Appendix 2-6:
Distribution System Plan

TABLE OF CONTENTS

List of Appendices

LIST OF TABLES

List of Figures

Foreword

The context for this Distribution System Plan (DSP) is the Ontario Energy Board's (OEB) Renewed Regulatory Framework for Electricity Distributors (RRFE) and the Filing Requirements for Electricity Transmission and Distribution Applications Consolidated Distribution System Plan Filing Requirements (Chapter 5). The main theme of the RRFE can be summarized in the following quote from the Report of the Board:

> *"The renewed regulatory framework is a comprehensive* ***performance-based*** *approach to regulation that is based on the* ***achievement of outcomes*** *that ensure that Ontario's electricity system provides* ***value for money for customers****. The Board believes that* ***emphasizing results*** *rather than activities, will better* ***respond to customer preferences****, enhance distributor* ***productivity*** *and promote* ***innovation."*** *[emphasis added]*

London Hydro has a long history of responding to customer preferences. When polled, using a variety of methods, customers in London, like those across Canada, have consistently expressed their two top priorities with respect to the supply of electricity – reliability and low cost. Over the past ten years, targeted investments in London Hydro's infrastructure have resulted in improved reliability from an average of 3 interruptions per year for the typical customer in the mid 1990's to approximately 1.5 interruptions per year in the mid 2010's. London Hydro seeks feedback from its customers in a number of ways: senior management goes out into the community by organizing events at local home shows, in libraries and malls; we hold focus groups and we conduct annual third-party surveys. Through these avenues and others, our customers have expressed satisfaction with this level of reliability, and they support London Hydro's efforts to continue to maintain the system.

During this same time period, London Hydro's costs have remained competitive and are now within the bottom quartile of all Ontario LDCs. This result has been achieved by investing in our people, which includes the safety of our employees and the public, and fostering a culture of continuous improvement and innovation. The distribution assets are monitored and optimized to minimize total lifecycle cost while still maintaining acceptable reliability levels. New technology is evaluated, tested and adopted only after it has been proven to provide a net benefit to customers. Projects are managed and executed by skilled professionals who receive on-going training and development, including sharing best practices with other utilities in Ontario and across North America.

While reliability and low cost are important attributes of customer expectations, we also understand the need to incorporate advancements in technology into both the distribution network and customer interfaces. In the distribution area, for example, we have launched an outage management system that provides enhanced safety and improved operability (reliability) as well as improved outage notification options all aimed at enhancing the customer experience. With respect to customer interfaces, we have strengthened our online service offerings by increasing self-service options. London Hydro has also been a leader in innovation with the development of on-line tools aimed at providing more comprehensive and more current information to customers, including the recent Green Button initiative. We capitalize on existing industry relationships and seek to build new ones in order to facilitate the adoption of the Green Button Standard at other utilities. We also seek opportunities to share our expertise with other utilities and encourage cooperative ventures such as providing control room monitoring services for some smaller LDCs, which gives their customers superior service at lower cost while offsetting the cost to our own customers.

In an effort to better understand the value that customers receive from reliability improvements, London Hydro retained a consultant who identified a methodology to estimate the avoided cost to customers based on projected outages that are prevented.[1] While this analysis is still being developed, the preliminary results show that the value to customers for improved reliability exceeds the capital costs associated with the projects London Hydro has selected to maintain and continuously improve reliability. London Hydro will be working to refine and validate this analysis in the coming years. Feedback on this new methodology from industry stakeholders is welcomed and encouraged.

This DSP has been prepared and reviewed by a team of experts comprised of internal and external professionals. These individuals have expertise in reliability analysis, system planning and design, asset management, project execution, customer engagement, information technology, regulatory requirements and industry best practices. A listing of these resources and their contributions is included in Appendix P.

In summary, London Hydro has prepared a comprehensive plan that aligns with the four Performance Outcomes identified by the OEB – Customer Focus, Operational Effectiveness, Public Policy Responsiveness and Financial Performance. Our team of over 300 high-performing employees will successfully execute this plan in the coming years with a focus on achieving those Performance Outcomes while exceeding our customers' expectations.

In the spirit of continuous improvement, we look forward to hearing comments and suggestions for additional ways in which we can "keep the lights on and costs low" while engaging our customers in the evolving energy landscape, with all the challenges and opportunities it presents.

Vinay Sharma, CEO

[1] See Appendix B

Executive Summary

This Distribution System Plan (DSP) covers the Historical Period and Bridge Year: 2012 – 2016 and the Test Year and Forecast Period: 2017 – 2021. The projects and programs that have been selected for the Bridge Year and Test Year (and are expected to continue through to 2021) are the ones that London Hydro expects will provide the most value to our customers and respond to their stated preferences.

Customer engagement consistently identifies reliable supply and low cost as the most important aspects of what we provide to our community. With this in mind, our team continues to focus on identifying assets most at risk of failure and replacing or refurbishing them at the most appropriate time while balancing safety, reliability and cost. We also take a long term view of the future of the grid to ensure that the reliable supply will continue to be available when it is needed, and work that is done today will support what needs to be done tomorrow.

While a significant portion of this DSP is focused on the distribution assets, other projects have been included that provide value to our customers in terms of enhanced and expanded services and that allow London Hydro to work safely, efficiently and effectively.

To help our team understand how system reliability improvements provide real value to our customers, an external expert was retained to review industry best practices and recommend a methodology for estimating the savings to customers by preventing future outages. While this calculation has been referred to in some studies as the Customer Cost of Outages, or Value of Lost Load (VOLL), London Hydro prefers to consider it the Customer Value of Reliability Improvements (CVRI). The impact of an outage to a customer depends on several factors, including when the outage occurs, how long it lasts, and how the customer uses electricity. A brief outage to a typical residential customer will have little if any impact while the same outage to a manufacturing plant could cost it thousands of dollars. Historically, a residential customer and an industrial customer have been treated equally in the recording of outage statistics. As a result, reliability improvements have been focused on the ones that would save the most customer minutes of outage and prevent outages to large groups of customers regardless of the impact of an outage on those customers. Yet intuitively and through feedback from customers, we know the impact is not equal for these different types of customer, so a different evaluation method was sought to try to account for differences in customers and set priorities based on the value delivered to customers through the various projects and programs.

Using CVRI as a tool to refine the selection of projects is a work in progress. For this DSP, London Hydro has performed a rough analysis of the projects and programs selected for 2016 and 2017, and the initial result is that the aggregate CVRI exceeds London Hydro's capital investment in distribution system assets for both years. Details on the methodology and results are included in Section 3.5, "Justifying Capital Expenditures" (5.4.5) with the background material found in Appendix B. In parallel with this Cost of Service Rate Application, London Hydro will continue to refine the analysis and validate the results with stakeholders. In applying CVRI, care will be taken to ensure that cross-subsidization among Customer Groups is minimized.

The focus of spending for the next five years will continue to be on System Renewal and System Access projects that address aging infrastructure, safety and reliability risks and provide capacity for future growth.

A significant portion of the capital spending will be directed to London's downtown. The downtown core of London is unique in a number of ways: it is supplied by a mix of different voltages[2] and distribution systems[3]; much of the infrastructure is over 50 years old; and City Planners and Developers are implementing a plan that will see further intensification of the load in the downtown core, which will also have an impact on the supporting structures (vaults, duct banks) and locations for future feeders. The supply to the downtown has been under review by our team for over 20 years as the City evolved and the supply points (transformer stations) from Hydro One approached end of life. Originally, two transformer stations supplied the downtown 13.8 kV system – Nelson and Highbury.

In the early 1990s, Ontario Hydro advised London Hydro that when the Highbury TS reached end of life, it would be converted to 27.6 kV, which is the standard distribution voltage for most of London and the surrounding area. Along with the conversion of Highbury TS to 27.6 kV in 1999, London Hydro initiated a long range plan to eliminate 13.8 kV from the downtown when the Nelson TS would be converted to 27.6 kV. During the subsequent years, some load in the downtown was converted to 27.6 kV when opportunities such as a building redevelopment took place. Through regular consultations, Hydro One and London Hydro worked cooperatively on a plan that would ensure the transition from 13.8 kV to 27.6 kV would be completed in a way that minimized risk to customers and workers and would provide the best long-term solution with the lowest cost. With the conversion of Nelson TS expected to be completed in 2018, it has become necessary to accelerate the pace of work in the downtown, which is adding to the normal amount of capital work done by London Hydro over the next five years. When this major project is complete, the downtown core will be served by a more reliable supply and capacity will be available to meet anticipated load growth for many years to come.

This DSP follows the outline provided in the OEB Chapter 5 Consolidated Distribution System Plan Filing Requirements. For ease of reference, the sections of the DSP are numbered sequentially (from 1.1 to 3.2) with the corresponding Chapter 5 Sections provided in parentheses, such as *1.1 Distribution System Plan Overview (5.2.1)*. The *Foreword* and this *Executive Summary* have been added to introduce the reader to the London Hydro DSP. Unless otherwise stated, references to an Appendix will direct the reader to an Appendix at the end of the DSP. References to other Exhibits in the Cost of Service Rate Application are clearly noted (e.g., *Exhibit 1 Administration Appendix 2-AC, Tab 6, Schedule 1, "Customer Engagement"*).

[2] 13.8 kV and 27.6 kV
[3] 120/208 V network, 120/208 V and 347/600 V spot networks, 13.8 kV non-network, and standard 27.6 kV connections

1.1 Distribution System Plan Overview

From OEB Filing Guidelines 5.2.1

a) Key elements of the plan that affect its rates proposal, especially prospective business conditions driving the size and mix of capital investments needed to achieve planning objectives
b) Sources of cost savings expected to be achieved over the forecast period through good planning and DS Plan execution
c) Period covered by the plan (historical and forecast years)
d) Vintage of information on investment 'drivers' used to justify investments identified in the application (i.e. the information should be considered "current" as of what date?)
e) Changes in asset mgt. process (e.g. enhanced asset data quality or scope; improved analytic tools; process refinements; etc.) since the last DS Plan filing
f) Dependent events aspects of the DS Plan that relate to or are contingent upon the outcome of ongoing activities or future events, the nature of the activity (e.g. Regional Planning Process) or event (Board decision on LTLT) and the expected dates by which such outcomes are expected or will be known

1.1 Distribution System Plan Overview (5.2.1)

With this Distribution System Plan, London Hydro has fully incorporated the Ontario Energy Board Outcomes as outlined in the RRFE Report issued in 2012. These Outcomes have shaped high level strategies (Mission, Vision, Values, and Strategic Plan) and the objectives and principles used to evaluate performance, select appropriate solutions and create this Distribution System Plan. As a result, the output of the DSP (Capital and Maintenance Plans) can be directly linked to one or more of the Outcomes and London Hydro's Strategic Plan[4].

Section 2.1 (5.3.1) provides a detailed explanation of how this alignment has been achieved, which is summarized in Table 1 below.

	OEB PERFORMANCE OUTCOMES			
	CUSTOMER FOCUS	**OPERATIONAL EFFECTIVENESS**	**PUBLIC POLICY RESPONSIVENESS**	**FINANCIAL PERFORMANCE**
Objectives	Customer Focus, Capacity, Reliability, Costs	Safety, Capacity, Reliability, Losses	Safety, Regulatory, Environmental	Capacity, Losses, Costs
Principles	Quality Services, Growth, Revitalize Core	Quality Services, Growth, Revitalize Core	Quality Services	Growth
Mission	Customer Service, Competitive Rates, Reliability, Safety	Safety, Reliability	Safety	Competitive Rates, Safety
Vision	Customer Service, Community Value, Growth	Innovation	Community Value	Corporate Value
Values	Accountability, Integrity	Innovation	Social & Environmental Responsibility	Innovation, Accountability

Table 1: The Alignment of OEB Performance Outcomes and London Hydro's Corporate Statements

Understanding and responding to the preferences of our customers has been and continues to be the focus of our efforts in developing our short and long-term plans. Customers have expressed overall satisfaction with the current level of reliability and a desire to keep rates low. Additionally, they readily adopt the new and expanded services offered by London Hydro, such as web-based customer interaction applications. This combination of preferences has directed the development of this DSP to ensure spending on infrastructure is optimized and targeted at portions of the distribution system most at risk of causing reliability to deteriorate, allowing for continued development and enhancement of service offerings, while keeping rates competitive within the industry. A portion of the spending in the coming five years will be allocated to the supply to the downtown core and will address both the long-term capacity requirements and the elimination of a significant reliability risk (single supply point).

[4] Based on the current Strategic Plan, which is in effect until the end of 2016; the Strategic Plan for 2017-2021, pending Board approval, maintains these values.

The Asset Management Plan has been prepared with a vision of sustaining the assets such that they continue to perform at the present level of safety and reliability while improving cost effectiveness. For each asset type, sustainment options, such as increased maintenance, proactive and reactive replacement, and elimination / substitution are considered and evaluated. The option selected for each asset type reflects the assessment of risk and total lifecycle cost. The condition and performance of the assets are carefully monitored so that adjustments can be made to the sustainment plan to ensure safety, reliability and cost effectiveness are not compromised.

Figure 1 below summarizes the capital spending from 2012 to 2021.

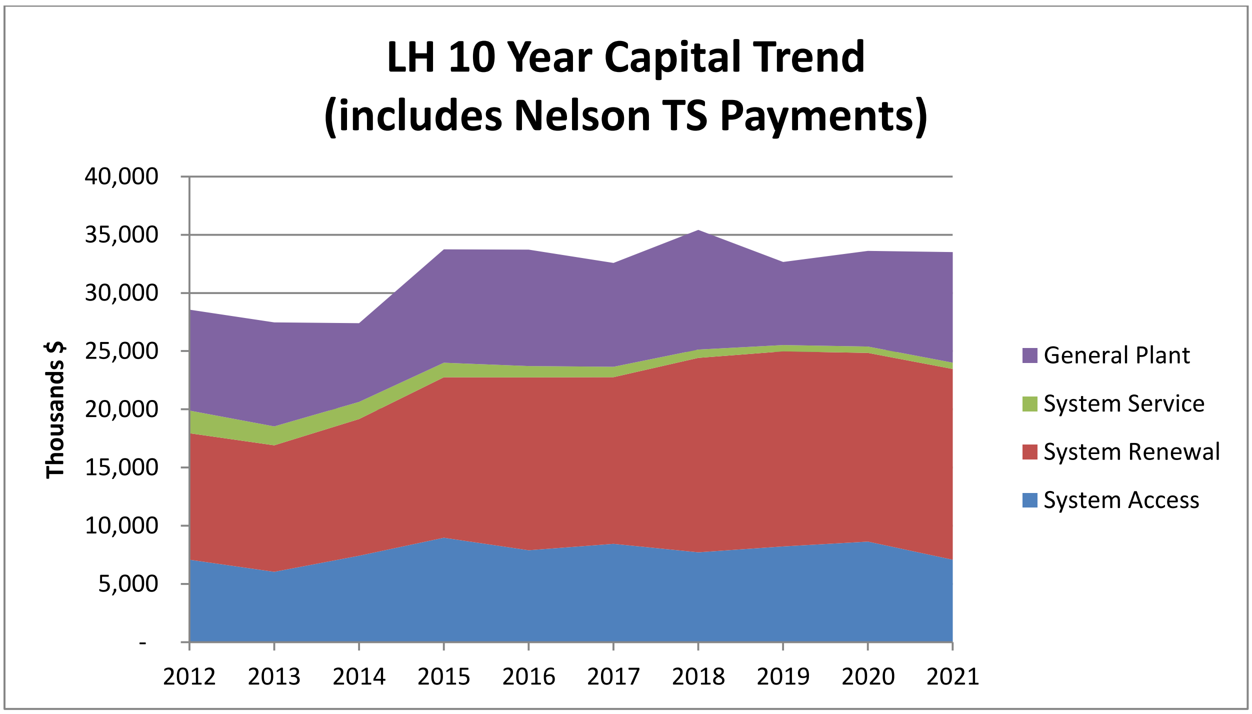


Figure 1: London Hydro 10-Year Capital Trend (includes Nelson TS Payments)

The overall trend in Capital spending for the 2012 to 2021 period is an increase from $27.8M in 2012 to $33.8M in 2021, which is an increase of about 21% (2.1% annualized growth). Part of the overall increase is the series of capital contribution payments made to Hydro One for the conversion of Nelson Transformer Station from 13.8 kV to 27.6 kV, made between 2016 and 2021[5]. Excluding the Nelson TS payments, the budget for 2021 is $32.0M or an increase of 15% over 2012 (about 1.5% per year).

System Access spending is relatively stable around 25% of total spending (excluding Nelson TS payments), with some fluctuations year over year due to the changing volume of work associated with relocations to accommodate City of London initiated projects.

[5] Scheduled Payments to Hydro One for Nelson TS are 2015 $1.6M, 2016 $1.8M, 2017 $1.8M, 2018 $1.8M, 2021 $1.5M (Total of $8.5M). These payments are included in an Advanced Capital Module (ACM) application included in Exhibit 2, Appendix 2-4.

System Service spending is expected to be minor around 2% of total spending (excluding Nelson TS payments), driven by the need to make incremental investments in distribution automation to keep technology current.

General Plant spending will typically be around 24% of total spending (excluding Nelson TS payments), with much of this focused on IT investments to address customer preferences, accommodate regulatory requirements, and make workflow more effective and efficient.

System Renewal is the area with the largest planned increase, going from 39% in 2012 to 49% in 2021 (excluding Nelson TS payments). This increase reflects the increasing volume of work that needs to be done each year to address aging infrastructure, system voltage conversion and maintain system reliability.

1.1.1 Key Elements of the DSP (5.2.1 a)

This Distribution System Plan (DSP) has been shaped by the following prospective business conditions, including

- the preferences expressed by customers,
- public and worker safety,
- challenges associated with aging infrastructure,
- a long-term approach to ensuring a reliable supply of electricity is available for present and future customers, and
- the use of technology and innovation to provide new and better service to customers and equip workers with the tools they need to effectively manage assets for optimal performance and cost.

Customer Focus

The DSP has been developed in response to what London Hydro customers have expressed are their top two priorities – maintain system reliability at the present level and keep costs as low as practical. For the past several years, customer surveys have indicated that the vast majority of customers find the existing level of reliability acceptable[6]; therefore, London Hydro has adopted an Asset Management and Asset Sustainment philosophy of planning investments that will, over time, keep the system performing at the present level. The actual performance of the system (reliability) over the past 20 years has demonstrated that the level of spending and the focus of asset replacements have been appropriate.

Knowing that the total cost of electricity is also of concern to customers, London Hydro has implemented programs aimed at optimizing spending by maximizing the useful life of assets and replacing only those that are most at risk of failure and adversely affecting reliability, safety or the environment. This optimization has kept the cost to London Hydro customers within the bottom quartile of all Ontario LDCs for the past several years.

[6] In 2015, 90% of customers surveyed agreed with the statement that London Hydro “provides consistent, reliable energy”, with an overall satisfaction rating of 85%. Only 10% felt London Hydro should invest more to prevent outages, 23% would accept lower system reliability for lower rates, while 56% felt current level of reliability was acceptable and rates should not increase to support reliability improvements. (The remaining 11% responded with “depends” or “don’t know”.)

Public and Staff Safety

The safety of the public and workers is paramount to London Hydro. The ZeroQuest Platinum safety culture that has been developed at London Hydro has been recognized by several organizations[7] and permeates the decision-making process at all levels of the organization. The on-going risk assessment of the distribution system identifies potential safety hazards to both the public and workers, and projects that reduce the safety risk are given top priority. Approximately 7% of the System Renewal Projects in the next five years are triggered as a result of this safety risk assessment[8].

Aging Infrastructure

As with most Ontario distributors, many of London Hydro's assets are approaching end of life, and maintaining system reliability has required an increase in System Renewal spending over the past ten years. System renewal continues to be the focus of investment for the next five years, representing 50% of the total capital spending. London Hydro uses a variety of tools and techniques to extend the useful life of assets and defer replacement until the most optimal time. For some assets, such as poles and underground primary cable, the quantity replaced each year is below the level indicated by the asset age pool without compromising system reliability, safety or total cost to customer. By continuously monitoring system reliability and identifying emerging trends in equipment failures, London Hydro can quickly adapt the focus of renewal spending to target areas of weakness and highest risk.

Long Term Supply

Growth in the City of London has been moderate, and in recent years, the impact of the economy (including the loss of one 8 MW Industrial Customer), Conservation and Demand Management (CDM) and Distributed Generation (DG) has offset most of the load growth associated with new customers. The supply to most of the service area is expected to be adequate for many years to come, with the exception of the downtown core. The City of London has developed a plan that will focus growth in the downtown core and the corridor north to the Masonville area. Much of this growth is expected to relate to high density, high-rise buildings downtown. London Hydro's infrastructure in the downtown core is approaching end of life, and most routes are already congested making it difficult to add new supply feeders. To alleviate this problem and to address Hydro One's end of life Nelson Transformer Station, London Hydro has agreed with Hydro One to replace the 13.8 kV supply from Nelson with 27.6 kV supply. The higher voltage will allow more load to be carried on each feeder (reducing the need for new feeder routes) and remove the final "island" of 13.8 kV distribution. The capital contribution payable to Hydro One for the voltage change at the Transformer Station and the associated voltage conversion on the distribution system represents a sizable portion of capital spending during the next five years, but it will address aging

---

[7] Safety Recognition Awards include the following: 2013 – ESA Powerline Safety, Benefits Canada Silver Award for Wellness Program, IHSA President's Award; 2014 – Canada's Safest Employer Gold Award for Utilities, Benefits Canada Gold Award for Wellness Program, IHSA President's Award; 2015 – ESA Worker Safety, Benefits Canada Silver Award for Wellness Program, IHSA President's Award, Electrical Business Magazine Safety Champion Award

[8] Examples include Explosion Limiting Maintenance Hole Covers, Replacement of Deteriorating Poles and Poles Susceptible to Pole Fires, Quick Sleeve and Porcelain Insulator Replacements, installing Station Class Arrestors on 4.16 kV under build, and Installation of Copper-Clad Steel Grounds.

infrastructure, capacity constraints and reliability issues for the downtown core, as well as reduce losses, provide capacity and backup supply to the areas surrounding downtown.

New Technology & Innovation

London Hydro has been very active in the development and use of new technology to improve customer engagement and internal business processes. The most significant initiatives are the adoption of Cloud computing, mobile computing (customers and internal business operations) and the development of the Green Button.

Cloud computing provides operational flexibility not available within the conventional model of on-site, fully-owned and supported IT assets. It transforms fixed costs to variable costs and provides for instant scaling of resources either increasing or decreasing as customer demand requires.

Mobility computing has increased customer engagement as customers have more selection and are able to conduct their business with London Hydro in the manner and medium of their choice. Additionally, they are not constrained to business hours for account and service information.

Mobility computing has had an impact on the internal business operations to perhaps an even greater extent as field crews can now converse with administrative staff in real time to exchange the most current information on equipment and work order status, service status and restoration of service priority as well as have instant access to the latest safety protocols and advisories for all field work.

London Hydro has implemented a new web portal, "MyLondonHydro," as a platform to deliver many new service options for the customer (many of which were prompted by either direct requests from customers or the identification of an opportunity to provide better service to customers), including

1. online Move in/move out or transfer of account
2. online reporting of historical and current electricity and water consumption data
3. consumption data downloads by the customer
4. paperless billing registration options
5. real time outage map
6. service notifications (power outage and restoration events, payment due) in the medium of the customer's choice (telephone/voice mail, email, social media)
7. specialized adjuncts such as property management and builders' portals
8. a loyalty plan

The Property Management Tool is one example through which London Hydro was able to develop an online process for landlords and property managers to manage the tenancy class and obtain year end reports with nil to minimal involvement of London Hydro staff. This Tool provides an enhanced level of service to this group of customers while reducing the overall cost of providing the service.

The Outage Management System, recently integrated with the SCADA, Interactive Voice Recognition (IVR) systems and Advanced Metering Infrastructure (AMI) provides the system operator with greater operational awareness and confirmation of service interruptions to the point where London Hydro can identify a service problem before a customer does. Again, the mobility aspect allows field crews to relay the effort required to restore power from the field and keep the system operator updated with current progress and updated estimates. The IVR system makes this information immediately available to the customer or alternately directs them to CSR personnel if their inquiries are not related to an outage. In this manner, many more calls may be handled than with the legacy telephone support process, especially in times of large scale outages such as winter storms.

London Hydro has demonstrated its leadership in innovation with the development of the Green Button application. The OEB had expressed its expectation that each utility provide greater customer choice and that all customers should be able to access their consumption data. With the Green Button applications, ‘Download My Data’ (DMD) and ‘Connect My Data,’ London Hydro was the first Ontario utility to meet that expectation. Furthermore, the Green Button platform exceeds the OEB’s expectation with an industry “open standard” design that enables third parties to build other customer-oriented analytical applications, supports inter-utility collaboration and, again, has fostered other “in-house” developed applications. Two such applications that London Hydro has created to support its commercial customers include the “Interval Data Centre” (IDC) and “Event Assist.” London Hydro also built the “My Account” functionality for Whitby Hydro Electric Corporation and Festival Hydro Inc. using the Green Button data.

1.1.2 Sources of Cost Savings (5.2.1 b)

London Hydro takes a long term approach to distribution planning and considers all available options (including maintenance and refurbishment) before replacing an asset. This long term view ensures that an asset is replaced only when it needs to be, and it is replaced with an asset that will deliver long-term benefits at minimal long-term cost. Where practical, work is undertaken to extend the useful life of an asset when doing so will not compromise system reliability and safety.

Residential Underground Primary Conductor

One way in which London Hydro has been able to generate sustainable savings is through the life extension of residential underground primary conductors. Rather than replace this type of cable when it reaches end of life and starts to fail, London Hydro uses silicone injection to extend the life of the cable by up to several decades. The cost of silicone injection is about one third to one half the cost of cable replacement. The primary cable is replaced with new cable only when silicone injection is not an option or no longer effective.

Wood Poles

In addition to testing wood poles to determine their residual strength, London Hydro adds a risk-based component to its testing process that adjusts the recommended retest interval. Poles that pass the test and are considered low risk (due to location or other physical factors) will have a retest interval based on age, while poles at a higher risk will be retested sooner. London Hydro has found that this process has extended the typical useful life of wood poles from 50 years to 55 years. This approach results in fewer wood poles being replaced each year than originally predicted.

Voltage Conversions

When lower voltage (4.16 kV and 13.8 kV) infrastructure approaches end of life or needs to be relocated to accommodate other work, there is often the opportunity to convert the infrastructure to a higher voltage (typically 27.6 kV). The higher voltage reduces losses associated with lines and transformers and often eliminates the need for a step-down station. The amount of money saved due to voltage conversion is difficult to estimate and is not the primary driver of conversion projects, but with each kW converted to a higher voltage, an incremental decrease in system losses is achieved. Voltage conversions also increase the capacity of feeder cables, which results in fewer circuits being needed to supply the same amount of load. This benefit is most apparent in the downtown core where space is very limited for installing new underground infrastructure (ducts, vaults and maintenance chambers). Converting the 13.8 kV feeders to 27.6 kV will double the amount of load that can be supplied by each cable, which means fewer ducts and less space in vaults and chambers are needed and associated maintenance costs are reduced.

Furthermore, material savings are achieved when transformers that are removed from the 4.16 kV and 13.8 kV conversion projects are rebuilt at 27.6 kV for use on future rebuilds and/or expansions. Capital cost savings of up to two-thirds of the price of a new transformer can be achieved when retrofitting from 4.16 kV to 27.6 kV instead of purchasing new transformers.

Automation

To the extent that there are proven benefits for each investment, London Hydro increases the level of automation in the distribution system every year. This increase includes upgrades to protection and control devices (relays, RTUs, batteries), communication systems, metering and automated/remote switching (reclosers). These investments reduce the need to dispatch workers to complete various tasks, which has a positive impact on operating and maintenance costs.

Fleet

London Hydro has been utilizing the E3 Fleet Economic Life Model[9] to optimize the replacement schedule of vehicles. Since introducing this tool in 2013, London Hydro has deferred the purchase of replacement vehicles by several years, reducing the average annual capital spending on vehicles from $1.6M in 2012 to an average of just under $1M from 2013 to 2017.

Self-Serve Customer Service

Enhancements are continually made to the functionality of the London Hydro website to allow customers to interact with us at their own convenience without the need to contact a Customer Service Representative. This level of online functionality allows London Hydro to offer superior service to our customers without hiring additional staff.

---

[9] E3 Fleet is a Canada-wide program created by the Fraser Basin Council of Vancouver that helps public and private sector organizations 'green' their vehicle fleets.

1.1.3 Period Covered (5.2.1 c)

This DSP covers the historical period and Bridge Year from 2012 to 2016 and the Test Year and forecast period from 2017 to 2021.

1.1.4 Vintage of Information (5.2.1 d)

Much of the DSP was developed in 2015 using data that was current up to the end of 2014 (Asset Management Plan, reliability analysis, load forecast, customer preferences, Strategic Plan). The DSP is a living document, subject to minor changes to reflect the most current information available. The Asset Management Plan and Asset Sustainment Plan were both reviewed during 2015 and updated with the most current information available. The updates did not have an impact on the DSP materially during 2015. The Capital Plan was prepared in late 2015 and updated in Q1 and Q2 of 2016.

1.1.5 Changes since Last DSP Filing (5.2.1 e)

This is London Hydro's first DSP filing. However, an Asset Management Plan was filed with the Cost of Service Rate Application in 2012 for 2013 Rates (EB-2012-0146). Since 2012, the Asset Management Process has been refined and Table 2 below summarizes the major changes that have been implemented and their impact on the DSP.

Document/Process	Summary of Changes	Impact to DSP
Engineering Instruction 31 (EI-31): Asset Management and Capital Expenditures Planning: Policy and Processes (Asset Management Policy)	• references to applicable sections of OEB Chapter 5 were added; • new categories for projects were adopted; • emphasis was added regarding customer preference as an input to the decision process; • roles and responsibilities for each department were clarified; • flow charts to clarify processes were added	Language aligns with OEB Chapter 5 expectations and classifications of projects and drivers; renewed focus on ensuring proposed projects align with and address customer preferences (drivers and outcomes)
Asset Management Plan	Updated various plans and schedules to accommodate the timing of the conversion of Nelson TS to 27.6 kV	Accelerated pace of 13.8 kV voltage conversions (non-network downtown)
Asset Sustainment Plan	Added – • additional data and analytics related to pole testing; • additional data and analytics related to padmount transformers; • third party audit of maintenance holes and vaults	Life expectancy of wood poles increased from 50 years to 55 years, which reduced the quantity of "pole replacements" in the forecast; the increase in the failure rate of transformers triggered a slight increase in the recommended quantity of transformer replacements; pace of vault rebuilds/replacements increased from 2 per year to 3 per year
Project Sheets	Updated to include sections related to drivers, outcomes, strategic plan links, customer engagement	
Tree Trimming Cycle	In 2015, the tree trimming cycle was reduced from 5 years to 3 years.[10]	Expected to reduce the impact of severe weather conditions on the distribution system

Table 2: Summary of Major Changes and their Impact on the DSP

1.1.6 Contingent Activities (5.2.1 f)

Some aspects of this DSP are contingent on the outcome of activities beyond the control of London Hydro, which includes the potential impact of changes in economic conditions that may increase or decrease customer driven projects.

Road Relocations

London Hydro has budgeted $2-$3 million in line relocations each year to accommodate work initiated by the City of London (road authority widenings). The actual amount completed each year (and the amount recoverable from the City) is dependent on the extent to which the City executes its projects. London Hydro must comply with these relocations in accordance with the Public Service Works on Highways Act.

Downtown Development

The City of London has created a development plan for the downtown core and the corridor north to the Masonville area. Approximately $2 million has been added to the five-year Capital Plan to support the projected changes needed to accommodate growth in the downtown core. The actual

[10] In 2015 the ESA/EDA utility-recommended trimming cycle was increased from 5 to 3 years. The cost increase in 2015 contract tree trimming is a result of London Hydro's efforts to catch up to the new 3-year trimming cycle.

amount and pace of work (and the amount recoverable as capital contributions) will be dictated by developers and City planners.

New Customer Connections

The quantity of new customer connections and upgraded connections for both residential and commercial customers is expected to be similar to previous years. Economic conditions will have an impact on the actual quantities each year.

Completion of Nelson Transformer Station Rebuild

Hydro One is planning the conversion of the Nelson Transformer Station from 13.8 kV to 27.6 kV will be completed by 2018, with the removal of all 13.8 kV supply points by 2021. London Hydro has paced the conversion of the non-network 13.8 kV load to coincide with this schedule. London Hydro will be working very closely with Hydro One on this project and will make adjustments accordingly.

1.2 Coordinated Planning With Third Parties

From OEB Filing Guidelines 5.2.2

To demonstrate that a distributor has met the Board's expectations in relation to coordinating infrastructure planning with customers, the transmitter, other distributors and/or the OPA or other third parties where appropriate, a distributor must provide:

a) a description of the consultation(s), including

- the purpose of the consultation (e.g. Regional Planning Process);
- whether the distributor initiated the consultation or was invited to participate in it;
- the other participants in the consultation process (e.g. customers; transmitter; OPA);
- the nature and prospective timing of the final deliverables (if any) that are expected to result from or otherwise be informed by the consultation(s) (e.g. Regional Infrastructure Plan; Integrated Regional Resource Plan); and
- an indication of whether the consultation(s) have or are expected to affect the distributor's DS Plan as filed and if so, a brief explanation as to how.

b) where a final deliverable of the Regional Planning Process is available, the final deliverable; where a final deliverable is expected but not available at the time of filing, information indicating:

- the role of the distributor in the consultation;
- the status of the consultation process; and
- where applicable the expected date(s) on which final deliverables are expected to be issued.

c) the comment letter provided by the OPA in relation to REG investments included in the distributor's DS Plan (see 5.2.4.2), along with any written response to the letter from the distributor, if applicable.

1.2 Coordinated Planning with Third Parties (5.2.2)

London Hydro has extensive, on-going consultations with various stakeholders regarding infrastructure planning. These consultations vary in nature from regularly scheduled meetings with senior representatives to ad-hoc / as-needed discussions with developers, electrical contractors and customers. The common purpose of all these consultations is to obtain a clear understanding of the expectations of each stakeholder regarding London Hydro's role in the success of its endeavors and to provide the stakeholders with the various solutions that may be available.

1.2.1 Description of Consultations (5.2.2 a)

Table 3 provides a brief summary of the various consultations that London Hydro participates in during the year. Details regarding the deliverables and impact to the DSP are provided in the noted references.

Purpose of Consultation	Initiator	Other Participants	Deliverables – Scope and Timing	Impact to DSP
Customer Engagement	London Hydro	Other LDCs[11]	See Appendix A	Continued focus on maintaining a reliable system at low cost while providing useful and innovative customer service applications. See Sections 3.1.6 (5.4.1 f) and 3.2.4 (5.4.2 d)
Regional Planning	Hydro One / IESO	Hydro One, IESO, St Thomas Energy, Tillsonburg Hydro, Erie Thames Powerlines (Aylmer), Entegrus (Strathroy)	See Section 1.2.1 (5.2.2 b), Appendix C	Conversion of Nelson TS from 13.8 kV to 27.6 kV proceeding as planned, which will require conversion of remaining 13.8 kV distribution in downtown core. See Section 1.2.1 (5.2.2 b)
Load Forecasting – Total System	Hydro One		Total Load for London Hydro per Delivery Point, done annually	No direct impact, see Section 3.1.1 (5.4.1 a) for details
Load Forecasting – Local Areas	London Hydro	Municipal planners, local developers	Annual forecast of new customer connections, feeder extensions	Budget allocations for System Access new connections to be similar to previous levels with some increases in 2019 and 2020 for line expansions and relocations for developer driven projects. See Sections 3.1.1 (5.4.1 a) and 3.5.2 (5.4.5.2)
Utility Coordination Meetings	City of London	All local utility providers and municipal representatives	Multi-year forecast of major projects involving most utility providers, updated monthly/yearly	Budget allocations increased for 2016 to 2020 relocations for City Road projects. – see Section 3.5.2 (5.4.5.2)
London Home Builders Association (LHBA)	LHBA	Businesses involved with building homes in London	On-going meetings to improve information exchange between LH and home builders	2016 IT Project: developing Builder's Portal – web-based medium for builders to submit service requests
Conservation, Demand Management, Distributed Generation Planning	London Hydro	IESO (formerly OPA), other LDCs, Hydro One	Comment Letter from IESO (OPA), ongoing program planning and execution – see Appendix D	No specific impact on DSP. See Sections 1.2.3 (5.2.2 b) and 3.3 (5.4.3)

Table 3: Impact of Consultations on the DSP

[11] The survey conducted by UtilityPulse includes aggregated results from other utilities in Ontario and across Canada.

1.2.2 Deliverables of Regional Planning (5.2.2 b)

Hydro One issued a Needs Assessment Report for the London Region on April 1, 2015. Among the recommendations that may have an impact on London Hydro is the need for further study of transformation capacity limitations at Wonderland TS, Clarke TS and Talbot TS. It was also noted that the Nelson TS will be redeveloped and converted from 13.8 kV to 27.6 kV by Hydro One. Hydro One also issued a Scoping Assessment Outcome Report on August 28, 2015. This report recommends that the IESO develop an Integrated Regional Resource Plan (IRRP) for the Greater London sub-region, which is expected to be ready in Q4 of 2016. Copies of the Needs Assessment Report and Scoping Assessment Outcome Report are included in Appendix C.

1.2.3 Comment Letter IESO (OPA) – REG Investments (5.2.2 c)

The Comment Letter from the IESO (OPA) regarding REG Investments is included as Appendix D.

The IESO did not have any concerns with London Hydro’s plans regarding REG investments and Regional Planning.

1.3 Performance Measurement for Continuous Improvement

From OEB Filing Guidelines 5.2.3

As mentioned in section 5.0, good distributor planning is an essential element of the Board's performance-based rate-setting approaches. The Board understands that distributors often use certain qualitative assessments and/or quantitative metrics to monitor the quality of their planning process, the efficiency with which their plans are implemented, and/or the extent to which their planning objectives are met. The Board expects that this information is used to improve continuously a distributor's asset management and capital expenditure planning processes.

a) identify and define the methods and measures (metrics) used to monitor distribution system planning process performance, providing for each a brief description of its purpose, form (e.g. formula if quantitative metric) and motivation (e.g. consumer, legislative, regulatory, corporate). These measures and metrics are expected to address, but need not be limited to:

- customer oriented performance (e.g. consumer bill impacts; reliability; power quality);
- cost efficiency and effectiveness with respect to planning quality and DS Plan implementation (e.g. physical and financial progress vs. plan; actual vs. planned cost of work completed); and
- asset and/or system operations performance.

b) provide a summary of performance and performance trends over the historical period using the methods and measures (metrics/targets) identified and described above. This summary must include historical period data on: 1) all interruptions; and 2) all interruptions excluding loss of supply' for a) the distribution system average interruption frequency index; b) system average interruption duration index; and c) customer average interruption duration index.

Where performance assessments indicate marked adverse deviations from trend or targets (including any established in a previously filed DS Plan), provide a brief explanation and refer to these instances individually when responding to provision 'c)' below.

c) explain how this information has affected the DS Plan (e.g. objectives; investment priorities; expected outcomes) and has been used to continuously improve the asset management and capital expenditure planning process.

1.3 Performance Measurement for Continuous Improvement (5.2.3)

1.3.1 Planning Process Performance Metrics (5.2.3 a)

London Hydro has metrics in place to ensure that ongoing and new initiatives related to the distribution system are effective. The main performance indicator is the reliability of the system. While the overall system reliability (expressed as SAIDI and SAIFI) is important, London Hydro has refined the outage reporting and analysis to the point where specific outage causes (such as underground primary cable faults) can be tracked before and after implementing a change in remediation (such as introducing silicone cable injection).

For this DSP, the following reliability metrics (Table 4) will be monitored and used to make annual adjustments to the projects and programs that are in place to make improvements.

Reliability Metric	Purpose & Form	Desired Outcome	Motivation	Related Projects / Programs
System Average Interruption Duration Index (SAIDI) – Equipment Design-Related Outages (outages related to controllable causes such as defective equipment)	SAIDI – EDRO (Equipment Design Related Outages) provides a measure of the reliability of the distribution system as affected by controllable causes. It is calculated using only outages related to controllable causes such as defective equipment.	Stable year-over-year; slight decrease over time in customer minutes of outage	Consumer: Consistent level of reliability for customers Corporate: Cost effectiveness – prevent costs associated with unplanned outages System Performance: Evidence that assets are performing as expected	Most System Renewal Projects; 16C1 Feeder Tie; 17C1 Supply to Core; 16B7, 17B7 Installation of Backup Supply; 16B8, 17B8 Installation of Fault Indicators; 16H1, 17H1 Recloser Installation; 16H5, 17H5 Line Status Sensors
System Average Interruption Frequency Index (SAIFI) – Equipment Design Related Outages	SAIFI – EDRO provides a measure of the reliability of the distribution system as affected by controllable causes. It is calculated using only outages related to controllable causes such as defective equipment.	Stable year-over-year; slight decrease over time in number of customers affected by an outage	Consumer: Consistent level of reliability for customers Corporate: Cost effectiveness – prevent costs associated with unplanned outages System Performance: Evidence that assets are performing as expected	Most System Renewal Projects
Customer Acceptance of Existing Level of Reliability (via surveys)	This metric measures customer acceptance of reliability. Expressed as a percentage of respondents who agree "London Hydro provides consistent, reliable energy"	Consistent year-over-year majority of responses find existing level of reliability acceptable (90%)	Consumer: Consistent level of reliability for customers	Overall spending on System Renewal and reliability focused projects are kept relatively consistent year-over-year
Number of Faults in Residential Underground Primary Conductor	This metric tracks the quantity of faults on residential underground primary conductor per year to determine if the level of investment in cable injection and rebuilds is effective.	Year-over-year decrease	Consumer: Consistent level of reliability for customers Corporate: Cost effectiveness – prevent costs associated with unplanned outages System Performance: Evidence that assets are performing as expected	16B1, 17B1 Cable Silicone Injection; 16B2, 17B2 Subdivision Conversions / Rebuilds with Silicone Injection

Number of Outages Caused by Lightning	This metric tracks the quantity of outages caused by lightning each year to determine if lightning mitigation measures are effective.	Year-over-year decrease (relative to the number of lightning flashes)	Consumer: Consistent level of reliability for customers Corporate: Cost effectiveness – prevent costs associated with unplanned outages System Performance: Evidence that assets are performing as expected	Pre-2016 projects (15G6) to install shield wire and arrestors on critical main feeders; now part of new construction standard for overhead main feeders
Number of Broken Poles (not due to motor vehicle accidents)	This metric tracks the quantity of outages caused by broken poles each year to determine if the pole testing and replacement program is effective.	Stable year-over-year quantity	Consumer: Consistent level of reliability for customers Corporate: Cost effectiveness – prevent costs associated with unplanned outages and optimize the lifecycle cost of wood poles System Performance: Evidence that assets are performing as expected	16G1, 17G1 Replace Deteriorating Poles
Number of Pole Fires	This metric tracks the quantity of outages caused by pole fires each year to determine if the pole inspection and replacement program is effective.	Year-over-year decrease	Consumer: Consistent level of reliability for customers Corporate: Cost effectiveness – prevent costs associated with unplanned outages and optimize the lifecycle cost of wood poles System Performance: Evidence that assets are performing as expected	16G2, 17G2 Replacement of Poles Susceptible to Pole Fires
Number of Outages due to Sectionalizing Enclosure (SE) Failures	This metric tracks the quantity of outages caused by SE failures each year to determine if the SE inspection and replacement program is effective.	Year-over-year decrease	Consumer: Consistent level of reliability for customers Corporate: Cost effectiveness – prevent costs associated with unplanned outages System Performance: Evidence that assets are performing as expected	16B3, 17B3 Replacement / Removals of SE's

Table 4: Reliability Metrics used and Effect on Projects and Programs

London Hydro also monitors the overall cost to our customers to ensure competitiveness with our peers and affordable increases year-over-year. The following cost-based metrics (Table 5) provide feedback to our customers and stakeholders regarding our overall cost efficiency.

Cost Metric	Purpose & Form	Desired Outcome	Motivation	Related Projects / Programs
Controllable Cost per Customer	This metric tracks the controllable costs per customer each year to ensure costs are competitive with peers. Values are sourced from OEB Yearbook.	Bottom quartile of all LDCs	<u>Consumer</u>: Customers should see rates competitive with similar sized LDCs <u>Corporate</u>: Feedback to management on cost effectiveness of LDC	Top down budget constraints, System Renewal Projects[12]; 16B8, 17B8 Installation of Fault Indicators & 16H5, 17H5 Line Status Sensors (reduce time required to locate problems)
PEG Efficiency Assessment	This metric measures the LDC's overall efficiency as determined by PEG. Values are sourced from OEB/PEG.	Remain within Group 2 (2nd most efficient)	<u>Consumer</u>: Customers should see rates competitive with similar sized LDCs <u>Corporate</u>: Feedback to management on cost effectiveness of LDC	Top down budget constraints; innovation and IT services to improve efficiency to reduce costs
Annual Distribution Revenue (Residential)	This metric tracks the average annual distribution revenue per residential customer. Values are sourced from OEB yearbook; stats by class tab.	Bottom quartile of all LDCs	<u>Consumer</u>: Customers should see rates competitive with similar sized LDCs <u>Corporate</u>: Feedback to management on cost effectiveness of LDC	Top down budget constraints; innovation and IT services to improve efficiency to reduce costs

Table 5: Cost-Based Metrics

To ensure the work outlined in the DSP is carried out efficiently, London Hydro has developed some measurement tools to assist in the timely execution of projects and completion of the overall planned projects.

Each crew leader is given access to a smart phone application referred to as EASY (Economic Assessment System, see Figure 2), which provides current data on the progress of capital projects. Providing field crews with near-real time tracking of their work effort against the budgeted amount allows them to identify potential variances early in the project and take appropriate corrective action to address inefficiencies or adjust the mix of resources assigned to the project.

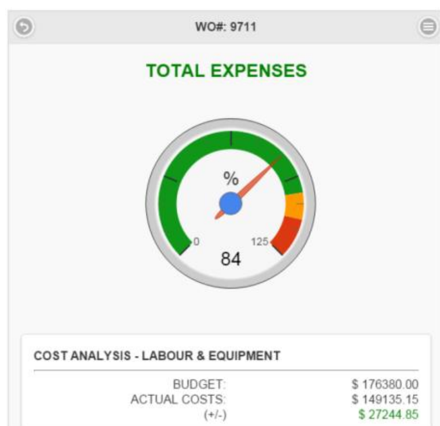


Figure 2: EASY Budget Status App

An Engineering Instruction (EI-21 Engineering & Operations Capital Program Project Cost Control Requirements) is used by staff to assess the variance to budget for all capital projects. Any project valued at $25,000 or more that comes in over or under budget by 10% or more requires analysis to determine the source of the variance. These variance reports are reviewed by managers to determine if opportunities exist to improve the estimating process and/or project execution process.

[12] Replacing aging infrastructure will marginally reduce after-hours call-outs due to failed equipment.

Regular meetings with engineering and operations staff are used to provide status reports (red/green/amber) on capital projects and review significant variances. Bi-weekly meetings focus on the project level while monthly meetings focus on the program level. A year-end report is used to assess total variance to budget and actual completion of planned work to budget.

DSP Implementation Metric	Purpose & Form	Desired Outcome	Motivation	Related Projects / Programs
Utilization of the EASY application (number of crew leaders using application on a regular basis)	Crew leaders are encouraged to take ownership of projects and monitor their costs compared to budget. This metric will track the number of crew leaders using this application to ensure it is effective and user-friendly.	Higher utilization should result in lower variance to budget for capital projects	Corporate: Less variance to budget should assist with keeping costs within budget, resource allocation is optimized Consumer: Meeting budget targets should keep rates stable	All capital projects
Average % Variance to Budget for System Renewal and System Service Projects	This metric measures the variance percentage to budget to determine the accuracy of budgeting and effectiveness of project execution. Calculated as the percent difference in actual annual spending to budget on System Renewal and System Service projects.	Slight improvement each year with ultimate goal of 10% or less	Corporate: Less variance to budget should assist with keeping costs within budget Consumer: Meeting budget targets should keep rates stable	All System Renewal and System Service Projects
Percentage of Actual System Renewal and System Service Projects Completed per Half Year vs Planned	This measures the quantity of actual work vs planned work to determine the effectiveness of the planning and execution of capital projects. Calculated as the percent difference of actual vs planned System Renewal and System Service projects each quarter. Some subjectivity will be used as some projects will span set time periods.	Slight improvement each year with ultimate goal of 100%	Corporate: Less variance to budget should assist with keeping costs within budget Consumer: Meeting budget targets should keep rates stable	All System Renewal and System Service Projects

Table 6: DSP Implementation Metrics

For customer-focused initiatives, London Hydro monitors the number of customers using each initiative and then adjusts either the promotion of the initiative (so more customers are aware of them) or the actual initiative (to make it more useful to customers) (see Table 7).

Customer Participation Metric	Purpose & Form	Desired Outcome	Motivation	Related Projects / Programs
Number of Customers Subscribed to Paperless Billing	This measure will track usage of this website option to determine how many customers find this application useful. Software tracks the number of subscribers.	Gradual Increase in usage year-over-year	Consumer: Easier customer access to billing information Corporate: Effectiveness of website development, proper allocation of resources in Customer Service area.	CE (Customer Engagement) Website Enhancements

Number of Customers Subscribed to Customer Portals (UCES / myLondonHydro)	This measure will track usage of this website option to determine how many customers find this application useful. Software tracks the number of subscribers.	Gradual Increase in usage year-over-year	Consumer: Easier customer access to billing information Corporate: Effectiveness of website development, proper allocation of resources in Customer Service area.	Builders Portal, New Property Management Portal
Number of Customers Subscribed to Outage Notification	This measure will track usage of this website option to determine how many customers find this application useful. Software tracks the number of subscribers.	Gradual Increase in usage year-over-year	Consumer: Better communication with customers on outage status	CE (Customer Engagement) Website Enhancements
Number of Customers on Paperless Billing Enrolled in Aeroplan	This measure will track usage of this website option to determine how many customers find this application useful. Software tracks the number of subscribers.	Gradual Increase in usage year-over-year	Consumer: Travel Rewards for converting to paperless billing; reduced costs to customers over time due to lower OM&A Corporate: Effectiveness of website development, proper allocation of resources in Customer Service area.	CE (Customer Engagement) Website Enhancements
Number of online move-in / move-out / transfer of service requests placed via LH website	This measure will track usage of this website option to determine how many customers find this application useful. Software tracks the number of subscribers.	Gradual Increase in usage year-over-year	Consumer: Services available on-demand, anywhere Corporate: Effectiveness of website development, proper allocation of resources in Customer Service area.	CE (Customer Engagement) Website Enhancements
Number of Accounts Utilizing Delegate Functionality	This measure will track usage of this website option to determine how many customers find this application useful. Software tracks the number of subscribers.	Gradual Increase in usage year-over-year	Consumer: More flexibility for customers to assign others to be responsible for hydro account, fewer missed or late payments Corporate: Effectiveness of website development, proper allocation of resources in Customer Service area.	CE (Customer Engagement) Website Enhancements
Number of Budget Billing Sign Ups via MyLondonHydro	This measure will track usage of this website option to determine how many customers find this application useful. Software tracks the number of subscribers.	Gradual Increase in usage year-over-year, decline in quantity and value of late and delinquent accounts	Consumer: Option for customers to assist with budgeting hydro payments Corporate: Effectiveness of website development, proper allocation of resources in Customer Service area.	CE (Customer Engagement) Website Enhancements
Number Payment Notifications via MyLondonHydro	This measure will track usage of this website option to determine how many customers find this application useful. Software tracks the number of subscribers.	Gradual Increase in usage year-over-year, decline in quantity and value of late and delinquent accounts	Consumer: Reduces the likelihood of late or missing payments and subsequent repercussions Corporate: Effectiveness of website development, proper allocation of resources in Customer Service area.	CE (Customer Engagement) Website Enhancements

Number Payment Arrangements via MyLondonHydro	This measure will track usage of this website option to determine how many customers find this application useful. Software tracks the number of subscribers.	Gradual Increase in usage year-over-year, decline in quantity and value of late and delinquent accounts	Consumer: Simplifies payment process Corporate: Effectiveness of website development, proper allocation of resources in Customer Service area.	CE (Customer Engagement) Website Enhancements

Table 7: Customer Participation Metrics

In addition to these metrics, Google Analytics is used to monitor the number of website visits (total, unique, new, and returning), the percentage of mobile users, average bounce rate and most popular page.

1.3.2 Performance Summary and Trends (5.2.3 b)

The Reliability metrics have shown favourable trends indicating the projects and programs have been and continue to be effective. This analysis has been in place for many years, and it has not only indicated but also directly contributed to the overall improvement in SAIDI and SAIFI since 1994[13]. Since much of the focus of the annual Capital Plan is replacing infrastructure at risk of failure, the SAIDI and SAIFI numbers have been analyzed to separate equipment design related outages (EDRO) from other non-controllable outages (loss of supply, scheduled). The Figures below show the gradual improvement in both SAIDI-EDRO and SAIFI-EDRO, while the non-EDRO trend has remained relatively constant.

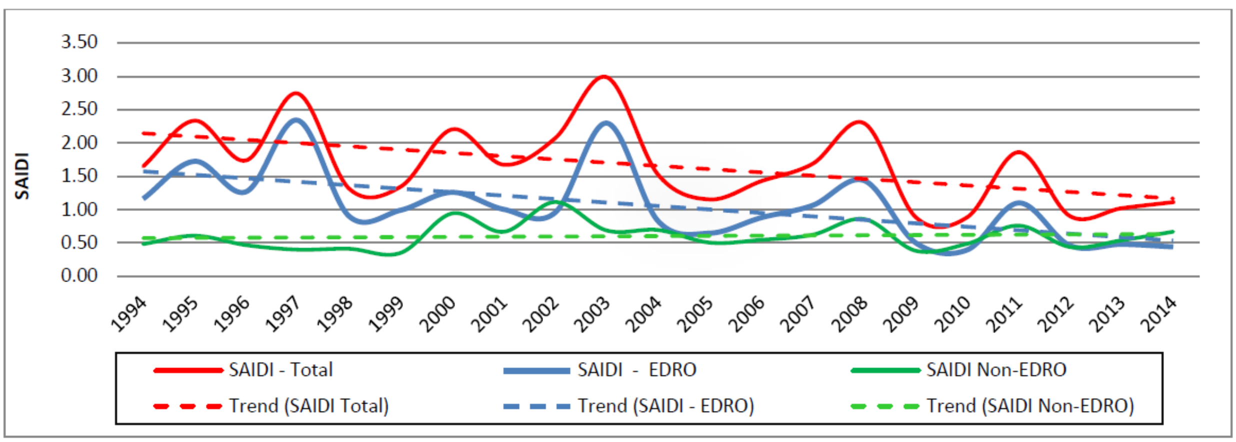


Figure 3: SAIDI Historical Trend 1994 to 2014

[13] See Appendix E for the most recent Quality of Supply Report for extensive analysis on Reliability

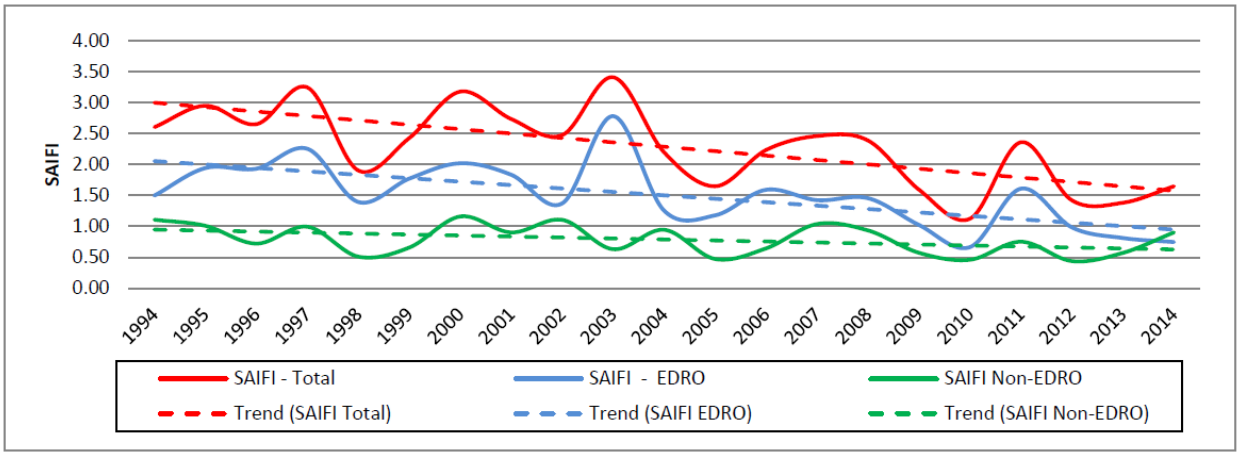


Figure 4: SAIFI Historical Trend 1994 to 2014

Customer Satisfaction with the current level of reliability is reviewed each year as part of the annual survey by a third party. The key indicator is the response to "London Hydro provides consistent, reliable energy." Table 8 below summarizes the survey results from residential and commercial customers from 2012 to 2015.

Customer Type	2012	2013	2014	2015
Residential	91%	96%	90%	90%
Commercial	91%	95%	91%	90%

Table 8: Survey Results - Percentage of Customers who agree that "London Hydro provides consistent, reliable energy"

Other indicators from the survey support this such as questions associated with whether London Hydro should spend more to reduce outages, spend less and allow more outages, or keep spending about the same. In 2015, 56% of respondents accepted the current level of reliability and did not want rates to increase to support improvements in reliability, with only 10% wanting more investment and 23% wanting less.

The number of outages (momentary and sustained) due to lightning has decreased since 2013 after London Hydro implemented mitigation pilot projects (shield wire and/or arrestors) and changes to main feeder construction practices. For 2014, the number of outages was down significantly despite a slight increase in the number of lightning flashes, as shown in Figure 5 below, and London Hydro continues to analyze the data to determine if the reduction is due to the pilot projects.

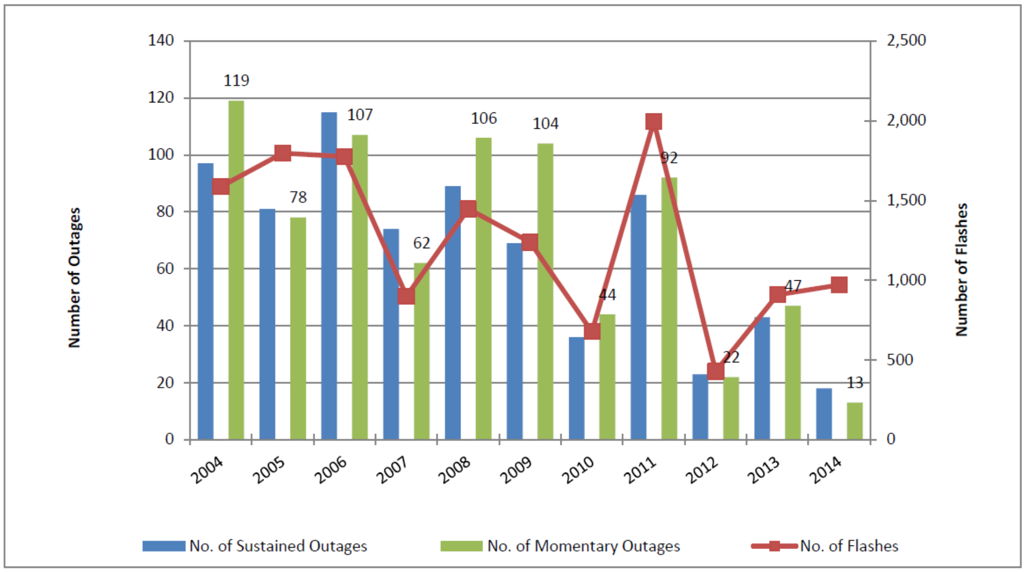


Figure 5: Sustained and Momentary Outages due to Lightning

Table 9 below illustrates that the number of faults in underground primary conductors has dropped from a high of 31 in 2010 to a low of 12 in 2015. This decrease implies that the related programs are avoiding between 10 and 19 outages per year associated with this type of failure. The number of broken poles has decreased from a high of 8 in 2010 to a low of 1 in 2015. While broken poles do not typically cause an outage, they can be a safety concern. The number of pole fires has remained constant, at approximately two per year. The number of outages associated with sectionalizing enclosure failures has increased in recent years, as described below.

Reliability Metric	2010	2011	2012	2013	2014	2015
Number of Faults in Residential Underground Primary Conductor	31	22	21	14	12	12
Number of Broken Poles (not due to motor vehicles)	8	4	1	4	4	1
Number of Pole Fires	2	0	2	2	1	2
Number of Outages due to Sectionalizing Enclosure (SE) Failures	0	1	0	4	2	5

Table 9: Reliability Metrics by Main Causes 2010-2015

The Cost metrics have shown favourable and stable trends (See Table 10). For the past several years, London Hydro has been ranked in the bottom quartile of all LDCs for OM&A cost per customer and Annual Distribution Revenue (residential customers). London Hydro has been assessed as being within Group 2 by PEG since inception of this ranking method in 2012.

Cost Metric	2011	2012	2013	2014	2015
Controllable Cost per Customer[14]	19th lowest of 75 LDCs	7th lowest of 73 LDCs	5th lowest of 73 LDCs	6th lowest of 72 LDCs	11th lowest of 71 LDCs
PEG Efficiency Assessment	n/a	Group 2	Group 2	Group 2	Group 2
Annual Distribution Revenue (Residential)[15]	25th lowest of 75 LDCs	22nd lowest of 73 LDCs	19th lowest of 73 LDCs	16th lowest of 72 LDCs	16th lowest of 71 LDCs

Table 10: London Hydro's Ranking by Cost Metric

The DSP Implementation metrics are new; therefore, no trend analysis is available.

The Customer Participation metrics have shown desirable increases each year in the number of customers utilizing these tools, while the expected marginal decrease in costs has not been quantified and will require further analysis (See Table 11, below).

Customer Participation Metric	2011	2012	2013	2014	2015
Number of Customers Subscribed to Paperless Billing	8,153	15,639	21,941	28,795	36,800
Number of Customers Subscribed to Customer Portals (UCES / myLondonHydro)	26,015	40,424	48,148	56,484	65,660
Number of Customers Subscribed to Outage Notification	N/A	N/A	N/A	2,569	3,781
Number of Customers on Paperless Billing Enrolled in Aeroplan	N/A	N/A	N/A	N/A	4,008
Number of online move-in / move-out / transfer of service requests placed via LH website	N/A	N/A	N/A	N/A	1,091
Number of Accounts Utilizing Delegate Functionality	N/A	N/A	N/A	1,580	4,984
Number of Budget Billing Sign Ups via MyLondonHydro	N/A	N/A	N/A	225	707
Number Payment Notifications via MyLondonHydro	N/A	N/A	N/A	2,122	11,974
Number Payment Arrangements via MyLondonHydro	N/A	N/A	N/A	923	4,906

Table 11: London Hydro's Performance on Customer Participation Metrics

1.3.3 Impact on DSP (5.2.3 c)

The data and trends noted above have affected the development of the DSP in the following areas:

Reliability

Through annual surveys, customers have advised us that they find the current level of reliability to be acceptable, which indicates the pace of equipment replacement is appropriate to sustain the level of reliability at the level our customers prefer. Thus the criteria used to select projects for System Renewal and System Service is expected to remain constant for the next five years.

The continuing decrease in the number of cable faults is attributed to the effectiveness of the silicone injection / cable replacement program which will be continued and targeted at areas with the highest risk as assessed in the SPOORE analysis (see Appendix N for a summary of the SPOORE analysis process).

The decrease in outages caused by lightning since 2013 is attributed to the mitigation projects implemented in 2013 to 2015 and the change in construction standard for main overhead feeders.

[14] Ranking based on data published in OEB Yearbooks
[15] Ranking based on data published in OEB Yearbooks

Since this is a relatively short sample period, this trend will be closely monitored to ensure it is effective.

The number of poles broken each year (not due to motor vehicle accidents) has declined over the past years to a very small number. As noted in Section 1.1 of the Asset Sustainment Plan (Appendix G, Section 7), London Hydro is pushing the useful life of a wood pole from 50 years to 55 years and possibly 60 years by inspecting and testing poles on a prioritized basis and only replacing ones that fail the test. This change in life expectancy has resulted in a forecasted decrease in the number of poles replaced each year. This metric is also closely monitored to ensure the wood pole population does not reach the point at which the number that needs be replaced each year becomes excessive.

The number of pole fires has remained constant at two per year as the related Capital Program continues to address poles most at risk of this type of failure. The existing pace of the pole replacement program will remain constant.

Outages due to failures of sectionalizing enclosures have increased in frequency in recent years although many of these units have been replaced or eliminated. Additional analysis has revealed that each of the failures in 2014 and 2015 were units that were identified as high risk and scheduled to be replaced in the year they failed. This program is expected to continue until 2020 at which time all suspect units will have been addressed.

Cost

London Hydro continues to be competitive with cost metrics, which would indicate overall spending is in line with peers and customer expectations. The existing cost envelopes will remain at similar levels, adjusted for inflation and focused on the five-year trend, which may allow variations within each year due to fluctuations in customer-driven work or large capital projects.

DSP Implementation

The DSP metrics will be monitored closely and adjusted when necessary to ensure the feedback they provide is useful. Metrics used by other LDCs will be considered if they have demonstrated value to customers and can be easily adopted by London Hydro.

Customer Participation

The number of customers using the identified programs has increased each year. This on-going increase in participation along with requests from customers for more services has led to the development of new service offerings and enhancements of existing ones. This trend is expected to continue in coming years as customers become more connected and expect to be able to conduct more and more of their interactions with service providers using electronic formats.

2.1 Asset Management Process Overview

From OEB Filing Guidelines 5.3.1

This section provides the Board and stakeholders with a high level overview of the information filed on a distributor's asset management process, including key elements of the process that have informed the preparation of the distributor's capital expenditure plan and therefore are referred to in response to requirements for more detailed information supporting the overall capital expenditure plan, budget allocations to categories of investments, or material projects/activities proposed for recovery in rates. The information provided should include but need not be limited to:

a) a description of the distributor's asset management objectives and related corporate goals, and the relationships between them; where applicable, show and explain how the distributor ranks asset management objectives for the purpose of prioritizing investments;

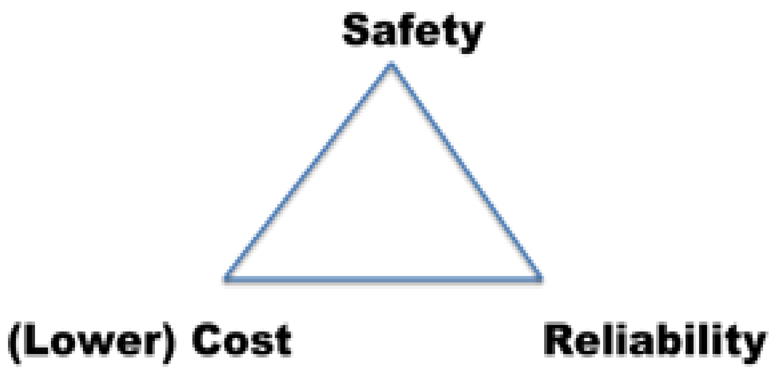
b) information regarding the components (inputs/outputs) of the asset management process used to prepare a capital expenditure plan, identify and briefly explain the data sets, primary process steps, and information flows used by the distributor to identify, select, prioritize and/or pace investments; e.g.

- asset register
- asset condition assessment
- asset capacity utilization/constraint assessment
- historical period data on customer interruptions caused by equipment failure
- reliability-based 'worst performing feeder' information and analysis
- reliability risk/consequence of failure analyses.

Use of a flowchart illustration accompanied by explanatory text is recommended.

2.1 Asset Management Process Overview (5.3.1)

The overarching goal of Asset Management at London Hydro is to maintain the balance among the three outcomes that London Hydro perceives to be the most important to customers – safety, reliability and cost. Through survey results and direct feedback, London Hydro's customers have consistently communicated that they value the safe and reliable electrical system that is provided to them at a reasonable cost.



At the core of effective Asset Management is engineering. It is an engineering perspective that helps to understand how the distribution system should operate, the role each component plays in delivering reliable service, how the components need to be monitored and maintained, when the components require replacement, and what replacement options are best for current and future needs, all while maintaining the balance of safety, reliability and cost.

To ensure Asset Management continues to be effective and improve each year, London Hydro has increased the investment in it by hiring internal and external experts, giving them additional training and collaborating with industry peers to seek best practices. While these investments have increased the cost of Asset Management, the result has been that the overall cost of Operating and Maintenance (O&M) spending has remained fairly constant[16] and spending on major capital assets such as poles, underground cables, and vehicles has been further optimized[17]. The additional resources allow for specific metrics to be monitored ensuring the assets are being well maintained[18].

London Hydro understands that a spectrum of effort can be applied to Asset Management – from low or minimal (repair or replace components when they fail) to extreme (where every nut and bolt is inspected, tested and proactively replaced). Generally, as the level of effort put into Asset Management increases, the overall value to customers (a function of safety, reliability, and cost) will increase as the spending on assets and their overall performance becomes optimized. However, a point exists at which additional effort put into Asset Management does not add value to customers and will eventually decrease value to customers as the cost of managing the assets (monitoring, testing, planning,

[16] See "2013 Actuals to 2017 Test Year Comparison" Table 4-7, Exhibit 4) for details on Operating Expenses. Between 2013 and 2017 (projected): spending on Asset Management has increased about 8% per year. Spending on Operations and Maintenance has increased about 2% per year.

[17] See Section 1.1.2 Sources of Cost Savings (5.2.1 b)

[18] See Section 1.3 Performance Measurement for Continuous Improvement (5.2.3)

evaluating, reviewing, etc.) becomes excessive and does not lead to better system performance. London Hydro's approach is shown graphically below.

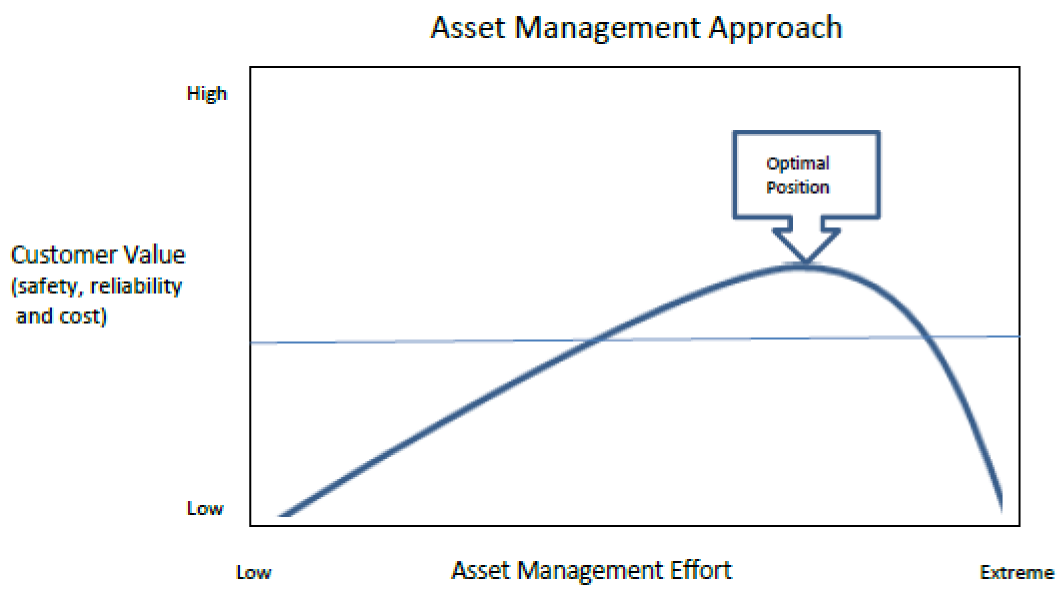


Figure 6: London Hydro's Asset Management Approach

London Hydro's goal is to operate at an optimal position on the Customer Value curve. While it is difficult to know exactly where on the curve London Hydro is currently operating, external benchmarks regarding safety, reliability and cost would suggest we are at least near the optimal point.[19]

London Hydro has pursued the best practices of the electricity industry for many years. In doing so, it has continuously adhered to the OEB's Distribution System Code, which sets out good utility practice, minimum performance standards for electricity distribution systems in Ontario and minimum inspection requirements for distribution equipment. Consistent with best practices, London Hydro has diligently maintained its equipment in safe and reliable working order, and only when economically justified, has it upgraded or replaced its equipment.

By describing this pursuit in its internal guidance document, *Engineering Instruction 31 (EI-31)*, "*Asset Management and Capital Expenditures Planning: Policy and Processes (Asset Management Policy),"* and by implementing it through capital and operational activities, London Hydro is not only able to achieve excellence in financial performance, but it is also able to focus on its customers and their preferences in addition to continuous improvement. Replacing or refurbishing infrastructure in a planned fashion with

[19] In 2015, London Hydro achieved one million hours without a lost time injury for the first time in its over 100 year history. In 2016, we surpassed that record by reaching 1.25 million hours. In 2014 and 2015, London Hydro was named Canada's Safest Employer (winning gold and silver respectively); in 2015 London Hydro won the ESA Safety Excellence Award for Worker Safety and Electrical Business Magazine's Safety Champion award. Reliability Indices (SAIDA and SAIFI) are among the lowest of Ontario LDCs of similar size and continued a ten-year trend of improvement in 2015; In 2014 (the last year for which data is available), London Hydro had the lowest cost per customer in the province for medium and large utilities and the sixth lowest out of all 72 listed by the OEB. In 2015 our OM&A costs were further reduced.

due regard to expense and operations supports London Hydro's ability to deliver high quality and reliable service to its customers.

In addition to providing its customers with service and information in the ways in which they want to receive it, London Hydro seeks to foster a relationship with its customers whereby it can convey the utility perspective on the management of the distribution system and continue to improve its understanding of the customer perspective with the aim of incorporating the customers' stated preferences into the capital planning process. In this manner, London Hydro's Asset Management Plan continually evolves to meet the ever-changing needs of the customers, the regulator and the utility overall.

Originally drafted in 2011, EI-31 is reviewed and updated annually, as needed, to meet evolving customer expectations, utility best practices and the current regulatory environment. EI-31 is the core document used by London Hydro staff to ensure the Asset Management Plan (AMP) is kept up to date, and it provides the framework required to derive the annual Capital Budgets and Five-Year Capital forecasts. EI-31 is included in Appendix F and will be referenced extensively throughout this section. In addition, the Asset Management Plan is also included in Appendix G and it includes details of the various components of the process.

This section contains key highlights of EI-31 along with supporting documentation to provide an overview of the Asset Management Process. Additional details are also provided in DSP sections 2.3 *Asset Lifecycle Optimization Policies and Practices* (5.3.3), 3.2 *Capital Expenditure Planning Process Overview* (5.4.2), and 3*.5 Justifying Capital Expenditures* (5.4.5).

2.1.1 Objectives (5.3.1 a)

London Hydro's Asset Management Policy (EI-31), identifies the **Asset Management Objectives** as follows (EI-31, page 3):

London Hydro continually seeks innovative methods to meet the following **objectives** while balancing the competing needs of its stakeholders.

> **Safety** – ensuring that London Hydro's assets are maintained in a safe condition so they never cause injury to employees or the public;
>
> **Regulatory** – ensuring that London Hydro complies with all legislative requirements;
>
> **Environmental** – ensuring that the assets are managed in an environmentally responsible manner by meeting and, where practical, exceeding all environmental regulatory requirements;
>
> **Capacity** – ensuring that the distribution system has sufficient capacity to supply both new and existing customer loads and, where appropriate, connect new generation facilities;
>
> **Reliability** – ensuring that London Hydro's reliability performance meets or exceeds OEB requirements and equals or is above the average of its LDC peer group;

Customer Focus – ensuring that services are provided in a manner that responds to customer preferences when they are identified and practical;

Losses – ensuring that the distribution system's technical losses are effectively minimized through the introduction of changes in system design or operating practices;

Costs – ensuring that the lifecycle costs of London Hydro's assets are optimized while meeting the above objectives and ensuring that capital expenditures are paced to levelize the impact on customer bills;

London Hydro seeks to foster a culture of continuous improvement in its approach to achieving the objectives above and is committed to developing performance measures to monitor its improvement. Currently, London Hydro measures, for any given year, the extent to which planned projects are completed and whether they are completed on budget. The percentage of projects completed is the metric selected for the OEB's Scorecard for measuring the progress of Distribution System Plan Implementation.

These Objectives are shaped by three **Guiding Principles** identified in the Asset Management Plan (AMP Section 2).

Provide for the City's Growing Needs – working with customers, developers and the City

Provide Quality Service to the City Residents – maintaining a safe and reliable system

Revitalize the City's Core – renewing downtown infrastructure

The **Guiding Principles** reflect London Hydro's **Mission, Vision** and **Core Values**.

Mission Statement:

London Hydro is an electricity distributor dedicated to the pursuit of excellence in safety, reliability, customer service, and competitive rates.

Vision:

Through the pursuit of innovation and growth, we will provide leadership in customer services and add value to the corporation and community.

Values:

Integrity – *to exhibit trust in all relationships by acting openly and honestly in all matters and by treating people fairly and respectfully*.

Innovation – *to foster an exciting working environment that inspires employees to think creatively*.

Accountability – *to be truly accountable to our customers, our employees, our shareholder, and our community*.

Social and Environmental Responsibility – *to act as a positive influence on our employees, society, and environment*.

As a result of these corporate influences, the Distribution System Plan prepared by London Hydro achieves the four **Performance Outcomes** identified by the Ontario Energy Board[20]:

Customer Focus

Operational Effectiveness

Public-Policy Responsiveness

Financial Performance

The table below illustrates how these various influences are related to and align with the OEB Performance Outcomes.

	OEB PERFORMANCE OUTCOMES			
	CUSTOMER FOCUS	OPERATIONAL EFFECTIVENESS	PUBLIC POLICY RESPONSIVENESS	FINANCIAL PERFORMANCE
Objectives	Customer Focus, Capacity, Reliability, Costs	Safety, Capacity, Reliability, Losses	Safety, Regulatory, Environmental	Capacity, Losses, Costs
Principles	Quality Services, Growth, Revitalize Core	Quality Services, Growth, Revitalize Core	Quality Services	Growth
Mission	Customer Service, Competitive Rates, Reliability, Safety	Safety, Reliability	Safety	Competitive Rates, Safety
Vision	Customer Service, Community Value, Growth	Innovation	Community Value	Corporate Value
Values	Accountability, Integrity	Innovation	Social & Environmental Responsibility	Innovation, Accountability

Table 12: The Alignment of OEB Performance Outcomes and London Hydro's Corporate Statements

As part of the prioritizing process (detailed in DSP Section 3.2.3), the **Asset Management Objectives** are ranked into the following groups:

Obligations – As a distributor, London Hydro must comply with obligations related to Safety (of workers and the public), Regulatory requirements (e.g., Road Authority, connecting new

[20] OEB Filing Requirements for Electricity Transmission and Distribution Applications, Chapter 5, Consolidated Distribution System Plan Filing Requirements, Section 5.0.4

customers, providing quality services, meeting mandated targets), and Environmental impact (both regulatory compliance and striving for best practices). Generally, these Objectives receive the most weight, and projects that fulfill these obligations are given the highest priority.

Performance – London Hydro must keep the distribution system performing at the level expected by stakeholders and accommodate the connection of new load and generation. Thus, the performance related Objectives – Capacity and Reliability – are generally second in priority.

Customer Preference and Cost – While accommodating customer requests for services and service levels above the current offering may be desirable, it must be balanced by the overall cost to consumers. Through innovation, London Hydro has been able to introduce some new services that have little to no impact on cost yet provide value to customers. Likewise, investments that reduce system losses or otherwise reduce future costs are considered if a viable business case can be made for the project.

2.1.2 Components (5.3.1 b)

Asset Management Lifecycle

The ongoing process for managing the assets of London Hydro is summarized in the following flowchart (Figure 7, also found in EI-31 page 6).

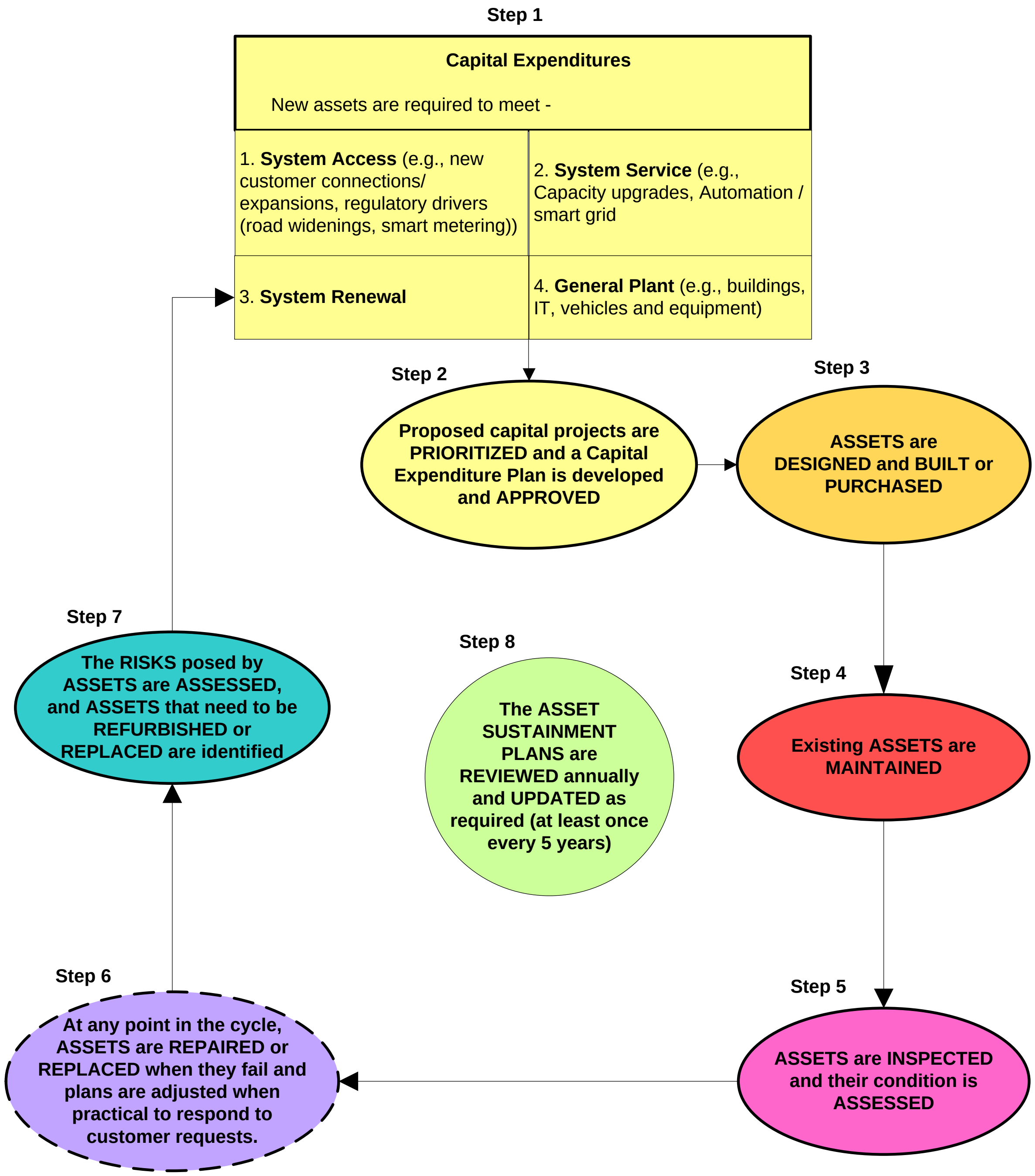


Figure 7: Asset Management Lifecycle

Each step of the **Lifecycle** is described in detail in EI-31, including cross-references to the OEB Chapter 5 sections.

Capital Expenditure Plan – Creation (Step 1)

The process used to create the annual Capital Expenditure Plan is outlined in DSP 3.2 *Capital Expenditure Planning Process Overview*. Project lists for all categories are created throughout the year as needs and opportunities arise. However, the majority of the annual Capital Budget work is driven by the formalized Asset Sustainment Plan (ASP), which results in project lists primarily within the System Renewal category. The ASP is reviewed every year and updated as needed (at least once every five years). The ASP is included in the Asset Management Plan (Section 7), located in Appendix G.

Each category of investment (System Access, System Service, System Renewal, and General Plant), follows a process, which is outlined in flowcharts included in EI-31 Step 1 (pages 9, 10, 11, and 13).

Capital Expenditure Plan – Prioritization and Approval (Step 2)

Once the listing of capital expenditures has been created (Step 1 of the Lifecycle), a prioritization process takes place (Step 2 of the Lifecycle, EI-31, page 14).

The prioritization process involves both a top down and bottom up approach. The London Hydro Board of Directors along with senior management consider corporate constraints such as impact on billing, levelized spending, cash flow, and balancing customer requests and preferences with the need to sustain the assets. An annual Capital Budget along with a rolling five-year forecast for capital spending is reviewed and adjusted yearly.

The Engineering, Operations and IT staff identify all potential projects (from Step 1) and highlight the main and secondary drivers (customer value, reliability, safety, efficiency, economic development and environmental benefits – these are further defined in EI-31 Step 2 page 34). The listing of all projects is then reviewed and ranked so that the overall list is adjusted to meet the annual financial targets set by the Board and senior management. The ranking process utilizes the Objectives identified in DSP 2.1.1, and additional details on the prioritization of capital projects are provided in DSP 3.2.3.

In the event that the annual financial target for capital spending is found to be too restrictive – either in the planning stage or during project execution – senior management reviews the overall budget either to make adjustments to project priorities in order to meet the financial target or to approach the Board of Directors with a request to change the financial target. The Board of Directors may consider an increase to the annual capital spending target to allow for unexpected projects (which may result from customer demand, major equipment failure or damage, regulatory requirements, or a business opportunity, for example), giving due consideration to the overall five-year Capital Plan and corporate objectives.

Capital Expenditure Plan – Execution, Maintenance and Review (Steps 3-8)

Once the Capital Expenditure Plan has been approved, the projects are **designed** and **built** or **purchased** (Step 3), existing assets are **maintained** (Step 4), assets are **inspected** and **assessed** (Step 5), assets are **repaired** or **replaced** (Step 6), **risks** are assessed (Step 7), and the Asset Sustainment Plan is **reviewed** annually and updated as required (Step 8).

Engineering Instruction 31 includes details on the responsibilities and procedures for each of these Steps.

Asset Sustainment Plan

The Asset Sustainment Plan (ASP) is included within the Asset Management Plan (AMP) in Section 7. The ASP provides documentation regarding the various assets sorted by type, including where the information regarding the asset is stored and maintained (asset register), the overall condition assessment of the asset type (typically presented in tables or graphs), the inspection plan for the asset type, a risk assessment by asset type, the asset capacity utilization, and the asset sustainment strategy.

Reliability Analysis

Section 5 of the Asset Management Plan (AMP) is a summary of the System Reliability Performance. Engineering Instruction 31 outlines the Responsibilities (Step 7, Risk Assessment, page 21) and Procedures (Step 7, Managing System Reliability, page 50) for monitoring the reliability of the system, identifying trends, and ensuring capital and maintenance programs are aligned with the reliability expectations of London Hydro customers.

London Hydro utilizes a dedicated internal resource (Reliability Engineer) to review all outages regularly, determine the root cause, and advise the various departments on any changes or corrective action that should be taken to prevent similar occurrences. An annual '*Quality of Supply Report*[21]' is created to summarize the performance of the previous year, including the identification of the worst performing feeders. Weekly and monthly '*Reliability Summary Reports*' highlight significant outages and recommend action plans, when required. These reports are circulated to various departments to enable them to take appropriate action, which may include additional customer engagement activities (to inform customers of recent outages and action being taken to address the root cause), improved or increased preventative maintenance activity, or adjustments to Capital Expenditure Plans and the Asset Sustainment and Asset Management Plans.

The Asset Sustainment Plan (ASP) utilizes current and historical reliability analysis, asset age, and asset condition to conduct a **risk assessment** for each category of asset. The risk assessment, combined with the capacity utilization review, is used to create the Asset Sustainment Strategy, which identifies the level of replacement / upgrading needed to keep the system operating safely and at the level of reliability expected by customers.

[21] See Appendix E- 2014 Quality of Supply Report

Information Technology (IT)

The pace of technological developments and change in the IT industry has resulted in a far more rapid management and life cycle of IT assets than that of the traditional timeframes associated with the bulk of LDC assets. For London Hydro, three years is deemed optimal for IT strategic planning and five years is the expected service life for physical assets and software applications, as illustrated in Figure 8. London Hydro continues to plan and execute work according to its three year rolling IT strategy (first initiated in 2010 and regularly updated since then). Throughout each update to London Hydro's Strategic Plan, there has been a consistent focus upon on key three objectives: the sustainment, enhancement and growth of its IT assets. While these three key objectives are always part of the plan, there is typically unequal investment emphasis from period to period.

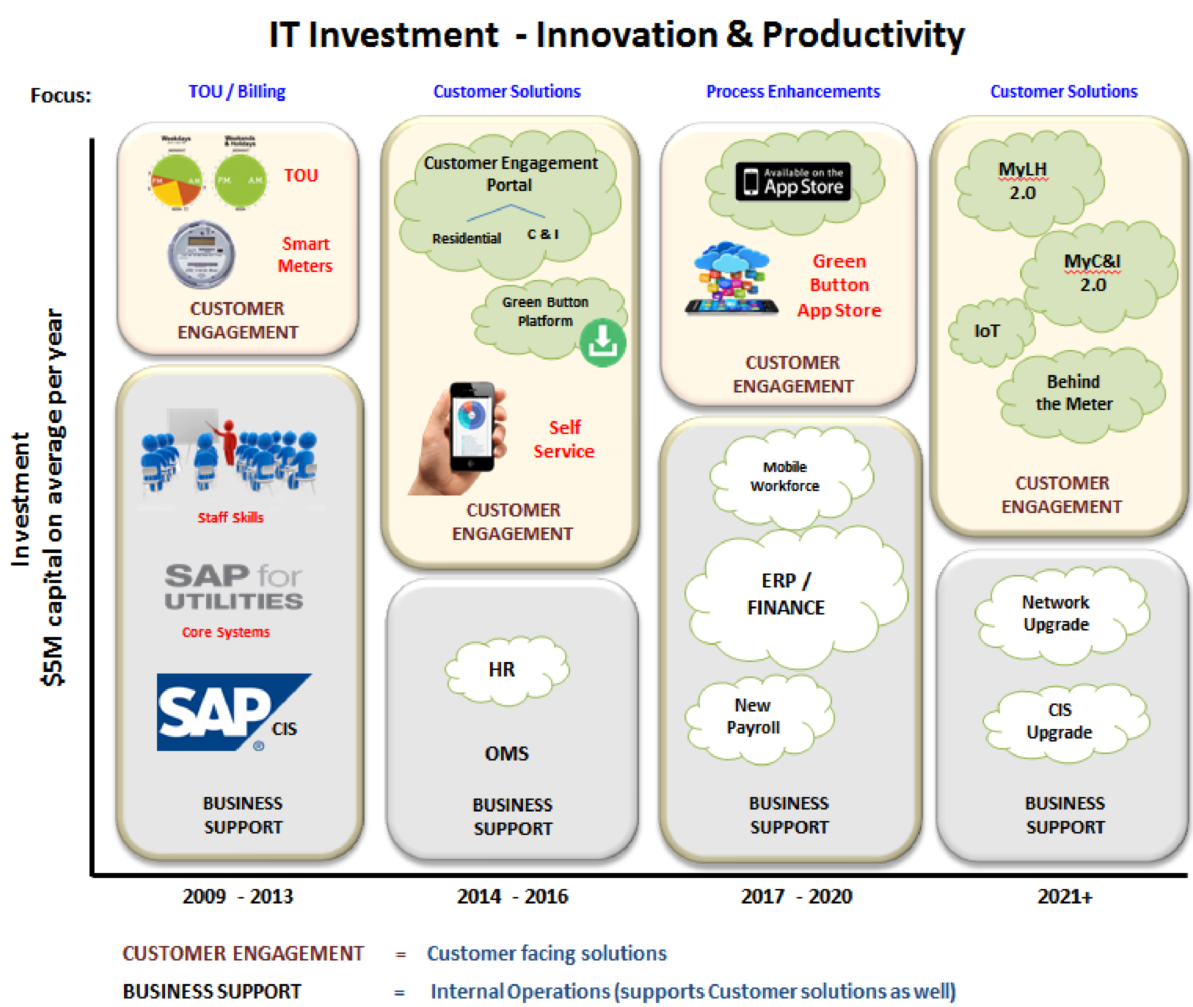


Figure 8: IT Investment Cycle

This approach has led to the development of a wide array of innovative, useful and high quality applications, Intellectual Property and standards to serve customers, business operations and stakeholders.

The 2016/2017 update to the 'three-year rolling strategy' has evolved with innovations in technology, regulatory changes and changing customer expectations, but consistently adheres to these main thrusts:

- a technology roadmap driven by customer expectations, early adoption of industry leading systems and technology advances
- a focus on mobile, open source, Cloud-based secure customer engagement solutions
- a staffing strategy that attracts and builds an internal team with strong IT and Project Management skills
- a culture of industry leadership, innovation and co-creation amongst customers

2.2 Overview of Assets Managed

From OEB Filing Guidelines 5.3.2

a) Service area description: a description and explanation of the features of the distribution service area (e.g. urban/rural; temperate/extreme weather; underground/overhead; fast/slow economic growth) pertinent for asset management purposes, highlighting where applicable expectations for the evolution of these features over the forecast period that have affected elements of the DS Plan

b) System configuration: including length (km) of underground and overhead systems; number and length of circuits by voltage level; number and capacity of transformer stations

c) Service profile and asset condition: information (in tables and/or figures) by asset type (where available) on the quantity/years in service profile and condition of the distributor's system assets, including the date(s) the data was compiled

d) System utilization: an assessment of the degree to which the capacity of existing system assets is utilized relative to planning criteria, referencing the distributor's asset related objectives and targets
    - where cited as a 'driver' of a material investment(s) included in the capital expenditure plan, provide a level of detail sufficient to understand the influence of this factor on the scope and value of the investment

2.2 Overview of Assets Managed (5.3.2)

2.2.1 Service Area Description (5.3.2a)

London Hydro services approximately 154,000 customers within the City of London and a municipal water pumping plant located immediately north of the municipal boundary. The total service area is approximately 421 square kilometers and has a peak load of approximately 700 MW. With a population of almost 367,000, London is primarily a medium to high density urban area with some pockets of lower density, rural areas. The only neighbouring LDCs are Hydro One Networks Inc., which supplies most of the rural areas outside of the municipal boundary of the City of London, and Erie Thames Powerlines Corporation, which supplies the Belmont area to the southeast.

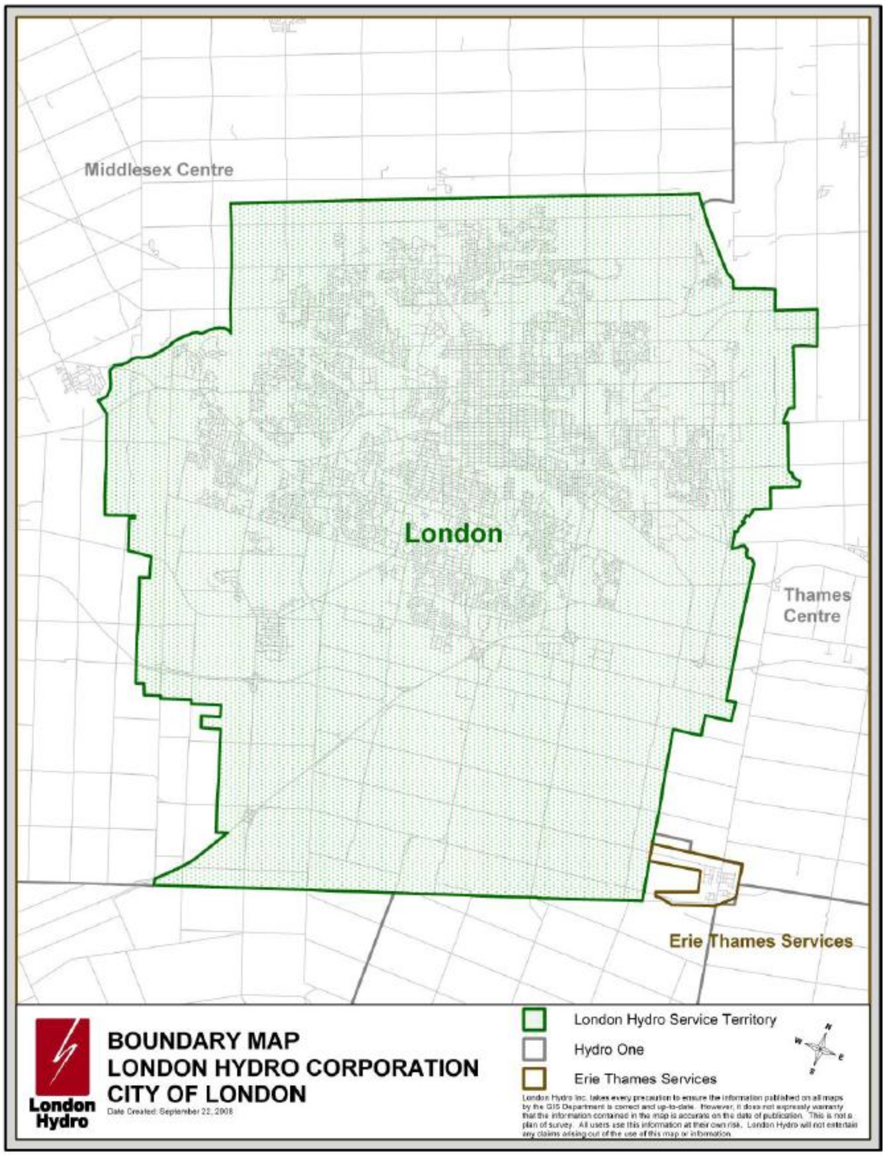


Figure 9: Map of London Hydro's Service Area

Located in the middle of southwestern Ontario, London's temperature ranges and weather patterns are typical for the area, with recent trends to more frequent extreme conditions such as ice storms, heavy snowfall, high winds, and thunderstorm activity. For the most part, London was not affected by the ice storms that affected much of Ontario in April and December of 2013, but it has experienced some severe wind activity and thunderstorms, which have had an impact on the distribution system. London has a humid continental climate (Köppen Dfb), due to its downwind location relative to Lake Huron and elevation changes across the city, it is virtually on the Dfa/Dfb (hot summer) boundary favouring the former climate zone to the southwest of the confluence of the South and North Thames Rivers, and the latter zone to the northeast (including the airport).

Because of its location in the continent, London experiences large seasonal contrast, tempered to a point by the surrounding Great Lakes. The summers are usually warm to hot and humid, with a July average of 20.8 °C (69.4 °F), and temperatures above 30 °C (86 °F) occur on average of 10 days per year. The City is affected by frequent thunderstorms due to hot, humid summer weather, as well as the convergence of breezes originating from Lake Huron and Lake Erie. The same convergence zone is responsible for spawning funnel clouds and the occasional tornado. London is located in Canada's Tornado Alley. Spring and autumn do not last long, and winters are cold but witness frequent thaws. Annual precipitation averages 1,011.5 mm (39.82 in); winter snowfall totals are heavy, averaging about 194 cm (76 in) per year. The majority of snow results from a lake effect and snow squalls originate from Lake Huron, some 60 km (37 miles) to the northwest, which occur when strong, cold winds blow from that direction.

Environment Canada tracks lightning activity and notes that, within Ontario, the London area experiences some of the most frequent lightning strikes (over 140,000 from 1999 to 2013) and an average of 40 days per year with lightning activity.[22] The frequent lightning activity and the increase in the frequency and severity of storms in general has prompted London Hydro to make some changes to its asset management and planning.

To decrease the potential damage of lightning strikes, London Hydro has installed shield wires or surge arrestors on critical overhead circuits and has upgraded the standard of line post insulators to 46 kV from 35 kV.[23] London Hydro receives details on the location of each lightning strike from a third party and is using this data to evaluate the effectiveness of these new standards.[24] To decrease the damage caused by high winds and ice storms, London Hydro has moved from a five-year tree trimming cycle to a three-year tree trimming cycle[25].

The distribution system in London is a fairly even balance of overhead and underground. Overhead distribution is used for most of the main feeder routes and in older residential areas of the City while underground distribution is used in newer developments and the downtown core. The trend for the past

[22] See source data in Appendix H.

[23] These changes began in 2010 based on recommendations included in the "Lightning Protection Study for London Hydro" (2009) – Kinetrics, see Appendix I.

[24] A report on the effectiveness of the lightning mitigation techniques is expected by the end of 2016.

[25] The three-year tree trimming cycle was adopted in 2015 upon review of actions taken by other LDCs after the December 2013 ice storm and discussion with the Electrical Safety Authority (ESA) regarding best practices for tree trimming. Tree trimming is contracted out to a third party.

and the foreseeable future is a relative increase the amount of underground distribution. The table below shows the pattern in the amount of underground distribution relative to the total amount of distribution.

Running Circuit[26]	2010	2011	2012	2013	2014
Overhead km of Line	1,364	1,363	1,362	1,374	1,379
Underground km of Line	1,410	1,457	1,480	1,507	1,537
Total km of Line	2,774	2,820	2,842	2,881	2,916
Underground % of Total	50.8%	51.7%	52.1%	52.3%	52.7%

Table 13: Amount of Underground Distribution as a Percentage of the Total (2010 - 2014)

The gradual increase in the amount of underground distribution is not due to a deliberate effort on behalf of London Hydro to convert the overhead system to underground. It is the result of how the system growth is serviced. For new growth areas, overhead circuits are typically extended along existing main traffic routes, while the majority of servicing to new developments is provided through underground circuits. The portions of the new circuits that are installed underground are the result of customer (developer) preference, and London Hydro is able to recover the incremental cost of the underground portion through the economic evaluation process outlined in Appendix B of the Distribution System Code.

The net result is that more underground distribution is added to the system each year than overhead. The cost to build, maintain, and replace underground systems is higher than it is for overhead, and the continued growth in underground assets tends to drive the overall capital and operating and maintenance budgets higher each year. A significant portion of the annual System Renewal budget (around 22%) is allocated to underground assets such as residential subdivisions that are at end of life. While the initial installation of many of these underground assets was financially supported by developers via capital contributions, the full cost of the eventual replacement or life extension of these assets is now recovered through rates.

The City of London has seen periods of moderate growth during the past ten years, with three key areas that continue to see growth: the north end (Masonville area), the downtown core, and the Highway 401 corridor. Providing additional capacity to the north end of London is a challenge because the transmission system (lines and transformer stations owned by Hydro One) does not extend to the north end of the City. The closest transformer stations are Talbot TS and Clark TS (shown in Figure 10 below).

[26] Running Circuit is the length of the complete circuit, which could include more than one cable per km

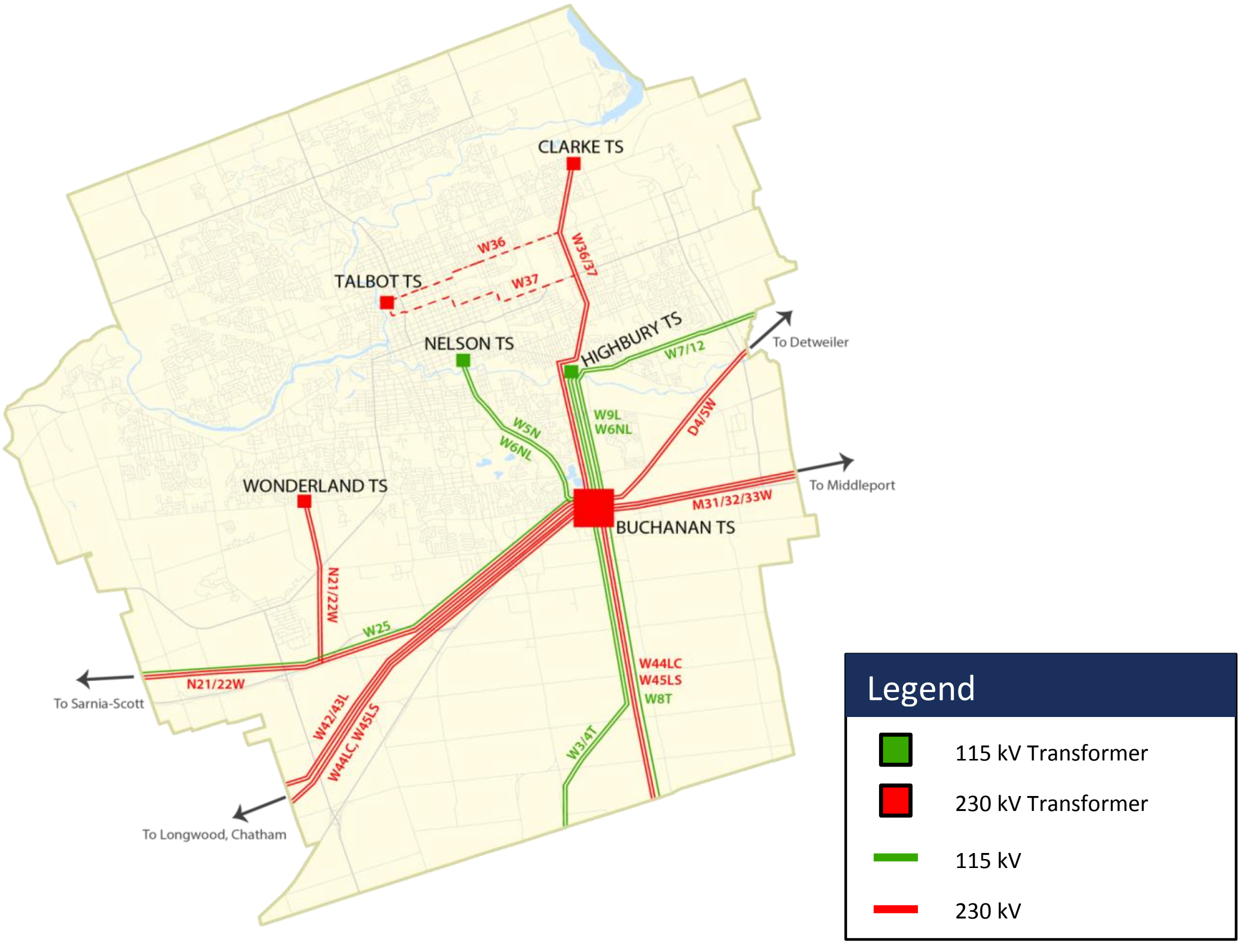


Figure 10: Location of London Hydro Transformer Stations (Source: IESO)

To accommodate load growth in the north, London Hydro has main feeder ties between Wonderland, Talbot, Clarke and Highbury transformer stations and will be adding additional feeder ties when the Nelson Transformer Station is converted from 13.8 kV to 27.6 kV. The additional feeder ties are expected to accommodate load growth in the north end for the foreseeable future.

The load in the downtown core is supplied by a mixture of voltages and systems including 27.6 kV 3phase 4wire, 13.8 kV 3phase 4wire, and 13.8 kV 3phase 3wire. The 13.8 kV 3phase 3wire supplies the underground secondary network which is the largest system supplying the downtown core.

The Downtown Core is supplied through a system of chambers, vaults, maintenance holes, and ducts, which contain the cables, transformers and network protectors. Many of these assets are either approaching end of life (such as the primary cables – paper insulated lead covered (PILC)) or are fully used (such as many of the concrete encased duct banks). As the load continues to intensify in downtown

London (due, in part, to new high rise buildings for offices, retail and residential), it becomes increasingly difficult to supply reliable capacity. The City of London has been working on a revitalization project (referred to as "*The London Plan*") that will see further intensification of the downtown core and the corridor up to and including the Masonville area. This ambitious plan comes at a time when much of the electrical infrastructure in the downtown core (including the Hydro One owned Nelson Transformer Station) is approaching end of life.

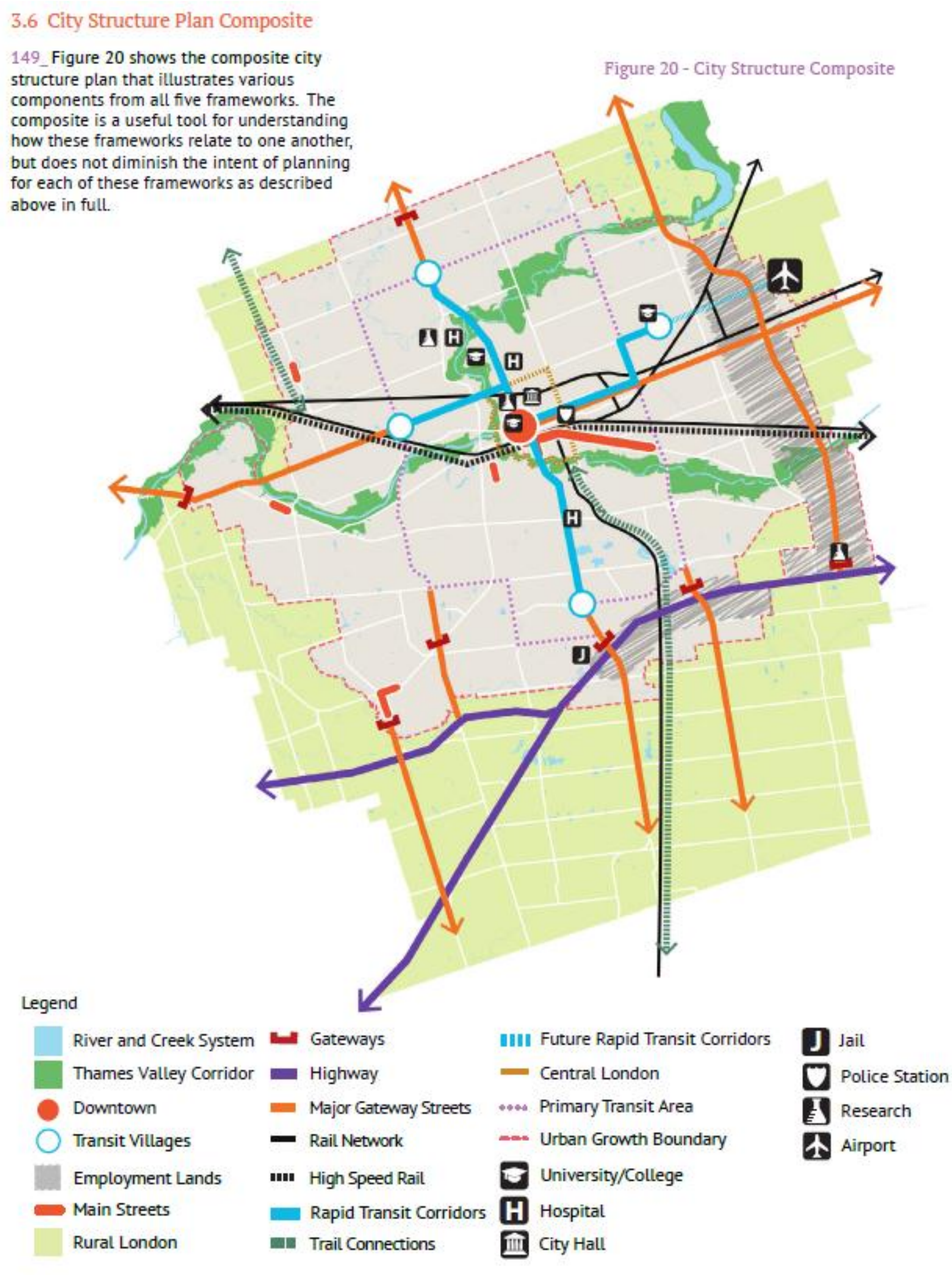


Figure 11: Composite Plan - City of London (The London Plan)

To service this growth area reliably and to support load growth in north London, Hydro One and London Hydro agreed to rebuild the end-of-life Nelson Transformer Station and convert the voltage to 27.6 kV. The conversion from 13.8 kV to 27.6 kV will eliminate the island of 13.8 kV load in downtown (which cannot be supplied by any other station other than Nelson TS) and allow the available capacity at Nelson TS to supply load currently supplied by the other five transformer stations in London. The voltage conversion will also alleviate congestion in the duct and maintenance hole system as the 27.6 kV feeders can supply twice the load as the 13.8 kV feeders thus requiring fewer ducts.

Growth along the Highway 401 corridor is less challenging to accommodate because two transformer stations (Wonderland and Buchanan) and several distribution feeders can supply this area. Essentially all of this growth is industrial and commercial and can be serviced with overhead distribution along municipal streets and right-of-ways.

2.2.2 System Configuration (5.3.2b)

London is supplied by seven (7) high-voltage transformer stations located throughout the City, which are owned and operated by Hydro One.[27] Table 14 below summarizes the capacity at each transformer station allocated to London Hydro, and the recent peak load.

Transformer Station	Voltage	Capacity Allocated to London Hydro[28]	Peak Load 2014[29] (non-coincident)
Buchanan	230 kV – 27.6 kV	176.7 MVA	125.4 MW
Clarke	230 kV – 27.6 kV	101.1 MVA	99.8 MW
Highbury	115 kV – 27.6 kV	105.2 MVA	86.1 MW
Talbot (T1&T2)	230 kV – 27.6 kV	305.7 MVA	246.9 MW
Wonderland	230 kV – 27.6 kV	90.7 MVA	101 MW
Nelson[30]	115 kV – 13.8 kV	120 MVA	36.1 MW
	Total	899.4 MVA (824.3 MW)[31]	691.3 MW
		(non-coincident peaks)	**(non-coincident peaks)**

Table 14: London Hydro Transformer Stations - Capacity and Peak Load

The feeders emanating from these stations operate at either 27.6 kV or 13.8 kV. The distribution system includes 52 feeders on the 27.6 kV system and 12 feeders on the 13.8 kV system. At 33 substations, transformation steps down voltage from 27.6 kV to 4.16 kV, and at one substation on the outskirts of the City, the voltage steps down from 27.6 kV to 8.32 kV.

[27] London Hydro also shares a feeder from the Edgeware TS but the load is less than 1 MW so it has not been included.
[28] The capacity allocated to London Hydro per transformer station is a calculated weighted average distribution using Hydro One's Planning LTR values provided as part of the 2015 Needs Assessment of the Regional Planning Process based on breaker allocation only. As well, the total allocated capacity in megawatts is based on the weighted system averaged power factor from Hydro One's planning criteria in the Needs Assessment.
[29] Actual Peak load in Mega Watts from wholesale metering.
[30] Nelson allocated capacity is based on new 27.6kV station
[31] Using Hydro One planning criteria for power factor at stations with and without capacitors

2.2.3 System Profile and Asset Condition (5.3.2c)

London Hydro has a database containing the asset registry and condition assessment, which is reviewed annually and analyzed within the Asset Sustainment Plan (ASP) (see section 7 in Asset Management Plan in Appendix G), which drives the Asset Management Plan. The figures below are taken from the ASP to provide a brief summary of the assets by type, including their condition profile. The data is current as of the end of 2014. There have been no significant changes to the assets that would have an impact on the overall ASP or AMP.

The scope of the ASP and AMP includes the distribution system assets (poles, wires, transformers, etc.). Other assets such as fleet, facilities[32] and information technology (including metering) are managed separately.

Poles (see ASP Section 1.1) - London Hydro owns approximately 28,000 poles (primarily wood) and shares another 3,200 poles with third parties (Hydro One and Bell Canada). The majority of these poles (approximately 76%) have been assessed as in "fair to good" condition based on testing conducted between 2008 and 2013.

Poles are tested by a third party using the following criteria:[33]

- Poles that have been in service less than 20 years are not tested.[34]
- Poles are tested when they turn 20.
- Poles that have been tested at least once are retested every five years unless a shorter interval is recommended.
- Poles that are recommended for immediate replacement are replaced within 12 months.

From the test results, pole age and other observations, the pole tester makes a recommendation for immediate action or for a retest interval that ranges from 1 year to 5 years. The two tables below show how the retest interval is calculated.

Table 15 represents urgent results based on remaining strength or the presence of carpenter ants.

Results	Recommendation
Strength < 50%	Replace Immediately
Strength 50% to 67%	Re-test in 1 year
Carpenter Ants Present	Re-test in 1 year

Table 15: Pole Testing - Urgent Results

As Table 16 illustrates, poles are categorized based on the adjusted retest interval recommended by the pole tester.

[32] Substation buildings are included in the ASP and AMP, but the main office and storage buildings are excluded.
[33] Pole testing consists of a visual inspection and sound test (hammer test). If the sound test indicates possible rot damage, a bore test is done to assess residual strength based on shell thickness.
[34] These poles are inspected every three years, and these inspections may trigger an earlier test based on observed condition.

Recommendation	Condition Ranking
Action Required	Bad Condition
Retest in 1 year	Major Deterioration
Retest in 2-4 years	Moderate Deterioration
Retest in 5-6 years	Minor Deterioration
Retest in 7-10 years	Fair to Good Condition

Table 16: Pole Testing - Condition Rankings

The results of the recent pole testing are summarized in Figure 12 below.

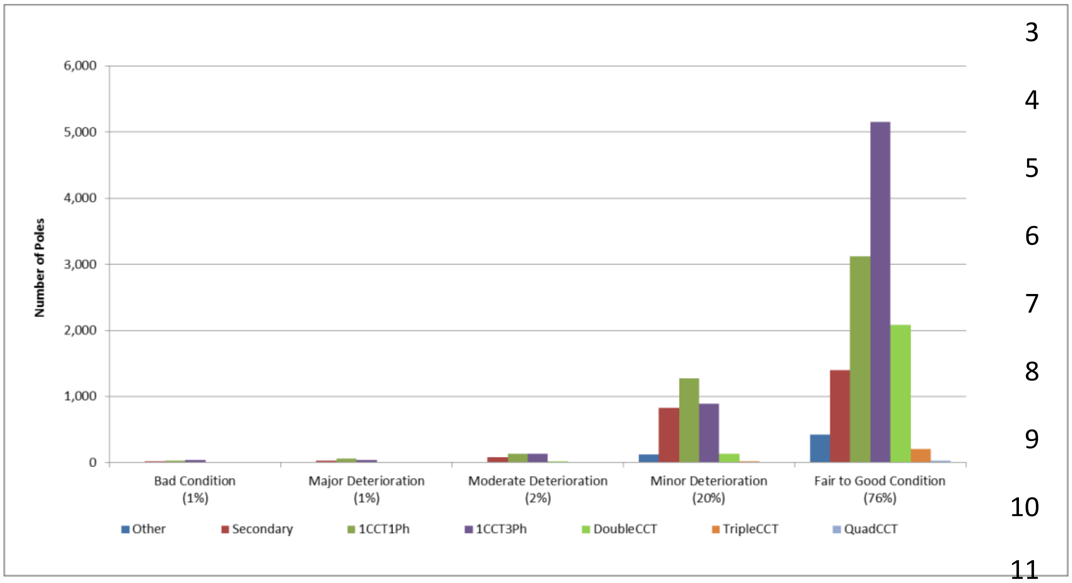


Figure 12: Condition Assessment of Poles by Occupancy (ASP Figure 1-6)

Distribution Transformers (see ASP Sections 1.4, 4.1, and 6.1) - London Hydro has approximately 7,630 pole-mounted transformers, 7,243 pad-mounted transformers, and 76 network transformers (installed in vaults downtown). Pole-mounted transformers are generally run to failure (or replaced due to other reasons such as a line relocation, overload, hot spot or damage noted during an inspection) and are not given an overall assessment. The age demographic profile is used in lieu of an actual condition ranking (see Figure 13 below).

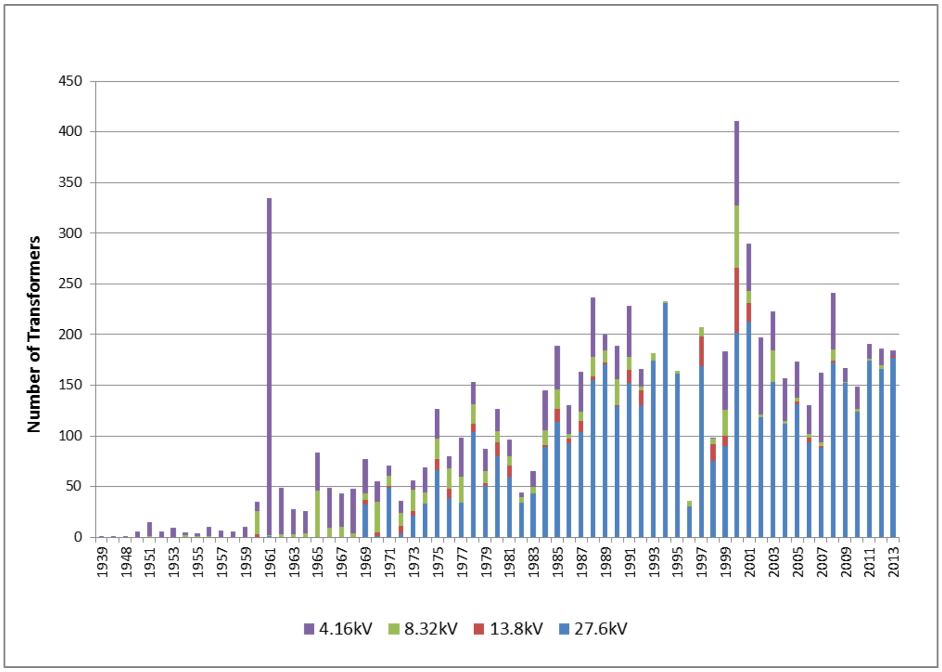


Figure 13: Number of In-Service Pole-Mounted Transformers by Age (ASP Figure 1-12)

Since padmount transformers are in closer proximity to the public and a failure could, therefore, create a safety hazard, a formal condition assessment based on field audits is conducted every three years (See Table 17 below for an example of inspection results).

	Corrosion/ Paint	Placement	Lock	Grade Change	Access	Oil Leakage (Y/N?)	Barriers	Insulators
Good	81%	99%	90%	99%	93%	98%	95%	95%
Fair	16%	--	--	--	5%	--	1%	1%
Poor	3%	1%	10%	1%	3%	2%	4%	3%

Table 17: Inspection Results from 2011-2013 Padmount Transformer Audits (ASP Table 4-1)

Network transformers are inspected every two months to check for oil leaks and overheating (which can lead to vault fires). Since the transformers are interconnected, a single failure will generally not cause an outage, so these units are kept in service as long as possible, barring any oil leaks or other component damage. As the figure below illustrates, over half of the units are less than 15 years old and only a few are expected to be replaced in the coming years.

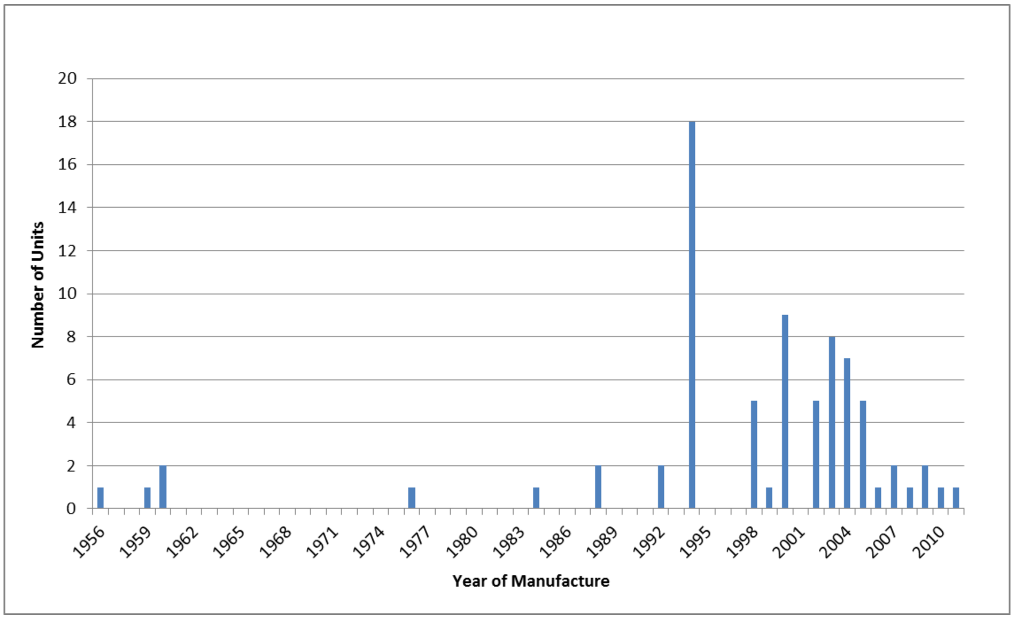


Figure 14: Age Distribution of Network Transformers (ASP Figure 6-1)

Substation Transformers (see ASP Section 3.1) - London Hydro has 52 substation transformers in service, of which most were installed over 40 years ago when 4.16 kV was considered the common distribution voltage. Since that time, 27.6 kV has become the standard distribution voltage and many areas of the City formerly served by these substations have been converted to the higher voltage, which has reduced and in some cases eliminated the load on these substation transformers. As a result, there are no plans to replace substation transformers within the next five years (and approximately 15 will be removed through voltage conversion projects). An age distribution profile is provided below, showing the units planned for removal. It should be noted that when a substation transformer is removed from service, it is assessed, and those in the best condition are kept as spare units to be used in the event of a failure of an in-service unit.

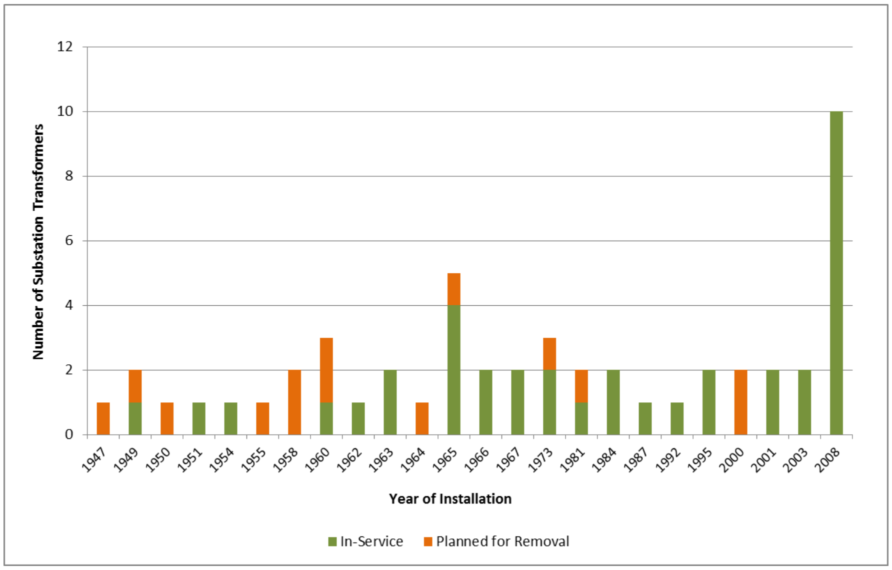


Figure 15: Age Distribution of Substation Transformers (ASP Figure 3-1)

Primary Underground Cable (see ASP Section 2) - London Hydro has approximately 1,800 km of primary underground cable installed to service residential and commercial customers. The table below shows the amount of cable by voltage rating, insulation type and size.

Cable Voltage Rating	Cable Type		Conductor Size	Conductor Length (in meters)
28 kV or higher	AL	XLPE/TR-XLPE	#1/0	1,611,040
			#2/0	21,608
			#4/0	168
			250 kcmil	663
				1,633,479
28 kV	CU	XLPE	#3/0	112,639
				112,639
15 kV	AL	XLPE	#1/0	26,527
				26,527
15 kV	CU	XLPE	#2	1,519
			#1/0	1,541
			#3/0	5,756
				8,816
5 kV	CU	PE/XLPE	#2	1,402
			#4	217
			#6	498
			#1/0	3,769
			#3/0	4,594
				10,480
		Rubber	#2	5,124
			#6	98
			#1/0	456
			#3/0	54
				5,732
Grand Total				1,797,673

Table 18: Residential/Commercial Total Cable Length by Voltage and Type (ASP Table 2-1)

The condition of underground primary cable is difficult to assess, but it is generally accepted within the industry that the different types of insulation and year of manufacture have limited life spans, as indicated in the following table.

Cable Vintage	Useful Life of cable
28 kV XLPE (<1980)	20-25 years
28 kV XLPE (1980-1989)	25-30 years
28 kV TR-XLPE (≥1990)	30-35 years

Table 19: Life Expectancy of 28 kV XLPE Cable by Vintage (ASP Table 2-3)

The age demographic profile of the installed cable is illustrated in Figure 16 below.

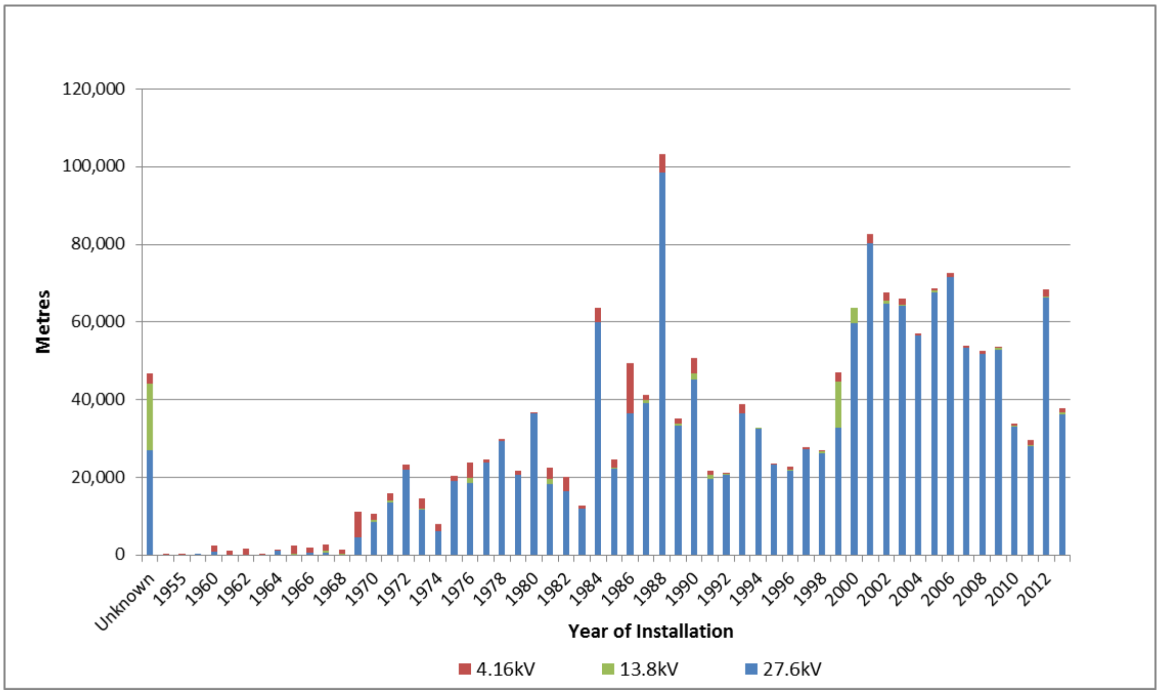


Figure 16: Cumulative Cable Length by Year of Installation (Residential/Commercial Distribution) (ASP Figure 2-3)

Since the quantity of underground primary cable that is beyond the expected useful life is substantial, London Hydro has developed a tool (SPOORE[35]) to analyze and rank the performance of cable in subdivisions. This tool takes into account safety, performance, operability, outage, risk and environment and gives an overall ranking, which is used to prioritize work.

London Hydro also has approximately 215 km of primary underground cable used for station egress and downtown feeders. The table below shows the amount of cable by voltage rating, insulation type and size.

[35] Safety, Performance, Operability, Outage, Risk, Environment - see ASP Section 2.1.2 in Appendix G and Appendix N for details.

Cable Voltage Rating	Cable Type		Cable Size	Conductor Length (in meters)
28 kV	AL	XLPE	1000 kcmil	136,554
				136,554
28 kV	CU	XLPE	750kcmil	6,996
				6,996
28 kV	CU	EPR	#2/0	1,452
				1,452
15 kV	CU	EPR	#2/0	5,486
			500 kcmil	2,377
				7,863
15 kV	CU	PILC	#3/0	18,939
			#4/0	536
			500 kcmil	5,186
			600 kcmil	33,981
				58,642
8 kV	Copper	PILC	750 kcmil	221
				221
5 kV	Copper	PILC	350 kcmil	569
			500 kcmil	3,374
				3,943
Grand Total				**215,671**

Table 20: Station Egress/Downtown Total Cable Length by Voltage and Type (ASP Table 2-2)

The condition of station egress and downtown primary cable is difficult to assess, but it is generally accepted within the industry that the different types of insulation and year of manufacture have limited life spans, as indicated in the following table.

Cable Vintage and Type	Useful Life of Cable
Large 28 kV XLPE (<1980)	20-25 years
Large 28 kV XLPE (1980-1989)	25-30 years
Large 28 kV XLPE (≥1990)	30-35 years
PILC	60-70 years

Table 21: Life Expectancy of XLPE and PILC Cable (ASP Table 2-5)

The age demographic profile of the installed cable is illustrated in Figures 17 and 18 below.

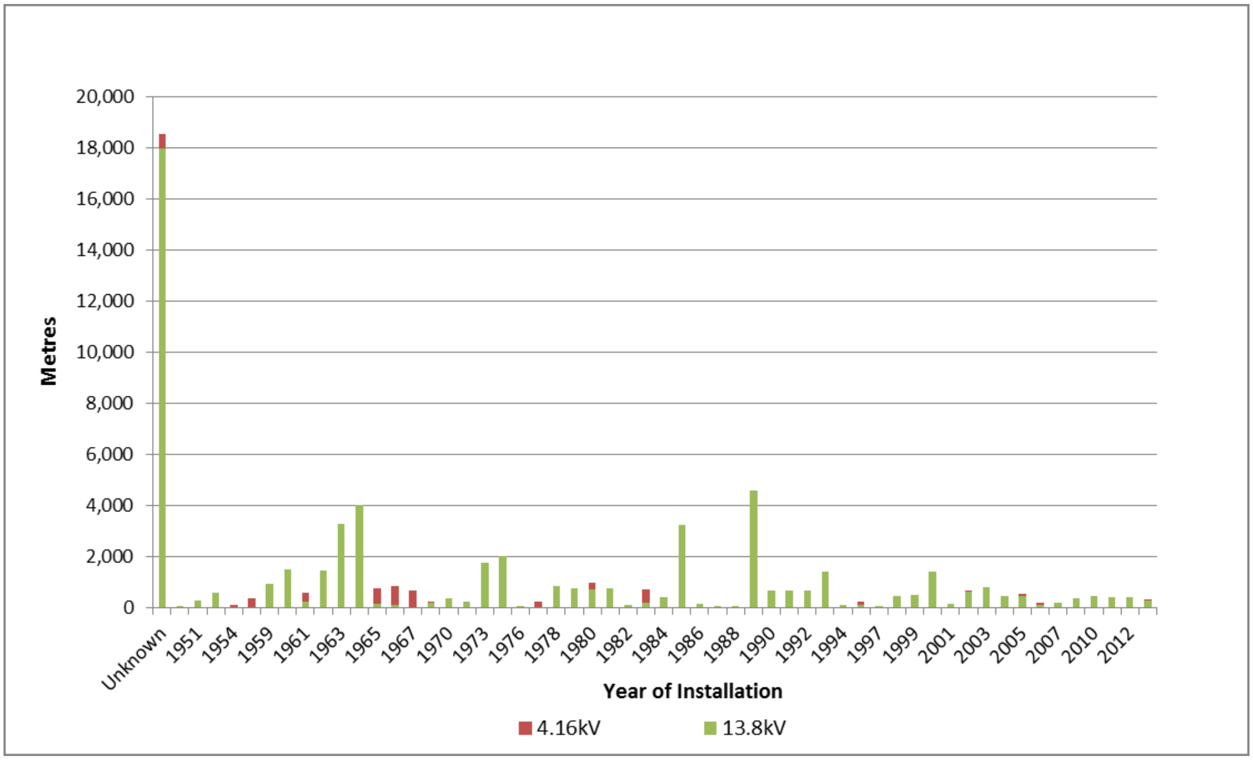


Figure 17: In-service PILC Cable Length by Year of Installation (ASP Figure 2-8)

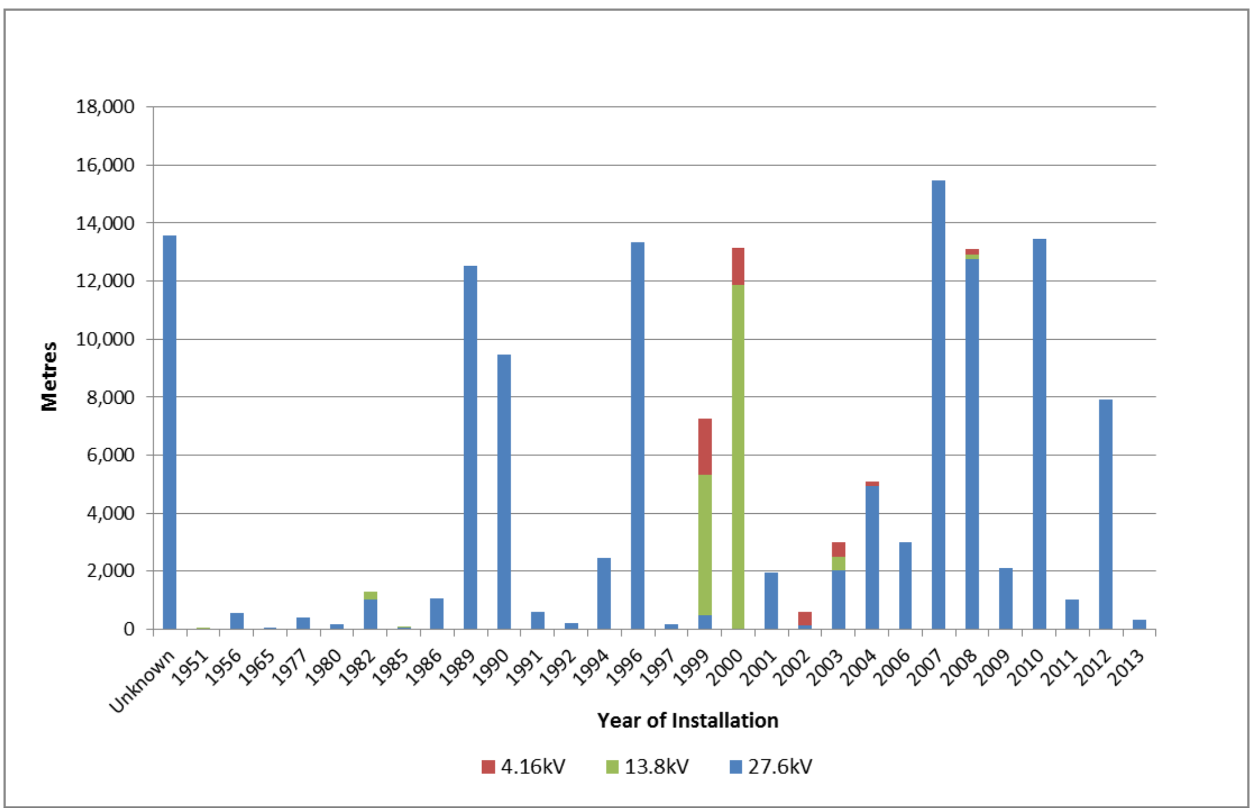


Figure 18: In-Service Large XLPE Cable Length by Year of Installation (ASP Figure 2-8)

London Hydro typically uses a “run to failure” approach for feeder egress cables and will either repair the faulted section or replace the entire cable depending on cable length, available space to install splices and future plans for the area. London Hydro has been replacing PILC cable with an EPR equivalent to eventually eliminate PILC cable from the system as it contains lead, which is considered an environmental and health hazard. The PILC cable is installed mainly in the 13.8 kV downtown network with a lesser amount in 4.16 kV Substations. With plans in place to convert the 13.8 kV system to 27.6 kV (part of the Nelson TS rebuild), these PILC cables will eventually be removed from the system and replaced with XLPE or EPR feeder cables.

Fleet – London Hydro’s Fleet and rolling stock assets consist of 149 vehicles, trailers and specialty-powered equipment (see Table 22 below for detailed fleet breakdown). Budgetary decisions are made based on the rationale described below.

In 2013, an extensive review of all Fleet processes was conducted, including the operating life of all London Hydro vehicles. As a result of this review, large vehicles (Classes 6, 7 & 8 such as Bucket Trucks and RBD vehicles) are now budgeted on a 12-year replacement schedule. Crane trucks (Class 8) are on a 15-year replacement schedule. Smaller work vehicles, pickup trucks, SUV’s etc. are budgeted on an 8-year schedule. Trailers are on a 20-year budgeted replacement schedule, which usually translates to running them to the point at which structural failure is imminent or the trailer no longer passes required MTO inspection protocols.

Specialty equipment, such as line tensioners and cable winch trailers, is on a 15-year budgeted replacement schedule due to the complex hydraulics, controls and motors used in this equipment. Usually this type of equipment is run to the point at which annual repair costs exceed 50% of the cost of a replacement or the equipment can no longer be operated safely due to key system failures. Other fuel-motorized equipment, such as chainsaws, gas drills, pumps, etc., is usually run to failure.

London Hydro maintains the Vehicle and Equipment Fleet with a combination of internal staff (three Mechanics and one Supervisor) and external contractors. London Hydro has found that operating the Fleet Department this way allows us to maintain the fleet, provide emergency/specialized repairs or maintenance as required and control costs.

Vehicle maintenance and fuel costs are tracked by individual unit and are summarized annually to determine cost trends. When a vehicle comes due for budgeted replacement, an overall assessment of the vehicle’s mileage, engine hours, repair history and future intended usage is performed by the Fleet Supervisor. The process includes, but is not limited to

- Using mileage, hours and age as determining factors in vehicle replacement;
- Flagging vehicles for replacement consideration when maintenance on the specific vehicle exceeds 20% of the value of the vehicle for two consecutive years;
- Considering resale value, which can have an impact on total cost of ownership (we look at maintenance cost over mileage bands of 10k miles or Hours based on 1 Hour = 40 km); and
- Considering current MTO, IHSA, departmental needs that might necessitate major modifications for vehicle to remain in service

If the life of a vehicle can be extended based on these criteria, the vehicle will also be inspected in relation to any applicable government regulations to ensure it will still meet requirements if it is to remain in service. London Hydro also uses the E3 Fleet Economic Life model (see Figure 19) as part of the replacement evaluation. Finally, the department that uses the vehicle is consulted to determine whether the vehicle still performs as required or if replacement with a vehicle that has newer or different features would provide work group efficiencies. This assessment may result in the vehicle replacement being deferred to the next budget year when the vehicle would be assessed again to see if replacement is necessary. While this deferral extends the vehicle beyond the fully depreciated life cost, it also results in savings related to not purchasing a new vehicle.

The Director of Logistics and Operations Support reviews the London Hydro vehicle replacement schedule and associated maintenance costs annually. This review results in a prioritized list of vehicles and equipment to be replaced in the following year's budget. Table 23 illustrates the budgeted vehicle replacements from 2013 to 2021. From 2013 to 2015, ten out of fifteen vehicles that were budgeted to be replaced were kept in service using the E3 Fleet Economic Life model.

Vehicle Type	# in Fleet
Air Compressor	1
Aisle Walkie Stacker	4
Backhoe	1
Backhoe Loader	2
Bucket Truck	19
Car	4
Chipper	2
Cube/Cutaway Van	9
Dump Truck	4
Flat Deck	2
Flat Deck Crane	4
Fork Lift	2
HighwayTractor	1
Ho-Pac	1
Hyd. Breaker	1
Large Van	3
Mini Van	1
Pickup	24
Pulling Machine	2
RBD	6
Reel Handler	1
SUV	27
Tensioner	2
TRAILER	21
Transformer Lifter	1
Van / Super Van	4

Table 22: Fleet / Rolling Stock Inventory

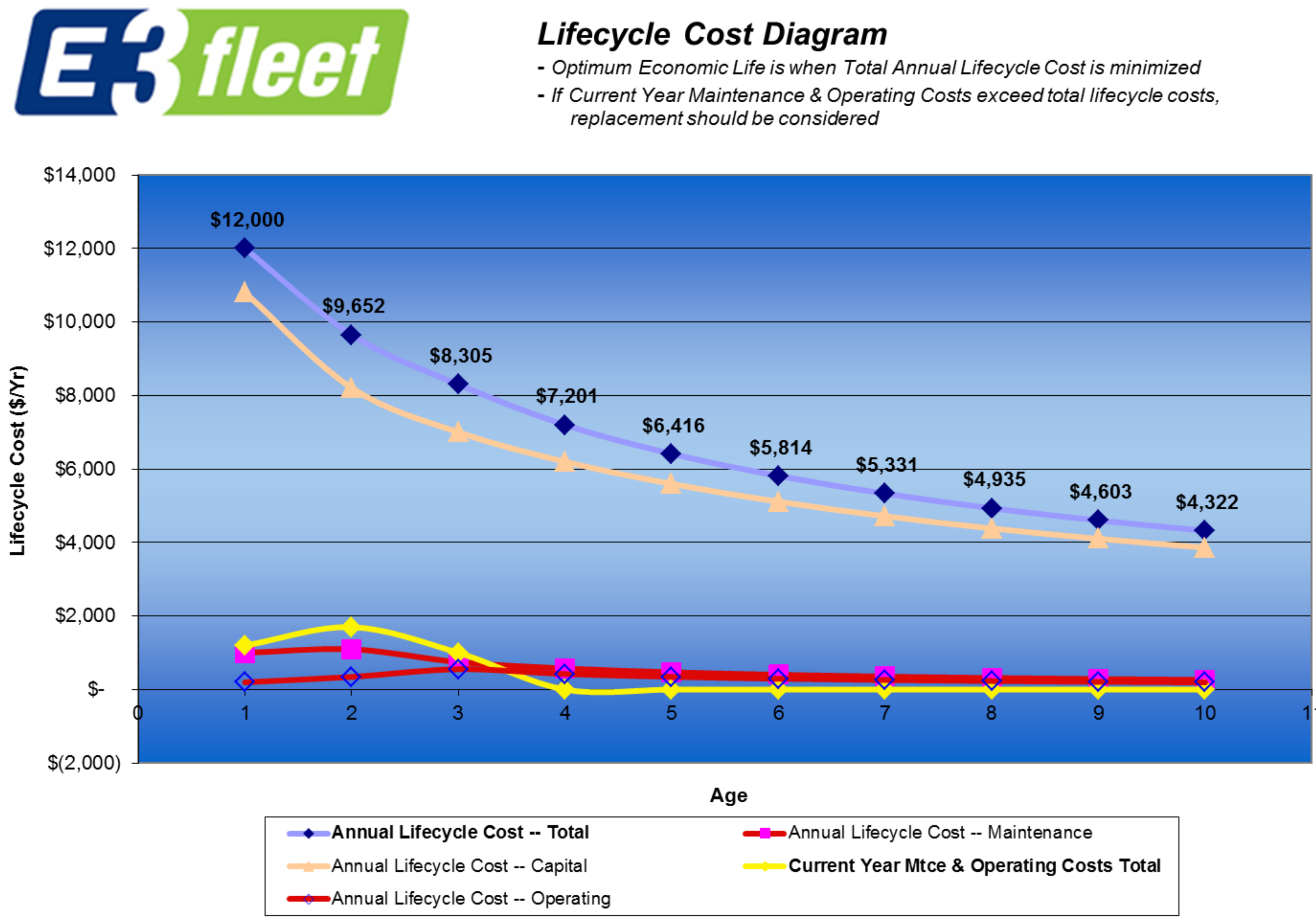


Figure 19: Vehicle Optimum Economic Life Model

Budgeted Replace. Date	Replacement Cycle Yrs.	Actual Replace. Date	Unit #	Acquired Year	Description	Department	Notes
2013	12	TBD[36]	5	2001	Ford Dump Truck	Line	Low usage
2013	12	TBD	30	2001	IHC Holan 47' S Bucket	Line	Low hours
2013	12	TBD	107	2001	IHC Holan 42' S Bucket	Line	Low hours
2013	20	TBD	924	1993	Util Equip Transformer Trailer	Line	Low usage
2014	15	TBD	13	1999	Freightliner Hiab Flat Deck	Construction	Low usage
2014	15	TBD	51	1999	Freightliner Flat Deck	Construction	Low usage
2014	15	2015	70	2014	Freightliner RBD	Line	
2014	20	TBD	916	1994	Util-Equip Transf. Trailer 3 phase	Line	Low usage
2015	15	2016	11	2000	Freightliner Flat Deck	Construction	
2015	12	2016	57	2003	Freightliner Holan 47' S Bucket	Line	
2015	8	2016	122	2007	Chevy Silverado Ext. cab 4x4	Line	
2015	8	TBD	126	2007	Chevy Silverado Ext.cab 4x4	Construction	Low Km
2015	8	TBD	127	2007	Chev Equinox AWD	Pool	Moved to pool
2015	15	2016	140	2000	IHC Dump Truck	Forestry	
2015	20	TBD	911	1995	T J Welding Reel Trailer	Line	Low usage
2016	8		8	2008	Ford Compact 4x4 SUV Hybrid	Pool	
2016	8		16	2008	Ford Compact 4x4 SUV Hybrid	Engineering	
2016	8		36	2008	Ford Compact 4x4 SUV Hybrid	EUS	
2016	15		50	2001	Freightliner RBD	Line	
2016	8		52	2008	Ford Compact 4x4 SUV Hybrid	Construction	
2016	15		93	2001	Freightliner Palfinger Flat Deck	Construction	
2016	7		801	2009	Vermeer Chipper	Forestry	
2016	6		812	2010	Case 4x4 Backhoe Loader	Construction	
2016	6		855	2010	Case 4x4 Backhoe Loader	Construction	
2017	8		10	2009	Ford Compact 4x4 SUV Hybrid	Locates/GIS	
2017	8		12	2009	Ford Ext. Cab 4x4 pickup	Construction	
2017	8		21	2009	Ford Compact 4x4 SUV Hybrid	Executive - Corporate Communications	
2017	8		22	2009	Ford Compact 4x4 SUV Hybrid	Meter Reading	
2017	8		27	2009	Ford Compact 4x4 SUV Hybrid	Pool	
2017	8		31	2009	Ford Compact 4x4 SUV Hybrid	Safety	
2017	8		35	2009	Ford Compact 4x4 SUV Hybrid	Safety	
2017	8		37	2009	Ford Compact 4x4 SUV Hybrid	Engineering	
2017	8		39	2009	Ford F350 4x4 pickup/plow	Construction	
2017	8		41	2009	Ford 4x4 Ext. Cab pickup	Construction	
2017	8		43	2009	Ford 4x4 Extended cab pickup	Line	
2017	8		48	2009	Ford Compact 4x4 SUV Hybrid	Garage	
2017	8		76	2009	Ford Ext. Cab 4x4 pickup	Construction	

[36] Vehicles with TBD in this column have not been replaced as of 2016 and their expected replacement date is to be determined (TBD) as Fleet personnel review the E3 Fleet Model results.

2017	8		88	2009	Ford Compact 4x4 SUV Hybrid	Control	
2017	8		94	2009	Ford Compact 4x4 SUV Hybrid	Engineering	
2017	8		98	2009	Ford Compact 4x4 SUV Hybrid	Line	
2017	8		102	2009	Ford Compact 4x4 SUV Hybrid	EUS	
2017	8		114	2009	Ford 4x4 Ext. Cab pickup	Construction	
2017	8		115	2009	Ford Compact 4x4 SUV Hybrid	Instrumentation	
2017	8		131	2009	Ford extended Cab 4x4 pickup	Forestry	
2017	15		805	2002	Hyster Fork Lift	Stores	
2017	15		840	2002	Hyster Fork Lift	Stores	
2017	15		856	2002	Hyster Aisle Walkie Stacker	Stores	
2018	15		6	2003	Freightliner Palfinger Crane Flat Deck	Construction	
2018	8		17	2010	Ford Compact 4x4 SUV Hybrid	Stores	
2018	8		20	2010	Ford Compact 4x4 SUV Hybrid	El. Meter	
2018	8		38	2010	Ford Compact 4x4 SUV Hybrid	Pool	
2018	4		228	2015	Toyota Highlander 4x4 SUV Hybrid	Executive - Pool	
2019	8		46	2011	Chev 4x4 pickup ext. cab	EUS	
2019	8		56	2011	Ford Compact 4x4 SUV Hybrid	Engineering	
2019	8		58	2011	Ford Compact 4x4 SUV Hybrid	Executive - Corporate Communications	
2019	4		230	2015	Ford Pick-Up	Line	
2019	20		917	1999	Nando Dump Trailer	Construction	
2020	8		49	2012	Chev 4x4 Pickup Crew	Line	
2020	8		54	2012	Chevy VOLT - electric car	CDM	
2020	8		61	2012	Ford Compact 4x4 SUV Hybrid	CDM	
2020	8		85	2012	Chev 4x4 Pickup - Crew	Line	
2020	8		112	2012	Chev Ext. Cab 4x4 pickup	EUS	
2020	7		810	2013	Vermeer Chipper	Forestry	
2020	6		811	2014	Case 4x4 Backhoe Loader	Construction	
2020	20		929	2000	12,000lb. Utility Trailer	Line	
2020	20		936	2000	Beavertail Float	Construction	
2021	12		2	2009	Freightliner 45' S. Bucket	Line	
2021	12		9	2009	Freightliner 45' S. Bucket	Line	
2021	20		14	2000	Freightliner Timberland Puller	EUS	
2021	8		26	2013	Chev Ext. Cab 4x4 Pickup	Line	
2021	8		33	2013	Chev Ext. Cab 4x4 Pickup	Sub Stn Mtce	
2021	8		53	2013	Chevy VOLT - electric car	CDM	
2021	8		59	2013	Chev Pickup 4x4 Crew	Line	
2021	8		73	2013	Chev Pickup 4x4 Crew	Line	

Table 23: Budgeted Vehicle Replacement Schedule

Facilities – London Hydro operates out of one main facility at 111 Horton Street in London and 41 municipal substations, both outdoor and building style, located throughout the City. London Hydro also maintains portions of customer vaults and transformer enclosures that house a combination of London Hydro-owned and customer-owned equipment. While London Hydro owns all buildings at the 111 Horton Street site, these facilities sit on leased land. Originally constructed in the early 1900's, the 111 Horton facility is now comprised of four buildings: the two oldest buildings (built before 1960) house the Engineering, Planning, Health & Safety and Materials Management Departments; a third building, constructed in 1981, houses the Operations, Fleet and Facilities Departments; and a fourth building, constructed in 1987, houses Customer Service, Information Technology, Finance and Executive offices, for a total gross area of 194,363 square feet. London Hydro has a staff of 316 full and part-time employees plus 15 Contract staff who work mainly in the IT Department. The buildings are inspected on a regular basis by employees and third party experts and plans are made to ensure they are safe and functional, and critical equipment such as elevators and HVAC units are regularly maintained with upgrades or replacements planned based on age and condition.

The land at 111 Horton Street is located along the South Branch of the Thames River and is leased from the City of London. London Hydro also leases a three-acre lot that provides employee parking. Under the terms of both leases, London Hydro is responsible for all asphalt, maintenance, security, repairs or remediation required on the lands. In 2007, the City of London (our shareholder) completed a Thames Valley Corridor Plan. This Plan has, in turn, sparked a project called "Back to the River," and the City has notified us that they will be using a significant part of our river facing land as part of this project. Since this project has been under discussion for a few years, London Hydro has deferred much needed yard, material storage, and some building repair projects while awaiting the City's decision on how much land it is going to reclaim. Recently, London Hydro has been notified that it will be losing approximately three acres of its seven-acre property; however, no final decision has been made by the City as of this application. This land reduction will result in some increased short-term costs related to reorganizing material storage and vehicle parking space plus the installation of new security fencing, cameras etc. Much of the asphalt in the yard is in need of replacement and these projects are expected to begin in 2017 when the land boundary issue with the City of London is formalized.

London Hydro has budgeted to bring all buildings up to AODA compliance over the next five years. Work related to building new accommodations is covered in London Hydro's Capital Plan. Work related to repairing existing infrastructure to comply with AODA legislation is captured in the O&M budget.

While this task will be relatively straightforward in the two buildings constructed in the 1980's, it will be a more challenging and, therefore, more costly project in the two older buildings.

Another major project involves the replacement of the 25-year-old Steelcase office furniture which has become increasingly hard to maintain and retrofit to today's ergonomic standards. London Hydro is currently working on new furniture standards with ergonomic design features, such as sit/stand workstations and noise dampening panel boards. This project started in 2016 and it is anticipated that furniture replacements in all remaining departments will be completed in five years. This project will reduce the inventory of spare Steelcase parts and provide long-term savings in maintenance and repairs costs. The 29-year-old elevators in the Administration Building will be replaced in 2016. This replacement contract also includes a 15-year warranty and a maintenance contract that provided savings in excess of $10,000 per year in maintenance costs.

Until 2015, many employees parked their vehicles in the lower yard, which caused a number of safety and security concerns. Specifically,

- The lower yard location forced staff to walk through an industrial area with large machinery and vehicles moving around frequently. Large delivery vehicles, as well as London Hydro's own fleet and equipment, navigate a relatively tight area between buildings and storage areas, leaving pedestrians vulnerable. For employees travelling in the dark, either in winter or for shift work, these moving vehicles were even more dangerous to negotiate, despite the improved lighting in the area.
- An increase in staffing levels resulted in a corresponding increase in traffic in the parking area, resulting in greater risk of accidents in an already congested area.
- Problems were beginning to arise with large vehicle parking (bucket trucks, RBDs, etc.), as the yard set-up did not allow pull through parking and, therefore, forced large vehicles with long trailers to reverse into tight areas to navigate the yard.
- With a large number of unmarked, personal vehicles entering our secured operations yard daily, it was increasingly difficult for our security staff to identify vehicles that were not authorized to be in the yard.

To address all of these safety and security issues, a new parking area was leased directly to the north of London Hydro for staff. The lot is monitored by Security staff and is equipped with LED lighting and security cameras. The land on which the new parking lot is situated is leased from neighbouring Labatt Brewing Company Limited.

Metering – London Hydro has a total of 154,171 revenue meters in service. Table 24 below provides a break down by customer class.

Customer Class	Quantity	%
Residential	140,044	90.8
GS < 50 kW	12,545	8.1
GS > 50 kW	1,582	1.0
Large Use > 5000 kW	2	<0.1
Total	154,171	100

Table 24: Meters by Customer Class

London Hydro, in conjunction with a contracted metering service provider, also services seven wholesale meter points at Hydro One transformer stations. A total of 36 main and alternate wholesale meters and related instrument transformers are used for metering at these locations. In addition, there are six retail meter points with Hydro One distribution.

The meters for residential and many small general service customers are smart meters installed primarily between 2009 and 2011. Additional smart meter infrastructure includes 17 regional collector radio base stations and related height-asset towers to support the base-stations as well as wireless backhaul data networks to send the data to the head-end computer databases.

Metering installations for general service and large use customers will include voltage and current transformers (as applicable) and telecommunication equipment.

Measurement Canada requires revenue meters to be verified for accuracy on a periodic basis, which has the result that the total population of meters are considered to be in “good” condition. Instrument transformers do not need to be verified as frequently, which has resulted in some installations (such primary metering installations used on high voltage connections) being in service much longer than the revenue meters. Some of these installations (24) are older, oil-filled units which will be replaced in the coming years with modern oil-free equivalents.

In 2014, the OEB amended the Distribution System Code such that customers with greater than 50 kW demand now require an interval meter (EB-2013—0311) and LDCs have been given six years to make the necessary changes. There are 1080 meters to be changed, which will significantly increase the quantity of meter replacements per year until the end of 2020.

The telecommunication infrastructure necessary to retrieve the billing data from the various meter types has a much shorter useful life and much of it requires replacement. A plan to amalgamate and update the various telecom networks has been prepared and included in Appendix M.

Information Technology - London Hydro has a progressive and innovative Information Technology (IT) Department that supports the internal business units and the various customer engagement services. As described above (see section 2.1.2) the IT Department operates on a three-year rolling strategy to focus its investments and service delivery.

Period: 2009 - 2013

As illustrated in Figure 20, prior to 2013, the IT strategy focused on the back-end systems of the business ensuring that its internal systems were robust, met business process needs and were compliant with smart meter regulations (TOU billing). The business systems were upgraded to industry leading standards using vendor products such as an SAP CIS solution, Itron and Intergraph for Operations data management and Sensus for a completely new AMI infrastructure. One system, one source of data was the essence of this design implementation. London Hydro met its key milestone date with the OEB March 2012 deadline for TOU and demonstrated ongoing top performance, consistently scoring among the best LDC’s for lowest average cost per customer.

Period: 2013 - 2016

The period from 2014 to 2016 has been primarily focused on the front-end customer-facing systems, while improving the effectiveness of some underlying business processes. Among the major accomplishments to date was the re-platforming and re-launching of London Hydro’s corporate website and the new customer MyLondonHydro portal. Replacing the earlier static web presence, the new corporate website offers dynamic, continually updated content that is of interest to customers. The new MyLondonHydro customer portal provides registered customers (both residential and commercial) access to an ever-increasing suite of self-service functionality, which has resulted in a corresponding reduction in calls traditionally handled by Customer Service representatives. London Hydro was the proud recipient of a Silver Creativity International Media and Interactive Award for its innovative web design.

London Hydro continues to enhance, update or re-platform its internal operating systems as they approach end of life. As an example, since 2014 the legacy HR system was updated and re-platformed to a Cloud-based, Software as a Service (SaaS) subscription solution (SAP Success Factors). Implementation of a new HRIS offers cost savings/avoidance, operational efficiencies and better management of staffing including improved reporting and information and improved oversight/accountability.

Period: 2017 and Going Forward

The focus for the period beginning in 2017 will be balanced between continuing to enhance and expand customer engagement solutions and enhancing/upgrading some of the core business support systems, which, in turn, indirectly support the customer engagement solutions.

In term of its customer engagement solutions, London Hydro believes that, going forward, the following factors will act as catalysts for increasing customer adoption, engagement and positive behaviour change:

- Continued Green Button adoption across utilities will break down “data silos” among utilities, provinces and, potentially, countries.
- Continued third party mobile app development based on the Green Button standard will result in increased customer choice - driven by
    - Emerging Cloud-based technologies that will make customer consumption data available on a near real-time basis.
    - Mainstream availability and affordability of “smart” home appliances (Internet of Things)
    - Customer apps that will incorporate other important related data e.g. water, gas, inside/outside temperature, thermostat set points, appliance data, social benchmarking etc.
- Continued enhancement and enrichment of current customer engagement solutions

Improvements to core operational systems will be focused primarily on enhancing Mobile Workforce Management, upgrading the aging JD Edwards Financial system, the GIS system, the Customer Information Systems (CIS) and replacing the legacy payroll system. Going forward, when upgrading or replacing core operational systems currently on premise, London Hydro will include the option of moving to a Cloud-based Software as a Service (SaaS) solution in the business case evaluation.

Service Delivery

Key service delivery elements include Application Hosting, Cloud computing, Mobile first, Green Button, and cyber security.

Application Hosting

Figure 20 illustrates London Hydro’s general application hosting strategy: traditionally, utilities host all applications on-site within their own IT centre and network. However, technological advances have given rise to alternative methodologies for hosting applications allowing for optimal use of resources and lowest total cost of operations.

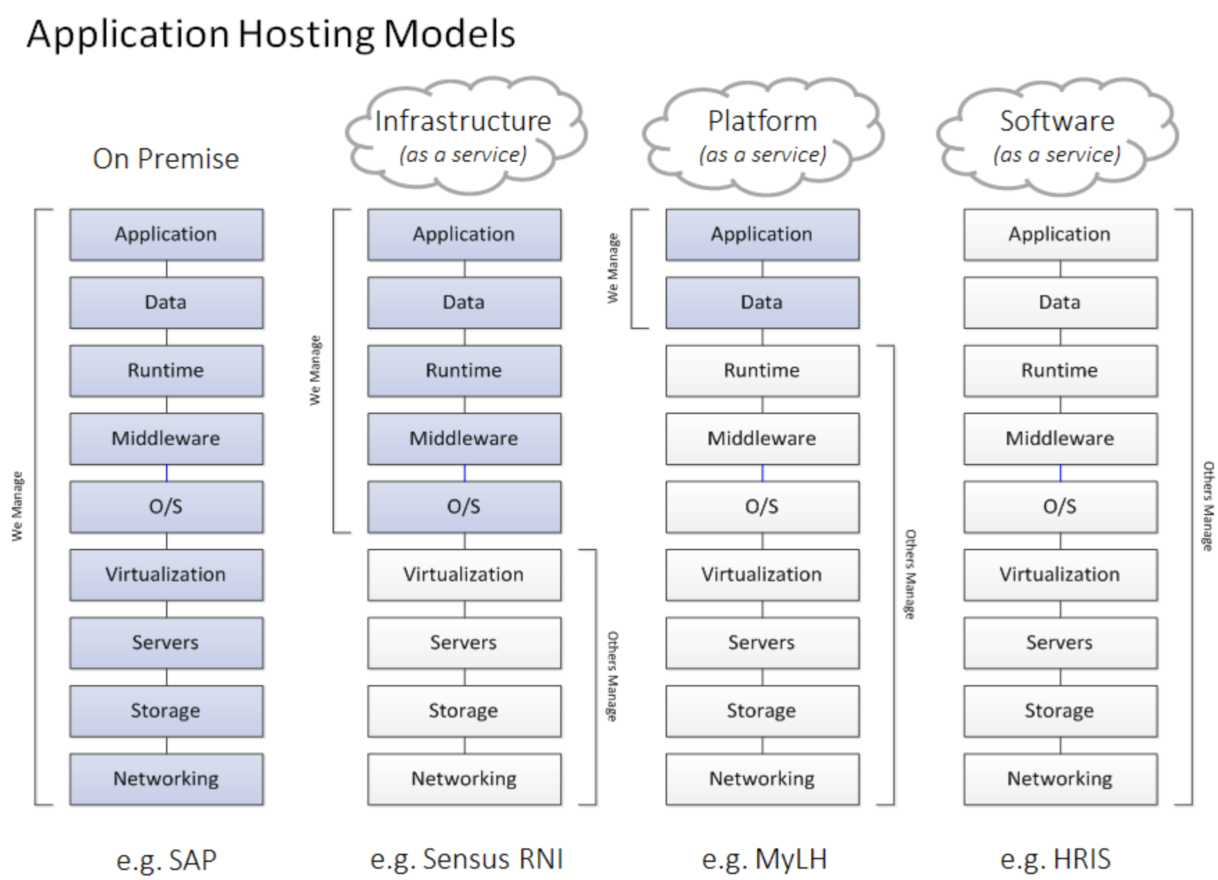


Figure 20: Application Hosting Models

Cloud Computing

The most profound new capability adopted at London Hydro is Cloud computing, where large service providers host client applications and/or data storage needs over the internet for a monthly fee based upon client's actual usage. Large service providers, such as Google and Amazon, can deliver these services and functions at significantly lower costs than "in-house" based systems when the total cost of ownership is compared over a five-year period. Aside from the cost benefits, other benefits from Cloud computing include

1. Services are purchased on an incremental basis to match demand. This approach is not possible with "owned" capital assets, which must be purchased for peak demand, and typically results in underutilization of these assets.

2. Reduced in-house support efforts for maintaining currency and patches for both hardware and software.
3. Cyber security for Cloud infrastructure provided by the service providers reduces the risk to London Hydro as their efforts (again through economy of scale) have more extensive capabilities.
4. 24/7 support and almost instantaneous resumption of services are delivered as part of their extensive inventory due to economies of scale in service delivery.
5. Cloud-based resources (e.g. computing power and storage) can be turned off when not in use in order to reduce cost.

Figure 21 illustrates the current and planned movement of LH applications to the cloud environment.

Customer requirements for options that are mobile-based, accessible, secure, responsive and scalable have led London Hydro to embrace innovative Cloud technologies. London Hydro believes that as customer preferences become more sophisticated and information updates approach real-time, its Cloud-based customer engagement solutions will continue to be future- proofed.

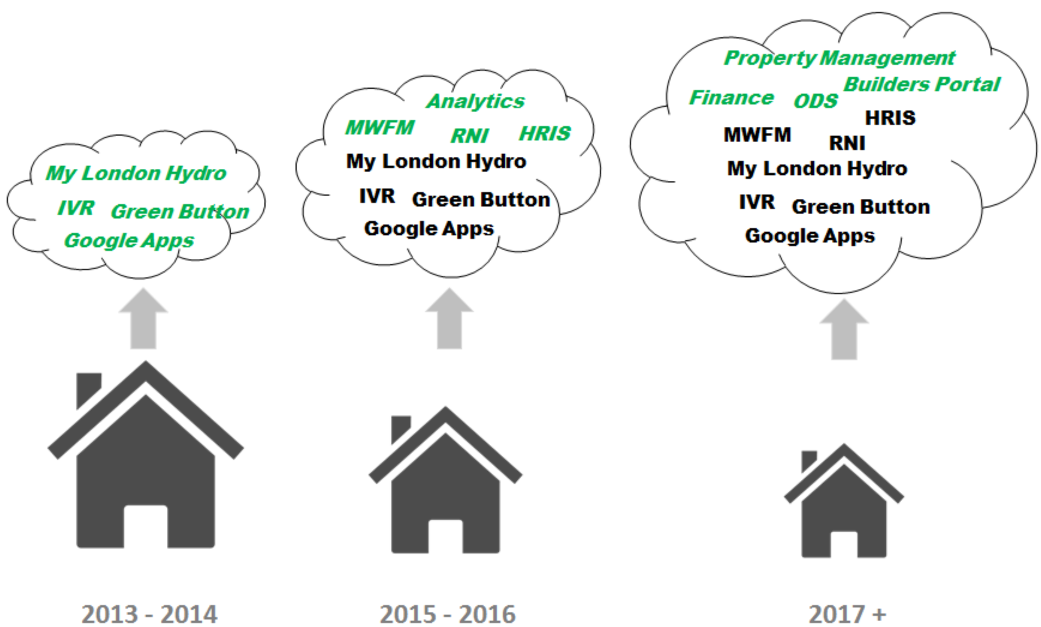


Figure 21: Move to the Cloud

Mobility

London Hydro's "mobile first" strategy refers to the design of products for mobile phones or devices while continuing to make complementary offerings for traditional desktop and laptop computers. London Hydro has incorporated "responsive web design" into all of its customer engagement apps which means that the content of a website automatically reformats based on the user device's screen size, orientation and operating system.

London Hydro's "mobile first" strategy is driven by the increasing use of mobile devices by customers. People are increasingly making decisions using their phones and tablets. London Hydro believes that the emerging mobile-based payment alternatives (e.g. iPay, e-wallet) will continue to make mobile access the first choice with customers.

Green Button

London Hydro has committed to providing its customers with software choices to help them manage their energy consumption. This commitment is achieved primarily through the 'Green Button' standard and applications that are built upon and enabled by this standard. The Green Button standard, as integrated within the existing London Hydro IT architecture (MyLondonHydro), ties into its Customer Engagement Strategy by helping customers manage their energy consumption in a proactive way before they receive their monthly bill. Currently, 100% of London Hydro's customer consumption data is accessible through Green Button to third party applications.

In February 2013, London Hydro was the first utility in Canada to provide Green Button Download My Data to customers through its customer engagement portal, MyLondonHydro. Since then, Green Button Connect My Data gave London Hydro an opportunity to meet its strategic objective of providing leading edge technologies to its customers, and we have worked closely with the government to explore this emerging market.

Working closely with the National Institute for Standards and Technology (NIST), a US agency under the Department of Energy, and Smart Grid Interoperability Panel (SGIP), and recently with CS Week's Smart Grid Infrastructure Synergy Group, London Hydro has become Green Button's champion and model for other utilities.

London Hydro has been championing the Green Button initiative as part of the Ontario Ministry of Energy's "Conservation First" initiative and Ontario's Long-Term Energy Plan (LTEP). By leveraging the province's investment in smart meters, the Green Button Initiative will empower consumers by providing them with easier access to their own electricity data.

Green Button enhances the role of utilities as a Data Custodian partnering with customers in energy management solutions as opposed to simply being a source of raw data for third-party service providers. More value is realized because the infrastructure is positioned to handle and scale to near real-time/real-time data.

Another advantage of the Green Button Platform is that it leverages the existing utility processes and systems to expose the data to other applications. London Hydro has built a cost effective Green Button Cloud ecosystem that is highly responsive, secure and scalable. This infrastructure can be replicated or configured to be multi-tenant, which facilitates implementation by other utilities.

Cyber Security

London Hydro's cyber security program is part of the overall Enterprise Risk Management (ERM) Strategy and continues to evolve as increasing cyber intrusions threaten London Hydro's operations and its customers' privacy. As exposure to the internet increases (primarily through deployment of customer service and engagement applications) so does the possibility of a security breach.

Since the decision was made to make cyber security a priority at London Hydro, the ISO 27001 standard was adopted as the desired goal. By achieving this standard, London Hydro will be in a position to comply with any other recognized Information Security Standards (NERC CIP, COBIT, etc.) with minimal effort.

The ISO 27001 international standard for information security is comprised of numerous "controls" that are grouped into sections. Figure 22 illustrates the progress London Hydro has made since 2013 towards this goal.

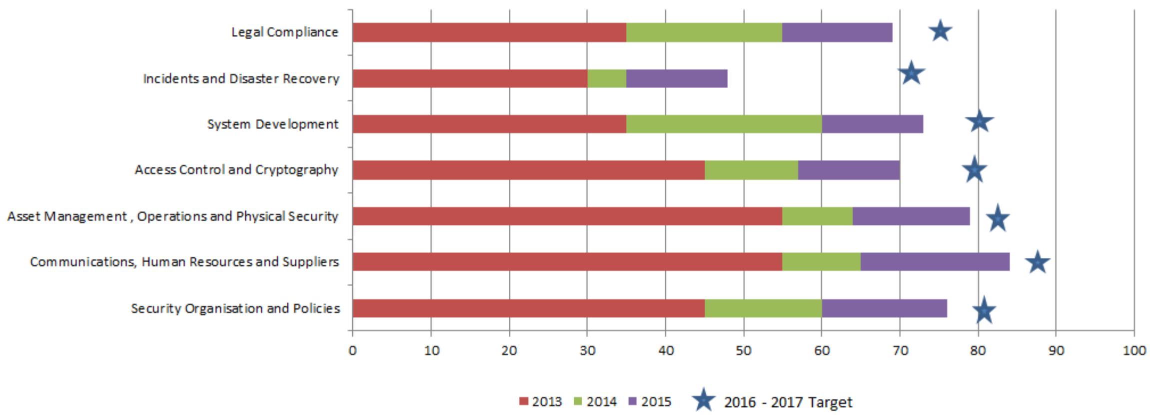


Figure 22: London Hydro's ISO 27001 Cyber Security Compliance Progress

An overall score of 80% is considered compliant and London Hydro expects to reach 80% in all measures in 2016. London Hydro expects to be in a position to absorb any changes to standards that could affect London Hydro as part of its cyber security program.

The following section details the significant accomplishments that have been achieved to "harden" the infrastructure by securing systems, data and infrastructure against cyber and malware attacks.

Development and Approval of Cloud Security Strategy. A presentation was made to the Executive Council in the summer of 2015 outlining the Cloud Strategy. The stated direction of "Cloud First" for all new development has been supported by this strategy.

SIEM Implementation. As the first line of defence, London Hydro commissioned a Security Information Event Monitoring ("SIEM") system into full production with the intent of providing real-time monitoring of all critical systems for existing and emerging threats. This system alerts London Hydro to shortcomings in the operations, allowing the Company to proactively harden its infrastructure against known weaknesses.

Moving towards full ISO 27001 Compliance. London Hydro is not bound to comply with ISO and Control Objectives for Information and Related Technology ("COBIT") standards; however, it has a mission to achieve these goals by the end of 2016. The upgrade of London Hydro's firewalls, implementation of the SIEM, single sign-on and End-Point Security ("EPS") technologies has raised the level of overall ISO compliance from 70% at the end of 2014 to 76% in 2015. A level of 80% is needed to be compliant.

Security Awareness Plan Redevelopment. A new awareness plan has been created which encompasses the following:

- Digital posters of current cyber security topics displayed on monitors throughout the building
- A redesigned IT Security folder on the corporate Intranet, which will include copies of all current policies, animations and games to strengthen security concepts as well as articles on subjects such as phishing, unsecured wireless, laptop and USB security
- Lunchtime security learning sessions that will take a less technical approach and promote discussion on safe practices

Single Sign-On/Access Control Policy Implementation. In 2015, London Hydro introduced Single Sign-On (SSO) for employees as part of the HRIS deployment. Single Sign-on, along with the SIEM and London Hydro's Cloud Strategy, is one of the cornerstones of London Hydro's overall Security Strategy. SSO provides the following advantages:

- It allows London Hydro to apply consistent and strong user ID/password policies, which were difficult to enforce before
- It will become the Access Control platform for all new applications
- It allows for easy access to London Hydro applications from any location and using any device

Single Sign-On technology becomes the basis for Mobile Device Management ("MDMT") and Bring Your Own Device ("BYOD") strategies that will be developed in 2016

Cyber security initiatives planned for 2016/2017

Endpoint Security Protection Implementation. Towards the end of 2015, London Hydro introduced an enhancement to the McAfee Anti-Virus system by adding the Endpoint Security set of features to London Hydro's enterprise environment. This system offers three key elements:

- *Host Intrusion Protection* – This feature provides enhanced protection to all computers and servers and adapts to emerging or perceived threats.
- *File Encryption* – With this feature, users will have the ability to selectively encrypt specific files on their computers or servers, helping to protect sensitive data.
- *Data Loss Prevention* – This feature will alert the user and London Hydro's monitoring systems whenever a USB or other external storage device is connected to a London Hydro computer.

Introduction of an Application Security Testing Platform Solution. As part of the work being completed to improve standardize testing of applications, London Hydro will be looking to implement a tool that can test the (security) vulnerability of all applications, including existing applications, at any point in their development.

Security Enhancements of the Amazon Cloud Space. As London Hydro moves more data centre operations into the virtual world, it must also ensure that the right monitoring systems and protection are in place. Additionally, London Hydro will be looking at on-demand SaaS (Software as a Service) vulnerability assessment systems for all Cloud-based web applications.

Updates to the Disaster Recovery Plan. These updates are required to bring the disaster recovery plan up-to-date and get London Hydro to a compliant ISO 27001 level.

Full Vulnerability Assessment. A comprehensive vulnerability assessment will be undertaken of the corporate infrastructure.

Infrastructure

Table 25 highlights the major initiatives within the IT Infrastructure environment at London Hydro.

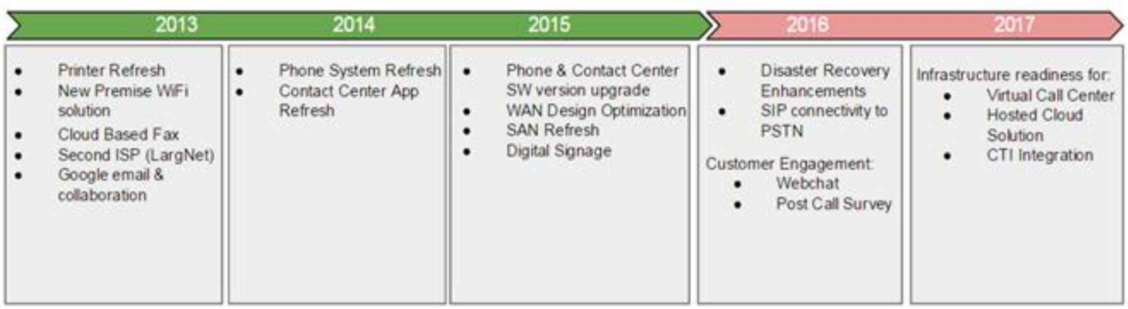


Table 25: Major IT Initiatives 2013-2017

Server virtualization enables consolidation of multiple physical servers used for sharing workload. London Hydro continues to virtualize its premise-based server environment and currently has 47 physical servers, 193 virtual servers and 78 new Cloud-based instances. With this “internal Cloud” strategy, London Hydro has avoided purchasing of over 100 physical machines to meet the business needs (See Table 26).

	2013	2015	2016
Number of Physical Servers	63	49	47
Number of Virtual Servers	125	211	193
Number of Amazon VMs	0	16	16
Number of Google VMs	0	62	62
Number of Smart Phones	100	185	185

Table 26: Server Counts

2.2.4 System Utilization (5.3.2d)

London Hydro has an internal team that reviews the existing and future capacity of the distribution system in close communication with the Transmitter (Hydro One) and the IESO. Short and long range plans for capacity are updated as new information becomes available. This planning team works closely with the engineering and operations teams to ensure the plans reflect the asset conditions and operating performance requirements. The plans also take into consideration the impact of conservation and demand activities as well as existing and future distributed generation. Various contingency conditions are reviewed to ensure the plans are robust enough to accommodate reasonably foreseeable events and changes. The overall system capacity may be sufficient, but load movement between areas and feeders can become a concern, and in some cases, this movement has driven the need for additional capacity.

With the conversion of Nelson TS, London Hydro will have approximately 899.4 MVA of allocated capacity from the various transformer stations owned by Hydro One.[37] Figure 23 below shows the recent total system loading and a forecast for the next twenty years (assuming a modest gross load growth of 1% per year). Based on this projection, the total system load will not exceed the allocated capacity until 2030. Therefore, London Hydro has not included any projects or spending associated with increasing the allocated capacity at the transformer stations. The conversion of Nelson TS from 13.8 kV to 27.6 kV[38] will provide switching flexibility but will not add capacity;[39] however, the total allocated capacity available to London Hydro pushes the need for additional planning capacity well beyond a 20-year planning horizon.

[37]The capacity allocated to London Hydro per transformer station is a calculated using Hydro One's Planning LTR values provided as part of the 2015 Needs Assessment of the Regional Planning Process based on breaker allocation only.

[38] Hydro One initiated a redevelopment of Nelson TS as part of its Asset Sustainment Program. London Hydro and Hydro One had previously agreed to a long term plan to eliminate 13.8 kV supply points in London, and the conversion of Nelson TS is the conclusion of that plan. For more details, see the report included in Appendix J.

[39] Actual system capacity will be reduced by 13 MVA

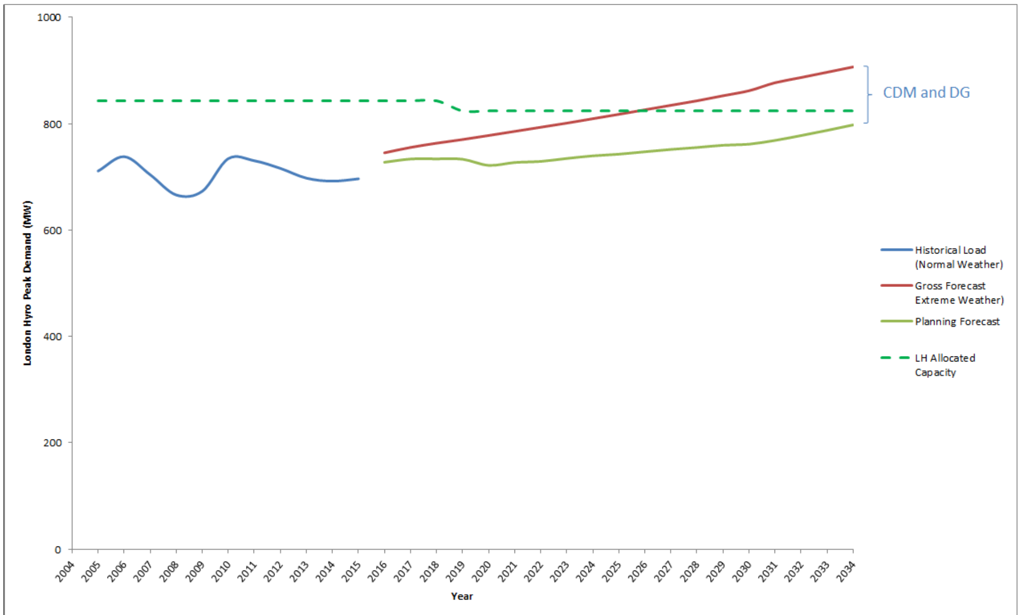


Figure 23: London Hydro Peak Load Forecast[40]

As noted in Section 2.2.2, London is supplied by seven (7) transformer stations connected to the provincial transmission grid. These transformer stations are owned and maintained by Hydro One. London Hydro is assigned a specific amount of capacity at each transformer station, which represents the maximum amount that London Hydro can use under normal operating conditions. Table 27 below summarizes the capacity allocated to London Hydro at each station and recent peak loads.

Transformer Station	Voltage	Capacity Allocated to London Hydro[41]	Peak Load 2014[42]	Previous Peak Load (2013)
Buchanan	230 kV – 27.6 kV	176.7 MVA	125.4 MW	132 MW
Clarke	230 kV – 27.6 kV	101.1 MVA	99.8 MW	98 MW
Highbury	115 kV – 27.6 kV	105.2 MVA	86.1 MW	84 MW
Talbot	230 kV – 27.6 kV	305.7 MVA	246.9 MW	241.7 MW
Wonderland	230 kV – 27.6 kV	90.7 MVA	101 MW	100 MW
Nelson[43]	115 kV – 13.8 kV	120 MVA	36.1 MW	45 MW
	Total	899.4 MVA (824.3 MW)[44]	691.3 MW	700.7 MW
			(non-coincident peaks)	**(non-coincident peaks)**

Table 27: Capacity of each London Hydro Transformer Station and Peak Loads

*Although the transformer stations noted above supply all of London, the Downtown Network is considered a separate system for planning and operations purposes as the entire network is supplied exclusively by the Nelson Transformer Station. Load on the network has been decreasing as new load and re-developed sites have been placed on the 27.6 kV supply. However, the Nelson TS and most of the infrastructure associated with the Downtown Network are at end of life and require replacement. A comprehensive planning report regarding the Downtown Network is included in Appendix J.

[40] Includes the impact of CDM and DG

[41] The capacity allocated to London Hydro per transformer station is a calculated weighted average distribution using Hydro One's Planning LTR values provided as part of the 2015 Needs Assessment of the Regional Planning Process based on breaker allocation only. As well, the total allocated capacity in megawatts is based on the weighted system averaged power factor from Hydro One's planning criteria in the Needs Assessment.

[42] Actual Peak load in Mega Watts from wholesale metering.

[43] Nelson allocated capacity is based on new 27.6kV station

[44] Using Hydro One planning criteria for power factor at stations with and without capacitors

For most of the transformer stations, the load is well below the capacity allocated to London Hydro although Wonderland TS has exceeded LTR. For Clarke and Wonderland TS, London Hydro works closely with Hydro One to ensure the total station capacity (LTR rating) is not exceeded. When Nelson TS and the downtown core are converted to 27.6 kV, load will be able to be transferred between the various transformer stations to optimize loading. Based on this analysis, London Hydro does not anticipate the need to obtain additional feeder positions at the existing transformer stations.

2.3 Asset Lifecycle Optimization Policies and Practices

From the OEB Filing Guidelines 5.3.3

An understanding of a distributor's asset lifecycle optimization policies and practices will support the regulatory assessment of system renewal investments and decisions to refurbish rather than replace system assets. Information provided should be sufficient to show the trade-off between spending on new capital (i.e. replacement) and life-extending refurbishment, and should include but need not be limited to:

a) A description of asset lifecycle optimization policies and practices, including but not necessarily limited to:

- a description of asset replacement and refurbishment policies, including an explanation of how (e.g. processes; tools) system renewal program spending is optimized, prioritized and scheduled to align with budget envelopes; and how the impact of system renewal investments on routine system O&M is assessed;
- a description of maintenance planning criteria and assumptions; and
- a description of routine and preventative inspection and maintenance policies, practices and programmes (can include references to the DSC).

b) A description of asset life cycle risk management policies and practices, assessment methods and approaches to mitigation, including but not necessarily limited to the methods used; types of information inputs and outputs; and how conclusions of risk analyses are used to select and prioritize capital expenditures.

2.3 Asset Lifecycle Optimization Policies and Practices (5.3.3)

As noted in section 2.1.2 Asset Management Process Overview, London Hydro follows an Asset Management Lifecycle that is documented in Engineering Instruction (EI) -31.

2.3.1 Asset Replacement, Refurbishment and Maintenance (5.3.3a)

Once assets are put into service, Steps 4 through 7 of EI-31 are followed to maintain, inspect and assess the assets to determine if they need to be repaired, refurbished or replaced.

- EI-31 Step 4 describes the responsibilities and procedures for maintaining assets.
- EI-31 Step 5 describes the responsibilities and procedures for inspecting assets and assessing their condition.
- EI-31 Step 6 describes the responsibilities and procedures for repairing or replacing assets when they fail.

Each of these steps reference the Asset Sustainment Plan (ASP), which contains specific details regarding the age demographics, overall condition, inspection plan, capacity utilization, and asset sustainment strategy for each category of asset. In general, assets are inspected on a regular cycle, maintained either proactively or reactively, and then repaired / replaced / refurbished depending on urgency, risk and cost.

In general, London Hydro seeks to extend the life of all assets through planned maintenance, minor repairs and refurbishments. In practice, it can be difficult to repair or refurbish some assets in the field without causing an extended power outage. In many cases (such as transformers, switches, switchgear) a defective or deficient item is removed from service and replaced with one from stock. The defective or deficient item is then closely examined to determine if a repair can be made, if the unit is worth refurbishing, or if the best course of action is to scrap the item. It is not practical to conduct a complete "business case" to evaluate options for individual transformers, so a set of guidelines has been provided to staff to allow them to determine the fate of a transformer removed from the field based on inspections and testing. For other assets, such as load break switches, qualified staff will review the condition of the item and use their best judgement to determine if the switch can be repaired or should be scrapped. In other cases (such as conductors), repairs can be made relatively quickly in the field and the repair will be logged within a database. Areas experiencing a high rate of failures will become prioritized for replacement. The inspection cycles, inspection results, and details on repairs are presently stored in GIS (for most distribution assets) or in various databases maintained by different departments in a shared network location referred to as EIAM. Plans are in place to migrate these various databases to a central software package in the near future to make it easier to analyze and track the assets, when they are due for inspection, and detect trends in failures or condition assessment.

The tables below summarize by asset type the inspection cycle, maintenance program, the factors used to determine if an asset is repaired, replaced or refurbished, and the sustainment strategy for each asset class. Section 7 of the AMP provides additional details on the inspection and maintenance cycles by department.

Overhead Distribution System Assets (Asset Sustainment Plan – Section 1)

ASSET	INSPECTION CYCLE	MAINTENANCE PROGRAM	ASSESSMENT FACTORS	SUSTAINMENT STRATEGY
Poles	Once every 3 years	Wood poles tested after 20 years in service and retested based on findings[45]	Visual check of condition, pole test results, age, circuit occupancy	Replace poor condition poles based on test results (approximately 40 per year)[46]
Crossarms	Once every 3 years	None – run to failure	Visual check of condition, pole fire risk (27.6 kV circuits)	Proactively replace "at risk" installations
Insulators	Once every 3 years	Infrared scanning every year, otherwise run to failure	Circuit type, "suspect insulators,"[47] hot spots	Identify and proactively replace "suspect insulators"
Transformers	Once every 3 years	Infrared scanning every year, otherwise run to failure	Oil leaks, rusting, cracked bushings, hot spots	Reactively replace failed or poor condition units[48]
Switches	Once every 3 years	Infrared scanning every year, otherwise run to failure[49]	Operability, frequency of use, hot spots	Reactively replace failed or poor condition units
Conductors	Once every 3 years	Tree trimming on a 3 year cycle[50], infrared scanning every year[51], repair indefinitely	Electrical load, excessive sag, #6 copper, hot spots	Proactively replace #6 copper, repair hot spots, replace open secondary during rebuilds

Table 28: Summary of Asset Sustainment Plan for Overhead Distribution Assets

[45] The retest period is adjusted based on findings. See Section 2.2.3 for details.

[46] Other poles are replaced each year due to other drivers such as road widenings, voltage conversions and service upgrades as are other assets connected to poles such as crossarms, insulators, transformers and switches. Approximately 500 poles are replaced annually.

[47] London Hydro has identified groups of insulators by manufacturer and date range that are known to be prone to premature failure. The exact locations of these insulators are not known, but once they are identified through a detailed inspection or other planned work, they are replaced as soon as practical.

[48] Transformers are also replaced during voltage conversions and are often replaced when an entire pole line is rebuilt or relocated. Used units are inspected and then either scrapped, repaired, refurbished or returned to stock depending on condition (following LH procedures for testing and returning transformers to stock – SWP 147 & 148 and EI-23-R7).

[49] For motorized switches with batteries, batteries are proactively replaced every 6 years.

[50] In 2015, London Hydro transitioned to a 3-year cycle from a 5-year cycle based on learnings from other LDCs and their experiences with ice storms.

[51] Overhead conductors are not specifically targeted during the infrared scanning process, but hot spots are occasionally identified at splice locations, taps and connections to insulators.

Underground Distribution System Assets (Asset Sustainment Plan – Sections 2, 4 to 8)

ASSET	INSPECTION CYCLE	MAINTENANCE PROGRAM	ASSESSMENT FACTORS	SUSTAINMENT STRATEGY
Primary cable	Terminations once every 3 years[52]	Terminations – infrared scanning every year,[53] cables - silicone injection	Insulation type, voltage, utilization, SPOORE[54]	Silicone injection or replacement based on SPOORE analysis for residential; planned replacement of PILC[55]
Padmount Transformers	Once every 3 years	Infrared scanning every year, otherwise run to failure	Oil leaks, rusting, cracked bushings, hot spots, placement, access	Reactively replace failed or poor condition units[56]
Padmount Switchgear	Every year	Infrared scanning every year	Insulating medium, voltage level	Replace air-insulated units based on condition and test results; maintain solid dielectric units
Network Transformers	Every year	Oil tests every 2 years, infrared scanning every year	Insulating oil type, oil leaks, rusting, cracked bushings, hot spots, placement, access	Maintain or refurbish until network is eliminated
Network Protectors	Every year	Testing and calibrating every 5 years, infrared scanning every year	Rusting, hot spots, ability to work safely	Maintain or refurbish until network is eliminated
Ducts, Vaults, Maintenance holes	Every five years minimum[57]	Detailed review by civil engineer when required, repair as needed to extend life as long as possible	Cracks, exposed rebar, water ingress, utilization, ability to work safely	Repair, maintain, refurbish as long as possible[58]

Table 29: Summary of Asset Sustainment Plan for Underground Distribution Assets

[52] Cable terminations (terminators, elbows) are the only visible portions of primary cable that can be inspected.
[53] Cable terminations are scanned as part of rise pole scans, switchgear scans and transformer scans.
[54] See Appendix G Asset Management Plan – Section 16 for details on the SPOORE ranking process.
[55] PILC (paper insulated lead covered) cable is being phased out as it is reaching end of life; it is difficult to work with, and lead is a designated substance that requires special handling and disposal procedures
[56] Transformers are also replaced during voltage conversions and are often replaced when underground lines are relocated. Used units are inspected and then either scrapped, repaired, refurbished, or returned to stock depending on condition (following LH procedures for testing and returning transformers to stock – SWP 147 & 148 and EI-23-R7).
[57] Most vaults and maintenance holes are inspected more frequently as part of the inspection of other components such as network transformers, junctions, etc. Network vaults inspected every 3 months and cleaned every year.
[58] In some cases, replacing with new may be the best alternative considering other factors such as the need for increased capacity, City work in vicinity, extent of deterioration, etc.

Distribution Station Assets (Asset Sustainment Plan – Section 3)

ASSET	INSPECTION CYCLE	MAINTENANCE PROGRAM	ASSESSMENT FACTORS	SUSTAINMENT STRATEGY
Transformers	Monthly for outdoor, every two months for indoor	Infrared scanning every year, annual oil tests	Oil leaks, rusting, cracked bushings, hot spots, future conversion plans	Repair and maintain indefinitely; replace failed or poor condition units with spares[59]
Switchgear / Breakers	Monthly for outdoor, every three months for indoor	Infrared scanning every year, annual oil tests, preventative maintenance every four years	Oil leaks, rusting, cracked bushings, hot spots, future conversion plans, maintainability	Repair, maintain, or refurbish indefinitely; replace failed or poor condition units with spares[60]
Switches	Monthly	Infrared scanning every year, preventative maintenance every four years	Rusting, cracked bushings, hot spots, future conversion plans, maintainability	Repair and maintain to extend life; replace at end of life
Relays	Monthly for outdoor, every three months for indoor	Functional testing and preventative maintenance every four years	Test results, obsolescence, compatibility	Repair and maintain to extend life; replace at end of life
Batteries	Monthly for outdoor, every three months for indoor	On-line monitoring (where available), testing every three years	Leaks, corrosion, hot spots, test results	Maintain then replace at 6 years
Buildings	Monthly for outdoor, every three months for indoor, detailed structural inspection annually	Repair and maintain as needed (e.g., re-paint, seal cracks, replace lights, fans, heaters, etc.)	Security, structural integrity, future conversion plans	Repair and maintain indefinitely

Table 30: Summary of Asset Sustainment Plan for Distribution Station Assets

Secondary Connection Assets (Asset Sustainment Plan – Section 9)

ASSET	INSPECTION CYCLE	MAINTENANCE PROGRAM	ASSESSMENT FACTORS	SUSTAINMENT STRATEGY
Residential	none	Tree trimming on a 3 year cycle for overhead secondary bus, otherwise run to failure	Open wire secondary bus, number of faults	Repair up to two faults per service, then replace; replace open wire secondary when adding new or upgraded services
Network	Every two months (as part of network protector inspection)	Infrared scanning every two months (as part of network protector)	Loading, fault history	Repair, if possible; replace when necessary or as part of larger rebuild

Table 31: Summary of Asset Sustainment Plan for Secondary Connection Assets

[59] Several substations are expected to be eliminated during the next 10 years due to voltage conversions. When each substation transformer is removed from service, it is thoroughly inspected and tested, and the best units are kept in stock as spares to replace other units still in service if they fail or become a risk.

[60] Similar to substation transformers, the best switchgear units are kept as spares when substations are eliminated.

1 *Other Assets (SCADA: Asset Sustainment Plan – Section 10, IT: Strategy[61])*

ASSET	INSPECTION CYCLE	MAINTENANCE PROGRAM	ASSESSMENT FACTORS	SUSTAINMENT STRATEGY
SCADA	On-line monitoring	Master station replaced every 7 years, remote stations (RTUs) replaced every 20 years, SCADA fail-over tests performed 3 times per year with a black-start exercise conducted annually	Obsolescence, compatibility, functionality, performance	Proactively replace master station every 7 years; reactively replace RTUs when they fail or become unreliable
Fleet	Daily circle checks and CVOR, annual detailed inspections	Regular maintenance as recommended by manufacturer; repair or replace minor parts	Total operating cost, reliability, maintainability, functionality, performance, utilization, E3 Fleet Economic Life Model (see section 2.2.3 / 5.3.2c for details)	Repair and maintain to extend life; replace when overall assessment is poor or a critical component fails
Facilities	Monthly	Regular maintenance as recommended by component manufacturer; repair or replace minor parts	Total operating cost, reliability, maintainability, functionality, performance, utilization	Repair and maintain structures indefinitely; replace components such as furniture, HVAC, as needed
IT & Communication	On-line monitoring	Most units maintained under supplier warranty.	Critical units (high impact if there is a failure) given priority; performance, obsolescence, end of warranty; consideration given to migration to Cloud to decrease dependence on local hardware and software	Critical units replaced after warranty expires; non-critical units replaced upon failure or performance issues; data storage migrating to cloud
Metering	On-line monitoring	Sample testing based on Measurement Canada Requirements, additional testing and verification for interval meters; whenever meter is exchanged, the PT/CT compartment is accessed, or any wiring is changed.	Test results, technical obsolescence	Replace when obsolete or fails calibration test

2 **Table 32: Summary of Asset Sustainment Plan for Other Assets (e.g., SCADA)**

3

4 Annual Operating and Maintenance budgets for each asset category are created by reviewing historical
5 trends regarding the amount of work and amount spent each year and adjusting for expected changes
6 as noted in the Asset Sustainment Plan. The ASP creates an "Asset Sustainment Strategy" for each
7 category of asset that provides guidance to Engineering and Operations regarding the pacing of
8 replacements, which will be affected by the inspection, maintenance and testing results.

[61] See "IT Strategy" section in Exhibit 4.

The quantity of work related to O&M that is forecasted for asset maintenance is translated into resource requirements by Business Unit (internal labour and related expenses, and external contracts), which are used to adjust the annual Operating, Maintenance and Administration Budget. As some assets, such as wood poles, are being left in service longer than previously, additional OM&A expenses are incurred each year for inspection and testing. Additional engineers and technologists have been hired and additional training provided to existing staff to allow for more resources to be dedicated to monitoring and analyzing the performance of the assets, thus ensuring the total lifecycle cost for the assets is optimized. The net effect has been that although London Hydro's OM&A cost per customer has been increasing each year, it remains lower than the Ontario average and the percentage increase per year is less than the Ontario average.

2.3.2 Risk Management (5.3.3b)

EI-31 Step 7 describes the responsibilities and procedures for assessing the risk of asset failure and taking an appropriate course of action to prevent it. The Asset Sustainment Plan (ASP) contains specific details regarding the Risk Assessment process for each category of asset.

Within the context of Asset Management, risk is assessed by considering how an asset failure could have an impact on **reliability** (specifically the customers' expectation of service reliability), **safety** (for workers and the public), and the **environment**.

As each asset is inspected and maintained, the failure risk is reviewed. This risk assessment is completed fairly quickly for individual components (either during the inspection or maintenance activity or when test results are available). Appropriately qualified personnel (trained and experienced) conduct the asset inspections and maintenance activities. Based on their judgement and various procedures, a decision can be made immediately to replace or repair an asset that poses an imminent risk of failure or to flag the asset for urgent work.

For assets that do not require immediate or urgent repair or replacement, the data collected during the inspection and maintenance activity is used to update the overall risk for all assets within the common asset pool. The data is analyzed and used to create a forecast of future replacement requirements based on assessed condition and risk. This forecast is documented in greater detail within the Asset Sustainment Plan (Appendix G, Section 7).

Risk Assessment is also used to prioritize projects for annual budgets (EI-31 Step 2). Section 4 of the Asset Management Plan (Appendix G) describes the "analytical ranking model" that generates a score (Engineering Ranking Index = ERI) for each project based on reliability and safety (with environmental risk considered a component of the safety score). The ERI scores for each project become coordinates (x,y) that are plotted onto a graph that is divided into four quadrants. Projects that land in the upper right quadrant (high reliability and high safety risk) are considered most critical, while those in the lower left quadrant (low reliability and low safety risk) are less critical and could be deferred if necessary.[62]

[62] Projects deemed less critical in this analysis will often represent opportunities to improve system efficiency or operating flexibility and should not be immediately excluded from the annual budget without further analysis of the overall value to customers and ability to complete within annual budget constraints.

Giving higher priority to the most critical projects ensures risks are addressed and both safety and reliability are not compromised. The model has been developed to reduce some of the subjectivity associated with ranking projects. The projects are reviewed and ranked by a distribution engineer with extensive experience who was not directly involved in the preparation of any of the projects, thus removing any bias toward any specific projects. The results are reviewed by the managers to ensure the relative rankings make sense. If senior management deems it necessary to reduce the budget, projects with the lowest ERI scores (in or near the bottom left quadrant) would be selected for deferral.

The graph below shows the relative positioning of the projects proposed for 2016 and 2017.

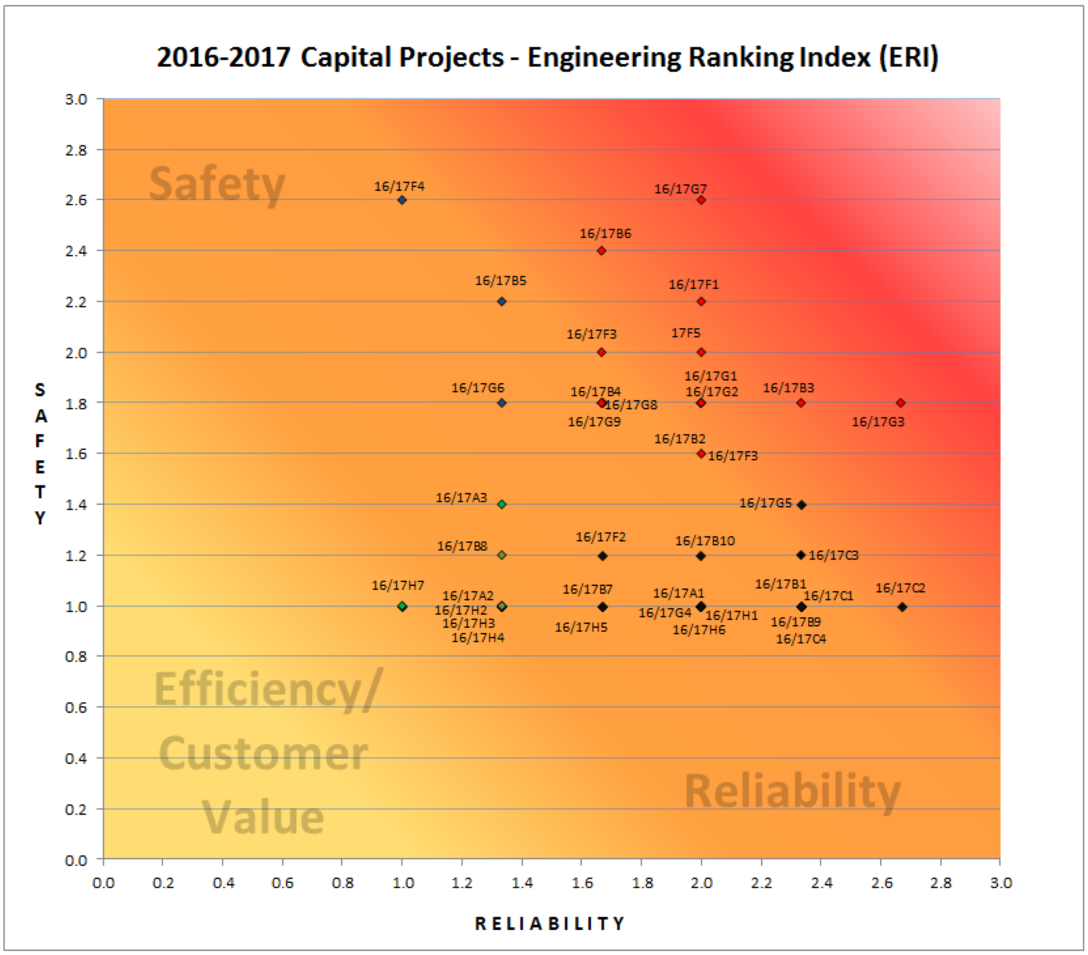


Figure 24: 2016 - 2017 Capital Projects - Engineering Ranking Index (ERI)

A	SUBSTATION REBUILDS
16/17A1	Relay Replacements
16/17A2	Battery Bank Replacement Program
16/17A3	Substation RTU Standardization
B	SUBDIVISIONS
16/17B1	Silicone Injection of Underground Cable
16/17B2	Subdivisions Conversions / Rebuilds with Silicone Injection
16/17B3	Replacement of Air Insulated Sectionalizing Enclosures
16/17B4	Deteriorating/Leaking Transformer Replacements
16/17B5	Residential Secondary Pedestal Replacements
16/17B6	Vault Transformer Replacements
16/17B7	Installation of Underground Backup Supply
16/17B8	Installation of Fault Indication on Padmount Transformers
16/17B9	Zone 'B' Underground Conversion
16/17B10	13.8 kV Underground Conversion
C	MAIN FEEDERS
16/17C1	27.6 kV Supply to Downtown Core
16/17C2	13.8 kV Conversion Main Feeders
16/17C3	Civil Structure Installation
16/17C4	New Main Feeder Ties
F	NETWORK
16/17F1	Network Vaults/Maintenance Holes/Transformer Replacements
16/17F2	Primary & Secondary Cable Replacements
16/17F3	Maintenance Hole Cable Rebuilds
16/17F4	Explosion-Limiting Maintenance Hole Covers
17F5	13.8 kV Network Conversion
G	OVERHEAD LINES
16/17G1	Replacement of Fully Depreciated Poles
16/17G2	Replacement of Poles Susceptible to Pole Fires
16/17G3	Rebuild of Fully Depreciated Overhead Areas
16/17G4	13.8 kV Overhead Conversion
16/17G5	Zone 'B' Overhead Conversion
16/17G6	Automatic Splice Replacement Program
16/17G7	Porcelain Insulator Replacement Program
16/17G8	Copperclad Ground Wire Installation Program
16/17G9	In-Line Firon Switch Replacements
H	AUTOMATION
16/17H1	Recloser Installations
16/17H2	Serial Conversion Program
16/17H3	DART RTU Replacement Program
16/17H4	SCADA Cyber Security Program
16/17H5	Line Status Sensors
16/17H6	Automatic Fault Detection, Isolation and Restoration
16H7	Control Centre – Consoles and Digital Maps
17H7	Control Centre – Display Technologies

3.1 Capital Expenditure Plan Summary

From OEB Filing Guidelines 5.4.1

A distributor's DS Plan details the programme of system investment decisions developed on the basis of information derived from its asset management and capital expenditure planning process. It is critical that investments, whether identified by category or by specific project, be justified in whole or in part by reference to specific aspects of that process.

5.4.1 Summary

This section elicits key information about a distributor's capital expenditure plan including, by category (see section 5.1.1), significant projects and activities to be undertaken and their respective key drivers; the relationship between investments in each category and a distributor's objectives and targets; and the primary factors affecting the timing of investment in each category (or of projects within each category, if significant).

The following information should be provided:

a) information on the capability of the distributor's system to connect new load or generation customers in sufficient detail to convey the basis for the scope and quantum of investments related to this 'driver';

b) total annual capital expenditures over the forecast period, by investment category (see section 5.4);

c) a brief description of how for each category of investment, the outputs of the distributor's asset management and capital expenditure planning process have affected capital expenditures in that category and the allocation of the capital budget among categories;

d) a list and brief description including total capital cost (table format recommended) of material capital expenditure projects/activities, sorted by category;

e) information related to a Regional Planning Process or contained in a Regional Infrastructure Plan that had a material impact on the distributor's capital expenditure plan, with a brief explanation as to how the information is reflected in the plan;

f) a brief description of customer engagement activities to obtain information on their preferences and how the results of assessing this information are reflected in the plan;

g) a brief description of how the distributor expects its system to develop over the next five years, including in relation to load and customer growth, smart grid development and/or the accommodation of forecasted renewable energy generation projects;

h) a list and brief description including where applicable total capital cost (table format recommended) of projects/activities planned:

- in response to customer preferences (e.g., data access and visibility; participation in distributed generation; load management);
- to take advantage of technology-based opportunities to improve operational efficiency, asset management and the integration of distributed generation and complex loads; and
- to study or demonstrate innovative processes, services, business models, or technologies.

3.1 Capital Expenditure Plan Summary (5.4.1)

London Hydro's long-term vision for the future of the distribution system has been shaped by the Objectives, Principles, Mission, Vision, and Values as described previously in Section 2.1.1 and later in Section 3.2.1. These Corporate Statements are aligned with the OEB Performance Outcomes of Customer Focus, Operational Effectiveness, Public Policy Responsiveness and Financial Performance.

London Hydro's Mission Statement is "*London Hydro is an electricity distributor dedicated to the pursuit of excellence in safety, reliability, customer service, and competitive rates."* This statement provides a high-level description of what London Hydro envisions as the desired future state of the distribution system – one that is safe and reliable – while also expressing an emphasis on offering excellent customer service within the envelope of competitive rates. To achieve this desired state, London Hydro continuously reviews the current and expected future condition and utilization of assets, reviews alternatives, and selects options that are best aligned with the Performance Outcomes.

One example of how the long-term vision has manifested is London Hydro's decision to have a single distribution voltage within the City. The planning for this end-state goes back to the early 1990s with London Hydro and Ontario Hydro working cooperatively to review the long term supply needs of the City of London, knowing that the Highbury Transformer Station (13.8 kV) was at end of life. The standard distribution voltage for most of London and the rest of Ontario had migrated to 27.6 kV, and the long term vision agreed to by London Hydro and Ontario Hydro in the 1990s was to use 27.6 kV as the distribution voltage for the entire City. Adopting 27.6 kV as the standard voltage would result in a system with greater operating flexibility, overall improved reliability, and lower costs associated with reduced line and transformer losses as well as reduced material and inventory costs. When the Highbury Transformer Station was rebuilt in 1999 (at end of life), it was converted to 27.6 kV and London Hydro accommodated this change in supply voltage by converting the 13.8 kV distribution assets in that area to 27.6 kV as they approached end of life. This same cooperative long-term planning process (now with Hydro One and the IESO) will address the end of life Nelson Transformer Station, which will be converted from 13.8 kV to 27.6 kV in 2018. London Hydro reviewed the costs and benefits of different options to address the end of life Nelson Transformer Station (see DSP Appendix J "London Downtown 13.8 kV/27.6 kV Nelson TS 5 Year Plan" Section 3) and ultimately selected the option with the best overall assessment of benefits and cost.

Across the City, there are areas supplied through municipal substations that step voltage down from 13.8 kV or 27.6 kV to 4.16 kV. As these areas approach end of life, they are also converted to 27.6 kV using a risk-based prioritization method that considers cost, safety, reliability, capacity and physical condition of assets.

A second example of working towards the long-term vision of a safe and reliable system is the improvement in reliability that has been achieved over the past twenty years. By targeting underperforming areas and addressing issues with specific components, the average reliability has improved from 3 interruptions per year to 1.5 interruptions per year. Through regular surveys, customers have expressed acceptance of this current level of reliability, and London Hydro's vision for the future is to maintain this level of reliability with marginal improvements each year. This result will be achieved by continuing to target investments in areas that have the worst reliability or that are at greatest risk of wide-spread or extended outages due to their condition and performance. Areas and improvement options are prioritized by considering the safety and reliability risk (ERI – Engineering Ranking Index[63]), and London Hydro is reviewing a second prioritization process that attempts to quantify the value that customers receive from reliability improvements (CVRI – Customer Value of Reliability Improvements[64]) in return for the cost of the projects.

The London Hydro executive team and Board of Directors provide guidance regarding spending targets for the distribution system that balance the competing needs for customer service improvements, fleet and facility spending, information technology investment and opportunities, and customer preferences regarding the value they receive for all the services provided to them by London Hydro. Maintaining "competitive rates" is a key component of the Mission Statement, and London Hydro uses data collected by the OEB to monitor Cost Metrics[65] such as the Controllable Cost per Customer, PEG Efficiency Assessment, and Annual Distribution Revenue (per residential customer).

The end result is a five-year Capital Plan that will achieve the objectives of the Mission Statement: a distribution system that is safe and reliable while offering excellent customer service within the envelope of competitive rates.

3.1.1 Capability to Connect Load and Generation (5.4.1 a)

As noted in Section 2.2.4, System Utilization (5.3.2d), the London Hydro distribution system has capacity to connect new load and generation with some areas requiring reinforcement to meet future demand.

London Hydro connects new generation within prescribed timelines, with few exceptions and rejections. In most areas, ample capacity is available to connect additional generation customers. In areas where restrictions exist, they are due to constraints at the Hydro One owned transformer station or on the transmission grid. Therefore, there is no foreseeable need to make investments in the distribution system specifically to enable generation connections.

Customers can check for the most up-to-date availability of transformer station generation capacity on the London Hydro website, which includes a map that shows the relative area supplied by each transformer station and any restrictions. Details on the available capacity and any restrictions are noted in Section 3.3.4 Constraints – Distribution and Upstream (5.4.3 d).

While total system load growth has remained relatively flat, plans are in place for significant growth over the next 20 years. The City's plan to revitalize downtown coupled with London Hydro and Hydro One's plan to eliminate the sole supply of 13.8 kV (Nelson TS) and replace it with a 27.6 kV supply has triggered a series of investments in the downtown that will eventually result in a more robust system, which can accommodate the anticipated new load.

[63] See Section 2.3.2 (5.3.3b) Risk Management
[64] See DSP Appendix B
[65] See Section 1.3.1 (5.2.3a) Planning Process Performance Metrics

As noted in the Downtown Intensification report (Appendix J), London Hydro has a multi-year plan to replace the 13.8 kV feeders with 27.6 kV. By 2019, the 27.6 kV feeders will be extended into the downtown core, which will provide capacity for any foreseeable load or generation to connect to the grid. The report also provides a high level view of the ultimate configuration of the 27.6 kV system in the downtown core by 2030.

Converting Nelson TS to 27.6 kV will also provide capacity and backup supply to the other 27.6 kV transformer stations around London, enabling the connection of future load customers in those areas. As noted in the Nelson Report (Appendix J: London Downtown - 13.8 kV/27.6 kV - Nelson TS - 5 Year Plan – February 2015: Section 6.0), rebuilding Nelson TS at 27.6 kV will add approximately 100 MW of capacity to the system, deferring the need to add another transformer station or increase the capacity at existing transformer stations until approximately 2038.

The decision to convert Nelson TS from 13.8 kV to 27.6 kV was based on a collaborative approach to long term supply options for the City of London, conducted by London Hydro and Hydro One (Ontario Hydro). The planning started in the early 1980's with the installation of the Talbot TS (near downtown), which provided 27.6 kV supply to the north side of downtown. At that time, 27.6 kV had become the standard distribution voltage for most of Ontario, including much of the City of London outside the downtown core. The Nelson TS was one of the oldest transformer stations in London and had several non-standard designs that made it more vulnerable to some contingencies. The only other 13.8 kV supply point was at Highbury TS to the east, which was approaching end of life and was in need of replacement.

In 1990, London Hydro and Hydro One agreed that new connections would be made only to the 27.6 kV supply (if possible) and existing 13.8 kV load would be reduced over time. With much of the 13.8 kV distribution system approaching end of life, reduction of the 13.8 kV load proceeded at a gradual pace.

By 1999, the 13.8 kV station at Highbury TS was decommissioned, which left the Nelson TS as the sole supply of 13.8 kV for London's downtown core.

In 2005/2006, joint planning meetings with Hydro One examined supply options and needs for the City of London, with the Nelson TS identified as the preferred location for new supply. In subsequent years, different scenarios were reviewed and issues at the 13.8 kV Nelson TS surfaced, which made conversion to 27.6 kV more desirable. Between 2009 and 2014, Hydro One and London Hydro examined the cost and benefits of keeping Nelson at 13.8 kV or converting it to 27.6 kV.

In early 2015, an agreement was reached whereby Hydro One would rebuild Nelson TS at 27.6 kV and London Hydro would be responsible for only the incremental cost of conversion. The plan required London Hydro to accelerate some 13.8 kV conversion plans so that Hydro One could decommission the 13.8 kV supply in 2021. London Hydro has documented this decision making process in a report entitled, "London Downtown - 13.8 kV/27.6 kV - Nelson TS - 5 Year Plan – February 2015," which is included in Appendix J. In addition, the plan to convert the 13.8 kV distribution system and accommodate future connections has been documented in the report entitled, "Downtown Intensification – December 2015," which is also included in Appendix J. These two reports provide a comprehensive review of the work needed in the downtown core to continue to provide safe and reliable supply for the foreseeable future.

3.1.2 Total Annual Expenditures by Category (5.4.1 b)

The tables below summarize the planned capital expenditures for the forecast period, grouped by investment category. Table 33 shows the spending amounts in gross dollars (including payments to Hydro One for Nelson TS), while in Table 34 the dollars amounts have been converted to percentages.

$,000	**Year**					
OEB Category	**2017**	**2018**	**2019**	**2020**	**2021**	**5 Year Total**
System Access	8,441	7,716	8,220	8,617	7,080	40,074
System Renewal	14,319	16,702	16,757	16,213	16,384	80,375
System Service	895	715	545	545	546	3,246
General Plant	8,920	10,584	7,437	8,518	9,797	45,256
Annual Total	**$32,575**	**$35,717**	**$32,959**	**$33,893**	**$33,807**	**$168,951**

Table 33: Total Annual Expenditures in Thousands of Dollars

	Year					
OEB Category	**2017**	**2018**	**2019**	**2020**	**2021**	**5 Year Total**
System Access	26%	22%	25%	25%	21%	**24%**
System Renewal	44%	47%	51%	49%	48%	**48%**
System Service	3%	2%	2%	2%	2%	**2%**
General Plant	27%	29%	23%	25%	29%	**27%**
Annual Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 34: Total Annual Expenditures as a Percentage of the Total

3.1.3 Impact of Asset Management and Expenditure Planning (5.4.1 c)

As noted in Section 2.1 Asset Management Process Overview (5.3.1), London Hydro has an internal document referred to as *Engineering Instruction 31 (EI-31)*, which describes the "*Asset Management and Capital Expenditures Planning: Policy and Processes (Asset Management Policy).*" EI-31 explains in detail the various inputs, outputs, responsibilities and procedures used to generate the annual Capital Budget. The following is a brief summary of how the Asset Management Process and Capital Expenditure Planning Process affect the expenditures within each category and the overall allocation of investments among the categories.

System Access

Projects within this category are primarily driven by requests from customers (load and generation), the municipality (road widenings/reconstruction), and mandated obligations (such as migrating to interval metering for customers with greater than 50 kW demand). The Asset Management and Capital Expenditure Processes do not typically affect these projects but are definitely influenced by these projects and forecasts. For example, when we review load forecasts for specific areas and feeders, the anticipated growth in new load customers and possible offset by new generation will influence the timing and scope of feeder upgrades or additional feeders. In a similar way, the timing of voltage conversion projects (4.16 kV or 13.8 kV) may be influenced by planned works by the City to widen a roadway, resulting in the conversion project being completed sooner or later than originally planned to accommodate the City's schedule. The volume of work within this category is forecasted based on historical trends, housing and commercial development forecasts, communication with the municipality and mandated timelines from regulators. Projects within this category are considered mandatory and the forecasted amounts are not adjusted unless information is received that would alter the forecast (e.g., the City deferring a road project).

System Renewal

These projects are driven primarily by the Asset Management Plan (AMP), to replace or refurbish assets that have reached end of life or otherwise need to be addressed due to failure, risk of failure, underperformance or risk of underperformance, obsolescence, safety risk, or environmental risk. The AMP is based on the Asset Sustainment Plan (ASP) which analyses the age, condition, risk and utilization of each category of asset and then provides a high level sustainment strategy for the asset category. The sustainment strategy will typically be a long range plan (15 years) with a recommended amount of annual investment needed to sustain the asset category in suitable condition to provide the level of reliability expected by our customers. In most cases, the work needed over the long range plan is levelized (average per year), in recognition that this approach can provide benefits to the customer (rate stability) and London Hydro (resource stability). The AMP then uses the results of the ASP to create a Five-Year Capital Expenditure Plan, which takes into account specific areas that need to be addressed as a priority, and also the total spending envelope as recommended by London Hydro Board of Directors and senior management. A prioritization process is used (as outlined in Section 2.1 Asset Management Process Overview 5.3.1, 2.3 Asset Lifecycle Optimization Policies and Practices 5.3.3, and 3.2.3 Prioritization 5.4.2 c) to adjust the yearly projects to stay within the total spending envelope. As noted in section 3.2.3 Prioritization, customer feedback or complaints are considered an input into the decision-making process for setting priorities for System Renewal spending. Many of the System Renewal projects are targeted at maintaining system reliability at its current level (identified as a customer preference through annual surveys), by addressing portions of the system that have either become unreliable or are at greatest risk of becoming unreliable.

System Service

These projects address the system's capacity to accommodate existing and new load and generation customers and the ability of the system to perform at the desired level of reliability, as safely and efficiently as possible. Many projects within this category arise from customer preferences or complaints (see flowchart in Section 3.2.3 Prioritization). One of the main themes from various customer engagement activities is that customers value system reliability and expect it to be maintained. This preference is coupled with the results of inspections, maintenance, and analysis conducted during the Asset Sustainment and Asset Management processes to set priorities for the annual Capital Plan. For example, customer complaints about the decrease in reliability within a specific subdivision due to an increase in faults on underground cables as they age can be addressed, in part, through the installation of fault indicators on padmount transformers which decreases the time needed to locate and isolate a section of faulted cable. System Planning provides input and analysis to the AMP to ensure future load and generation connections can be accommodated with any planned replacements and, in the case of the upgrade of the Nelson TS to 27.6 kV, can give priority to specific areas (such as downtown) that should be converted or upgraded first to accommodate a much larger capacity driven project. In other cases, distribution automation may be a viable alternative to adding new feeders to an area with below average reliability. As noted in Section 3.1.1, with the exception of the downtown core (which is being addressed as part of the Nelson TS project), growth is minimal and few projects are driven by the need to alleviate capacity constraints.

General Plant

The focus of the ASP and AMP are the distribution system assets – poles, wires, transformers, vaults, etc. Most of the General Plant assets – fleet, facilities, information technology, communication systems and metering – are analyzed, maintained and budgeted for on a separate but parallel track to the distribution system.[66] Therefore, the ASP and AMP processes have minimal, if any impact on these projects. The allocation of the Capital Budget to General Plant projects is done on a corporate level by the senior management team. Consideration is given to the known fluctuations in annual capital spending on distribution assets, and where possible, General Plant projects may be deferred to assist in smoothing the total annual capital spending and to keep it within the targeted spending envelope. However, projects that are proposed in response to customer requests (such as the Builders' Portal and New Property Management Tool) are considered a priority if the overall cost/benefit analysis indicates the project is of value to customers. The General Plant category includes payments made to Hydro One for the conversion of Nelson TS from 13.8 kV to 27.6 kV.

[66] See Exhibit 2, "Information Systems" for IT strategy details.

3.1.4 Capital Projects by Category (5.4.1 d)

The following tables summarize the total capital cost for the forecast period of the capital projects and Programs, sorted by category.

System Access	Year					
Project	**2017**	**2018**	**2019**	**2020**	**2021**	**5 Year Total**
City of London (Road Authority) Relocations	$3,410,000	$1,925,000	$1,695,000	$1,670,000	$730,000	**$9,430,000**
Developer Driven Distribution Circuit Expansions and Relocations	$350,000	$500,000	$999,200	$1,300,800	$200,000	**$3,350,000**
Residential Secondary Service Upgrades	$355,000	$363,000	$370,000	$377,000	$384,000	**$1,849,000**
New Single Family Residential Underground Distribution	$1,380,000	$1,410,000	$1,440,000	$1,470,000	$1,494,000	**$7,194,000**
New Multi-Housing Underground Distribution	$900,000	$920,000	$940,000	$955,000	$974,000	**$4,689,000**
New Commercial Distribution Services	$1,950,000	$1,960,000	$2,030,000	$2,070,000	$2,111,000	**$10,121,000**
Meter Sealing and Quality system	$30,000	-	-	-	-	**$30,000**
New Meters	$638,000	$657,140	$676,854	$697,159	$718,074	**$3,387,227**
Primary Meter Tank Replacement	$354,000	$364,620	$375,558	$368,825	$398,430	**$1,861,433**
AMI Communications Renewal	$649,000	$699,370	$720,351	$741,961	$764,220	**$3,574,902**
Cost Recoveries	($1,575,000)	($1,083,000)	($1,027,000)	($1,034,000)	($694,000)	**($5,413,000)**
Annual Total	**$8,441,000**	**$7,716,130**	**$8,219,963**	**$8,616,745**	**$7,079,724**	**$40,073,562**

Table 35: System Access - Capital Costs

System Renewal	Year					
Project	**2017**	**2018**	**2019**	**2020**	**2021**	**5 Year Total**
Battery Bank Replacement Program	$15,000	$15,000	$15,000	$15,000	$15,000	**$75,000**
Substation RTU Standardization	$30,000	$30,000	$30,000	$30,000	$30,000	**$150,000**
Cable Silicone Injection	$2,711,000	$2,029,000	$1,909,000	$2,802,000	$3,228,000	**$12,679,000**
Subdivision Rehabilitation	$75,000	$328,000	$1,334,000	-	$780,000	**$2,517,000**
Replacement/Removals of SEs	$293,000	$866,500	$689,500	$398,000	$99,500	**$2,346,500**
Fully Depreciated and Leaking Transformers	$700,000	$800,000	$800,000	$800,000	$800,000	**$3,900,000**
Secondary Pedestal Replacement	$20,000	$20,000	$20,000	$20,000	$21,000	**$101,000**
Vault Rebuilds	$144,000	$203,000	$331,000	$174,000	$288,000	**$1,140,000**
Zone B Underground Conversion	$287,000	$111,000	$42,000	$327,000	$448,000	**$1,215,000**
13.8 kV UG Conversions	$269,000	$866,000	$1,340,000	$2,169,000	-	**$4,644,000**
27.6 kV Supply to Core	$1,560,000	-	-	-	-	**$1,560,000**
13.8 kV Conversion Main Feeders	$815,000	$690,000	-	$550,000	-	**$2,055,000**
Civil Structure Installation	$1,000,000	$1,500,000	$1,200,000	$200,000	$1,200,000	**$5,100,000**
New Main Feeder Ties	$0	$2,352,100	$653,000	$650,000	$2,100,000	**$5,755,100**
Network Vaults / Maintenance Holes / Transformer Replacements	$1,020,000	$1,030,000	$950,000	$1,050,000	$1,050,000	**$5,100,000**
Primary & Secondary Cables Replacements	$380,000	$380,000	$380,000	$380,000	$380,000	**$1,900,000**
Maintenance Hole Replacement due to Cable Rebuilds	$200,000	$150,000	$200,000	$200,000	$150,000	**$900,000**
Explosion-Limiting Maintenance Hole Covers	$100,000	$25,000	$25,000	$25,000	$25,000	**$200,000**
13.8 kV Network Conversion	$370,000	-	-	-	-	**$370,000**
Replace Deteriorating Poles	$300,000	$300,000	$300,000	$300,000	$300,000	**$1,500,000**
Replacement of Poles Susceptible to Fires	$110,000	$225,000	$120,000	$275,000	-	**$730,000**
Rebuild Depreciated Areas	$260,000	$314,600	$1,611,300	$1,230,000	$4,859,500	**$8,275,400**
13.8 kV Overhead Conversions	$315,000	$243,000	$445,000	$32,000	-	**$1,035,000**
Zone B Overhead Conversion	$2,965,000	$3,704,000	$3,902,600	$4,501,200	$575,300	**$15,648,100**
Quick Sleeve Replacements	$30,000	$70,000	$35,000	$35,000	$35,000	**$205,000**
Porcelain Insulator Replacement	$500,000	$600,000	$600,000	$200,000	$150,000	**$2,050,000**
Copper-Clad Steel Grounds	$50,000	$50,000	$25,000	$50,000	$50,000	**$225,000**
Transformer Returns	($200,000)	($200,000)	($200,000)	($200,000)	($200,000)	**($1,000,000)**
Annual Total	**$14,319,000**	**$16,702,200**	**$16,757,400**	**$16,213,200**	**$16,384,300**	**$80,376,100**

Table 36: System Renewal - Capital Costs

System Service	Year					5 Year
Project	**2017**	**2018**	**2019**	**2020**	**2021**	**Total**
Relay Replacements	$80,000	-	-	-	-	**$80,000**
Backup Supply Installation	$70,000	$70,000	-	-	-	**$140,000**
Fault Indicator Installations	$20,000	$20,000	$20,000	$20,000	$21,000	**$101,000**
Recloser Installations	$195,000	$195,000	$195,000	$195,000	$195,000	**$975,000**
Serial Modem Conversion Program	$30,000	$30,000	$30,000	$30,000	$30,000	**$150,000**
DART RTU Replacement Program	$100,000	$100,000	$100,000	$100,000	$100,000	**$500,000**
SCADA Cyber Security	$50,000	$50,000	$50,000	$50,000	$50,000	**$250,000**
Line Status Sensors, (Remote Current & Real time Fault Indication)	$50,000	$50,000	$50,000	$50,000	$50,000	**$250,000**
Automatic Fault Detection, Isolation and Restoration	$50,000	$50,000	$50,000	$50,000	$50,000	**$250,000**
Control Centre - Display Technologies	$250,000	$150,000	$50,000	$50,000	$50,000	**$550,000**
Annual Total	**$895,000**	**$715,000**	**$545,000**	**$545,000**	**$546,000**	**$3,246,000**

Table 37: System Service - Capital Costs

General Plant	Year					Total
	2017	**2018**	**2019**	**2020**	**2021**	**5 Years**
Information Technology (IT)						
IT: Regulatory and Sustainment[67]	$850,000	$1,350,000	$950,000	$1,450,000	$950,000	**$5,550,000**
IT: Enhancements[68]	$2,025,000	$1,550,000	$1,400,000	$1,100,000	$850,000	**$6,925,000**
IT: New Systems[69]	$900,000	$2,400,000	$1,500,000	$2,500,000	$3,300,000	**$10,600,000**
IT Infrastructure (HW/SW)	$735,000	$800,000	$850,000	$950,000	$950,000	**$4,285,000**
IT Sub-Total	**$4,510,000**	**$6,100,000**	**$4,700,000**	**$6,000,000**	**$6,050,000**	**$27,360,000**
Fleet and Facilities						
HVAC Upgrades	$154,000	$155,000	$160,000	$165,000	$170,000	**$804,000**
Misc. Buildings and Fixtures	$308,000	$386,000	$315,000	$321,000	$258,000	**$1,588,000**
Paving	$325,000	$325,000	$325,000	$325,000	$150,000	**$1,450,000**
Control Room Upgrades	$125,000	$125,000	-	-	-	**$250,000**
Security Equipment	$50,000	$51,500	$51,500	$51,500	$52,000	**$256,500**
Furniture and Equipment	$147,000	$202,200	$207,200	$210,600	$212,100	**$979,100**
Fleet Replacements - Vehicles and Equipment	$1,099,000	$1,104,000	$1,128,000	$1,145,000	$1,155,000	**$5,631,000**
Operating Equipment	320,000	300,000	300,000	300,000	300,000	**$1,520,000**
Fleet and Facilities Sub-Total	**$2,528,000**	**$2,648,700**	**$2,486,700**	**$2,518,100**	**$2,297,100**	**$12,478,600**
Capital Contribution to Transformer Station (Nelson)	$1,882,000	$1,835,000	$250,000	-	$1,450,000	**$5,417,000**
Annual Total All	**$8,920,000**	**$10,583,700**	**$7,436,700**	**$8,518,100**	**$9,797,100**	**$45,255,600**

Table 38: General Plant – Capital Costs

[67] For 2017, IT Regulatory and Sustainment projects include Oracle Update, HRIS Enhancements, Regulatory Changes, ODS Upgrade, Security System Upgrades and Infrastructure Upgrades (application enhancements)

[68] For 2017, IT Enhancement projects include Customer Engagement Solutions, Timesheet Field Automation, Asset Management System, Commercial & Industrial Apps Phase 2, SAP, Green Button and Analytics Systems Phase 2

[69] For 2017, IT New Systems projects include Automated Billing Payments (IVR/Online), Residential Customer Mobile App and JDE Upgrade

3.1.5 Impact of Regional Planning (5.4.1 e)

As noted in Section 1.2 Coordinated Planning with Third Parties, London Hydro is a participant in the Group 2 Regional Plan, London Area Region. The "*Needs Assessment Report*" (included as Appendix C) did not make any recommendations that would have an impact on London Hydro's five-year Capital Expenditure Plan.[70]

3.1.6 Impact of Customer Engagement (5.4.1 f)

London Hydro regularly solicits information from its customers to identify preferences which are then taken into account during the preparation of the Capital Plan. The main source of the most useful information regarding customer preferences is the annual Customer Satisfaction Survey.[71] For the past several years, customers have indicated a strong preference for maintaining the existing level of reliability and for keeping rates low. These preferences have been reflected in the DSP by ensuring reliability is maintained through the proactive replacement of assets at risk of failing and causing an outage and considering lower cost options for asset sustainment beyond like-for-like replacements.

Customer Engagement has also resulted in several non-distribution system initiatives such as the Builders' Portal and New Property Management Tool which were developed in response to customers' requests for new or enhanced services[72].

A complete listing of all Customer Engagement activities and the impact to the DSP and Capital Expenditure Plan is provided in Section 3.2.4 Customer Engagement (5.4.2 d). Projects that specifically address Customer Preference are noted in Section 3.1.8 (5.4.1 h).

3.1.7 Five-Year Outlook (5.4.1 g)

As noted in Section 3.1.2 Total Capital Expenditures (5.4.1 b), the majority of investments for the next five years are focused on System Renewal to maintain the existing level of system reliability (customer preference) by replacing assets at end of life and most at risk of failure. While total system load growth is expected to be moderate, it is anticipated that load will increase in the downtown core, which will be addressed by the addition of a new feeder tie and the conversion of the Nelson Transformer Station to 27.6 kV and related feeder voltage conversion projects.

[70] The redevelopment of Nelson TS is noted in Section 6.3 of the Needs Assessment Report and accounted for within this DSP.

[71] Details on the Customer Engagement process and results are in Section 3.2.4 Customer Engagement 5.4.2 d)

[72] Details on these and other IT projects addressing Customer Preferences can be found in Exhibit 4 ("Information Technology") and Exhibit 2 ("Application Development")

3.1.8 Projects in Response to Customer Preference, Technology and Innovation (5.4.1 h)

The following tables summarize the specific projects that are in direct response to Customer Preference, Technology or Innovation.

As noted in 3.1.6, Customer Satisfaction Surveys have indicated a pervasive preference for maintaining the existing level of system reliability, keeping costs low and enhancing communications with London Hydro to meet customer needs and expectations. Many projects in the System Renewal category will ensure the system remains reliable by addressing assets that are unreliable or at risk of becoming unreliable. As this preference is general in nature, the projects that are related to reliability maintenance have been excluded from the following list, which focuses on projects that are a direct result of more specific customer preferences. Many of these customer preference projects are innovative and utilize new technology but are listed here as they had their origins in customer preference.

The Serial Modem Replacement project will allow Commercial and Industrial (C&I) customers to realize savings related to metering of their consumption. All C&I customers must have each of their electricity meters connected to London Hydro. Traditionally, this connection has been made through a modem dial-up service over a telephone line. The Internet has proven to be a viable alternative communication system to telephone lines. Today approximately 689 interval-metered accounts are being read by phone lines through London Hydro's MV90 system. These phone lines are provided by customers at an assumed rate of $50 per month per line or approximately $415,000 per year. If a customer has an available internet connection, London Hydro can enable these cost reductions for the customer.

The CE Solutions project confirms London Hydro's commitment to the ongoing development of the "MyLondonHydro" website portal - and award winning internet tool for customers. To London Hydro, customer service and engagement are not one-time activities. Future additions to the portal will feature more online automation of typical customer requests such as "move in/move out" notifications to London Hydro by customers and outage restoration notifications from London Hydro to the customer. Improvements to performance and other customer functionality, such as more choice regarding notifications, are annually incorporated.

The three applications, Energy Optimization, Builders' and Property Management portals, are specific instances where London Hydro has made efforts to provide distinct services related to commercial customers, either the clearly commercial and industrial class of customer or customers whose activities are primarily commercial in nature. Due to a large transient student population, Property Managers have requested the ability to collect all account and related information regarding their rental properties in one easy-to-access spot. This request need has been met successfully with the Property Management portal. The focus of this effort is to include additional customer requested functionality and to lower support costs associated with this application.

Builders will be able to interact with London Hydro online for direct support using the new Builders' Portal. The Energy Optimization application has become a great success story for London Hydro and its

Commercial and Industrial (C&I) customers (small number of customers but biggest consumers and, therefore, benefit). Based on the innovated efforts of London Hydro staff working closely with selected C&I customers, a number of applications have been developed using the Green Button platform that gather consumption information within different reference frameworks, such as for specific events or across jurisdictional boundaries to provide these customers with insight into their business costs and savings potential not previously possible.

The Bill Print Refresh project will replace the current bill print capability, which has become outdated in its functionality and processes. The new Bill Print System, as well as being more efficient to administer (154,000 monthly invoices), will feature customer-oriented services such as targeted inserts. A common complaint from customers is that they do not want to receive conservation inserts in their bills for situations that do not apply to them. For example, currently an insert for reducing the cost of having a swimming pool is sent universally in all bills even to those who do not have swimming pools. This generates a negative perception that the utility is out of touch with that which important to them (and in their minds to all customers), not to mention the extra expense of needless printing.

Customer Preference Projects	2016	2017	2018	Total
Serial Modem Conversion Program	$30,000	$30,000	$30,000	**$90,000**
Builder's Portal	$240,000	-	-	**$240,000**
New Property Management Portal	$200,000	-	-	**$200,000**
Customer Engagement Solutions	$300,000	$425,000	-	**$725,000**
Commercial and Industrial Apps	$300,000	$400,000	-	**$700,000**
Automated Billing Payments IVR Online	-	$200,000	-	**$200,000**
Bill Print Refresh	$555,000	-	-	**$555,000**
Annual Total	**$1,625,000**	**$1,055,000**	**$30,000**	**$2,710,000**

Table 39: Projects that are a Direct Response to Customer Preference

The use of technology to enhance the system reliability, flexibility, operability, efficiency and customer service is common-place, and London Hydro strives to use the latest technology and in some cases, to be an industry leader in utilizing new technology. The projects noted below are most indicative of the implementation of newer technology.

As the table below illustrates, a significant effort is required just to maintain the existing systems in a reliable and supportable condition. Both regulatory changes (OEB and IESO mandated) and upgrades to major vendor software (SAP, JDE, Oracle) must be implemented regularly to either obtain new functionality or maintain product software supportability (typically within the last two or three versions of their current offering). These vendors provide the products that are the "backbone of the back-end" of London Hydro's business systems, and while system downtime can be a low risk, the consequence is extremely high.

The other major technology projects generally aim to increase internal system capability either through ongoing enhancement efforts, such as hardening cyber security or disaster recovery planning or to improve internal business efficiency by introducing automation and collaboration tools that instantly bring relevant information together for all staff.

Technology Projects	2016	2017	2018	Total
Relay Replacements	$80,000	$80,000	-	**$160,000**
Fault Indicator Installations	$20,000	$20,000	$20,000	**$60,000**
DART RTU Replacement Program	$100,000	$100,000	$100,000	**$300,000**
SCADA Cyber Security	$50,000	$50,000	$50,000	**$150,000**
Control Centre - Display Technologies	$250,000	$250,000	$150,000	**$650,000**
Mobile Workforce Phase 3	$300,000	-	-	**$300,000**
Timesheet Field Automation	-	$300,000	-	**$300,000**
Mobile Link (GIS)	$40,000	-	-	**$40,000**
Asset Management System	-	$200,000	-	**$200,000**
Learning Management System	$150,000	-	-	**$150,000**
Fleet Maintenance System	$225,000	-	-	**$225,000**
SAP Business Process Improvements	$150,000	$300,000	-	**$450,000**
JDE Upgrade	-	$500,000	$1,500,000	**$2,000,000**
Regulatory Changes	$140,000	$250,000	-	**$390,000**
Outage Management System Upgrade	$350,000	-	-	**$350,000**
Enhanced Disaster Recovery	$125,000	-	-	**$125,000**
IT Systems-Security Upgrades	$75,000	$50,000	-	**$125,000**
Automated System Monitoring and Alerts	$80,000	-	-	**$80,000**
SAP Persona/ECC EhP7 Upgrade	$150,000	-	-	**$150,000**
End point Security Initiative	$50,000	-	-	**$50,000**
Infrastructure Upgrade – Application Enhancement	$100,000	$50,000	-	**$150,000**
Specialized system upgrades	$100,000	-	-	**$100,000**
ODS Upgrade	-	$250,000	-	**$250,000**
ORACLE Upgrade	-	$100,000	-	**$100,000**
HRIS Enhancements	-	$150,000	-	**$150,000**
Analytics Systems	$175,000	$250,000	-	**$425,000**
Annual Total	**$2,710,000**	**$2,900,000**	**$1,820,000**	**$7,430,000**

Table 40: Technology Projects

London Hydro encourages employees to find innovative ways to improve existing services or create new services or offerings that add value to customers.

The 'Green Button' is London Hydro's response to a call to action for "greater customer choice" and that "every customer should be able to view and access their own consumption data." This project was initiated by the then Premier of Ontario, Dalton McGuinty, and echoed by the White House. London Hydro participated in OEB/MaRs sponsored pilots and was the first Ontario utility to provide a download service to its customers called "Download My Data" (DMD), which was followed closely by "Connect My Data" (CMD) – a variant that allows customers to delegate third party service providers with access to their data.

The real innovation with Green Button is that London Hydro chose to view the answer to this challenge as a platform adhering to a set of "Open Standards" rather than the traditional approach of developing another product based on a vendor specific proprietary application. This unique approach was designed to foster utility collaboration – not duplication, to provide entrepreneurial opportunities to the general software developer market place and not large System Integrators (SI) and to ensure seamless interoperability between local and international LDC's. The testament to this innovative approach is the establishment of the "Green Button Alliance," with board representation that includes the Ministry of Energy, MaRs, the US Dept. of Energy and many international utilities. This "Platform" approach has even been shown to provide a viable, cost effective alternative to traditional centralized approach of MDM/R for an Ontario-wide solution.

Under this initiative, London Hydro will continue to develop applications that will take advantage of the Green Button platform and continue to provide support to third party vendors for developing customer-focused applications to help customers reduce their energy consumption.

The Residential Customer Mobile Application responds to the increasing shift towards smartphones and tablets. London Hydro wants to give its customers more control over where, when and how they engage with the utility. This app will have innovative features, such as instant complaint registration (the ability to register a complaint, such as a broken line, simply by clicking a picture), location based outage notifications, billing alerts, online chat etc.

The SAP Enhancements project aims to continue leveraging the value of the SAP investments to date by enabling new business processes or enhancing and optimizing existing business processes by utilizing the technology available in the existing system deployments. This project will be comprised of several sub-projects addressing specific objectives on a per-department basis raised by employee assessments and experiences on the job.

Innovation Projects	**2016**	**2017**	**2018**	**Total**
Line Status Sensors, (Remote Current & Real time Fault Indication)	$50,000	$50,000	$50,000	**$150,000**
Automatic Fault Detection, Isolation and Restoration	$50,000	$50,000	$50,000	**$150,000**
Residential Customer Mobile App	-	$200,000	-	**$200,000**
Green Button Enhancements	$150,000	$150,000	-	**$300,000**
Customer Relationship Management Process Improvements	$175,000	-	-	**$175,000**
Annual Total	**$425,000**	**$450,000**	**$100,000**	**$975,000**

Table 41: Innovation Projects

3.2 Capital Expenditure Planning Process Overview

From the OEB Filing Guidelines 5.4.2

The information a distributor should provide includes, but need not be restricted to:

a) a description of the distributor's capital expenditure planning objectives, planning criteria and assumptions used, explaining relationships with asset management objectives, and including where applicable its outlook and objectives for accommodating the connection of renewable generation facilities;

b) if not otherwise specified in (a), the distributor's policy on and procedure whereby non-distribution system alternatives to relieving system capacity or operational constraints are considered, including the role of Regional Planning Processes in identifying and assessing alternatives;

c) a description of the process(es), tools and methods (including where relevant linkages to the distributor's asset management process) used to identify, select, prioritise and pace the execution of projects in each investment category (e.g. analysis of impact of planned capital expenditures on customer bills);

d) if not otherwise included in c) above, details of the mechanisms used by the distributor to engage customers for the purpose of identifying their needs, priorities and preferences (e.g. surveys, system data analytics, and analyses – by rate class – of customer feedback, inquiries, and complaints); the stages of the planning process at which this information is used; and the aspects of the DS Plan that have been particularly affected by consideration of this information; and

e) if different from that described above, the method and criteria used to prioritise REG investments in accordance with the planned development of the system, including the impact if any of the distributor's plans to connect distributor-owned renewable generation project(s).

3.2 Capital Expenditure Planning Process Overview (5.4.2)

As noted in 2.1 Asset Management Process Overview, London Hydro uses an internal document, referred to as Engineering Instruction 31 (EI-31), to describe the "Asset Management and Capital Expenditures Planning: Policy and Processes (Asset Management Policy)." The Capital Expenditure Planning Process is Step 1 of the Asset Management Lifecycle outlined in section 2.1.

3.2.1 Objectives and Assumptions (5.4.2 a)

The **Objectives** identified in section 2.1 for the Asset Management Plan are the same for the Capital Expenditure Plan, namely **Safety, Regulatory, Environmental, Capacity, Reliability, Customer Focus, Losses** and **Cost**. As noted in 2.1, these **Objectives,** along with the Guiding Principles, Mission, Vision, and Values, align with the OEB Performance Outcomes and are summarized in Table 42 below.

	OEB PERFORMANCE OUTCOMES			
	CUSTOMER FOCUS	OPERATIONAL EFFECTIVENESS	PUBLIC POLICY RESPONSIVENESS	FINANCIAL PERFORMANCE
Objectives	Customer Focus, Capacity, Reliability, Costs	Safety, Capacity, Reliability, Losses	Safety, Regulatory, Environmental	Capacity, Losses, Costs
Principles	Quality Services, Growth, Revitalize Core	Quality Services, Growth, Revitalize Core	Quality Services	Growth
Mission	Customer Service, Competitive Rates, Reliability, Safety	Safety, Reliability	Safety	Competitive Rates, Safety
Vision	Customer Service, Community Value, Growth	Innovation	Community Value	Corporate Value
Values	Accountability, Integrity	Innovation	Social & Environmental Responsibility	Innovation, Accountability

Table 42: The Alignment of OEB Performance Outcomes and London Hydro's Corporate Statements

The application of the **Objectives** in the context of Capital Expenditure Planning puts emphasis on managing the overall capital spending via individual projects within the constraints of the available budget. In the context of the Asset Management Plan, these same Objectives provide guidance for the creation of overall programs and areas of focus, with high level budget numbers used in a five-year forecast. For example, the Objectives are used within the Asset Management Plan to identify the approximate amount of primary underground cable that should be replaced or refurbished each year (program), while the Capital Expenditure Plan would use the Objectives to determine which specific subdivisions or areas should be worked on each year (projects) to meet the desired outcome of the program.

The major **assumptions** used during the Capital Planning Process are as follows:

New Customer Connections/Upgrades: The volume and approximate cost of connecting new customers or upgrading their connections will be similar to recent years, taking into account the most recent "*Housing Market Outlook*" prepared by the Canada Mortgage and Housing Corporation (CMHC) for the London Area, the availability of land suitable for new development, and anecdotal input from City staff and developers regarding the quantity and pacing of new construction.

Line Relocations: The amount of work to relocate infrastructure to accommodate work by the City of London is based in part on recent trends (generally increasing) and specific plans received from the City of London in accordance with the Public Service Works on Highways Act.

Reliability: Customer expectations of reliability remain consistent with previous years (based on survey results) and the existing level of reliability is acceptable to most customers. Thus, reliability related projects within the annual Capital Plan are planned to ensure reliability does not worsen (by targeting "at risk" infrastructure) and to address any problem areas that have been experiencing poor reliability.

Regulatory Stability: There are no known changes or proposed changes to any regulations that would have a material impact on Capital Plans.

CDM and DG: The impact of CDM and DG has been accounted for in overall load forecasts using the best available information, and where applicable, the impact of CDM and DG on individual projects is noted on the Project Sheet.

REG: There are no plans to upgrade any transmission or distribution facilities to specifically accommodate Renewable Energy Generation projects, which could require significant changes to the Capital Plans for the five-year horizon. It is expected that any pending or future REG projects can be connected to the distribution system without major changes or expansions.

Regional Plans: There are no known regional planning issues related to the transmission system that could require significant changes to the Capital Plans for the five-year horizon.[73] (See details on the Nelson Transformer Station Plans in Appendix J for proposed work during the five-year forecast.)

[73] At the time of writing, London Hydro is completing the IRRP with the IESO and Hydro One. There are issues meeting the ORTAC criteria at Talbot TS and Clarke TS; however, no solutions have been agreed to or designs finalized at this time.

3.2.2 Non-Distribution Alternatives (5.4.2 b)

Non-distribution alternatives are considered in both the planning stage and design stage. The Director of Network Operations takes Regional Planning and REG requirements into account when assessing capacity and forecasting constraints (EI-31, Responsibilities, Step 1, System Service Part 4; EI-31, Procedures, Step 1, System Access Part 5 and System Service Part 5; EI-31, Procedures, Step 3, CDM). The Manager of Engineering considers CDM and REG investment alternatives prior to building new capacity and works with the Senior Director of Energy Management Programs to explore ways in which CDM initiatives can be used to reduce the need to invest in system assets (EI-31, Responsibilities, Step 3, Engineering Design Part 1).

3.2.3 Prioritization (5.4.2 c)

Engineering Instruction 31 outlines the Responsibilities (EI-31, Responsibilities, Step 2) and Procedures (EI-31, Procedures, Step 2) for selecting and approving the capital projects to be completed each year. As noted in 2.1.1 and further detailed in EI-31 Step 2, the **prioritization process** involves both a **top down** and **bottom up** approach.

The Senior Executives and London Hydro Board of Directors determine the overall pace of short and long term capital investments to mitigate the impact on customer bills and balance the needs of the Asset Management Plan with customer preferences, including any proposed REG investments. This yearly process results in an annual Capital Budget and a rolling five-year capital spending forecast.

The Directors and Managers are then responsible for proposing the specific projects that will meet the annual budget target and achieve the Objectives of the Asset Management Plan.

- Projects resulting from the Asset Sustainment Plan are ranked using two tools – the SPOORE analysis and the Engineering Ranking Index. Details on these ranking tools are outlined in the Asset Management Plan located in Appendix G (see AMP Section 4 for the Engineering Ranking Index Appendix N for the SPOORE analysis description).
- Customer-driven work (new and upgraded connections for load and generators, subdivisions, line relocations to accommodate municipal work) is forecasted based on previous history and input from customers, developers and municipal staff.
- Capacity-related projects (new or upgraded transformer stations, new or upgraded feeders, improved switching capability, etc.) are based on short and long range load forecasts using standardized planning and contingency analysis and taking into account Asset Sustainment Plans, CDM, DG, municipal plans and Regional Planning information.
- IT projects are prioritized by forecasted customer demand (for metering), regulatory requirements (e.g., changes to billing, meter data management, etc.), customer preferences (website enhancements), and internal demand (new technology, process improvements, new support systems, etc.).
- Fleet and Facilities projects generally flow from asset management decisions to replace or upgrade assets (rather than maintain and repair them - such as vehicles, HVAC equipment, furniture) and demand for new assets to accommodate growth (new substation properties and buildings, office renovations).

In the event that the annual financial target for capital spending is found to be too restrictive – either in the planning stage or during project execution – senior management reviews the overall budget either to make adjustments to project priorities to meet the financial target or to approach the Board of Directors with a request to change the financial target. The Board of Directors may consider an increase to the annual capital spending target to allow for unexpected projects (customer demand, major equipment failure or damage, regulatory requirements, business opportunity), giving due consideration to the overall five-year Capital Plan and corporate objectives.

As outlined in DSP 2.1.1, the Objectives are used to provide guidance when prioritizing projects. The Objectives are not individually ranked but grouped into three priority categories – Obligations, Performance, and Customer Preference & Cost.

The flow charts below (one for each of the four investment categories - System Access, System Service, System Renewal, and General Plant) outline the general inputs, outputs, and process steps taken to create the listing of Capital Expenditures.

System Access Process

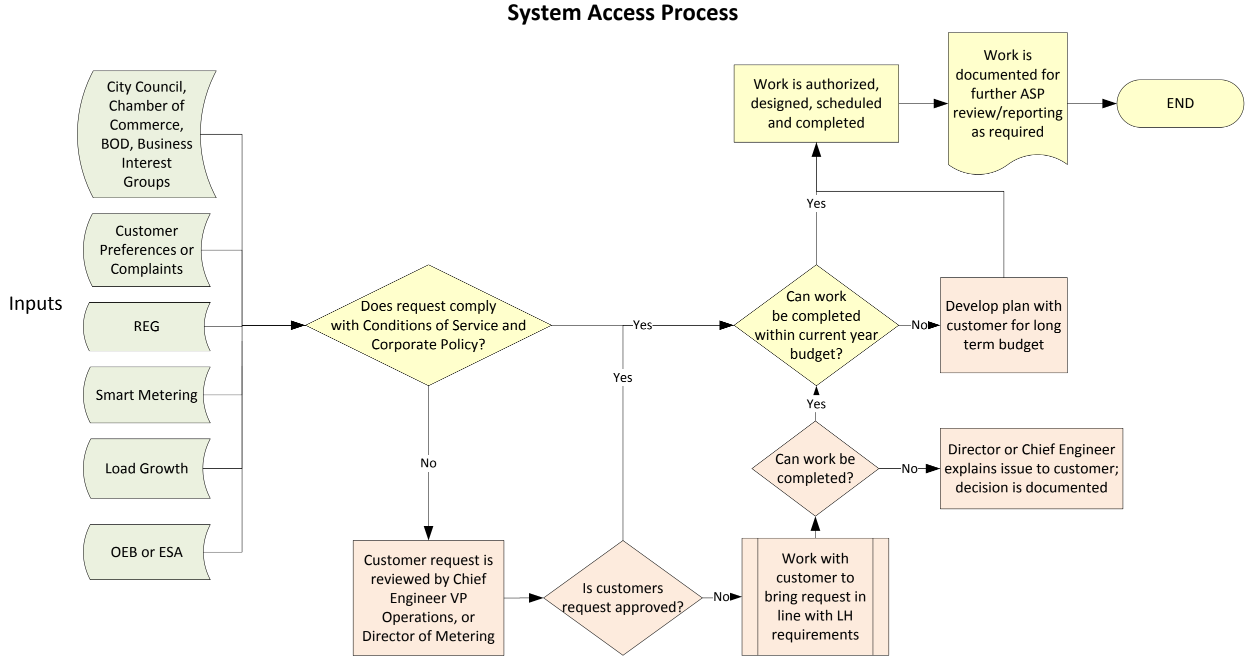


Figure 25: Process for Determining Capital Spending for System Access

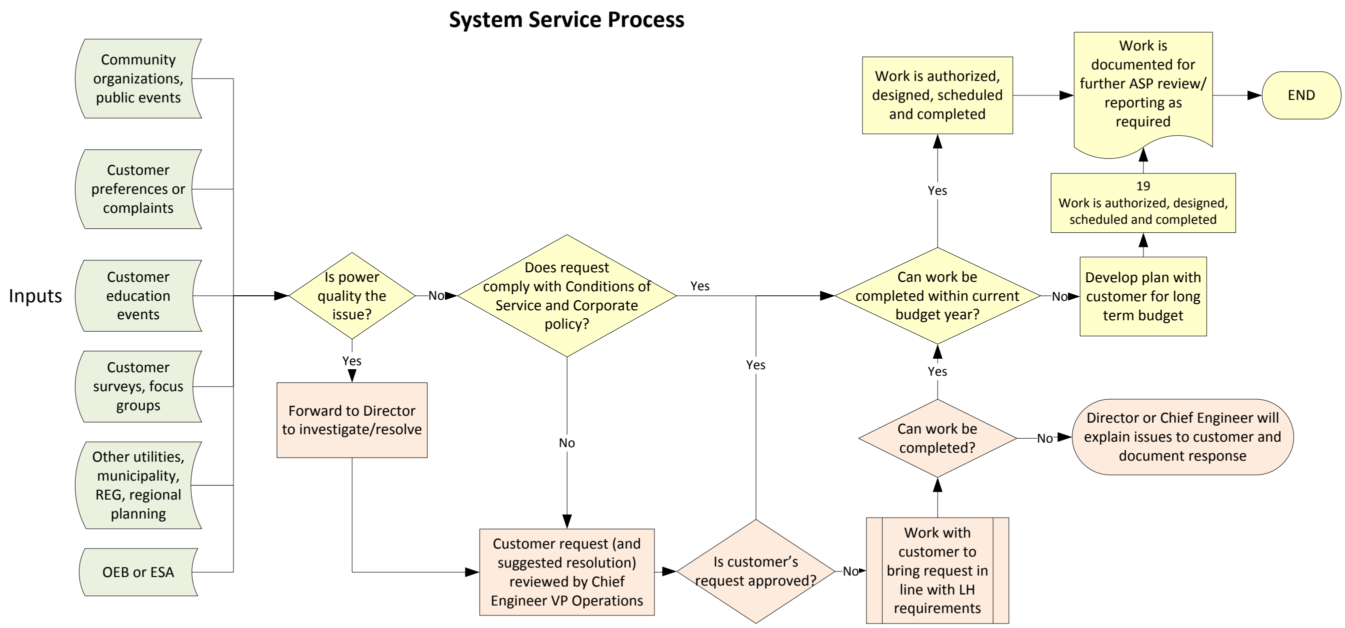


Figure 26: Process for Determining Capital Expenditures for System Service

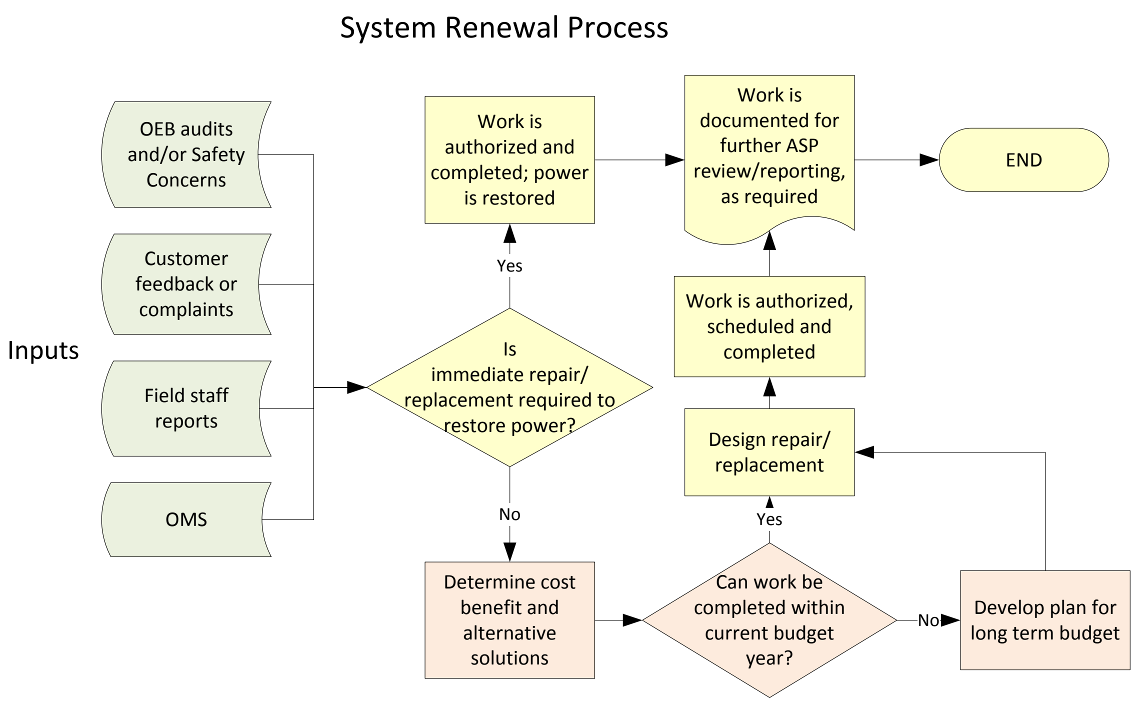


Figure 27: Process for Determining Capital Expenditure for System Renewal

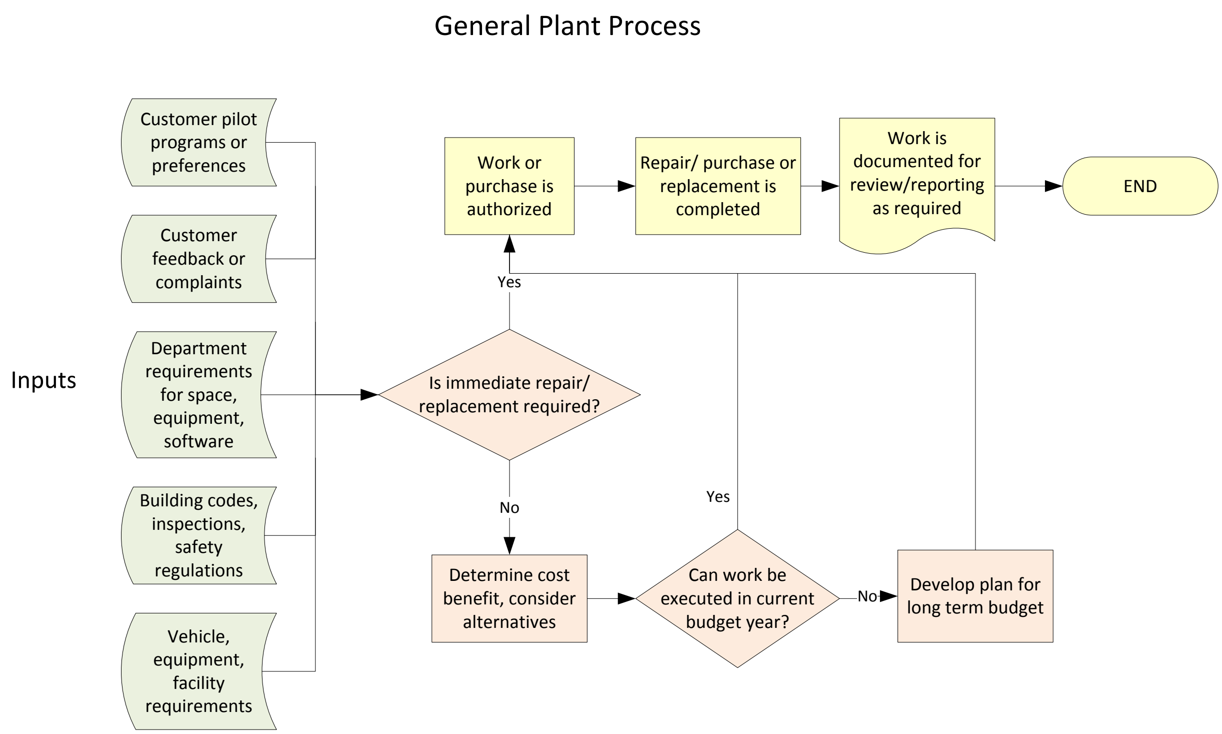


Figure 28: Process for Determining Capital Expenditures for General Plant

Project lists for all categories are created throughout the year as needs and opportunities arise. However, the majority of the annual Capital Budget work is driven by the formalized Asset Sustainment Plan (ASP), which results in project lists primarily within the System Renewal category. The ASP is reviewed every year and updated when required and is included in the Asset Management Plan (Section 7), located in Appendix G.

3.2.4 Customer Engagement (5.4.2 d)

The flowcharts above include several ways that London Hydro engages customers to identify their needs, priorities and preferences during the annual capital expenditure planning lifecycle. These activities are primarily ongoing in nature and part of London Hydro's normal business practices. Through these regular interactions with customers, London Hydro is made aware of what customers expect and are concerned about regarding their electricity provider. This awareness is then used to further refine and adjust the short and long range plans for projects and services.

London Hydro also initiates customer engagement activities to gauge customer satisfaction, to educate customers on service offerings including CDM and REG, to gain insight into new service offerings that may be of value to customers and to solicit input on major projects.

London Hydro utilized customer preferences during the creation of the DSP, and when the various capital programs were nearly finalized, London Hydro sought specific customer feedback on the proposed programs and spending levels. This outreach was accomplished by interacting with customers at community events (London Homebuilder Show January 15 – 17, Lifestyle Home Show April 15 – 17) and in local community centres (Byron Library June 10, East London Library June 17, Westmount Mall

June 2, Cherryhill Mall July 29). While the number of customers reached through this effort was low (63 documented interactions), the feedback provided was overwhelmingly supportive of the proposed programs and the value customers receive from them. Customers also expressed appreciation for providing them the opportunity to gain a better understanding of the investments London Hydro is making to maintain and improve the system. Based on these results, no changes were made to the proposed capital programs.

Table 43 summarizes the various customer engagement activities and how the results are used to shape the DSP and Capital Expenditure Plan. Additional details are available in DSP Appendix A and Exhibit 2 ("Application Development").

Engagement Activity	Target Customers	Impact to DSP and Capital Expenditure Plan
Annual Customer Satisfaction Surveys	All customers	Planning Stage: Continuing emphasis on maintaining a safe and reliable system. Support for a proactive replacement strategy. Reliability targets set similar to previous years. Interest in additional services such as outage notification via email or text, smart phone applications, better access to consumption data. (See Section 3.1.8 Projects in Response to Customer Preferences).
Participation in Home Shows, Community Events – Educating Customers on CDM and Capital Programs[74]	Residential and Small Commercial Customers, Builders and Developers, Electrical Contractors	Planning Stage: Continued interest in CDM programs and how to reduce electricity usage. Review Stage: General support for proposed Capital Plans.
Exhibits in Local Community Centres – Educating Customers on Capital Programs[75]	Residential Customers	Planning Stage: Reliability is becoming more important to residential customers. Most customers don't understand how system renewal projects benefit them – this triggered research into calculating a dollar value of the benefits to customers for reliability improvements (see Section 3.5 and Appendix B). Review Stage: Feedback from customers generally supports proposed Capital Plans. Execution Stage: More effort is needed to provide additional details to customers directly impacted by specific projects.
Customer Meetings	Commercial and Industrial Customers	Planning Stage: Engineering and operations staff meet with commercial and industrial customers to discuss potential connections, service upgrades, distributed generation, and LH initiated projects that may impact them (such as the work downtown to convert 13.8 kV to 27.6 kV). This feedback shapes the planning and scheduling of capital projects to minimize customer impact and ensure adequate capacity for future growth.
Builders and Developer Meetings	Builders and Developers	Planning and Execution Stage: Regular meetings with individual developers and the London Home Builders Association provide information on timing of developments and areas where LH can improve communication with builders.
Website – Educating Customers; Providing web-based services	All customers	Planning and Execution Stage: Customers readily started using new service offering and expressed interest in additional services such as outage notification via email or text, smart phone applications, better access to consumption data. (See Section 3.1.8 Projects in Response to Customer Preferences).

[74] See detailed write-up in Appendix A – DSP Specific Customer Engagement
[75] See detailed write-up in Appendix A – DSP Specific Customer Engagement

Billing Inserts – Educating Customers	All customers	Planning and Execution Stage: Billing Inserts would frequently direct customers to the LH website. Many customers expressed a desire to receive notifications electronically instead of bill inserts – supporting increased development of e-services.
Radio Advertisements – Educating Customers	All customers	Planning and Execution Stage: Customers are reminded to work safely around energized equipment and to call before they dig. An increase in number of locate requests have been received each year.
Media Interviews and Media Releases – Educating Customers	All customers	Planning and Execution Stage: Information conveyed will typically drive customers to the LH website for more information or to sign up for new service offerings.

Table 43: Impact of Customer Engagement Activities on DSP and Capital Expenditures

Through the various interactions with customers, it was noted that most customers have difficulty articulating the actual or perceived value of a safe and reliable distribution system. The annual surveys have identified that customers accept the current level of reliability and expect London Hydro to use a proactive replacement strategy that will prevent outages. They also want improved services and lower cost. When faced with rising energy prices, customers want London Hydro to do what they can to reduce cost, and when outages occur, customers ask why London Hydro is not doing more to prevent outages from happening. Describing the benefits of projects such as silicone cable injection to customers is often too technical, and most customers do not feel they can provide informed feedback to London Hydro on the question of whether the value they receive from the project is worth the cost.

In an effort to better understand the value that customers receive from reliability improvements[76], London Hydro retained a consultant who identified a methodology to estimate the avoided cost to customers based on projected outages that are prevented.[77] While this analysis is still being developed, the preliminary results show that the value to customers for improved reliability exceeds the capital costs associated with the projects London Hydro has selected to maintain and continuously improve reliability. London Hydro will be working to refine and validate this analysis in the coming years, which will include consulting with our customers and our peers to determine if this metric is an effective way to quantify reliability improvements.

3.2.5 REG Investments (5.4.2 e)

London Hydro does not have a separate process for prioritizing REG investments. All applications that have passed the upstream tests (transmission, transformer station, and 27.6 kV feeder - conducted by Hydro One and the IESO) have been approved by London Hydro for connection on a first-come first-served basis. Additional details on the capability for connecting REG are included in the next section.

[76] CVRI – Customer Value of Reliability Improvements

[77] See Appendix B

3.3 System Capability Assessment for REG

From OEB Filing Guidelines 5.4.3

This section provides information on the capability of a distributor's distribution system to accommodate REG, including a summary of the distributor's load and renewable energy generation connection forecast by feeder/substation (where applicable); and information identifying specific network locations where constraints are expected to emerge due to forecast changes in load and/or connected renewable generation capacity.

In relation to renewable or other distributed energy generation connections, the information that must be considered by a distributor and documented in an application (where applicable) includes:

a) applications from renewable generators over 10kW for connection in the distributor's service area;

b) the number and the capacity (in MW) of renewable generation connections anticipated over the forecast period based on existing connection applications, information available from the OPA and any other information the distributor has about the potential for renewable generation in its service area (where a distributor has a large service area, or two or more non-contiguous regions included in its service area, a regional breakdown should be provided);

c) the capacity (MW) of the distributor's distribution system to connect renewable energy generation located within the distributor's service area;

d) constraints related to the connection of renewable generation, either within the distributor's system or upstream system (host distributor and/or transmitter); and

e) constraints for an embedded distributor that may result from the connections.

3.3 System Capability Assessment for REG (5.4.3)

3.3.1 Applications Over 10 kW (5.4.3 a)

From 2010 to 2015, London Hydro connected 36 Feed-In-Tariff (FIT) projects plus 3 net metering projects with a total of 7,537 kW of renewable generation. During that time, an additional 236[78] micro Generation projects were connected adding 1,997 kW of connected renewables for a total of 9,534 kW of renewable generation.

3.3.2 Forecast of REG Connections (5.4.3 b)

As of January 2016, 29 FIT and 187 microFIT projects are in various stages of application and construction. Table 44 below summarizes the forecast for renewable energy connections for the next five years. This forecast is based on a combination of previous experience (regarding the number of actual connects versus total applications) and consultation with the IESO and applicants.

YEAR	kW
2016	2,450
2017	2,000
2018	2,000
2019	unknown
2020	unknown

Table 44: Forecasted Number of MicroFIT Projects (2016 - 2020)

Predicting REG connections beyond 2018 is difficult with the present level of uncertainty regarding the continuation of existing incentives and contract prices. While technological developments could create new opportunities, the limitations of the existing infrastructure at the transmission level may not be corrected in the short term.

3.3.3 Capacity Available (5.4.3 c)

In general, the London Hydro distribution system has capacity available to connect most REG projects. The exceptions are noted in the Constraints section below.

3.3.4 Constraints – Distribution and Upstream (5.4.3 d)

The London Hydro system is supplied by seven transformer stations owned by Hydro One. Most of the distribution system is at 27.6 kV with a few areas at 13.8 kV and 4.160 kV. Table 45 below summarizes the distribution system constraints by transformer station, feeder and supply voltage (as of January 26, 2016).[79]

[78] There are 226 MicroFit's and 10 Net Metering

[79] Constraints on Hydro One owned assets are based on the Hydro One List of Station Capacity and the published on the Hydro One website.

Station and Bus	Voltage	Current Available Capacity[80]	Limitation Source
Buchanan TS, B Bus	27.6 kV	600 kW	HONI Threshold Allocation to London Hydro
Buchanan TS, Y Bus	27.6 kV	0	Restricted by HONI
Highbury TS	27.6 kV	1,000 kW	HONI Threshold Allocation to London Hydro
Clarke TS, B Bus	27.6 kV	1,200 kW	As Above
Clarke TS, Y Bus	27.6 kV	1,000 kW	As Above
Talbot TS, B/Y Bus	27.6 kV	0	Restricted by HONI
Talbot TS, J1/J2 Bus	27.6 kV	4,950 kW	HONI Threshold Allocation to London Hydro
Talbot TS, Q1/Q2 Bus	27.6 kV	4,500 kW	As Above
Wonderland TS	27.6 kV	1,000 kW	As Above
Nelson TS, B/Q Bus	13.8 kV	0	Restricted by HONI
Nelson TS, Y/J Bus	13.8 kV	0	Restricted by HONI
Nelson TS, P/K Bus	13.8 kV	0	Restricted by HONI
Edgeware TS	27.6 kV	0	Feeder is owned by HONI

Table 45: Distribution System Constraints by Transformer Station, Feeder and Supply Voltage

3.3.5 Constraints – Embedded Distributor (5.4.3 e)

There are no distributors embedded to London Hydro's system.

[80] Capacity is based on current amounts available through Threshold Allocation Applications to Hydro One. Additional capacity may be made available through specific applications.

3.4 Capital Expenditure Plan Summary

From OEB Filing Guidelines 5.4.4

The purpose of the information filed under this section is to provide the Board and stakeholders with a 'snapshot' of a distributor's capital expenditures over a 10 year period, including five historical years and five forecast years. Note that where a distributor's internal investment planning framework does not align with the investment categories defined here, best efforts are expected to 'map' investments to these categories.

Despite the 'multi-purpose' character of a project or activity, for 'summary' purposes the entire costs of individual projects or activities are to be allocated to one of the four investment categories on the basis of the primary (i.e. initial or 'trigger') driver of the investment. Note, however, that for material projects, a distributor must estimate and allocate costs to the relevant investment categories when providing information to justify the investment, as this assists in understanding the relationship between the costs and benefits attributable to each driver underlying the investment. In any event, the categorization of an individual project or activity for the purposes of these filing requirements should not in any way affect the proper apportionment of project costs as per the DSC.

Table 2 illustrates how information filed under this section includes a distributor's actual and forecast (i.e. proposed) capital expenditures over the historical and forecast periods. System operations and maintenance (O&M) costs are also shown to reflect the potential impact, if any, of capital expenditures on routine system O&M. Note that 'Plan' expenditures over the historical period refer to a distributor's previous plan for capital expenditures after adjustments (if any) occasioned by the Board's decision on the relevant prior application.

Brief explanatory notes should be provided to explain the factor(s) and/or circumstances underlying marked changes in the share of total investment represented by a given investment category over the forecast period relative to 'actual' spending over the historical period. For example, a large expenditure over a relatively short period for a 'one-off' project (e.g. a distribution station) can cause a temporary 'step change' in category C spending compared to the trend in actual expenditures over the historical period.

While year over year 'Plan vs. Actual' variances for individual investment categories are expected, explanatory notes should be provided where

- for any given year "Total" 'Plan' vs. 'Actual' variances over the historical period are markedly positive or negative; or
- a trend for variances in a given investment category is markedly positive or negative over the historical period.

3.4 Capital Expenditure Summary (5.4.4)

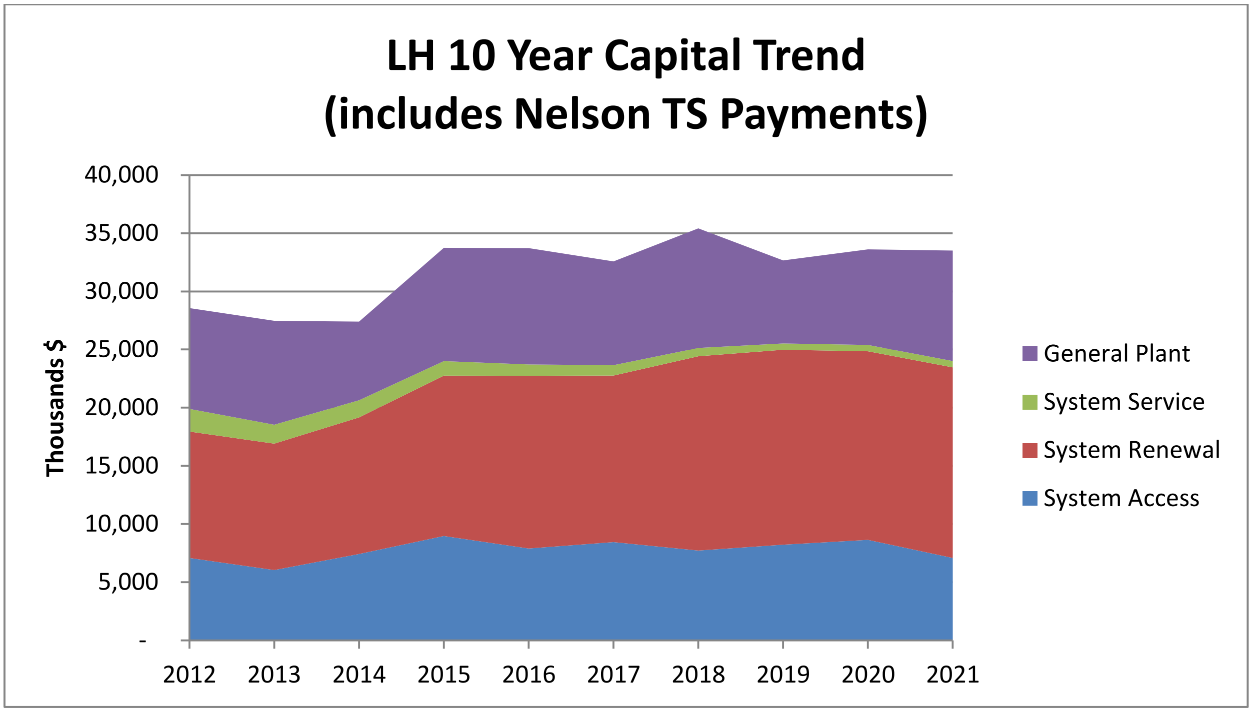


Figure 29: London Hydro 10-Year Capital Trend (including Nelson TS Payments)

As Figure 29 illustrates, the overall trend in capital spending for the 2012 to 2021 period is an increase from $27.8M in 2012 to $33.5M in 2021, which represents an increase of approximately 21%. Part of the overall increase relates to the series of capital contribution payments made to Hydro One for the conversion of Nelson Transformer Station from 13.8 kV to 27.6 kV, made between 2016 and 2021.[81] Excluding the Nelson TS payments, the budget for 2021 is $32.0M or an increase of 15% over 2012 (about 1.5% per year).

System Access spending is relatively stable at approximately 25% of total spending (excluding Nelson TS payments), with some fluctuations year over year due to the changing volume of work associated with relocations to accommodate City of London initiated projects.

System Service spending is expected to be minor at approximately 2% of total spending (excluding Nelson TS payments), driven by the need to make incremental investments in distribution automation to keep technology current.

General Plant spending will typically be approximately 24% of total spending (excluding Nelson TS payments), with much of this focused on IT investments to address customer preferences, accommodate regulatory requirements, and make workflow more effective and efficient.

---

[81] Scheduled Payments to Hydro One for Nelson TS are 2015 $1.6M, 2016 $1.8M, 2017 $1.8M, 2018 $1.8M, 2021 $1.5M (Total of $8.3M). These payments are included in an Advanced Capital Module (ACM) application included in Exhibit 2, Appendix 2-4.

System Renewal is the area with the largest planned increase, going from 39% in 2012 to 49% in 2021 (excluding Nelson TS payments). This jump is a reflection of the increasing volume of work that needs to be done each year to address aging infrastructure and maintain system reliability.

Category	2012 $'000			2013 $'000			2014 $'000			2015 $'000			2016 $'000		
	Plan	Actual	Var %	Plan	Actual	Var %	Plan	Actual	Var %	Plan	Actual	Var %	Plan	Actual[82]	Var %
Access	6,623	7,078	6.87	6,111	6,038	-1.19	6,430	7,420	15.4	6,105	8,966	46.86	7,893	7,893	0.0
Renewal	11,800	10,867	-7.91	11,673	10,869	-6.89	12,649	11,741	-7.18	14,535	13,787	-5.15	14,849	14,849	0.0
Service	1,505	1,949	29.50	1,774	1,626	-8.34	1,683	1,476	-12.3	1,357	1,249	-7.96	975	975	0.0
General	8,343	8,667	3.88	8,295	8,935	7.72	7,643	6,763	-11.51	7,921	9,742	22.99	10,002	10,002	0.0
Other[83]	-	(788)	0.00	-	242	0.00	-	(451)	0.00	(1)	757	0.00	-	-	0.0
Total	28,271	27,773	-1.8	27,853	27,710	-0.5	28,405	26,949	-5.1	29,917	34,501	15.3	33,719	33,719	0.0
O&M	16,193	14,677	-9.4	16,604	15,635	-5.8	n/a	15,878	n/a	n/a	17,070	n/a	17,563	17,563	

Table 46: Capital Plan Expenditure Summary 2012 to 2016 (in thousands of $)

Note: Since this is London Hydro's first DSP; the amounts shown above for "Plan" are the annual budget amounts as approved by London Hydro's Board of Directors.

Historical Variance Analysis by Year (See Table 46 above)

2012 – System Service +29.5% Variance

- Section C1: +$157k Pre-work for 2013 Capital Projects and Unbudgeted Feeder Rebuild – Hill Street Pole Line Rebuild.
- Section C2: +$120k Unbudgeted Pole Line Relocation (Sarnia Road)
- Section F3: +$150k Expanded Scope on original Dundas Street Conversion Project

2014 - General Plant -11.51%

- Section R8: +$110k Dual Feed backup supply for Control room, unbudgeted. Power failure to building caused SCADA system to go down and realization that the Control room had no backup supply
- Section V1: +$301k Due to Phone system upgrade and an introduction of call center applications. There was a compatibility issue between Mitel hardware with cisco backend which required additional cisco hardware, and additional Testing was required to ensure least operational interruption.
- Section W1: -$865k Deferred major CIS work due to CRM program which tied up most of the resources
- Section W2: -$190k Less than anticipated regulatory changes were performed
- Section W7: +$127k Additional work had to be performed than anticipated due to issues with stabilization of Mobile workforce system infrastructure.
- Section W9: -$145k Work shifted to 2015 due unavailability of key resources

---

[82] Actual spending is forecast as of June 30, 2016.

[83] "Other" refers to Inventory Held for Capital Projects and CGAAP to MIFRS Burden Adjustments, see Analysis of Capital Expenditures Exhibit 2

2014 - System Service -12.3%

- Section C1: -$525k Timing of Western Road and Talbot TS Projects Deferred to 2015
- Section H2: +$124k Variance Report written to move $100k unused budget to this section
- Section H4: +$138k Unbudgeted Capital Projects (RTU Cabinets & System Enhancement)

2014 – System Access +15.4%

- Section D1: +$420k City Demand above initial estimate
- Section E1-E5: +$470k Market Conditions and Customer Demand greater than anticipated
- Section M1: +$169k Customer Demand for new metering more than anticipated

2015 – General Plant +22.99%

- Section CC1: +$1,617k Unbudgeted HONI Payment for Nelson TS Rebuild
- Section N3: +$147k Deferred Purchase from 2014
- Section 02: -$113k Deferred miscellaneous equipment purchases in various business units.
- Section R2: -$278k Lower Yard Paving put on hold due to external concerns.
- Section R3: +$133k Unbudgeted Parking lot improvement tied to underspend in external concerns in Section R2.
- Section V1: +$518k Expedited SAN hardware purchase due to old SAN running out of space towards the end of the year.
- Section W1: -$411k The allocated budget was absorbed under other programs like MFWM wherein substantial CIS system enhancements were made to accommodate service order processing
- Section W14: +$448k Increased scope to include features like Move in Move out for existing customers, Aeroplan, enhanced notifications
- Section W15: -$326k Builders portal work was moved into 2016 due to unavailability of key resources to complete the project
- Section W2: +$105k More than anticipated system changes were made to accommodate regulatory mandates like OESP, Debt Retirement Charge (DRC) etc.
- Section W4: -$187k Deferred enhancements to OMS upgrade in 2016 to be more cost effective
- Section W7: +$259k Increased scope to include post processing, inter-department visibility of service orders and some OMS enhancements pertaining to electrical safety procedures
- Section W9: +$186k Added customization (Bank time, off-hour scheduling, Shift Pay etc.) that was required to align to the business processes that was otherwise not provided by the out of box solution.

2015 - System Access +46.86%

- Section D1: +$420k City Demand above initial estimate
- Section E1-E5: +$470k Market Conditions and Customer Demand greater than anticipated
- Section M1: +$169k Customer Demand for new metering more than anticipated
- Section M2: -$264k Customer Demand for new metering less than anticipated

Five Year Forecast

Category $'000	2017 Plan	2018 Plan	2019 Plan	2020 Plan	2021 Plan	Total	Average
Access	8,441	7,716	8,220	8,617	7,080	**40,074**	**8,018**
Renewal	14,319	16,702	16,757	16,213	16,384	**80,375**	**16,075**
Service	895	715	545	545	546	**3,246**	**649**
General	8,920	10,584	7,437	8,518	9,797	**45,256**	**9,051**
Total	**$32,575**	**$35,717**	**$32,959**	**$33,893**	**$33,807**	**$168,951**	**$33,790**
O&M	$18,239	$18,604	$18,976	$19,355	$19,742	$94,916	$18,983

Table 47: Capital Expenditure Summary 2017 - 2021 (in thousands of $)

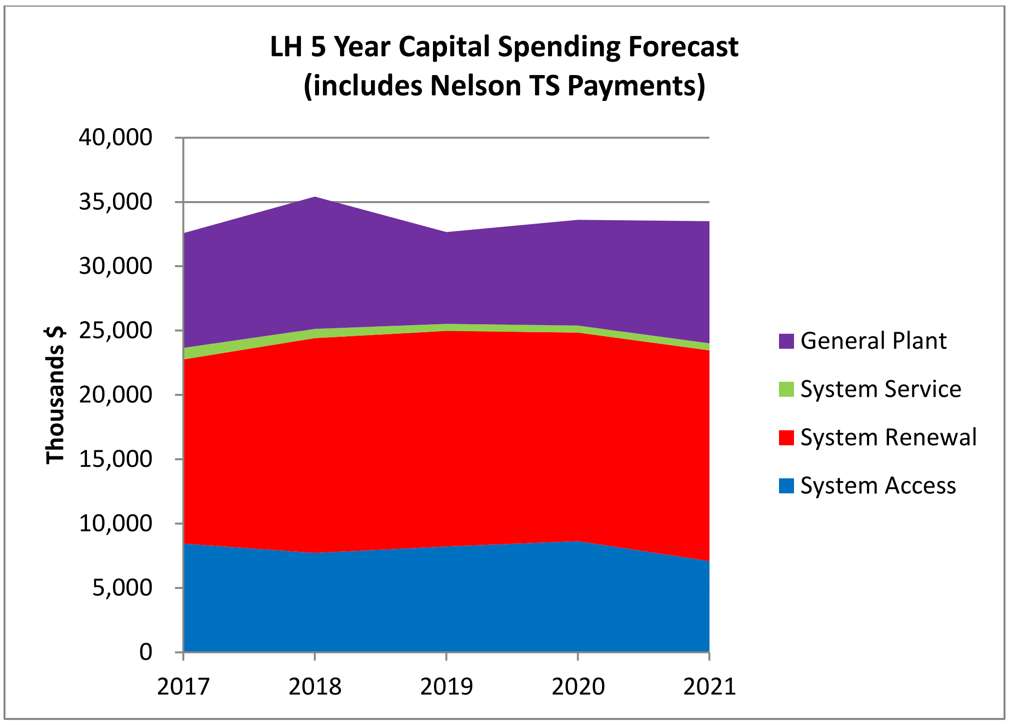


Figure 30: London Hydro 5-Year Capital Spending Forecast (includes Nelson TS Payments)

As the table and figure above illustrate, the overall capital spending trend for the coming five years is expected to be stable, with only minor shifts between categories. System Access work (relocations to accommodate City road projects) is expected to decline as the City has forecasted much of their work related to the London Plan will be complete by 2020. System Renewal spending is expected to continue to increase as the infrastructure ages and more and more assets reach end of life (for example, investment in replacing or silicone cable injection of primary underground cable will increase by 20% to keep pace with the quantity of cables exceeding their expected useful life). System Service and General Plant spending will remain consistent based on what is known today regarding the City allowing London Hydro to keep the main facility at 111 Horton Street. The final payment to Hydro One is expected to be made in 2021, so General Plant spending beyond 2021 should decrease by approximately $1.5M annually.

3.5 Justifying Capital Expenditures

From OEB Filing Guidelines 5.4.5

As indicated in Chapter 1, the onus is on a distributor to provide the data, information and analyses necessary to support the capital-related costs upon which the distributor's rate proposal is based. Filings must enable the Board to assess whether and how a distributor's DS Plan delivers value to customers, including by controlling costs in relation to its proposed investments through appropriate optimization, prioritization and pacing of capital-related expenditures.

5.4.5.1 Overall plan

The Board's assessment of DS Plans includes the costs of material projects/activities included in the DS Plan, as well as the costs represented by the respective shares of the overall DS Plan budget allocated to each of the four investment categories. Information to be provided in this section pertains to the latter; the former is addressed in section 5.4.5.2.

To support the overall quantum of investments included in a DS Plan by category, a distributor should include information on:

- comparative expenditures by category over the historical period;
- the forecast impact of system investment on system O&M costs, including on the direction and timing of expected impacts;
- the 'drivers' of investments by category (referencing information provided in response to sections 5.3 and 5.4), including historical trend and expected evolution of each driver over the forecast period (e.g. information on the distributor's asset-related performance and performance targets relevant for each category, referencing information provided in section 5.2.3);
- information related to the distributor's system capability assessment (see section 5.4.3)

5.4.5.2 Material investments

The focus of this section is on projects/activities that meet the materiality threshold set out in Chapter 2 of the Filing Requirements for Electricity Transmission and Distribution Applications. However, distributors are encouraged in all instances to consider the applicability of these requirements to ensure that all investments proposed for recovery in rates, including those deemed by the applicant to be distinct for any other reason (e.g. unique characteristics; marked divergence from previous trend) are supported by evidence that enables the Board's assessment according to the evaluation criteria set out below. The level of detail characterizing the evidence filed by a distributor to support a given investment project/activity should be proportional to the materiality of the investment.

3.5 Justifying Capital Expenditures (5.4.5)

London Hydro has historically justified capital spending by considering the typical benefits to customers – improved and consistent reliability, enhanced and expanded services, efficiency gains, safety, environmental benefit, competitive rates and capacity for new load and generation. Underpinning all of these benefits is the desire to provide value to customers in all that we do.

It can be challenging to explain to customers the value they receive for investments made in a project that improves long term reliability, such a silicone cable injection. The more sophisticated electricity users (typically industrial and commercial customers) will often have some notion of the financial impact to their operation if the power goes out, while most others will accept there is some cost to them even if it is only a minor inconvenience. To better understand the value to our customers of preventing outages, an external consultant was hired to review industry best practices and recommend a methodology for estimating the savings to customers by investing in projects that reduce the frequency and duration of future outages.

The result of this research is what London Hydro refers to as the Customer Value of Reliability Improvements (CVRI), while some literature refers to it as Customer Cost of Outages, or Value of Lost Load.[84] The value of CVRI is calculated by project/program and is based on the estimated number of outages reduced by the project/program each year and the cost incurred by customers for the outage type (momentary, sustained) and duration (in hours) of the outage reduced. The values used for the cost incurred by customers is based on work conducted by the US Department of Energy, EPRI, and Lawrence Berkley National Laboratory, which was completed in 2009 and updated in 2013.[85] While these values are not specific to London Hydro's customer base, it was felt they could be used for an initial estimate of CVRI until time and resources permit the collection of local information and feedback has been obtained from industry stakeholders on the validity of this methodology.

The calculated value of CVRI is then compared to the investment made by London Hydro to achieve the reliability improvement (Capital Budget) to calculate a ratio (CVRI/investment), with a value of 1 or greater considered desirable. In addition to considering each project/program, the aggregate amount for each year is also calculated.

Table 49 and 50 below show the final results of the CVRI calculations for the 2016 and 2017 distribution projects. Additional details including a sample calculation are included in Appendix B.

[84] See Appendix B for the complete report.
[85] See Appendix B Table ES-1

2016 Customer Value of Reliability Improvements (CVRI)			
Project/Program	**Capital Budget**	**CVRI**	**Ratio CVRI/Capital Budget**
Cable silicone injection	$1,891,000	$2,276,868	1.20
Subdivision Rehabilitation	$700,000	$948,695	1.36
Replacement/Removals of SEs	$246,000	$386,358	1.57
Leaking Transformer	$700,000	$793,083	1.13
Vault Rebuilds	$166,000	$236,748	1.43
Fault Indicator Installations	$20,000	$17,530	0.88
Zone B UG + OH Conversion	$1,943,000	$1,912,870	0.98
13.8 kV UG + OH Conversions	$1,726,000	$3,579,050	2.07
27.6 kV Supply to Core	$1,800,000	$2,600,615	1.44
13.8 kV Conversion Main Feeders	$667,000	$1,153,725	1.73
Civil Structure Installation	$690,000	$0	0.00
New Main Feeder Ties	$825,000	$448,270	0.54
Network Vaults / Maintenance holes / Transformers Replacements	$1,000,000	$5,063,550	5.06
Primary & Secondary Cables Replacements	$380,000	$2,531,775	6.66
Maintenance hole Replacement due to Cable Rebuilds	$450,000	$0	0.00
Replace Deteriorating Poles	$300,000	$61,108	0.20
Replacement of Poles Susceptible to Fires	$220,000	$211,987	0.96
Rebuild Depreciated Areas	$300,000	$421,527	1.41
Porcelain Insulator Replacement	$500,000	$594,936	1.19
Firon Switch Replacements	$300,000	$270,566	0.90
Recloser Installations	$275,000	$791,085	2.88
Total	**$15,099,000**	**$24,300,345**	**1.61**

Table 48: 2016 Customer Value of Reliability Improvements (CVRI)

2017 Customer Value of Reliability Improvements (CVRI)			
Project/Program	**Capital Budget**	**CVRI**	**Ratio CVRI/Capital Budget**
Cable silicone injection	$2,711,000	$2,276,868	0.84
Subdivision Rehabilitation	$75,000	$714,425	9.53
Replacement/Removals of SEs	$293,000	$386,358	1.32
Leaking Transformer	$700,000	$793,083	1.13
Vault Rebuilds	$144,000	$236,748	1.64
Fault Indicator Installations	$20,000	$17,530	0.88
Zone B UG + OH Conversion	$3,252,000	$1,912,870	0.59
13.8 kV UG + OH Conversions	$954,000	$3,579,050	3.75
27.6 kV Supply to Core	$1,560,000	$2,600,615	1.67
13.8 kV Conversion Main Feeders	$815,000	$1,153,725	1.42
Civil Structure Installation	$1,000,000	$0	0.00
Network Vaults / Maintenance holes / Transformers Replacements	$1,020,000	$5,063,550	4.96
Primary & Secondary Cables Replacements	$380,000	$2,531,775	6.66
Maintenance hole Replacement due to Cable Rebuilds	$200,000	$0	0.00
Replace Deteriorating Poles	$300,000	$61,108	0.20
Replacement of Poles Susceptible to Fires	$110,000	$211,987	1.93
Rebuild Depreciated Areas	$260,000	$421,527	1.62
Porcelain Insulator Replacement	$500,000	$594,936	1.19
Recloser Installations	$195,000	$791,085	4.06
Total	**$14,489,000**	**$23,347,239**	**1.61**

Table 49: 2017 Customer Value of Reliability Improvements (CVRI)

The vast majority of projects in both years have a ratio greater than 1, which indicates the value that customers receive from the projects exceeds their capital cost. Some of the projects such as the Civil Structures and Maintenance Hole Replacements have a ratio of 0 meaning that, on their own, these projects do not provide a quantifiable value to customers. However, these projects are necessary for safety and capacity reasons and not a direct result of a reliability risk analysis. A few projects have ratios slightly less than 1, such as Fault Indicator Installations, which has an additional driver of improving the efficiency of finding outages. It is expected that the inclusion of the cost savings associated with this efficiency improvement would make the ratio greater than 1. Projects such as Replacing Deteriorating Poles are driven in part by safety concerns while the New Main Feeder Ties project is driven in part by capacity requirements. When considered in aggregate, the projects selected for each year have a ratio of just over 1.6, which implies the projects deliver a value to the customer of $1.60 for every $1.00 spend on capital. London Hydro plans to expand this analysis to include other factors, such as the savings to O&M due to the outage reduction, and commission a survey to obtain cost impacts of outages that are specific to London Hydro customers.

3.5.1 Overall Plan (5.4.5.1)

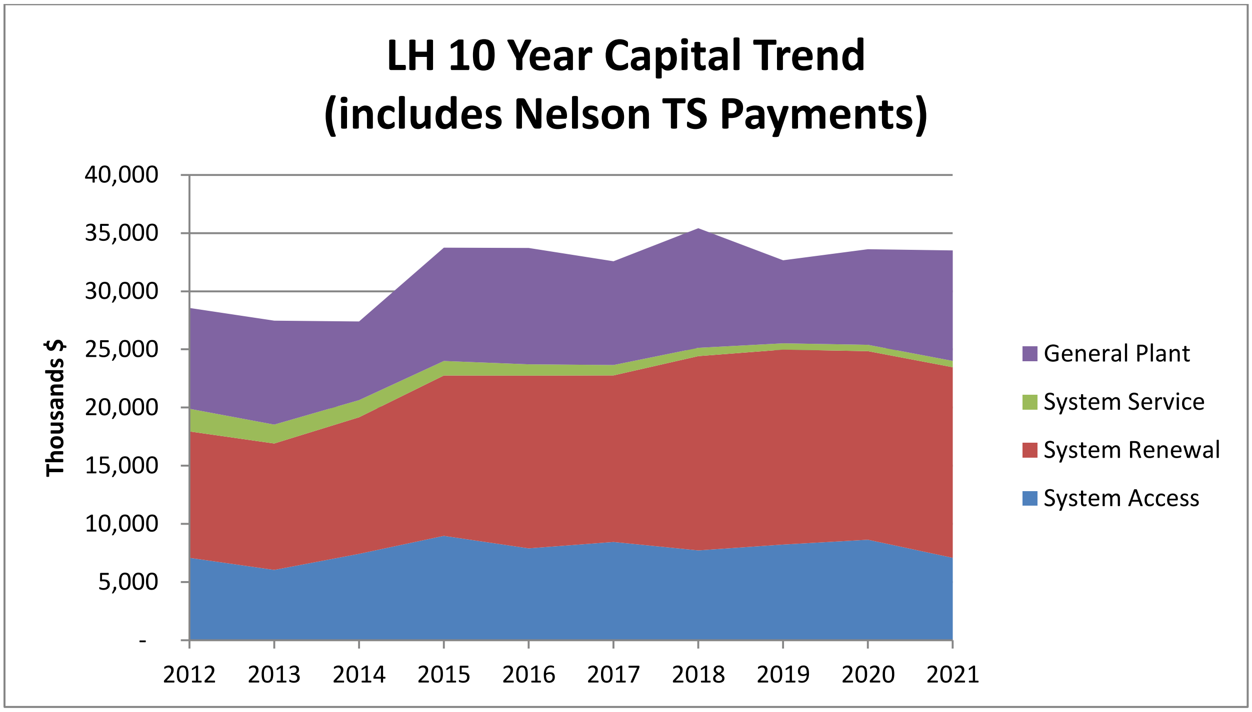


Figure 31: London Hydro 10-Year Capital Trend (including Nelson TS Payments)

3.5.1.1 Historical Comparison (5.4.5.1)

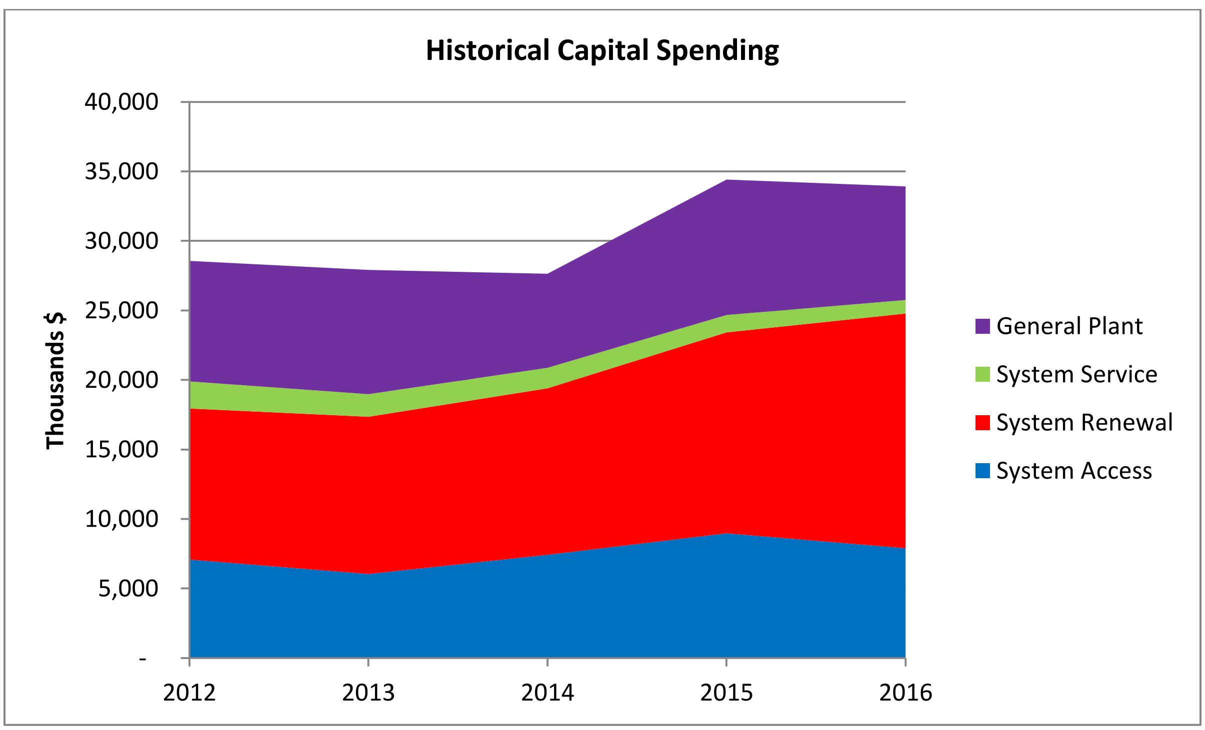


Figure 32: Historical Capital Spending 2012 to 2016

The planned capital work for the Test Year 2016 is $33.7M compared to $27.8M in 2012, which is an increase of 21%. Part of the increase in 2015 and 2016 is the due to the payments made to Hydro One for the Nelson TS voltage conversion ($1.6M in 2015 and $1.8M in 2016). The main driver of the overall increase in spending has been increased spending on System Renewal, which is a reflection of the age and condition of the distribution assets.

$,000	**Year**				
OEB Category	**2012**	**2013**	**2014**	**2015**	**2016**
System Access	7,078	6,038	7,420	8,966	7,893
System Renewal	10,867	10,869	11,741	13,787	14,849
System Service	1,949	1,626	1,476	1,249	975
General Plant	8,667	8,935	6,763	9,742	10,002
Other	(788)	242	(451)	757	-
Annual Total	**$27,773**	**$27,710**	**$26,949**	**$34,501**	**$33,719**

Table 50: Capital Work by OEB Categories 2012 – 2016

From 2012 to 2014, the total capital spending was flat and the most significant variance was in 2015 when total spending increased by about $7.6M and remained near this level for 2016.

System Access increased due to an unexpected increase in relocations to accommodate road projects in 2016 ($1.5M more than average).

System Renewal increased due to the following:

- The need to add 27.6 kV feeder ties in 2015 ($0.5M) and 2016 ($0.8M) to support 4.16 kV voltage conversions.
- Extending a 27.6 kV feeder into downtown in 2016 ($1.8M) to support 13.8 kV voltage conversions and future development.
- Upgrades to civil infrastructure in 2015 ($1.8M) and 2016 ($1.0M) in downtown to support 13.8 kV voltage conversions and provide a more secure supply for existing and future loads.
- The start of 13.8 kV main feeder conversions in 2015 ($0.5M) and 2016 ($0.7M) to facilitate the Nelson TS conversion.
- The start of 13.8 kV underground conversions in 2015 ($0.5M) and 2016 ($1.3M) to facilitate the Nelson TS conversion.
- The start of 13.8 kV overhead conversions in 2015 ($0.8M) and 2016 ($0.4M) to facilitate the Nelson TS conversion.
- Overall increase in replacing depreciated plant (poles, insulators, etc).

General Plant increased in 2015 by $1.5M due to the first payment to Hydro One for the Nelson TS conversion and increased in 2015 by $2.0M and in 2016 by $0.8M due to increased investment in IT projects (cyber security, mobile workforce, enterprise resource planning, OMS, servers and storage, and network development).

As Table 51 illustrates, the relative allocations between the categories has shifted from a fairly even split among System Access, System Renewal, and General Plant (with a small amount for System Service), to System Renewal taking the largest portion of the total budget.

% Allocation	Year				
OEB Category	**2012**	**2013**	**2014**	**2015**	**2016**
System Access	25%	22%	28%	26%	23%
System Renewal	39%	39%	44%	40%	44%
System Service	7%	6%	5%	4%	3%
General Plant	31%	32%	25%	28%	30%
Other	-3%	1%	-2%	2%	0%
Annual Total	**100%**	**100%**	**100%**	**100%**	**100%**

Table 51: Relative Allocations between OEB Categories 2012 - 2016

This shift is due primarily to the need to increase the investment in replacing aging infrastructure to ensure the system operates safely and reliably at the level preferred by our customers. The conversion of Nelson TS has also increased the investment in 13.8 kV conversions and 27.6 kV feeder extensions in downtown, which also replace aging assets.

3.5.1.2 Forecast Impact on O&M Cost (5.4.5.1)

The investments made in replacing aging infrastructure are expected to have a positive impact on O&M costs as there should be fewer unplanned failures which would decrease the cost of emergency response. The increased level of investment and the desire to optimize the total lifecycle costs and benefits to customers requires additional staff and skillsets for system planning and analysis, which will add to O&M costs going forward. The expected net result is stable O&M costs going forward.

3.5.1.3 Investment Drivers by Category (5.4.5.1)

System Access: The two main drivers of System Access projects are new and upgraded services for residential and commercial customers and infrastructure relocations to accommodate City of London Projects. Approximately 66% of projects in this category are the result of requests from customers for new or upgraded services, including developers of residential and commercial subdivisions. The remaining 34% of projects accommodate relocation requests from the City of London.

System Access	Year					
Project	**2017**	**2018**	**2019**	**2020**	**2021**	**5 Year Total**
City of London (Road Authority) Relocations	$3,410,000	$1,925,000	$1,695,000	$1,670,000	$730,000	**$9,430,000**
Developer Driven Distribution Circuit Expansions and Relocations	$350,000	$500,000	$999,200	$1,300,800	$200,000	**$3,350,000**
Residential Secondary Service Upgrades	$355,000	$363,000	$370,000	$377,000	$384,000	**$1,849,000**

New Single Family Residential Underground Distribution	$1,380,000	$1,410,000	$1,440,000	$1,470,000	$1,494,000	**$7,194,000**
New Multi-Housing Underground Distribution	$900,000	$920,000	$940,000	$955,000	$974,000	**$4,689,000**
New Commercial Distribution Services	$1,950,000	$1,960,000	$2,030,000	$2,070,000	$2,111,000	**$10,121,000**
Meter Sealing and Quality system	$30,000	-	-	-	-	**$30,000**
New Meters	$638,000	$657,140	$676,854	$697,159	$718,074	**$3,387,227**
Primary Meter Tank Replacement	$354,000	$364,620	$375,558	$368,825	$398,430	**$1,861,433**
AMI Communications Renewal	$649,000	$699,370	$720,351	$741,961	$764,220	**$3,574,902**
Cost Recoveries	($1,575,000)	($1,083,000)	($1,027,000)	($1,034,000)	($694,000)	**($5,413,000)**
Annual Total	**$8,441,000**	**$7,716,130**	**$8,219,963**	**$8,616,745**	**$7,079,724**	**$40,073,562**

Table 52: System Access Investment Drivers 2017 - 2021

System Renewal: Addressing aging infrastructure is the main driver of spending in this category. Specifically, addressing end-of-life primary underground cables via silicone injection or replacement accounts for approximately 19% of spending in this category. Voltage conversions (4.16 kV or 13.8 kV to 27.6 kV) of end-of-life assets account for 27% of spending in this category. Upgrades to the infrastructure (civil and electrical) supplying the downtown core account for 27% of spending in this category. The remaining work addresses components such as wood poles, insulators and switching enclosures that are at end-of-life and pose safety and reliability risks.

System Renewal	**Year**					
Project	**2017**	**2018**	**2019**	**2020**	**2021**	**5 Year Total**
Battery Bank Replacement Program	$15,000	$15,000	$15,000	$15,000	$15,000	**$75,000**
Substation RTU Standardization	$30,000	$30,000	$30,000	$30,000	$30,000	**$150,000**
Cable Silicone Injection	$2,711,000	$2,029,000	$1,909,000	$2,802,000	$3,228,000	**$12,679,000**
Subdivision Rehabilitation	$75,000	$328,000	$1,334,000	-	$780,000	**$2,517,000**
Replacement/Removals of SEs	$293,000	$866,500	$689,500	$398,000	$99,500	**$2,346,500**
Fully Depreciated and Leaking Transformers	$700,000	$800,000	$800,000	$800,000	$800,000	**$3,900,000**
Secondary Pedestal Replacement	$20,000	$20,000	$20,000	$20,000	$21,000	**$101,000**
Vault Rebuilds	$144,000	$203,000	$331,000	$174,000	$288,000	**$1,140,000**
Zone B Underground Conversion	$287,000	$111,000	$42,000	$327,000	$448,000	**$1,215,000**
13.8 kV UG Conversions	$269,000	$866,000	$1,340,000	$2,169,000	-	**$4,644,000**
27.6 kV Supply to Core	$1,560,000	-	-	-	-	**$1,560,000**
13.8 kV Conversion Main Feeders	$815,000	$690,000	-	$550,000	-	**$2,055,000**
Civil Structure Installation	$1,000,000	$1,500,000	$1,200,000	$200,000	$1,200,000	**$5,100,000**
New Main Feeder Ties	$0	$2,352,100	$653,000	$650,000	$2,100,000	**$5,755,100**
Network Vaults /	$1,020,000	$1,030,000	$950,000	$1,050,000	$1,050,000	**$5,100,000**

Maintenance Holes / Transformer Replacements						
Primary & Secondary Cables Replacements	$380,000	$380,000	$380,000	$380,000	$380,000	**$1,900,000**
Maintenance Hole Replacement due to Cable Rebuilds	$200,000	$150,000	$200,000	$200,000	$150,000	**$900,000**
Explosion-Limiting Maintenance Hole Covers	$100,000	$25,000	$25,000	$25,000	$25,000	**$200,000**
13.8 kV Network Conversion	$370,000	-	-	-	-	**$370,000**
Replace Deteriorating Poles	$300,000	$300,000	$300,000	$300,000	$300,000	**$1,500,000**
Replacement of Poles Susceptible to Fires	$110,000	$225,000	$120,000	$275,000	-	**$730,000**
Rebuild Depreciated Areas	$260,000	$314,600	$1,611,300	$1,230,000	$4,859,500	**$8,275,400**
13.8 kV Overhead Conversions	$315,000	$243,000	$445,000	$32,000	-	**$1,035,000**
Zone B Overhead Conversion	$2,965,000	$3,704,000	$3,902,600	$4,501,200	$575,300	**$15,648,100**
Quick Sleeve Replacements	$30,000	$70,000	$35,000	$35,000	$35,000	**$205,000**
Porcelain Insulator Replacement	$500,000	$600,000	$600,000	$200,000	$150,000	**$2,050,000**
Copper-Clad Steel Grounds	$50,000	$50,000	$25,000	$50,000	$50,000	**$225,000**
Transformer Returns	($200,000)	($200,000)	($200,000)	($200,000)	($200,000)	**($1,000,000)**
Annual Total	**$14,319,000**	**$16,702,200**	**$16,757,400**	**$16,213,200**	**$16,384,300**	**$80,376,100**

Table 53: System Renewal Investment Drivers 2017 - 2021

System Service: The main driver of System Service work is to improve the overall system reliability and decrease Operating and Maintenance costs by investing in technology that improves the visibility of the system performance and isolates problems faster.

System Service	Year					5 Year
Project	**2017**	**2018**	**2019**	**2020**	**2021**	**Total**
Relay Replacements	$80,000	-	-	-	-	**$80,000**
Backup Supply Installation	$70,000	$70,000	-	-	-	**$140,000**
Fault Indicator Installations	$20,000	$20,000	$20,000	$20,000	$21,000	**$101,000**
Recloser Installations	$195,000	$195,000	$195,000	$195,000	$195,000	**$975,000**
Serial Modem Conversion Program	$30,000	$30,000	$30,000	$30,000	$30,000	**$150,000**
DART RTU Replacement Program	$100,000	$100,000	$100,000	$100,000	$100,000	**$500,000**
SCADA Cyber Security	$50,000	$50,000	$50,000	$50,000	$50,000	**$250,000**
Line Status Sensors, (Remote Current & Real time Fault Indication)	$50,000	$50,000	$50,000	$50,000	$50,000	**$250,000**
Automatic Fault Detection, Isolation and Restoration	$50,000	$50,000	$50,000	$50,000	$50,000	**$250,000**
Control Centre - Display Technologies	$250,000	$150,000	$50,000	$50,000	$50,000	**$550,000**
Annual Total	**$895,000**	**$715,000**	**$545,000**	**$545,000**	**$546,000**	**$3,246,000**

Table 54: System Service Investment Drivers 2017 - 2021

General Plant: The main driver of General Plant investments is improvements in IT (Information Technology), which represents 62% of the spending in this category. Of this amount, approximately one third addresses customer preferences for additional or improved services (such as additional self-service options on the website and the Green Button initiative). Investments in Fleet and Facilities represent 26% of the spending in this category, which is needed to replace or upgrade equipment that is at end-of-life, unsafe, costly to maintain or obsolete. The remaining 12% is driven by the contributions to Hydro One for the voltage conversion of the Nelson TS from 13.8 kV to 27.6 kV.

General Plant	Year					Total
	2017	2018	2019	2020	2021	5 Years
Information Technology (IT)						
IT: Regulatory and Sustainment[86]	$850,000	$1,350,000	$950,000	$1,450,000	$950,000	**$5,550,000**
IT: Enhancements[87]	$2,025,000	$1,550,000	$1,400,000	$1,100,000	$850,000	**$6,925,000**
IT: New Systems[88]	$900,000	$2,400,000	$1,500,000	$2,500,000	$3,300,000	**$10,600,000**
IT Infrastructure (HW/SW)	$735,000	$800,000	$850,000	$950,000	$950,000	**$4,285,000**
IT Sub-Total	**$4,510,000**	**$6,100,000**	**$4,700,000**	**$6,000,000**	**$6,050,000**	**$27,360,000**
Fleet and Facilities						
HVAC Upgrades	$154,000	$155,000	$160,000	$165,000	$170,000	**$804,000**
Misc. Buildings and Fixtures	$308,000	$386,000	$315,000	$321,000	$258,000	**$1,588,000**
Paving	$325,000	$325,000	$325,000	$325,000	$150,000	**$1,450,000**
Control Room Upgrades	$125,000	$125,000	-	-	-	**$250,000**
Security Equipment	$50,000	$51,500	$51,500	$51,500	$52,000	**$256,500**
Furniture and Equipment	$147,000	$202,200	$207,200	$210,600	$212,100	**$979,100**
Fleet Replacements - Vehicles and Equipment	$1,099,000	$1,104,000	$1,128,000	$1,145,000	$1,155,000	**$5,631,000**
Operating Equipment	320,000	300,000	300,000	300,000	300,000	**$1,520,000**
Fleet and Facilities Sub-Total	**$2,528,000**	**$2,648,700**	**$2,486,700**	**$2,518,100**	**$2,297,100**	**$12,478,600**
Capital Contribution to Transformer Station (Nelson)	$1,882,000	$1,835,000	$250,000	-	$1,450,000	**$5,417,000**
Annual Total All	**$8,920,000**	**$10,583,700**	**$7,436,700**	**$8,518,100**	**$9,797,100**	**$45,255,600**

Table 55: General Plant Investment Drivers 2017 - 2021

[86] For 2017, IT Regulatory and Sustainment projects include Oracle Update, HRIS Enhancements, Regulatory Changes, ODS Upgrade, Security System Upgrades and Infrastructure Upgrades (application enhancements)
[87] For 2017, IT Enhancement projects include Customer Engagement Solutions, Timesheet Field Automation, Asset Management System, Commercial & Industrial Apps Phase 2, SAP, Green Button and Analytics Systems Phase 2
[88] For 2017, IT New Systems projects include Automated Billing Payments (IVR/Online), Residential Customer Mobile App and JDE Upgrade

3.5.1.4 System Capability Assessment (5.4.5.1)

As discussed in Section 3.1.1, London Hydro has the capacity to connect new load and generation customers for the foreseeable future. The conversion of Nelson TS from 13.8 kV to 27.6 kV and related distribution upgrades will provide sufficient capacity to accommodate an expected average load growth rate of approximately 0.5% to 1% for approximately 20 to 30 years. This conversion will also eliminate some of the constraints noted in Section 3.3 regarding REG connections. Transmission related constraints will persist for several years, which will limit the amount of generation that can be connected in specific areas of London.

3.5.2 Material Investments (5.4.5.2)

Project Sheets for essentially all capital projects have been created to provide the supporting information as generally described in Chapter 5 Section 5.4.5.2.

The 2016 & 2017 Asset Management Plan (AMP – Appendix G) contains Project Sheets for all distribution system projects for the Bridge Year (see AMP Section 13 Detailed Project Descriptions – 2016) and Test Year (see AMP Section 14 Detailed Project Descriptions – 2017), including the General Plant – Nelson TS Conversion to 27.6 kV Hydro One Payments.

Project Sheets for the rest of General Plant and System Access investments (Fleet, Facilities, IT and Metering) are located in Appendix L. Additional supporting material for IT investments can be found in Exhibit 2 (“Information Systems”).

The relative priority of distribution system projects is shown graphically in the Analytical Ranking Model (see Section 2.3.2).