CONNECTING DEVICES:

A BEST PRACTICE GUIDE FOR STANDARDIZED DISTRIBUTED ENERGY RESOURCE CONNECTIONS

Version 1: November 2019

EDA
The Voice of Ontario's Electricity Distributors
POWER OF LOCAL HYDRO

CONNECTING DEVICES: A BEST PRACTICE GUIDE FOR STANDARDIZED DISTRIBUTED ENERGY RESOURCE CONNECTIONS

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CONTENTS

Electricity Distributors Association

3700 Steeles Ave. W., Suite 1100, Vaughan, Ontario L4L 8K8 Tel/Fax 647.EDA.5300 1.877.262.8593 email@eda-on.ca www.eda-on.ca

1. BACKGROUND AND INTRODUCTION

The Electricity Distributors Association (EDA) is seeking to develop a set of best practices for the update of the connection process for Distribution Energy Resources (DERs) in Ontario. The EDA is interested in understanding the core issues raised by third party DER developers and how those issues relate to today's technical and safety requirements for Ontario's distribution system. To that end, the EDA has prepared this discussion paper to address key elements of evolving the distribution connection process. The objective of the discussion paper is to:

- Summarize the drivers for customer adoptions of DERs and the need for local distribution companies (LDCs) to evolve their connection processes to enable DERs; and
- Identify key issues and options for evolving the DER connection process

The EDA has retained Power Advisory LLC (Power Advisory) to assist in understanding DER and customer connection issues, and to support the drafting of the DER connection process evolution discussion paper. The discussion paper is written from the perspective of distributors and is organized into four sections including this first background section. The second section outlines the importance updating the connection process. The third section describes potential best practices for an evolved connection process for DERs. The final section provides the conclusion and summary. The intended audiences for the discussion paper are customers and device proponents (i.e., DER developers), government and its agencies, LDC owners and operators, the provincial regulator (i.e., the Ontario Energy Board (OEB)) and the Independent Electricity System Operator (IESO).

1.1 DER Opportunities for Customers in Ontario

The term DERs encompasses a wide range of distribution-connected technologies. This paper relies on the following definition of DER:

> A Distributed Energy Resource (DER) is any resource on the distribution system that provides electricity service(s) either to the distribution system, the transmission system and/or wholesale electricity market.

There are traditional DERs that have existed in the distribution system for decades such as combined heat-and-power (CHP) applications, demand management activities and net-metering. The Feed-In Tariff (FIT) program, and its precursor the Renewable Energy Standard Offer Program (RESOP), supported the rapid growth of distribution-connected renewable generation technologies in Ontario. With the conclusion of the FIT program, customer-based renewable generation is now driven by net-metering or load displacement opportunities. Most recently, there has been rapid growth in innovative and emerging technologies such as energy storage, smart appliances, and electric vehicles (see figure below for examples of DERs for residential customers), as well as uptake in demand response (DR) for commercial and industrial customers.

Figure 1: Examples of DER technologies[1]

Customers are entering a period of vastly expanded choice to meet their energy needs in combination with the safe and reliable delivery of power from the grid. In addition, there is a growing supply need in Ontario starting in the mid-2020s. The IESO forecasts show that a supply gap of ~1,400 MW will emerge in 2023, grow to 3,500 MW by 2025 before settling to 2,000 MW by 2030. Therefore, DERs have the potential to meet customer needs directly as well as the electricity grid broadly over the next decade (see Figure 2). While this discussion paper focuses on DER adoption and the potential evolution of the connection process, the paper does not address broader issues associated with deeper penetration of DERs on the distribution system.

[1] Source: 2030 Acadia Center -Energy Vision 2030 - https://2030.acadiacenter.org/grid-modernization/

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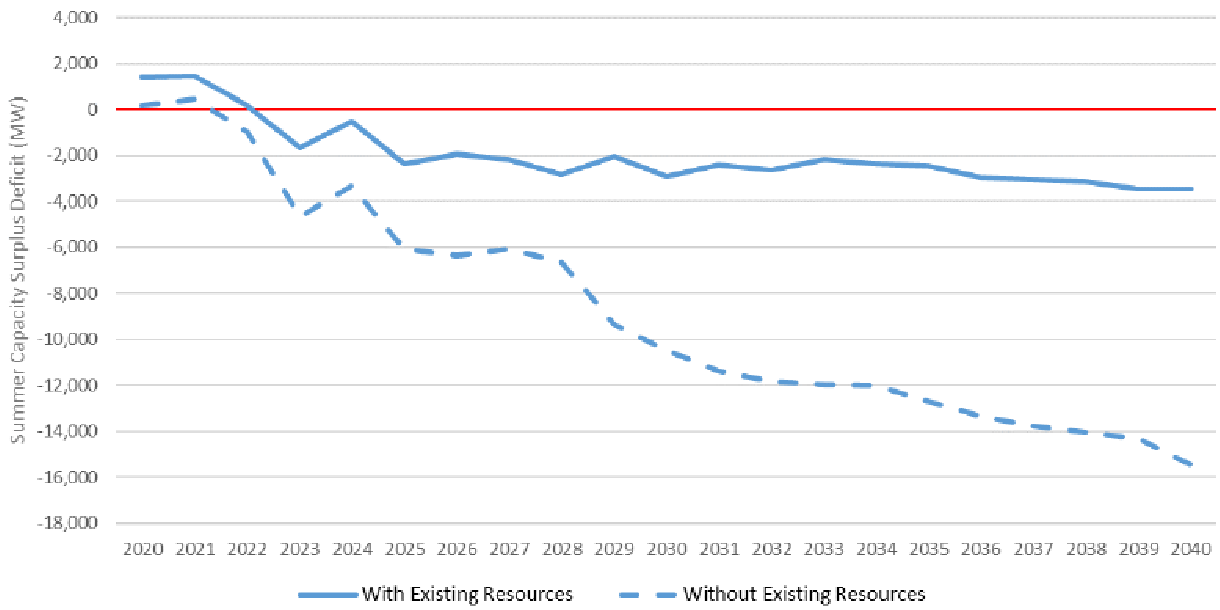

Figure 2: Ontario's Supply Need Outlook[2]

DERs are expected to provide Ontario's electricity customers with opportunities to meet electricity supply needs and simultaneously to offer services and products to system operators and grid operators. Overall, it is anticipated that Ontario LDCs will continue to experience increased demand from customers with respect to DER connections (see **Appendix A** for more details on DER opportunities in Ontario). At the same time, LDCs must maintain the high standards for safety, reliability, and power quality that have defined Ontario's distribution networks for the past century. It is expected that the continued growth in DER adoption will increase the complexity and costs of managing the distribution system. LDCs are positioning themselves to meet this challenge.

As detailed in the EDA's *Power to Connect: A Roadmap for a Brighter Future,* developing best practices and streamlined processes for connecting more DERs to the grid is part of creating a "DER-enabling Platform" which is a critical part of the evolution of LDCs to Fully Integrated Network Orchestrators (FINOs). As shown in Figure 3, the first few years of LDC evolution focuses on establishing new platforms and processes that will enable DER growth (see blue sphere along horizonal axis). The expected trend in growing DER connection requests will require an updated and renewed connection process that is efficient and effective for both

[2] Source: IESO 2018 Technical Planning Conference - http://www.ieso.ca/-/media/Files/IESO/Document-Library/planning-forecasts/tech-conf/2018-Technical-Planning-Conference-Presentation.pdf?la=en

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customers and distributors. The EDA expects that as DER penetration increases, LDCs will increasingly be responsible for system stability.[3]

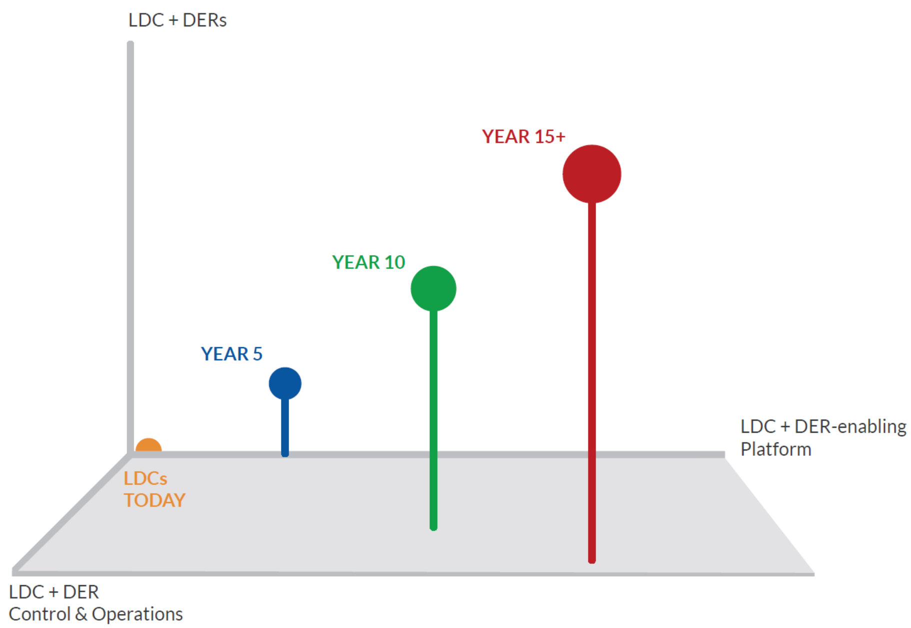

Figure 3: LDC Evolution to FINO

[3] For example, the IESO's 2019 Operability Assessment concluded that under certain operating conditions the most severe single contingency (MSSC) could be the loss of DERs during outage events if not managed appropriately. http://www.ieso.ca/-/media/Files/IESO/Document-Library/system-reliability/2019-IESO-Operability-Assessment.pdf?la=en

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2. THE IMPORTANCE OF AN UPDATED CONNECTION PROCESS

Distributors have designed, constructed, operated and maintained Ontario's distribution networks to a high standard of safety, reliability and power quality. Distributors have accomplished these standards in a cost-effective manner while meeting ever evolving needs of customers. Similar to past evolutions of the distribution grid, updating the DER connection process is important to distributors for many reasons.

2.1 Maintaining and Enhancing Safety and Reliability Standards

A top priority for distributors is to safely operate the distribution system and to maintain and continually improve reliability. The new challenge is to do so while responding to increasing requests for connection from innovative and emerging technologies. Growing adoption of DERs will introduce many challenges in planning, operating and maintaining the distribution system. In addition, LDCs will become more responsible for broader system stability as DERs become an increasing component of Ontario's supply mix. Updating the connection process to ensure that the appropriate technical details are collected and assessed prior to granting connection will benefit all affected stakeholders as it will improve clarity and reduce uncertainty. Rapid changes in the capability of DER technologies will mean that distributors will need to establish a working relationship with customers who own DERs so that the distributor understands the risks and opportunities of the DERs on the distribution system. Finally, increased adoption of DERs will require that LDCs change their approach to planning and operating the distribution system. The changes may increase costs, beyond those currently collected from customers through either rates or the existing connection process, and therefore, LDCs must manage all of the adjustments prudently.

2.2 Pivot in Connection Request Drivers

The key driver for connection requests has pivoted in the last few years. Under the FIT Program, entities with a long-term contract for renewable generation with the IESO sought to be directly connected to the distribution system. Their main objective was to receive a connection impact assessment[4] and cost estimate so that construction of the renewable generator could commence within the timeline of the contract milestone dates.

Today, and in the foreseeable future, connection requests will primarily be from existing LDC customers (e.g., those seeking to connect resources situated behind-the-meter (BTM) to manage their energy needs and costs). These connection requests are less certain than FIT program connection requests and require a greater amount of analysis by the customer to determine whether to proceed (e.g., a customer may be exploring new technologies to manage

[4] An impact assessment was a key development milestone (referred to as Notice-to-Proceed provision) under the FIT contract. FIT proponents were not allowed under the FIT contract to begin construction without completing all key development milestones.

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their energy needs and connection requirements are part of the due diligence process). In addition, the connection capability analysis can influence the final project specifications. Connection costs and system constraints are important decision-making factors, especially for customers with multiple sites located in many different LDC service territories who will be motivated to prioritize projects.

For LDCs, today's connection requests typically come from their largest customers who may require greater levels of support and engagement as they try to manage real-time energy costs (i.e., through the Industrial Conservation Initiative (ICI)[5]).

2.3 DERs will Drive Distributor Investment Decisions

The information gathered through the DER connection process as well as the pace of customer adoption will be important indicators for distributor investment decisions. First, as with any type of connection request (i.e., load or generation), LDCs planning and design processes should seek opportunities to co-ordinate multiple connection requests. Distribution system planning will need to consider how DERs will impact the existing distribution system as well as to determine how DER services could be used to maintain or enhance distribution standards.[6] DER connection information will be an important input into the distribution planning process. Second, DERs will change how distribution systems are operated. For example, and as detailed in the EDA's vision paper, a DER-enabling platform benefits from increased visibility of DERs to monitor and respond to changing distribution systems operations (e.g., power flows). Registering and maintaining accurate DER technical parameters in addition to establishing visibility of the DER through the connection process will be paramount to maintaining distribution system standards. Finally, the capital requirements of the distribution system will evolve as more DERs are added; control systems and new resources will be required in the future to manage a distribution system with high DER penetrations and more two-way flow of power. The pace and location of DER connection requests will influence how LDCs will deploy capital. For example, high penetration of DERs in a local area of the distribution system may defer or exacerbate the need for distribution system investments to accommodate load growth. On the other hand, DERs can increase the need to invest in visibility capabilities and enhancements to outage management systems.

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[5] See Appendix A for more details.

[6] There are many case studies throughout other jurisdictions that are exploring Non-Wire Alternatives (NWAs); for example, ConEdison's Brooklyn Queens Demand Management (https://www.coned.com/en/business-partners/business-opportunities/brooklyn-queens-demand-management-demand-response-program)

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2.4 Coordination and Collaboration of Interconnection Standard Updates

Finally, while each LDC is responsible for its own service territory, the Ontario power system is a highly interconnected and complex infrastructure. The shift in consumer preference towards DERs will impact upstream distribution systems and the transmission grid as much as it will impact the distribution system to which those DERs are connecting. Currently Ontario's de facto connection standard is Hydro One's Technical Interconnection Requirements (TIR)[7]. Coordination and collaboration on standards, such as Hydro One's TIR updates will be required as DER penetration levels in distribution systems increase.

[7] Hydro One owns over 99% of transmission assets in Ontario and a large majority of upstream distribution assets for many LDCs. Since Hydro One applies the standard for all upstream connection assessments, many LDCs logically have the same or higher standards.

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3. CONNECTION PROCESS EVOLUTION RECOMMENDATIONS

The following recommendations are offered to support the ongoing evolution of distributors' connection processes. They are intended to serve as a guide or best practices capable of meeting the challenges distribution systems face. In addition, the recommendations are intended to capture the benefits available to all customers and to mitigate any constraints or negative impacts as some customers rapidly adopt DERs. These recommendations are expected to be explored by each LDC in the context of their distribution system and their existing connection process. Evolving connection processes may give rise to potential costs; the associated costs recovery issues will need to be addressed.

3.1 Connection Assessment Process Streams

As the number of DER technologies expand and service offerings to customers multiply, it will be important for LDCs to categorize connection requests. In other words, key characteristics of the connection request will inform an LDC's approach when conducting and completing the connection assessment. Three of the initial questions that LDCs will raise when determining an appropriate connection process are:

- Is the technology based on synchronous generators or inverter-based?
  - Synchronous generators are the traditional connection request; however, most renewables or energy storage are inverter-based. Inverter-based connections have different impact on distribution system reliability and safety; for example, the short-circuit contribution of synchronous generators is significantly higher than inverter-based generation.
- Is the connection location BTM or in parallel (i.e. directly connected to the distribution system)?
  - Presently, the primary objective of directly connected DERs is to provide electricity services to the IESO wholesale electricity markets or grid services to distributors.
  - In comparison, the primary objective of DERs installed BTM is to meet the load customer's needs and, therefore, BTM DERs may be analogous to conservation and energy efficiency.
- If connected BTM, is the DER to be used exclusively for load displacement (i.e., non-exporting to the grid) or is it expected to be used to island the load (e.g., under outage situations using closed transition, or open transition for energy independence)?
  - Some resources (e.g., energy storage) are designed and controlled to only offset consumption at a customer site (i.e., non-exporting).

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- In addition, power electronic settings can be used to limit output for specific reliability settings. The customer's DER operational objective should influence how a connection request is treated by the LDC and balanced with the LDC's operational objective of safe and reliable service.
- The request of a customer to be able to island requires unique power system analysis and operating parameters.

The decision tree and table below illustrate the different connection process streams that LDCs' connection request processes may need to address. While each connection process stream may not differ significantly, it will contribute to an enhanced customer experience as it can allow the LDC to tailor the process (e.g., the LDC's connection information requirements could include references to treatment of energy storage resources or large equipment located behind-the-meter that is not part of the net-metering program). LDCs are expecting to update their connection information gathering and technical assessment away from standards suitable for the FIT and microFIT program and, instead, to create suitable connection applications types. For clarity, not all connection streams may need to be developed by each LDC.

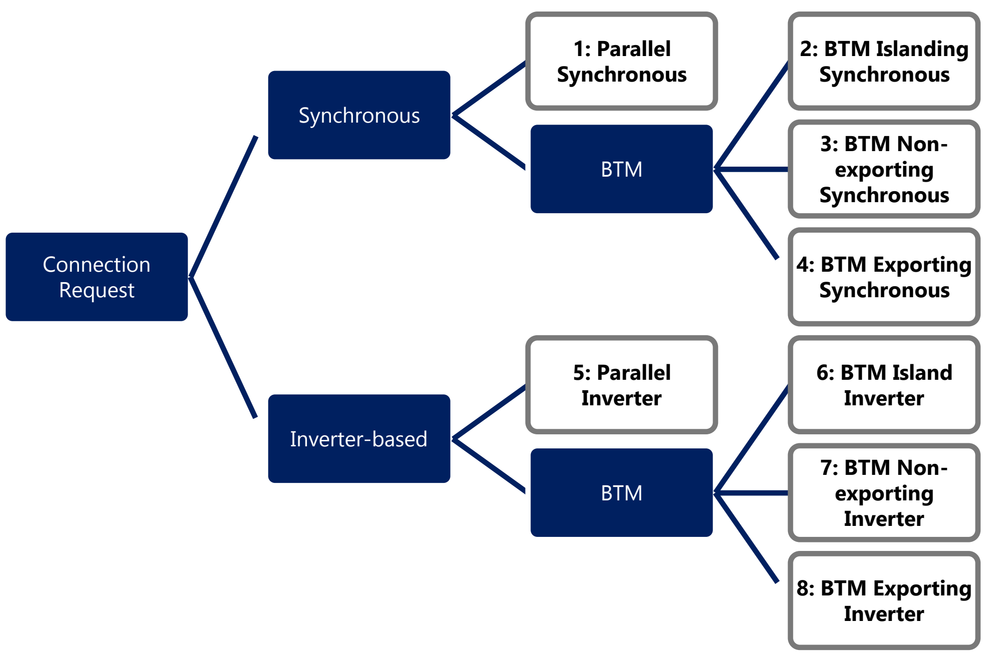

Figure 4: Connection Process Streams

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Connection Process Streams		Synchronous	Inverter-based
	Parallel	1: Parallel Synchronous	5: Parallel Connected Inverter
BTM	Island Capable	2: BTM Islanding Synchronous	6: BTM Islanding Inverter
	Non-Exporting	3: BTM Non-Exporting Synchronous	7: BTM Non-exporting Inverter
	Exporting	4: BTM Exporting Synchronous	8: BTM Exporting Inverter

Figure 5. Connection process breakdown

Depending on the type of connection process stream, potential opportunities to fast-track connection requests may be available and should be investigated (e.g., based on connection size (e.g., <50kWs), location within the distribution systems, the availability of connection capability, the presence or absence of other traits).

3.2 Expanded Definitions within Connection Processes

The type and function of DERs have evolved over the past decade as innovative and emerging technologies have been commercialized. Definitions of different DER types within the connection processes, as well as a distributor's Conditions of Service, should be updated to reflect this evolution.

There are two definitions that LDCs could adopt to assist customers' decision making. The first is a definition of Energy Storage Resources (ESRs). ESRs has several unique traits:

- They have characteristics of both a load and a generator.
- ESRs can have limited energy storage capability or expanded storage capability (i.e., the number of hours of storage) depending on the technology and design.
- The ability to manage distribution system disturbances (e.g., voltage ride-through capability) depending on connection type (i.e., inverter-based or synchronous motor).

Overall, a unique definition of an ESR and its treatment by the LDC will better inform customers seeking connection requests.

The second definition is for non-export load displacement resources. While the concept of load displacement is included in the Conditions of Service of many LDCs, expanding the definition to

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clarify the unique treatment of non-exporting load displacement DER applications will assist customers. Specifically, the definition could describe any differences in treatment during the connection process (e.g., timelines, information requirements, existing connection constraints).

Overall, updated and expanded definitions will provide clarity to customers seeking to install DERs.

3.3 Increased Availability of Publicly Available Information

The shift from centralized procurement (e.g., FIT Program) to a customer driven adoption of DERs means customers are seeking new information to assist their investment decision-making prior to making a formal connection request. For example, many DER solutions can be applied to multiple sites owned by a customer (or offered by DER technology providers to multiple customers with sites spread across the province). The ability to determine areas in the provinces with the lower barriers to connection (i.e., least likely to be connection constrained) is a valuable component to support customers' ability to prioritize sites. The following table suggests information that could be made available.

Information	Description	Assistance to Customer
Geographical Connection Capability Map	Map providing higher guidance on connection capability to other areas of the service territory or province.	Customers with multiple sites under consideration can quickly determine areas with lower risk of connection constraint
Summary of different connection process streams	As described in Section 4.1 of this discussion paper, a description of how connection requests are categorized and how the assessment is performed for each stream.	Customers will be able to identify what connection stream they are requesting as well as understand the requirements for completing a connection
Overview of complete connection process	Summary would include the different stages of connection assessment, requirements to complete each stage (i.e., deliverables from LDCs and customers to move forward) and typical timelines to complete each stage (e.g., Connection Impact Assessment (CIA), connection cost estimate, Connection Cost Recovery Agreement (CCRA), etc.)	The overview would set customer expectations for the process and describe what information is required of the customer for each stage. The typical timeline description can also describe common issues that result in delays in the process
Examples of compliant information submissions	Provide examples of completed connection request forms and other submission requirements throughout the connection process	Examples will help inform customers on expectations when preparing documents. Further, clarifications can be sought prior to submitting, reducing wasted effort

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		and improving the information requirements of the LDC

3.4 Enhancing Connection Process Updates

During the connection process, customers are typically unaware of the activities being undertaken either by the LDC or interconnected parties (i.e., upstream LDCs, transmitter, and the IESO) or both. In many instances, the customer has no way to access this information. Limited status updates for customers leaves them 'in the dark' with respect to how the connection process is proceeding and specifically whether issues that may cause delay have been encountered. While customers are generally advised to limit investment activities until the completion of the connection assessment process, the development of DERs are complex undertakings that require the coordination of many different activities and entities. Status updates on the progress of the connection assessment process can provide insights to customers that they can use to manage other processes that are impacted by the connection process.

Equally, there are opportunities for better communications from customers requesting DER connections to the LDC. Improved communication processes can ensure that LDCs have up to date information on the DER's parameters and any design decisions made by the customer. Communicating the context of the LDC's expected timelines for the customer to respond to information requests will provide an opportunity to increase the effectiveness of the connection process and opportunities for both the utility and the customer to better allocate resources.

Overall, the objective of enhancing connection process updates is to be responsive to the needs of the customer and the LDC, including recognizing that the connection process is part of a larger undertaking in delivering the project.

3.5 Regular Updates to Connection Standards

The rapid adoption of DERs is occurring across many jurisdictions and is resulting in action by international standards associations. Connection standards and procedures are evolving generally to better integrate DERs into power systems and some connection standards are adapting to enable additional functionality that will enable higher penetration of DERs. Regular review and updating of connection standards can create value for ratepayers, potentially without burdening the DERs requesting connections. For example, the Institute of Electricity and Electronic Engineers (IEEE) is updating its standards for DER interconnections and is focusing on the requirements for ride-through for inverter-based connections. As the penetration of DERs increases, LDCs will need a process to update connection standards in order to manage the many changes occurring to the design and operation of the distribution network.

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Hydro One's TIR, as the *de facto* connection standard for Ontario, should be regularly updated with input from all affected and impacted stakeholders (e.g., distributors, DER technology providers). The contemplated updates will benefit from the coordination and collaboration among all stakeholders to prioritize issues and assess technical and economic viability. It is recommended that a technical conference engaging Hydro One's connection experts, LDCs and DER proponents be established with the purpose of increasing understanding of technical requirements and developing working groups tasked with resolving issues and identifying best practices.

While the TIR sets the minimum standard for connection, it is distributors that must implement and be the customer facing entity for the TIR's obligations and standard; therefore, the LDC must be provided the resources to be confident and informed to describe to customers the applicability of the technical and economic requirements. An annual technical conference would provide an opportunity for distributors to work with Hydro One on a regular basis to update and understand the TIR for the benefit of their connection process and engagement with customers.

3.6 Potential Regulatory Framework Changes Required

To enact many of the recommendations described above, potential changes will be required to Ontario's regulatory framework. The following are a list of potential regulatory framework changes:

- Changes to the Ontario Energy Board (OEB) Distribution System Code (DSC) may be required to support multiple connection process streams. Currently, the DSC only operationalizes connection timelines and requirements for generators based on capacity. The DSC could be amended to provide LDCs flexibility to improve connection for their service territory.
- The DSC could benefit from providing a definition for ESR and for DER. Robust definitions will support the implementation of appropriate connection policy and identify and assess responsibilities to distributors appropriately.
- Similarly, the DSC could define non-exporting load displacement DERs that are not used for emergency purposes and clarify some of the issues of connecting these devices.
- Increase the provision of the data required by proponents in a public and readily available manner. While sharing data at this standard can be expected to require the investment of capital and/or operating expenditures by LDCs that will ultimately need to be recovered (e.g., through contributions or rates), it will ensure that equal access to data exists for all customers.

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All recommendations will need to balance the benefits for customers and the benefits to other customers served by the grid against the potential costs, both quantifiable and qualitative, to the system. Phasing the adoption of these recommendations may be appropriate and beneficial (e.g., managing costs, evolving the connection process) to meet the needs of customers deploying DERs and seeking to benefit from the deployment of DERs.

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4. SUMMARY AND CONCLUSION

Emerging DER technologies offer customers choice of how to manage energy needs and how to manage the associated costs. DERs can reduce energy costs, enhance power quality and provide resiliency for critical loads. For distributors, increasing DER penetration levels will change the design and operation of distribution systems and create opportunities to realize benefits. LDCs will likely incur added costs. DERs can assist in the replacement of end-of-life assets and facilitate the deployment of new infrastructure (e.g., non-wire alternatives) that can support the LDC in meeting consumers' ongoing need for service from the interconnected power system.

DERs are expected to continue to grow rapidly in the near future. Distributors will need to evolve their connection processes to preserve and enhance safety and to augment existing reliability. At the same time, enhanced connection processes from distributors are needed to support customers seeking DER solution opportunities. As such, LDCs are motivated to evolve the connection process to meet the challenges of growing DER connection requests. This discussion paper offers the following recommendations:

- Establish different connection process streams depending on the connection type, operational objective, and connection location;
- Expand the definition of resources in the connection process to include energy storage and non-exporting load displacement to recognize the opportunities they can support;
- Increase the amount and depth of publicly available information to help inform customers who are assessing DER investment opportunities;
- Enhance connection process communications and better support customers and specifically to reduce uncertainty; and
- Regularly update connection standards and procedures to appropriately align them with international standards, best practices from other jurisdictions and appropriate stakeholders' needs.

Operationalizing these recommendations can be addressed by amending the DSC, establishing a central repository of enhanced publicly available data and, at the earliest opportunity, clearly addressing the party responsible for the incremental costs and the potential achieved benefits.

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APPENDIX A: ROLE AND VALUE OF DISTRIBUTED ENERGY RESOURCES

The role of DERs is assessed as follows:

1) Value to the customer
2) Value to system operator
3) Value to grid operators

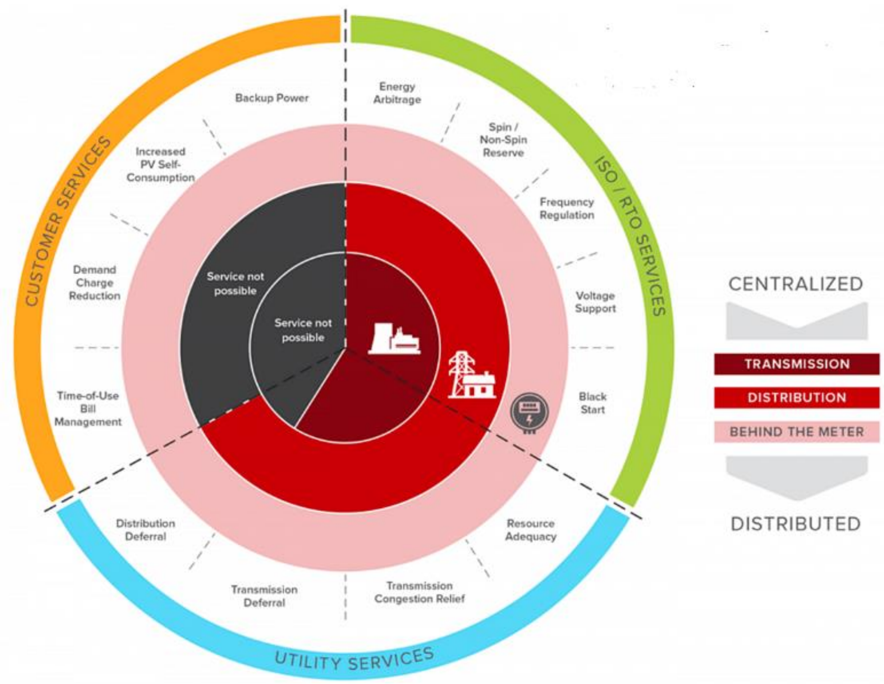

Figure 6: Potential Service Offerings from DERs[8]

In addition to services offered to customers, DERs can offer services to grid operators and wholesale electricity markets. DERs can offer multiple electricity services to different entities to 'value stack' the capabilities of the technology. Value stacking is an important benefit of DERs, especially considering their embedded connection arrangement within the distribution system. The figure above provides a summary example of the many different services that energy storage could offer depending on the connection arrangement of the energy storage resource.

[8]Energy Storage Resource service offerings -Rocky Mountain Institute, 2015 - https://www.nrel.gov/state-local-tribal/blog/posts/batteries-101-series-use-cases-and-value-streams-for-energy-storage.html

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First, from the perspective of the customer, DERs can offer a wide range of services that can reduce energy costs and meet a customer's specific energy needs. For example, BTM rooftop solar generation can reduce grid demand and provide avoided energy cost savings for customers. Another example is the ability of DERs to enhance power quality for customers that require a higher standard for their production processes. Yet another example is the ability of smart appliances (e.g., connected thermostat) to reduce demand during peak demand periods.

Today, the ICI for large commercial and industrial customers has spurred significant investment in DR and BTM energy storage helping customers minimize electricity costs if they avoid the top five coincident system peak demand hours.

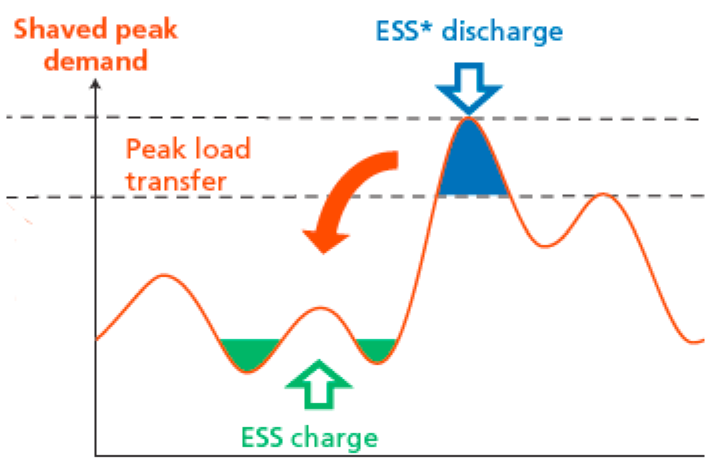

Figure 7: Peak Shaving with energy storage resources (ESR)[9]

Second, DERs can participate in IESO-Administered Markets. The IESO is expanding the DR Auction (i.e., now called the Capacity Auction (CA)) to include many different types of capacity resources[10]. The IESO expects to procure annual resource adequacy needs through the CA. DERs will be eligible to participate as DR resources (e.g., load reduction or energy storage). Included in the expansion of the CA is the ability directly connected energy storage to compete. The CA will offer DERs a revenue stream for capacity services that they can value stack with other services offered directly to customers or to LDCs themselves.

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[9] Source: https://www.edf-re.de/en/peak-shaving-service/what-is-peak-shaving/

[10] Initially the IESO is expanding the CA to include existing generation with expired contracts (e.g., Non-utility generators (NUGs)), followed by imports, storage, merchant capacity at contracted facilities, and uprates at existing facilities.

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For context in terms of the size of this opportunity, there is a growing resource adequacy need in Ontario starting in the mid-2020s. In September 2018, the IESO hosted a Technical Planning Conference (TPC) to present a new planning approach and update stakeholders on Ontario's supply need[11]. The 2018 TPC presentation stated a resource adequacy gap starting in 2023 of ~1,400 MW. The supply need increases to ~3,500 MW by 2025 before settling to 2,000 MW by 2030. See Figure 8; the resource need is the difference between the top of the bar charts and the black line.

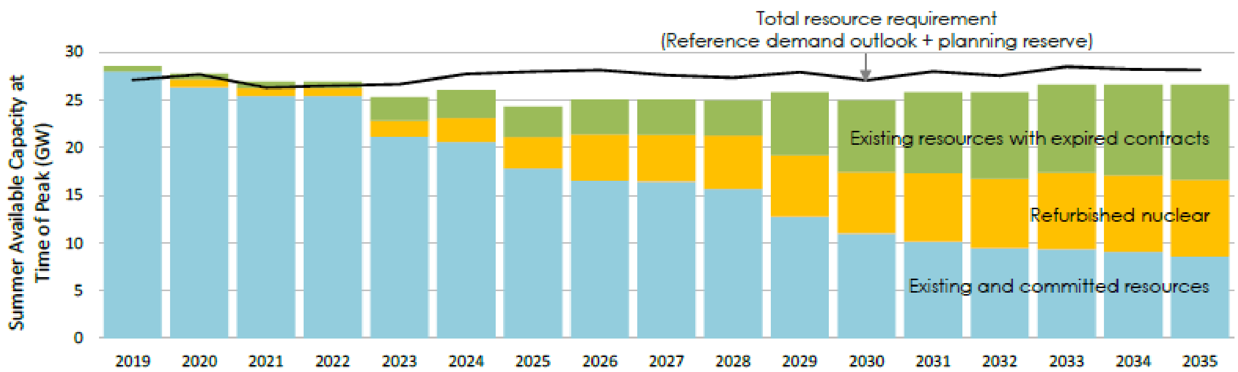

Figure 8: Ontario Resource Adequacy Need

It is important to note that the resource need conveyed in Figure 8 assumes all existing resources (e.g., large gas fired generation) with expired contracts will continue to operate. Due to a variety of factors (e.g., geographical location, age of equipment, site access), there is a risk that some of the existing resources will not continue to operate. Therefore, uncertainty in predicting the resource adequacy gap exists and potentially could results in a higher than expected supply need.

Third, DERs can replace assets that are at the end of their effective operating life. It is anticipated that many of Ontario's transmission and distribution assets will reach their expected service life within the next 20 years. Ontario's power system operators are working to ensure that there is a cost-effective and long-term approach to replacing these assets. It is important to note that there is a clear difference between an asset's expected service life and an asset's end-of-life. Expected service life is pre-defined and primarily based on the age of the asset. End-of-life (EOL) occurs when the asset can no longer adequately perform its function in the power system. Determining the difference is a key component of EOL asset replacement planning.

[11] The IESO is expected to present their annual planning outlook in the fall with an update on the supply need outlook for Ontario.

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The trend in Ontario is part of a trend from across the industrialized world. Although, electricity delivery systems (i.e., transmission and distribution networks) were expanded at a rapid pace to meet growing demand, as economic growth moderated, system expansion slowed. The figure below shows electric power consumption per capita growth from 1960 to 2010s. Starting in late 1980s, growth in electric consumption per capita slowed.

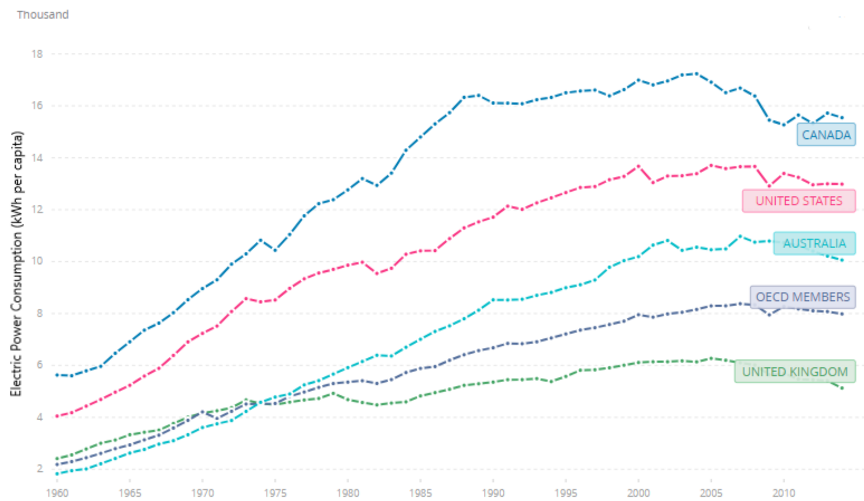

Figure 9: Electric Power Consumption per Capita[12]

The services offered by DERs can assist LDCs and grid operators in managing the cost-effective replacement of EOL assets. For example, DERs can reduce the peak capacity need and offer the potential to replace EOL assets with smaller costs, thus reducing cost and complexity. Further, DERs can defer capital investments driven by EOL assets by helping grid operators maintain safety and reliability standards with existing assets. Further, DERs can allow grid operators to increase the number of planned maintenance outages to extend the life of existing assets before costly replacement is required.

Overall, the value propositions of DERs to meet customer energy needs, LDC system needs, and wholesale market requirements creates a significant opportunity that is expected to result in a growing number of requests for interconnection to Ontario's distribution systems.

[12] Source: The World Bank: Electric Power Consumption (kWh per capita) - https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC

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3700 Steeles Ave. W., Suite 1100, Vaughan, Ontario L4L 8K8 Tel/Fax 647.EDA.5300 1.877.262.8593 email@eda-on.ca www.eda-on.ca