	6.1
		High-efficiency ovens	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High-efficiency dryers	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High-efficiency kilns	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		High-efficiency furnaces	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		Air curtains	$ 80,000	$ 18,000	$ 1,000	Now	15,985	424,112	$ 1,436,897	0.6	14.5
	Large (100 MMBTU)	Exhaust gas heat recovery	$ 900,000	$ 180,000	$ 10,000	Now	124,326	3,298,649	$ 9,333,733	0.8	9.1
		High-efficiency burners and burner controls	$ 500,000	$ 80,000	$ 5,000	Now	82,884	2,199,099	$ 7,380,303	0.7	12.9
		Insulation	$ 250,000	$ 30,000	$ 2,000	Now	41,442	1,099,550	$ 3,201,386	0.6	11.8
		Advanced heating and process controls	$ 500,000	$ 6,500	$ 8,000	Now	82,884	2,199,099	$ 6,425,848	0.6	12.3
		High-efficiency ovens	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High-efficiency dryers	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High-efficiency kilns	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
		High-efficiency furnaces	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
Other Process	Medium (20 MMTBU)	Pollution control measures	$ 80,000	$ 6,400	$ 20,000	Now	10,657	282,741	$ 772,269	1.1	4.0
		Hydrogen atmospheres for steel batch coil annealing	$ 250,000	$ 60,000	$ 3,000	Now	31,970	848,224	$ 2,364,557	0.9	8.1
		Process heat recovery	$ 300,000	$ 60,000	$ 10,000	Now	15,985	424,112	$ 912,627	2.3	3.1
	Large (100 MMBTU)	Pollution control measures	$ 1,000,000	$ 80,000	$ 125,000	Now	82,884	2,199,099	$ 5,858,675	1.5	3.7
		Hydrogen atmospheres for steel batch coil annealing	$ 2,000,000	$ 160,000	$ 10,000	Now	248,652	6,597,298	$ 18,743,528	0.8	9.4
		Process heat recovery	$ 1,000,000	$ 150,000	$ 25,000	Now	124,326	3,298,649	$ 9,149,642	0.9	7.8
HVAC	Small (0.8 MMBTU)	Radiant heaters	$ 30,000	$ 4,000	$ 1,000	Now	813	21,560	$ 35,946	4.5	1.8
		Automated temperature control	$ 12,000	$ 960	$ 500	Now	488	12,936	$ 29,859	2.8	2.7
		Solar walls	$ 100,000	$ 8,000	$ -	Now	488	12,936	-$ 60,924	20.3	0.4
		Ventilation & heat recovery optimization	$ 25,000	$ 1,600	$ 200	Now	553	14,661	$ 25,050	4.6	1.9
		Warehouse loading dock seals	$ 10,000	$ 5,000	$ 500	Now	163	4,312	-$ 7,286	12.2	0.6
		Air curtains	$ 13,000	$ 2,000	$ 500	Now	163	4,312	-$ 5,091	12.2	0.7
		Air compressor heat recovery	$ 18,000	$ 2,500	$ 500	Now	488	12,936	$ 22,319	4.4	1.9
		Destratification fans	$ 10,000	$ 800	$ -	Now	260	6,899	$ 14,307	3.8	2.3
	Medium (2 MMBTU)	Radiant heaters	$ 70,000	$ 10,000	$ 1,000	Now	2,031	53,899	$ 107,635	3.8	2.2
		Automated temperature control	$ 29,000	$ 2,320	$ 500	Now	1,219	32,340	$ 82,112	2.5	3.3
		Solar walls	$ 175,000	$ 14,000	$ -	Now	1,219	32,340	-$ 71,311	14.2	0.6
		Ventilation & heat recovery optimization	$ 70,000	$ 12,000	$ 1,000	Now	1,381	36,652	$ 42,868	5.9	1.5
		Warehouse loading dock seals	$ 20,000	$ 4,000	$ 500	Now	406	10,780	-$ 107	6.2	1.0
		Air curtains	$ 18,000	$ 1,440	$ 500	Now	406	10,780	$ 11,037	5.1	1.5
		Air compressor heat recovery	$ 45,000	$ 3,500	$ 1,000	Now	1,219	32,340	$ 60,676	4.0	2.1
		Destratification fans	$ 25,000	$ 2,000	$ 500	Now	650	17,248	$ 31,511	4.2	2.0
	Large (5 MMBTU)	Radiant heaters	$ 200,000	$ 20,000	$ 5,000	Now	5,079	134,749	$ 227,804	4.5	1.9
		Automated temperature control	$ 70,000	$ 5,600	$ 1,000	Now	3,047	80,849	$ 210,110	2.4	3.5
		Solar walls	$ 250,000	$ 20,000	$ -	Now	3,047	80,849	$ 24,223	8.1	1.1
		Ventilation & heat recovery optimization	$ 150,000	$ 15,000	$ 1,000	Now	3,454	91,629	$ 159,939	4.5	1.9
		Warehouse loading dock seals	$ 40,000	$ 8,000	$ 1,000	Now	1,016	26,950	$ 13,269	4.9	1.2
		Air curtains	$ 40,000	$ 7,000	$ 1,000	Now	1,016	26,950	$ 31,095	4.8	1.6
		Air compressor heat recovery	$ 100,000	$ 10,000	$ 2,000	Now	3,047	80,849	$ 167,196	3.6	2.3
		Destratification fans	$ 60,000	$ 4,800	$ 2,000	Now	1,625	43,120	$ 75,092	4.3	1.9

Appendix D-6

Industrial Sector TRC Calculation – Paper

End Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
System	Medium	Integrated control system	$ 165,000	$ 13,200	N/A	Now	96,000	2,547,095	$ 6,193,195	0.2	35.8
		Sub-metering	$ 330,000	$ 33,000	$ 3,300	Now	60,000	1,591,934	$ 4,674,294	0.6	13.0
Boiler	Small (200 BHP)	Economizer	$ 27,000	$ 3,000	$ 1,000	Now	1,239	32,886	$ 81,164.60	2.5	3.1
		Blowdown heat recovery	$ 23,000	$ 2,000	$ 1,000	Now	620	16,443	$ 26,326	4.5	1.8
		Boiler combustion air preheat	$ 50,000	$ 10,000	$ 2,000	Now	1,549	41,108	$ 55,512	4.2	1.7
		Process heat recovery to preheat makeup water	$ 70,000	$ 8,000	$ 1,500	Now	1,859	49,329	$ 88,747	4.2	2.0
		Condensing boiler	$ 120,000	$ 20,000	$ 1,000	EOL	3,099	82,216	$ 250,682	1.9	6.2
		Direct contact hot water heaters	$ 75,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 329,736	0.1	N/A
		Boiler right sizing and load management	$ 70,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 334,736	0.0	N/A
		High efficiency burners	$ 48,000	$ 6,000	$ -	Now	1,549	41,108	$ 95,598	3.2	2.8
		Insulation	$ 20,000	$ 1,500	$ 150	Now	1,549	41,108	$ 108,083	1.3	5.8
		Advanced boiler controls	$ 40,000	$ 1,200	$ 150	Now	930	24,665	$ 36,093	4.1	1.9
		Blowdown control	$ 35,000	$ 3,500	$ 600	Now	310	8,222	-$ 13,689	14.1	0.7
		Boiler water treatment	$ 10,000	$ 2,000	$ 500	Now	310	8,222	$ 5,493	4.3	1.4
		Boiler maintenance	$ -	$ -	$ 8,000	Now	1,549	41,108	$ 31,489	0.9	2.0
		Minimize deaerator vent losses	$ 35,000	$ 3,500	$ 600	Now	620	16,443	$ 16,231	6.4	1.4
		Condensate return	$ 40,000	$ 8,000	$ 700	Now	620	16,443	$ 5,880	8.0	1.1
		Steam trap survey and repair	$ 20,000	$ 1,000	$ -	Now	1,239	32,886	$ 11,628	1.6	1.6
		Instantaneous Steam Generation	$ 120,000	$ 20,000	$ 1,000	EOL	4,648	123,323	$ 344,565	1.2	8.2
	Medium (450 BHP)	Economizer	$ 55,000	$ 4,400	$ 1,000	Now	3,137	83,243	$ 235,022	1.8	4.5
		Blowdown heat recovery	$ 50,000	$ 4,000	$ 1,000	Now	1,569	41,622	$ 88,954	3.4	2.4
		Boiler combustion air preheat	$ 140,000	$ 21,000	$ 5,000	Now	3,922	104,054	$ 131,864	4.4	1.7
		Process heat recovery to preheat makeup water	$ 130,000	$ 15,000	$ 1,800	Now	4,706	124,865	$ 294,079	3.0	2.8
		Condensing boiler	$ 180,000	$ 15,000	$ 2,800	EOL	7,844	208,108	$ 688,500	0.8	11.0
		Direct contact hot water heaters	$ 130,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 804,906	0.1	N/A
		Boiler right sizing and load management	$ 125,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 809,906	0.1	N/A
		High efficiency burners	$ 90,000	$ 10,000	$ -	Now	3,922	104,054	$ 278,669	2.3	3.8
		Insulation	$ 35,000	$ 2,800	$ 1,000	Now	3,922	104,054	$ 285,489	0.9	7.3
		Advanced boiler controls	$ 75,000	$ 6,500	$ 800	Now	2,353	62,432	$ 110,952	3.3	2.3
		Blowdown control	$ 60,000	$ 6,000	$ 1,000	Now	784	20,811	$ 1,220	8.9	1.0
		Boiler water treatment	$ 20,000	$ 3,500	$ 1,000	Now	784	20,811	$ 22,412	3.2	1.8
		Boiler maintenance	$ -	$ -	$ 13,000	Now	3,922	104,054	$ 107,189	0.4	3.2
		Minimize deaerator vent losses	$ 60,000	$ 6,000	$ 1,000	Now	1,569	41,622	$ 76,954	4.2	2.0
		Condensate return	$ 80,000	$ 15,000	$ 1,200	Now	1,569	41,622	$ 46,251	6.1	1.4
		Steam trap survey and repair	$ 35,000	$ 1,500	$ -	Now	3,137	83,243	$ 46,089	1.1	2.3
		Instantaneous Steam Generation	$ 180,000	$ 28,000	$ 1,500	EOL	11,765	312,162	$ 936,275	0.6	17.6
	Large (3,000 BHP)	Economizer	$ 350,000	$ 40,000	$ 2,000	Now	32,536	863,263	$ 2,734,525	1.1	7.7
		Blowdown heat recovery	$ 200,000	$ 25,000	$ 5,000	Now	16,268	431,632	$ 1,303,208	1.3	5.9
		Boiler combustion air preheat	$ 500,000	$ 60,000	$ 7,000	Now	40,670	1,079,079	$ 2,818,259	1.3	5.6
		Process heat recovery to preheat makeup water	$ 400,000	$ 50,000	$ 5,000	Now	48,805	1,294,895	$ 4,219,760	0.9	9.6
		Boiler right sizing and load management	$ 2,700,000	$ 150,000	-$ 10,000	EOL	81,341	2,158,158	$ 8,039,015	0.0	N/A
		High efficiency burners	$ 400,000	$ 60,000	$ -	Now	40,670	1,079,079	$ 3,466,940	1.0	8.5
		Insulation	$ 150,000	$ 30,000	$ 1,500	Now	40,670	1,079,079	$ 3,240,092	0.4	17.9
		Advanced boiler controls	$ 200,000	$ 40,000	$ 3,000	Now	24,402	647,448	$ 1,796,082	0.9	7.8
		Blowdown control	$ 120,000	$ 12,000	$ 2,000	Now	8,134	215,816	$ 636,361	1.5	5.3
		Boiler water treatment	$ 50,000	$ 8,000	$ 3,000	Now	8,134	215,816	$ 463,416	0.7	7.1
		Boiler maintenance	$ -	$ -	$ 30,000	Now	40,670	1,079,079	$ 1,508,925	0.1	14.3
		Minimize deaerator vent losses	$ 150,000	$ 15,000	$ 2,000	Now	16,268	431,632	$ 1,388,749	1.0	8.6
		Condensate return	$ 350,000	$ 80,000	$ 10,000	Now	16,268	431,632	$ 1,055,640	2.6	3.0
		Steam trap survey and repair	$ 200,000	$ 30,000	$ -	Now	32,536	863,263	$ 626,482	0.6	3.7

End Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m^3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
Process Direct Heat	Small (2 MMBTU)	Exhaust gas heat recovery	$ 30,000	$ 5,000	$ 1,000	Now	1,421	37,699	$ 77,277	2.5	2.8
		High-efficiency burners and burner controls	$ 15,000	$ 2,000	$ -	Now	947	25,133	$ 74,461	1.6	5.4
		Insulation	$ 8,000	$ 500	$ 300	Now	474	12,566	$ 29,179	1.8	3.7
		High-efficiency ovens	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		High-efficiency dryers	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		Air curtains	$ 15,000	$ 2,000	$ 1,000	Now	1,421	37,699	$ 111,679	1.2	5.4
	Medium (20 MMBTU)	Exhaust gas heat recovery	$ 120,000	$ 35,000	$ 3,000	Now	15,985	424,112	$ 1,170,870	0.9	7.6
		High-efficiency burners and burner controls	$ 60,000	$ 4,000	$ -	Now	10,657	282,741	$ 964,941	0.6	16.1
		Insulation	$ 40,000	$ 3,000	$ 1,000	Now	5,328	141,371	$ 398,957	0.8	8.9
		Advanced heating and process controls	$ 100,000	$ 25,000	$ 3,000	Now	10,657	282,741	$ 751,307	1.1	6.1
		High-efficiency ovens	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High-efficiency dryers	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High-efficiency kilns	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		High-efficiency furnaces	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		Air curtains	$ 80,000	$ 18,000	$ 1,000	Now	15,985	424,112	$ 1,436,897	0.6	14.5
	Large (100 MMBTU)	Exhaust gas heat recovery	$ 900,000	$ 180,000	$ 10,000	Now	124,326	3,298,649	$ 9,333,733	0.8	9.1
		High-efficiency burners and burner controls	$ 500,000	$ 80,000	$ 5,000	Now	82,884	2,199,099	$ 7,380,303	0.7	12.9
		Insulation	$ 250,000	$ 30,000	$ 2,000	Now	41,442	1,099,550	$ 3,201,386	0.6	11.8
		Advanced heating and process controls	$ 500,000	$ 6,500	$ 8,000	Now	82,884	2,199,099	$ 6,425,848	0.6	12.3
		High-efficiency ovens	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High-efficiency dryers	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High-efficiency kilns	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
		High-efficiency furnaces	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
Other Process	Medium (20 MMTBU)	Pollution control measures	$ 80,000	$ 6,400	$ 20,000	Now	10,657	282,741	$ 772,269	1.1	4.0
		Hydrogen atmospheres for steel batch coil annealing	$ 250,000	$ 60,000	$ 3,000	Now	31,970	848,224	$ 2,364,557	0.9	8.1
		Process heat recovery	$ 300,000	$ 60,000	$ 10,000	Now	15,985	424,112	$ 912,627	2.3	3.1
	Large (100 MMBTU)	Pollution control measures	$ 1,000,000	$ 80,000	$ 125,000	Now	82,884	2,199,099	$ 5,858,675	1.5	3.7
		Hydrogen atmospheres for steel batch coil annealing	$ 2,000,000	$ 160,000	$ 10,000	Now	248,652	6,597,298	$ 18,743,528	0.8	9.4
		Process heat recovery	$ 1,000,000	$ 150,000	$ 25,000	Now	124,326	3,298,649	$ 9,149,642	0.9	7.8
HVAC	Small (0.8 MMBTU)	Radiant heaters	$ 30,000	$ 4,000	$ 1,000	Now	813	21,560	$ 35,946	4.5	1.8
		Automated temperature control	$ 12,000	$ 960	$ 500	Now	488	12,936	$ 29,859	2.8	2.7
		Solar walls	$ 100,000	$ 8,000	$ -	Now	488	12,936	-$ 60,924	20.3	0.4
		Ventilation & heat recovery optimization	$ 25,000	$ 1,600	$ 200	Now	553	14,661	$ 25,050	4.6	1.9
		Warehouse loading dock seals	$ 10,000	$ 5,000	$ 500	Now	163	4,312	-$ 7,286	12.2	0.6
		Air curtains	$ 13,000	$ 2,000	$ 500	Now	163	4,312	-$ 5,091	12.2	0.7
		Air compressor heat recovery	$ 18,000	$ 2,500	$ 500	Now	488	12,936	$ 22,319	4.4	1.9
		Destratification fans	$ 10,000	$ 800	$ -	Now	260	6,899	$ 14,307	3.8	2.3
	Medium (2 MMBTU)	Radiant heaters	$ 70,000	$ 10,000	$ 1,000	Now	2,031	53,899	$ 107,635	3.8	2.2
		Automated temperature control	$ 29,000	$ 2,320	$ 500	Now	1,219	32,340	$ 82,112	2.5	3.3
		Solar walls	$ 175,000	$ 14,000	$ -	Now	1,219	32,340	-$ 71,311	14.2	0.6
		Ventilation & heat recovery optimization	$ 70,000	$ 12,000	$ 1,000	Now	1,381	36,652	$ 42,868	5.9	1.5
		Warehouse loading dock seals	$ 20,000	$ 4,000	$ 500	Now	406	10,780	-$ 107	6.2	1.0
		Air curtains	$ 18,000	$ 1,440	$ 500	Now	406	10,780	$ 11,037	5.1	1.5
		Air compressor heat recovery	$ 45,000	$ 3,500	$ 1,000	Now	1,219	32,340	$ 60,676	4.0	2.1
		Destratification fans	$ 25,000	$ 2,000	$ 500	Now	650	17,248	$ 31,511	4.2	2.0
	Large (5 MMBTU)	Radiant heaters	$ 200,000	$ 20,000	$ 5,000	Now	5,079	134,749	$ 227,804	4.5	1.9
		Automated temperature control	$ 70,000	$ 5,600	$ 1,000	Now	3,047	80,849	$ 210,110	2.4	3.5
		Solar walls	$ 250,000	$ 20,000	$ -	Now	3,047	80,849	$ 24,223	8.1	1.1
		Ventilation & heat recovery optimization	$ 150,000	$ 15,000	$ 1,000	Now	3,454	91,629	$ 159,939	4.5	1.9
		Warehouse loading dock seals	$ 40,000	$ 8,000	$ 1,000	Now	1,016	26,950	$ 13,269	4.9	1.2
		Air curtains	$ 40,000	$ 7,000	$ 1,000	Now	1,016	26,950	$ 31,095	4.8	1.6
		Air compressor heat recovery	$ 100,000	$ 10,000	$ 2,000	Now	3,047	80,849	$ 167,196	3.6	2.3
		Destratification fans	$ 60,000	$ 4,800	$ 2,000	Now	1,625	43,120	$ 75,092	4.3	1.9

Appendix D-7

Industrial Sector TRC Calculation – Primary Metal

End Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
System	Medium	Integrated control system	$ 165,000	$ 13,200	N/A	Now	92,205	2,446,405	$ 5,941,327	0.2	34.3
		Sub-metering	$ 330,000	$ 33,000	$ 3,300	Now	57,628	1,529,003	$ 4,474,172	0.6	12.5
Boiler	Small (200 BHP)	Economizer	$ 27,000	$ 3,000	$ 1,000	Now	1,239	32,886	$ 81,164.60	2.5	3.1
		Blowdown heat recovery	$ 23,000	$ 2,000	$ 1,000	Now	620	16,443	$ 26,326	4.5	1.8
		Boiler combustion air preheat	$ 50,000	$ 10,000	$ 2,000	Now	1,549	41,108	$ 55,512	4.2	1.7
		Process heat recovery to preheat makeup water	$ 70,000	$ 8,000	$ 1,500	Now	1,859	49,329	$ 88,747	4.2	2.0
		Condensing boiler	$ 120,000	$ 20,000	$ 1,000	EOL	3,099	82,216	$ 250,682	1.9	6.2
		Direct contact hot water heaters	$ 75,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 329,736	0.1	N/A
		Boiler right sizing and load management	$ 70,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 334,736	0.0	N/A
		High efficiency burners	$ 48,000	$ 6,000	$ -	Now	1,549	41,108	$ 95,598	3.2	2.8
		Insulation	$ 20,000	$ 1,500	$ 150	Now	1,549	41,108	$ 108,083	1.3	5.8
		Advanced boiler controls	$ 40,000	$ 1,200	$ 150	Now	930	24,665	$ 36,093	4.1	1.9
		Blowdown control	$ 35,000	$ 3,500	$ 600	Now	310	8,222	-$ 13,689	14.1	0.7
		Boiler water treatment	$ 10,000	$ 2,000	$ 500	Now	310	8,222	$ 5,493	4.3	1.4
		Boiler maintenance	$ -	$ -	$ 8,000	Now	1,549	41,108	$ 31,489	0.9	2.0
		Minimize deaerator vent losses	$ 35,000	$ 3,500	$ 600	Now	620	16,443	$ 16,231	6.4	1.4
		Condensate return	$ 40,000	$ 8,000	$ 700	Now	620	16,443	$ 5,880	8.0	1.1
		Steam trap survey and repair	$ 20,000	$ 1,000	$ -	Now	1,239	32,886	$ 11,628	1.6	1.6
		Instantaneous Steam Generation	$ 120,000	$ 20,000	$ 1,000	EOL	4,648	123,323	$ 344,565	1.2	8.2
	Medium (450 BHP)	Economizer	$ 55,000	$ 4,400	$ 1,000	Now	3,137	83,243	$ 235,022	1.8	4.5
		Blowdown heat recovery	$ 50,000	$ 4,000	$ 1,000	Now	1,569	41,622	$ 88,954	3.4	2.4
		Boiler combustion air preheat	$ 140,000	$ 21,000	$ 5,000	Now	3,922	104,054	$ 131,864	4.4	1.7
		Process heat recovery to preheat makeup water	$ 130,000	$ 15,000	$ 1,800	Now	4,706	124,865	$ 294,079	3.0	2.8
		Condensing boiler	$ 180,000	$ 15,000	$ 2,800	EOL	7,844	208,108	$ 688,500	0.8	11.0
		Direct contact hot water heaters	$ 130,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 804,906	0.1	N/A
		Boiler right sizing and load management	$ 125,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 809,906	0.1	N/A
		High efficiency burners	$ 90,000	$ 10,000	$ -	Now	3,922	104,054	$ 278,669	2.3	3.8
		Insulation	$ 35,000	$ 2,800	$ 1,000	Now	3,922	104,054	$ 285,489	0.9	7.3
		Advanced boiler controls	$ 75,000	$ 6,500	$ 800	Now	2,353	62,432	$ 110,952	3.3	2.3
		Blowdown control	$ 60,000	$ 6,000	$ 1,000	Now	784	20,811	$ 1,220	8.9	1.0
		Boiler water treatment	$ 20,000	$ 3,500	$ 1,000	Now	784	20,811	$ 22,412	3.2	1.8
		Boiler maintenance	$ -	$ -	$ 13,000	Now	3,922	104,054	$ 107,189	0.4	3.2
		Minimize deaerator vent losses	$ 60,000	$ 6,000	$ 1,000	Now	1,569	41,622	$ 76,954	4.2	2.0
		Condensate return	$ 80,000	$ 15,000	$ 1,200	Now	1,569	41,622	$ 46,251	6.1	1.4
		Steam trap survey and repair	$ 35,000	$ 1,500	$ -	Now	3,137	83,243	$ 46,089	1.1	2.3
		Instantaneous Steam Generation	$ 180,000	$ 28,000	$ 1,500	EOL	11,765	312,162	$ 936,275	0.6	17.6
	Large (3,000 BHP)	Economizer	$ 350,000	$ 40,000	$ 2,000	Now	32,536	863,263	$ 2,734,525	1.1	7.7
		Blowdown heat recovery	$ 200,000	$ 25,000	$ 5,000	Now	16,268	431,632	$ 1,303,208	1.3	5.9
		Boiler combustion air preheat	$ 500,000	$ 60,000	$ 7,000	Now	40,670	1,079,079	$ 2,818,259	1.3	5.6
		Process heat recovery to preheat makeup water	$ 400,000	$ 50,000	$ 5,000	Now	48,805	1,294,895	$ 4,219,760	0.9	9.6
		Boiler right sizing and load management	$ 2,700,000	$ 150,000	-$ 10,000	EOL	81,341	2,158,158	$ 8,039,015	0.0	N/A
		High efficiency burners	$ 400,000	$ 60,000	$ -	Now	40,670	1,079,079	$ 3,466,940	1.0	8.5
		Insulation	$ 150,000	$ 30,000	$ 1,500	Now	40,670	1,079,079	$ 3,240,092	0.4	17.9
		Advanced boiler controls	$ 200,000	$ 40,000	$ 3,000	Now	24,402	647,448	$ 1,796,082	0.9	7.8
		Blowdown control	$ 120,000	$ 12,000	$ 2,000	Now	8,134	215,816	$ 636,361	1.5	5.3
		Boiler water treatment	$ 50,000	$ 8,000	$ 3,000	Now	8,134	215,816	$ 463,416	0.7	7.1
		Boiler maintenance	$ -	$ -	$ 30,000	Now	40,670	1,079,079	$ 1,508,925	0.1	14.3
		Minimize deaerator vent losses	$ 150,000	$ 15,000	$ 2,000	Now	16,268	431,632	$ 1,388,749	1.0	8.6
		Condensate return	$ 350,000	$ 80,000	$ 10,000	Now	16,268	431,632	$ 1,055,640	2.6	3.0
		Steam trap survey and repair	$ 200,000	$ 30,000	$ -	Now	32,536	863,263	$ 626,482	0.6	3.7

End Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m^3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
Process Direct Heat	Small (2 MMBTU)	Exhaust gas heat recovery	$ 30,000	$ 5,000	$ 1,000	Now	1,421	37,699	$ 77,277	2.5	2.8
		High-efficiency burners and burner controls	$ 15,000	$ 2,000	$ -	Now	947	25,133	$ 74,461	1.6	5.4
		Insulation	$ 8,000	$ 500	$ 300	Now	474	12,566	$ 29,179	1.8	3.7
		High-efficiency ovens	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		High-efficiency dryers	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		Air curtains	$ 15,000	$ 2,000	$ 1,000	Now	1,421	37,699	$ 111,679	1.2	5.4
	Medium (20 MMBTU)	Exhaust gas heat recovery	$ 120,000	$ 35,000	$ 3,000	Now	15,985	424,112	$ 1,170,870	0.9	7.6
		High-efficiency burners and burner controls	$ 60,000	$ 4,000	$ -	Now	10,657	282,741	$ 964,941	0.6	16.1
		Insulation	$ 40,000	$ 3,000	$ 1,000	Now	5,328	141,371	$ 398,957	0.8	8.9
		Advanced heating and process controls	$ 100,000	$ 25,000	$ 3,000	Now	10,657	282,741	$ 751,307	1.1	6.1
		High-efficiency ovens	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High-efficiency dryers	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High-efficiency kilns	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		High-efficiency furnaces	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		Air curtains	$ 80,000	$ 18,000	$ 1,000	Now	15,985	424,112	$ 1,436,897	0.6	14.5
	Large (100 MMBTU)	Exhaust gas heat recovery	$ 900,000	$ 180,000	$ 10,000	Now	124,326	3,298,649	$ 9,333,733	0.8	9.1
		High-efficiency burners and burner controls	$ 500,000	$ 80,000	$ 5,000	Now	82,884	2,199,099	$ 7,380,303	0.7	12.9
		Insulation	$ 250,000	$ 30,000	$ 2,000	Now	41,442	1,099,550	$ 3,201,386	0.6	11.8
		Advanced heating and process controls	$ 500,000	$ 6,500	$ 8,000	Now	82,884	2,199,099	$ 6,425,848	0.6	12.3
		High-efficiency ovens	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High-efficiency dryers	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High-efficiency kilns	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
		High-efficiency furnaces	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
Other Process	Medium (20 MMTBU)	Pollution control measures	$ 80,000	$ 6,400	$ 20,000	Now	10,657	282,741	$ 772,269	1.1	4.0
		Hydrogen atmospheres for steel batch coil annealing	$ 250,000	$ 60,000	$ 3,000	Now	31,970	848,224	$ 2,364,557	0.9	8.1
		Process heat recovery	$ 300,000	$ 60,000	$ 10,000	Now	15,985	424,112	$ 912,627	2.3	3.1
	Large (100 MMBTU)	Pollution control measures	$ 1,000,000	$ 80,000	$ 125,000	Now	82,884	2,199,099	$ 5,858,675	1.5	3.7
		Hydrogen atmospheres for steel batch coil annealing	$ 2,000,000	$ 160,000	$ 10,000	Now	248,652	6,597,298	$ 18,743,528	0.8	9.4
		Process heat recovery	$ 1,000,000	$ 150,000	$ 25,000	Now	124,326	3,298,649	$ 9,149,642	0.9	7.8
HVAC	Small (0.8 MMBTU)	Radiant heaters	$ 30,000	$ 4,000	$ 1,000	Now	813	21,560	$ 35,946	4.5	1.8
		Automated temperature control	$ 12,000	$ 960	$ 500	Now	488	12,936	$ 29,859	2.8	2.7
		Solar walls	$ 100,000	$ 8,000	$ -	Now	488	12,936	-$ 60,924	20.3	0.4
		Ventilation & heat recovery optimization	$ 25,000	$ 1,600	$ 200	Now	553	14,661	$ 25,050	4.6	1.9
		Warehouse loading dock seals	$ 10,000	$ 5,000	$ 500	Now	163	4,312	-$ 7,286	12.2	0.6
		Air curtains	$ 13,000	$ 2,000	$ 500	Now	163	4,312	-$ 5,091	12.2	0.7
		Air compressor heat recovery	$ 18,000	$ 2,500	$ 500	Now	488	12,936	$ 22,319	4.4	1.9
		Destratification fans	$ 10,000	$ 800	$ -	Now	260	6,899	$ 14,307	3.8	2.3
	Medium (2 MMBTU)	Radiant heaters	$ 70,000	$ 10,000	$ 1,000	Now	2,031	53,899	$ 107,635	3.8	2.2
		Automated temperature control	$ 29,000	$ 2,320	$ 500	Now	1,219	32,340	$ 82,112	2.5	3.3
		Solar walls	$ 175,000	$ 14,000	$ -	Now	1,219	32,340	-$ 71,311	14.2	0.6
		Ventilation & heat recovery optimization	$ 70,000	$ 12,000	$ 1,000	Now	1,381	36,652	$ 42,868	5.9	1.5
		Warehouse loading dock seals	$ 20,000	$ 4,000	$ 500	Now	406	10,780	-$ 107	6.2	1.0
		Air curtains	$ 18,000	$ 1,440	$ 500	Now	406	10,780	$ 11,037	5.1	1.5
		Air compressor heat recovery	$ 45,000	$ 3,500	$ 1,000	Now	1,219	32,340	$ 60,676	4.0	2.1
		Destratification fans	$ 25,000	$ 2,000	$ 500	Now	650	17,248	$ 31,511	4.2	2.0
	Large (5 MMBTU)	Radiant heaters	$ 200,000	$ 20,000	$ 5,000	Now	5,079	134,749	$ 227,804	4.5	1.9
		Automated temperature control	$ 70,000	$ 5,600	$ 1,000	Now	3,047	80,849	$ 210,110	2.4	3.5
		Solar walls	$ 250,000	$ 20,000	$ -	Now	3,047	80,849	$ 24,223	8.1	1.1
		Ventilation & heat recovery optimization	$ 150,000	$ 15,000	$ 1,000	Now	3,454	91,629	$ 159,939	4.5	1.9
		Warehouse loading dock seals	$ 40,000	$ 8,000	$ 1,000	Now	1,016	26,950	$ 13,269	4.9	1.2
		Air curtains	$ 40,000	$ 7,000	$ 1,000	Now	1,016	26,950	$ 31,095	4.8	1.6
		Air compressor heat recovery	$ 100,000	$ 10,000	$ 2,000	Now	3,047	80,849	$ 167,196	3.6	2.3
		Destratification fans	$ 60,000	$ 4,800	$ 2,000	Now	1,625	43,120	$ 75,092	4.3	1.9

Appendix D-8

Industrial Sector TRC Calculation – Petroleum Refineries

End Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
System	Medium	Integrated control system	$ 165,000	$ 13,200	N/A	Now	120,000	3,183,868	$ 7,786,043	0.1	44.7
		Sub-metering	$ 330,000	$ 33,000	$ 3,300	Now	75,000	1,989,918	$ 5,939,892	0.4	16.3
Boiler	Small (200 BHP)	Economizer	$ 27,000	$ 3,000	$ 1,000	Now	1,239	32,886	$ 81,164.60	2.5	3.1
		Blowdown heat recovery	$ 23,000	$ 2,000	$ 1,000	Now	620	16,443	$ 26,326	4.5	1.8
		Boiler combustion air preheat	$ 50,000	$ 10,000	$ 2,000	Now	1,549	41,108	$ 55,512	4.2	1.7
		Process heat recovery to preheat makeup water	$ 70,000	$ 8,000	$ 1,500	Now	1,859	49,329	$ 88,747	4.2	2.0
		Condensing boiler	$ 120,000	$ 20,000	$ 1,000	EOL	3,099	82,216	$ 250,682	1.9	6.2
		Direct contact hot water heaters	$ 75,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 329,736	0.1	N/A
		Boiler right sizing and load management	$ 70,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 334,736	0.0	N/A
		High efficiency burners	$ 48,000	$ 6,000	$ -	Now	1,549	41,108	$ 95,598	3.2	2.8
		Insulation	$ 20,000	$ 1,500	$ 150	Now	1,549	41,108	$ 108,083	1.3	5.8
		Advanced boiler controls	$ 40,000	$ 1,200	$ 150	Now	930	24,665	$ 36,093	4.1	1.9
		Blowdown control	$ 35,000	$ 3,500	$ 600	Now	310	8,222	-$ 13,689	14.1	0.7
		Boiler water treatment	$ 10,000	$ 2,000	$ 500	Now	310	8,222	$ 5,493	4.3	1.4
		Boiler maintenance	$ -	$ -	$ 8,000	Now	1,549	41,108	$ 31,489	0.9	2.0
		Minimize deaerator vent losses	$ 35,000	$ 3,500	$ 600	Now	620	16,443	$ 16,231	6.4	1.4
		Condensate return	$ 40,000	$ 8,000	$ 700	Now	620	16,443	$ 5,880	8.0	1.1
		Steam trap survey and repair	$ 20,000	$ 1,000	$ -	Now	1,239	32,886	$ 11,628	1.6	1.6
		Instantaneous Steam Generation	$ 120,000	$ 20,000	$ 1,000	EOL	4,648	123,323	$ 344,565	1.2	8.2
	Medium (450 BHP)	Economizer	$ 55,000	$ 4,400	$ 1,000	Now	3,137	83,243	$ 235,022	1.8	4.5
		Blowdown heat recovery	$ 50,000	$ 4,000	$ 1,000	Now	1,569	41,622	$ 88,954	3.4	2.4
		Boiler combustion air preheat	$ 140,000	$ 21,000	$ 5,000	Now	3,922	104,054	$ 131,864	4.4	1.7
		Process heat recovery to preheat makeup water	$ 130,000	$ 15,000	$ 1,800	Now	4,706	124,865	$ 294,079	3.0	2.8
		Condensing boiler	$ 180,000	$ 15,000	$ 2,800	EOL	7,844	208,108	$ 688,500	0.8	11.0
		Direct contact hot water heaters	$ 130,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 804,906	0.1	N/A
		Boiler right sizing and load management	$ 125,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 809,906	0.1	N/A
		High efficiency burners	$ 90,000	$ 10,000	$ -	Now	3,922	104,054	$ 278,669	2.3	3.8
		Insulation	$ 35,000	$ 2,800	$ 1,000	Now	3,922	104,054	$ 285,489	0.9	7.3
		Advanced boiler controls	$ 75,000	$ 6,500	$ 800	Now	2,353	62,432	$ 110,952	3.3	2.3
		Blowdown control	$ 60,000	$ 6,000	$ 1,000	Now	784	20,811	$ 1,220	8.9	1.0
		Boiler water treatment	$ 20,000	$ 3,500	$ 1,000	Now	784	20,811	$ 22,412	3.2	1.8
		Boiler maintenance	$ -	$ -	$ 13,000	Now	3,922	104,054	$ 107,189	0.4	3.2
		Minimize deaerator vent losses	$ 60,000	$ 6,000	$ 1,000	Now	1,569	41,622	$ 76,954	4.2	2.0
		Condensate return	$ 80,000	$ 15,000	$ 1,200	Now	1,569	41,622	$ 46,251	6.1	1.4
		Steam trap survey and repair	$ 35,000	$ 1,500	$ -	Now	3,137	83,243	$ 46,089	1.1	2.3
		Instantaneous Steam Generation	$ 180,000	$ 28,000	$ 1,500	EOL	11,765	312,162	$ 936,275	0.6	17.6
	Large (3,000 BHP)	Economizer	$ 350,000	$ 40,000	$ 2,000	Now	32,536	863,263	$ 2,734,525	1.1	7.7
		Blowdown heat recovery	$ 200,000	$ 25,000	$ 5,000	Now	16,268	431,632	$ 1,303,208	1.3	5.9
		Boiler combustion air preheat	$ 500,000	$ 60,000	$ 7,000	Now	40,670	1,079,079	$ 2,818,259	1.3	5.6
		Process heat recovery to preheat makeup water	$ 400,000	$ 50,000	$ 5,000	Now	48,805	1,294,895	$ 4,219,760	0.9	9.6
		Boiler right sizing and load management	$ 2,700,000	$ 150,000	-$ 10,000	EOL	81,341	2,158,158	$ 8,039,015	0.0	N/A
		High efficiency burners	$ 400,000	$ 60,000	$ -	Now	40,670	1,079,079	$ 3,466,940	1.0	8.5
		Insulation	$ 150,000	$ 30,000	$ 1,500	Now	40,670	1,079,079	$ 3,240,092	0.4	17.9
		Advanced boiler controls	$ 200,000	$ 40,000	$ 3,000	Now	24,402	647,448	$ 1,796,082	0.9	7.8
		Blowdown control	$ 120,000	$ 12,000	$ 2,000	Now	8,134	215,816	$ 636,361	1.5	5.3
		Boiler water treatment	$ 50,000	$ 8,000	$ 3,000	Now	8,134	215,816	$ 463,416	0.7	7.1
		Boiler maintenance	$ -	$ -	$ 30,000	Now	40,670	1,079,079	$ 1,508,925	0.1	14.3
		Minimize deaerator vent losses	$ 150,000	$ 15,000	$ 2,000	Now	16,268	431,632	$ 1,388,749	1.0	8.6
		Condensate return	$ 350,000	$ 80,000	$ 10,000	Now	16,268	431,632	$ 1,055,640	2.6	3.0
		Steam trap survey and repair	$ 200,000	$ 30,000	$ -	Now	32,536	863,263	$ 626,482	0.6	3.7

End-Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
Process Direct Heat	Small (2 MMBTU)	Exhaust gas heat recovery	$ 30,000	$ 5,000	$ 1,000	Now	1,421	37,699	$ 77,277	2.5	2.8
		High efficiency burners and burner controls	$ 15,000	$ 2,000	$ -	Now	947	25,133	$ 74,461	1.6	5.4
		Insulation	$ 8,000	$ 500	$ 300	Now	474	12,566	$ 29,179	1.8	3.7
		High efficiency ovens	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		High efficiency dryers	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		Air curtains	$ 15,000	$ 2,000	$ 1,000	Now	1,421	37,699	$ 111,679	1.2	5.4
	Medium (20 MMBTU)	Exhaust gas heat recovery	$ 120,000	$ 35,000	$ 3,000	Now	15,985	424,112	$ 1,170,870	0.9	7.6
		High efficiency burners and burner	$ 60,000	$ 4,000	$ -	Now	10,657	282,741	$ 964,941	0.6	16.1
		Insulation	$ 40,000	$ 3,000	$ 1,000	Now	5,328	141,371	$ 398,957	0.8	8.9
		Advanced heating and process controls	$ 100,000	$ 25,000	$ 3,000	Now	10,657	282,741	$ 751,307	1.1	6.1
		High efficiency ovens	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High efficiency dryers	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High Efficiency kilns	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		High Efficiency Furnaces	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		Air curtains	$ 80,000	$ 18,000	$ 1,000	Now	15,985	424,112	$ 1,436,897	0.6	14.5
	Large (100 MMBTU)	Exhaust gas heat recovery	$ 900,000	$ 180,000	$ 10,000	Now	124,326	3,298,649	$ 9,333,733	0.8	9.1
		High efficiency burners and burner	$ 500,000	$ 80,000	$ 5,000	Now	82,884	2,199,099	$ 7,380,303	0.7	12.9
		Insulation	$ 250,000	$ 30,000	$ 2,000	Now	41,442	1,099,550	$ 3,201,386	0.6	11.8
		Advanced heating and process controls	$ 500,000	$ 6,500	$ 8,000	Now	82,884	2,199,099	$ 6,425,848	0.6	12.3
		High efficiency ovens	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High efficiency dryers	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High Efficiency kilns	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
		High Efficiency Furnaces	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
Other Process	Medium (20 MMTBU)	Pollution control measures	$ 80,000	$ 6,400	$ 20,000	Now	10,657	282,741	$ 772,269	1.1	4.0
		Hydrogen Atmospheres for Steel Batch Coil Annealing	$ 250,000	$ 60,000	$ 3,000	Now	31,970	848,224	$ 2,364,557	0.9	8.1
		Process Heat Recovery	$ 300,000	$ 60,000	$ 10,000	Now	15,985	424,112	$ 912,627	2.3	3.1
	Large (100 MMBTU)	Pollution control measures	$ 1,000,000	$ 80,000	$ 125,000	Now	82,884	2,199,099	$ 5,858,675	1.5	3.7
		Hydrogen Atmospheres for Steel Batch Coil Annealing	$ 2,000,000	$ 160,000	$ 10,000	Now	248,652	6,597,298	$ 18,743,528	0.8	9.4
		Process Heat Recovery	$ 1,000,000	$ 150,000	$ 25,000	Now	124,326	3,298,649	$ 9,149,642	0.9	7.8
HVAC	Small (0.8 MMBTU)	Radiant heaters	$ 30,000	$ 4,000	$ 1,000	Now	813	21,560	$ 35,946	4.5	1.8
		Automated temperature control	$ 12,000	$ 960	$ 500	Now	488	12,936	$ 29,859	2.8	2.7
		Solar Walls	$ 100,000	$ 8,000	$ -	Now	488	12,936	-$ 60,924	20.3	0.4
		Ventilation & Heat Recovery Optimization	$ 25,000	$ 1,600	$ 200	Now	553	14,661	$ 25,050	4.6	1.9
		Warehouse loading dock seals	$ 10,000	$ 5,000	$ 500	Now	163	4,312	-$ 7,286	12.2	0.6
		Air curtains	$ 13,000	$ 2,000	$ 500	Now	163	4,312	-$ 5,091	12.2	0.7
		Air compressor heat recovery	$ 18,000	$ 2,500	$ 500	Now	488	12,936	$ 22,319	4.4	1.9
		Destratification fans	$ 10,000	$ 800	$ -	Now	260	6,899	$ 14,307	3.8	2.3
	Medium (2 MMBTU)	Radiant heaters	$ 70,000	$ 10,000	$ 1,000	Now	2,031	53,899	$ 107,635	3.8	2.2
		Automated temperature control	$ 29,000	$ 2,320	$ 500	Now	1,219	32,340	$ 82,112	2.5	3.3
		Solar Walls	$ 175,000	$ 14,000	$ -	Now	1,219	32,340	-$ 71,311	14.2	0.6
		Ventilation & Heat Recovery Optimization	$ 70,000	$ 12,000	$ 1,000	Now	1,381	36,652	$ 42,868	5.9	1.5
		Warehouse loading dock seals	$ 20,000	$ 4,000	$ 500	Now	406	10,780	-$ 107	6.2	1.0
		Air curtains	$ 18,000	$ 1,440	$ 500	Now	406	10,780	$ 11,037	5.1	1.5
		Air compressor heat recovery	$ 45,000	$ 3,500	$ 1,000	Now	1,219	32,340	$ 60,676	4.0	2.1
		Destratification fans	$ 25,000	$ 2,000	$ 500	Now	650	17,248	$ 31,511	4.2	2.0
	Large (5 MMBTU)	Radiant heaters	$ 200,000	$ 20,000	$ 5,000	Now	5,079	134,749	$ 227,804	4.5	1.9
		Automated temperature control	$ 70,000	$ 5,600	$ 1,000	Now	3,047	80,849	$ 210,110	2.4	3.5
		Solar Walls	$ 250,000	$ 20,000	$ -	Now	3,047	80,849	$ 24,223	8.1	1.1
		Ventilation & Heat Recovery Optimization	$ 150,000	$ 15,000	$ 1,000	Now	3,454	91,629	$ 159,939	4.5	1.9
		Warehouse loading dock seals	$ 40,000	$ 8,000	$ 1,000	Now	1,016	26,950	$ 13,269	4.9	1.2
		Air curtains	$ 40,000	$ 7,000	$ 1,000	Now	1,016	26,950	$ 31,095	4.8	1.6
		Air compressor heat recovery	$ 100,000	$ 10,000	$ 2,000	Now	3,047	80,849	$ 167,196	3.6	2.3
		Destratification fans	$ 60,000	$ 4,800	$ 2,000	Now	1,625	43,120	$ 75,092	4.3	1.9

Appendix D-9

Industrial Sector TRC Calculation – Transportation & Machinery

End Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
System	Medium	Integrated control system	$ 165,000	$ 13,200	N/A	Now	64,000	1,698,063	$ 4,069,396	0.3	23.8
		Sub-metering	$ 330,000	$ 33,000	$ 3,300	Now	40,000	1,061,289	$ 2,986,829	0.8	8.7
Boiler	Small (200 BHP)	Economizer	$ 27,000	$ 3,000	$ 1,000	Now	1,239	32,886	$ 81,164.60	2.5	3.1
		Blowdown heat recovery	$ 23,000	$ 2,000	$ 1,000	Now	620	16,443	$ 26,326	4.5	1.8
		Boiler combustion air preheat	$ 50,000	$ 10,000	$ 2,000	Now	1,549	41,108	$ 55,512	4.2	1.7
		Process heat recovery to preheat makeup water	$ 70,000	$ 8,000	$ 1,500	Now	1,859	49,329	$ 88,747	4.2	2.0
		Condensing boiler	$ 120,000	$ 20,000	$ 1,000	EOL	3,099	82,216	$ 250,682	1.9	6.2
		Direct contact hot water heaters	$ 75,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 329,736	0.1	N/A
		Boiler right sizing and load management	$ 70,000	$ 13,000	-$ 3,000	EOL	3,099	82,216	$ 334,736	0.0	N/A
		High efficiency burners	$ 48,000	$ 6,000	$ -	Now	1,549	41,108	$ 95,598	3.2	2.8
		Insulation	$ 20,000	$ 1,500	$ 150	Now	1,549	41,108	$ 108,083	1.3	5.8
		Advanced boiler controls	$ 40,000	$ 1,200	$ 150	Now	930	24,665	$ 36,093	4.1	1.9
		Blowdown control	$ 35,000	$ 3,500	$ 600	Now	310	8,222	-$ 13,689	14.1	0.7
		Boiler water treatment	$ 10,000	$ 2,000	$ 500	Now	310	8,222	$ 5,493	4.3	1.4
		Boiler maintenance	$ -	$ -	$ 8,000	Now	1,549	41,108	$ 31,489	0.9	2.0
		Minimize deaerator vent losses	$ 35,000	$ 3,500	$ 600	Now	620	16,443	$ 16,231	6.4	1.4
		Condensate return	$ 40,000	$ 8,000	$ 700	Now	620	16,443	$ 5,880	8.0	1.1
		Steam trap survey and repair	$ 20,000	$ 1,000	$ -	Now	1,239	32,886	$ 11,628	1.6	1.6
		Instantaneous Steam Generation	$ 120,000	$ 20,000	$ 1,000	EOL	4,648	123,323	$ 344,565	1.2	8.2
	Medium (450 BHP)	Economizer	$ 55,000	$ 4,400	$ 1,000	Now	3,137	83,243	$ 235,022	1.8	4.5
		Blowdown heat recovery	$ 50,000	$ 4,000	$ 1,000	Now	1,569	41,622	$ 88,954	3.4	2.4
		Boiler combustion air preheat	$ 140,000	$ 21,000	$ 5,000	Now	3,922	104,054	$ 131,864	4.4	1.7
		Process heat recovery to preheat makeup water	$ 130,000	$ 15,000	$ 1,800	Now	4,706	124,865	$ 294,079	3.0	2.8
		Condensing boiler	$ 180,000	$ 15,000	$ 2,800	EOL	7,844	208,108	$ 688,500	0.8	11.0
		Direct contact hot water heaters	$ 130,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 804,906	0.1	N/A
		Boiler right sizing and load management	$ 125,000	$ 20,000	-$ 5,000	EOL	7,844	208,108	$ 809,906	0.1	N/A
		High efficiency burners	$ 90,000	$ 10,000	$ -	Now	3,922	104,054	$ 278,669	2.3	3.8
		Insulation	$ 35,000	$ 2,800	$ 1,000	Now	3,922	104,054	$ 285,489	0.9	7.3
		Advanced boiler controls	$ 75,000	$ 6,500	$ 800	Now	2,353	62,432	$ 110,952	3.3	2.3
		Blowdown control	$ 60,000	$ 6,000	$ 1,000	Now	784	20,811	$ 1,220	8.9	1.0
		Boiler water treatment	$ 20,000	$ 3,500	$ 1,000	Now	784	20,811	$ 22,412	3.2	1.8
		Boiler maintenance	$ -	$ -	$ 13,000	Now	3,922	104,054	$ 107,189	0.4	3.2
		Minimize deaerator vent losses	$ 60,000	$ 6,000	$ 1,000	Now	1,569	41,622	$ 76,954	4.2	2.0
		Condensate return	$ 80,000	$ 15,000	$ 1,200	Now	1,569	41,622	$ 46,251	6.1	1.4
		Steam trap survey and repair	$ 35,000	$ 1,500	$ -	Now	3,137	83,243	$ 46,089	1.1	2.3
		Instantaneous Steam Generation	$ 180,000	$ 28,000	$ 1,500	EOL	11,765	312,162	$ 936,275	0.6	17.6
	Large (3,000 BHP)	Economizer	$ 350,000	$ 40,000	$ 2,000	Now	32,536	863,263	$ 2,734,525	1.1	7.7
		Blowdown heat recovery	$ 200,000	$ 25,000	$ 5,000	Now	16,268	431,632	$ 1,303,208	1.3	5.9
		Boiler combustion air preheat	$ 500,000	$ 60,000	$ 7,000	Now	40,670	1,079,079	$ 2,818,259	1.3	5.6
		Process heat recovery to preheat makeup water	$ 400,000	$ 50,000	$ 5,000	Now	48,805	1,294,895	$ 4,219,760	0.9	9.6
		Boiler right sizing and load management	$ 2,700,000	$ 150,000	-$ 10,000	EOL	81,341	2,158,158	$ 8,039,015	0.0	N/A
		High efficiency burners	$ 400,000	$ 60,000	$ -	Now	40,670	1,079,079	$ 3,466,940	1.0	8.5
		Insulation	$ 150,000	$ 30,000	$ 1,500	Now	40,670	1,079,079	$ 3,240,092	0.4	17.9
		Advanced boiler controls	$ 200,000	$ 40,000	$ 3,000	Now	24,402	647,448	$ 1,796,082	0.9	7.8
		Blowdown control	$ 120,000	$ 12,000	$ 2,000	Now	8,134	215,816	$ 636,361	1.5	5.3
		Boiler water treatment	$ 50,000	$ 8,000	$ 3,000	Now	8,134	215,816	$ 463,416	0.7	7.1
		Boiler maintenance	$ -	$ -	$ 30,000	Now	40,670	1,079,079	$ 1,508,925	0.1	14.3
		Minimize deaerator vent losses	$ 150,000	$ 15,000	$ 2,000	Now	16,268	431,632	$ 1,388,749	1.0	8.6
		Condensate return	$ 350,000	$ 80,000	$ 10,000	Now	16,268	431,632	$ 1,055,640	2.6	3.0
		Steam trap survey and repair	$ 200,000	$ 30,000	$ -	Now	32,536	863,263	$ 626,482	0.6	3.7

End-Use	Facility Size Category	Measure	Measure Capital Cost (Full)	Installation / Engineering Cost (Full)	Incremental Annual O&M Cost	Now/ EOL	Annual Gas Savings (GJ)	Annual Gas Savings (m3)	Net Measure TRC	Simple Payback Period (Yrs)	B/C Ratio
Process Direct Heat	Small (2 MMBTU)	Exhaust gas heat recovery	$ 30,000	$ 5,000	$ 1,000	Now	1,421	37,699	$ 77,277	2.5	2.8
		High efficiency burners and burner controls	$ 15,000	$ 2,000	$ -	Now	947	25,133	$ 74,461	1.6	5.4
		Insulation	$ 8,000	$ 500	$ 300	Now	474	12,566	$ 29,179	1.8	3.7
		High efficiency ovens	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		High efficiency dryers	$ 18,000	$ 2,000	$ -	Now	1,137	30,159	$ 89,754	1.6	5.5
		Air curtains	$ 15,000	$ 2,000	$ 1,000	Now	1,421	37,699	$ 111,679	1.2	5.4
	Medium (20 MMBTU)	Exhaust gas heat recovery	$ 120,000	$ 35,000	$ 3,000	Now	15,985	424,112	$ 1,170,870	0.9	7.6
		High efficiency burners and burner	$ 60,000	$ 4,000	$ -	Now	10,657	282,741	$ 964,941	0.6	16.1
		Insulation	$ 40,000	$ 3,000	$ 1,000	Now	5,328	141,371	$ 398,957	0.8	8.9
		Advanced heating and process controls	$ 100,000	$ 25,000	$ 3,000	Now	10,657	282,741	$ 751,307	1.1	6.1
		High efficiency ovens	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High efficiency dryers	$ 100,000	$ 15,000	$ -	Now	12,788	339,290	$ 1,119,729	0.8	10.7
		High Efficiency kilns	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		High Efficiency Furnaces	$ 100,000	$ 15,000	$ -	Now	14,919	395,838	$ 1,325,517	0.7	12.5
		Air curtains	$ 80,000	$ 18,000	$ 1,000	Now	15,985	424,112	$ 1,436,897	0.6	14.5
	Large (100 MMBTU)	Exhaust gas heat recovery	$ 900,000	$ 180,000	$ 10,000	Now	124,326	3,298,649	$ 9,333,733	0.8	9.1
		High efficiency burners and burner	$ 500,000	$ 80,000	$ 5,000	Now	82,884	2,199,099	$ 7,380,303	0.7	12.9
		Insulation	$ 250,000	$ 30,000	$ 2,000	Now	41,442	1,099,550	$ 3,201,386	0.6	11.8
		Advanced heating and process controls	$ 500,000	$ 6,500	$ 8,000	Now	82,884	2,199,099	$ 6,425,848	0.6	12.3
		High efficiency ovens	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High efficiency dryers	$ 1,000,000	$ 100,000	$ -	Now	99,461	2,638,919	$ 8,503,445	1.0	8.7
		High Efficiency kilns	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
		High Efficiency Furnaces	$ 1,000,000	$ 100,000	$ -	Now	116,038	3,078,739	$ 10,104,019	0.9	10.2
Other Process	Medium (20 MMTBU)	Pollution control measures	$ 80,000	$ 6,400	$ 20,000	Now	10,657	282,741	$ 772,269	1.1	4.0
		Hydrogen Atmospheres for Steel Batch Coil Annealing	$ 250,000	$ 60,000	$ 3,000	Now	31,970	848,224	$ 2,364,557	0.9	8.1
		Process Heat Recovery	$ 300,000	$ 60,000	$ 10,000	Now	15,985	424,112	$ 912,627	2.3	3.1
	Large (100 MMBTU)	Pollution control measures	$ 1,000,000	$ 80,000	$ 125,000	Now	82,884	2,199,099	$ 5,858,675	1.5	3.7
		Hydrogen Atmospheres for Steel Batch Coil Annealing	$ 2,000,000	$ 160,000	$ 10,000	Now	248,652	6,597,298	$ 18,743,528	0.8	9.4
		Process Heat Recovery	$ 1,000,000	$ 150,000	$ 25,000	Now	124,326	3,298,649	$ 9,149,642	0.9	7.8
HVAC	Small (0.8 MMBTU)	Radiant heaters	$ 30,000	$ 4,000	$ 1,000	Now	813	21,560	$ 35,946	4.5	1.8
		Automated temperature control	$ 12,000	$ 960	$ 500	Now	488	12,936	$ 29,859	2.8	2.7
		Solar Walls	$ 100,000	$ 8,000	$ -	Now	488	12,936	-$ 60,924	20.3	0.4
		Ventilation & Heat Recovery Optimization	$ 25,000	$ 1,600	$ 200	Now	553	14,661	$ 25,050	4.6	1.9
		Warehouse loading dock seals	$ 10,000	$ 5,000	$ 500	Now	163	4,312	-$ 7,286	12.2	0.6
		Air curtains	$ 13,000	$ 2,000	$ 500	Now	163	4,312	-$ 5,091	12.2	0.7
		Air compressor heat recovery	$ 18,000	$ 2,500	$ 500	Now	488	12,936	$ 22,319	4.4	1.9
		Destratification fans	$ 10,000	$ 800	$ -	Now	260	6,899	$ 14,307	3.8	2.3
	Medium (2 MMBTU)	Radiant heaters	$ 70,000	$ 10,000	$ 1,000	Now	2,031	53,899	$ 107,635	3.8	2.2
		Automated temperature control	$ 29,000	$ 2,320	$ 500	Now	1,219	32,340	$ 82,112	2.5	3.3
		Solar Walls	$ 175,000	$ 14,000	$ -	Now	1,219	32,340	-$ 71,311	14.2	0.6
		Ventilation & Heat Recovery Optimization	$ 70,000	$ 12,000	$ 1,000	Now	1,381	36,652	$ 42,868	5.9	1.5
		Warehouse loading dock seals	$ 20,000	$ 4,000	$ 500	Now	406	10,780	-$ 107	6.2	1.0
		Air curtains	$ 18,000	$ 1,440	$ 500	Now	406	10,780	$ 11,037	5.1	1.5
		Air compressor heat recovery	$ 45,000	$ 3,500	$ 1,000	Now	1,219	32,340	$ 60,676	4.0	2.1
		Destratification fans	$ 25,000	$ 2,000	$ 500	Now	650	17,248	$ 31,511	4.2	2.0
	Large (5 MMBTU)	Radiant heaters	$ 200,000	$ 20,000	$ 5,000	Now	5,079	134,749	$ 227,804	4.5	1.9
		Automated temperature control	$ 70,000	$ 5,600	$ 1,000	Now	3,047	80,849	$ 210,110	2.4	3.5
		Solar Walls	$ 250,000	$ 20,000	$ -	Now	3,047	80,849	$ 24,223	8.1	1.1
		Ventilation & Heat Recovery Optimization	$ 150,000	$ 15,000	$ 1,000	Now	3,454	91,629	$ 159,939	4.5	1.9
		Warehouse loading dock seals	$ 40,000	$ 8,000	$ 1,000	Now	1,016	26,950	$ 13,269	4.9	1.2
		Air curtains	$ 40,000	$ 7,000	$ 1,000	Now	1,016	26,950	$ 31,095	4.8	1.6
		Air compressor heat recovery	$ 100,000	$ 10,000	$ 2,000	Now	3,047	80,849	$ 167,196	3.6	2.3
		Destratification fans	$ 60,000	$ 4,800	$ 2,000	Now	1,625	43,120	$ 75,092	4.3	1.9

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APPENDIX E

Industrial Achievable Workshop Opportunities Profiles

Industrial Opportunity 1:
Steam Trap Survey & Repair

- Technology Description
  - Traps provide for condensate removal with little or no steam loss
  - If the traps do not function properly, excess steam will flow through the end-use device or the condensate will back up into it
- Discussion “Typical” Application:
  - Typical boiler size of 1.5 to 250 MMBTU
  - Measure life of 3 years

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Industrial Opportunity 1:
Steam Trap Survey & Repair

- Financial & Economic Indicators
  - Capital Cost of $4,000 – $1,000,000
  - Simple Payback Period of 1.5 years
  - Benefit to Cost Ratio of 2.9
  - Potential savings: 2% - 8%
- Basis of assessment = Full cost (retrofit)
- Discussion Sub Sector: Food (small, medium, and large)
- Approximate Total Sites = 500
- Approximate Eligible Sites = 260

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Industrial Opportunity 2: First Generation Super Boilers

- Technology Description
  - Two-stage firetube design and a transport membrane condenser and compact air heater
  - Also includes compact convective zones with intensive heat transfer, and a staged/intercooled combustion system for ultra-low emissions
  - Currently in the early stages of commercialization
- Discussion "Typical" Application:
  - Typical boiler size of 1.5 to 250 MMBTU
  - Measure life of 20 years

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Industrial Opportunity 2: First Generation Super Boilers

- Financial & Economic Indicators
  - Capital Cost of $200,000 - $3,800,0000
  - Operation and Maintenance Cost of $500 - 3,000
  - Simple Payback Period of 6.8
  - Benefit to Cost Ratio of 2.6
  - Potential savings: 10% - 20%
- Basis of assessment = Incremental Cost (EOL)
- Discussion Sub Sector: Food (large)
- Approximate Total Boilers = 50
- Approximate Eligible Boilers = 48

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Industrial Opportunity 3: Boiler High-efficiency Burners and Boiler Controls

- Technology Description
  - Efficient burner technology based on design and power injection to optimize fuel-air ratio throughout firing range
  - Boiler controls include linkage-less controls and servomotors to independently control the fuel and air, and combustion control based on flue gas monitoring
- Discussion "Typical" Application:
  - Typical size of 2 to 250 MMBTU/h
  - Measure life of 20 years

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Industrial Opportunity 3: Boiler High-efficiency Burners and Boiler Controls

- Financial & Economic Indicators
  - Capital Cost of $15,000 - $ 250,000
  - Simple Payback Period of 1.0 year
  - Benefit to Cost Ratio of 1.3
  - Potential savings: 1% - 6%
- Basis of assessment = Full cost (retrofit)
- Discussion Sub Sector: Food (small, medium, and large)
- Approximate Total Boilers = 400-500
- Approximate Eligible Boilers = 300-380

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Industrial Opportunity 4:
High-efficiency Ovens

- Technology Description
  - Advances in oven energy efficiency are primarily related to improved control systems, improved combustion efficiency, reduced energy losses, optimize uniform heating and reclaiming heat from exhaust gas
- Discussion "Typical" Application:
  - Typical oven size of 1.5 to 250 MMBTU/h
  - Measure life of 20 years

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Industrial Opportunity 4:
High-efficiency Ovens

- Financial & Economic Indicators
  - Capital Cost of $285,000 - $ 4,000,000
  - Simple Payback Period of 3.1 years
  - Benefit to Cost Ratio of 9.9
  - Potential savings: 5% - 20%
- Basis of assessment = Incremental Cost (retrofit)
- Discussion Sub Sector: Food (small, medium, and large)
- Approximate Total Sites = 170 - 200
- Approximate Eligible Boilers = 150 - 175

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Industrial Opportunity 5: Standard and Condensing Economizers

- Technology Description
  - Heat exchanger that is designed to use heat from hot boiler flue gases to preheat water
  - These installations have become more economical as energy prices have risen and smaller, lighter, and more durable economizers have been developed
  - A condensing economizer improves the effectiveness of reclaiming flue gas heat by cooling the flue gas below the dewpoint
- Discussion "Typical" Application:
  - Typical boiler size of 1.5 to 250 MMBTU
  - Measure life of 20 years

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Industrial Opportunity 5: Standard and Condensing Economizers

- Financial & Economic Indicators
  - Capital Cost of $25,000 - $100,000
  - Simple Payback Period of 3 - 5 years
  - Benefit to Cost Ratio of 2.3
  - Potential savings: 3% - 10%
- Basis of assessment = Full cost (retrofit)
- Discussion Sub Sector: Food (small, medium, & large)
- Approx. Total Boilers = 350 - 450
- Approx. Eligible Boilers = 25-35 (standard economizer)
- Approx. Eligible Boilers = 150-200 (condensing economizer)

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Industrial Opportunity 6: Process Heat Recovery

- Technology Description
  - The use of waste heat from industrial processes (heat source) to heat other process, or utility streams (heat sink)
  - Depends on quality of the heat (high-grade or low-grade heat), the distance between the heat source and heat sink, potential cross contamination of product, properties of the process stream (such as corrosiveness), the flow rates of the streams, and the fluctuation in the flow rates
- Discussion “Typical” Application:
  - Typical process unit size of 20 to 250 MMBTU/h
  - Measure life of 15 years

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Industrial Opportunity 6: Process Heat Recovery

- Financial & Economic Indicators
  - Capital Cost of $30,000 – $1,000,000
  - Operation and Maintenance Cost of $1,000 - 10,000
  - Simple Payback Period of 1-5 years
  - Benefit to Cost Ratio of 5.6
  - Potential savings: 5% - 20%
- Basis of assessment = Full cost (retrofit)
- Discussion Sub Sector: Chemical (small, medium, & large)
- Approx. Total Sites = 350-400
- Approx. Eligible Sites = 200-240 (high-grade heat)
- Approx. Eligible Sites = 310-360 (low-grade heat)

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Industrial Opportunity 7: Process Integration & Pinch Analysis

- Technology Description
  - Systematic and methodical techniques for designing a process and/or appropriate heat exchanger network to optimize industrial processes involving heat transfer between either process streams or between a utility stream and a process stream
  - Pinch analysis involves calculating thermodynamically attainable energy targets for a given process and then identifying how to achieve them
- Discussion "Typical" Application:
  - Applied to medium and large facilities
  - Measure life of 5 years

Industrial Opportunity 7: Process Integration & Pinch Analysis

- Financial & Economic Indicators
  - Capital Cost of $100,000 - $350,000
  - Simple Payback Period of 0.5 years
  - Benefit to Cost Ratio of 10.8
  - Potential savings: materialized through implementation of other measures (e.g. process heat recovery)
- Basis of assessment = Incremental Cost (retrofit)
- Discussion Sub Sector: Food (large)
- Approximate Total Sites = 35
- Approximate Eligible Sites = 32