Structural Options for Ontario's Electricity System in a High-DER Future:

Potential implications for reliability, affordability, competition and consumer choice

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ENERGY TRANSFORMATION NETWORK OF ONTARIO

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Executive Summary

A reliable, affordable and resilient electricity system is essential to Ontario's prosperity. Like other sectors, electricity is undergoing significant disruption, as the combined forces of decentralization, digitization and democratization take hold. In particular, small-scale, distributed energy resources (DERs) – such as combined heat and power (CHP), solar, energy storage and wind – are growing rapidly, thanks to decreasing technology costs, consumer trends and public policy. In Ontario, at least 4,000 megawatts (MW) of DERs have been contracted or installed in the last 10 years. This does not include an unquantifiable amount of load control, behind-the-meter energy storage and demand-response capacity that can also be regarded as DERs.

DERs promise wide-ranging benefits, from increased consumer choice and electricity market competition, to greater electricity system resilience and flexibility, and the avoidance or deferral of large-scale infrastructure development. DERs also pose potential challenges in terms of increased intermittent generation, unexpected fluctuations in supply and demand and the potential for stranded assets if some consumers reap the benefits of DERs, leaving others to pick up the costs of existing centralized resources.

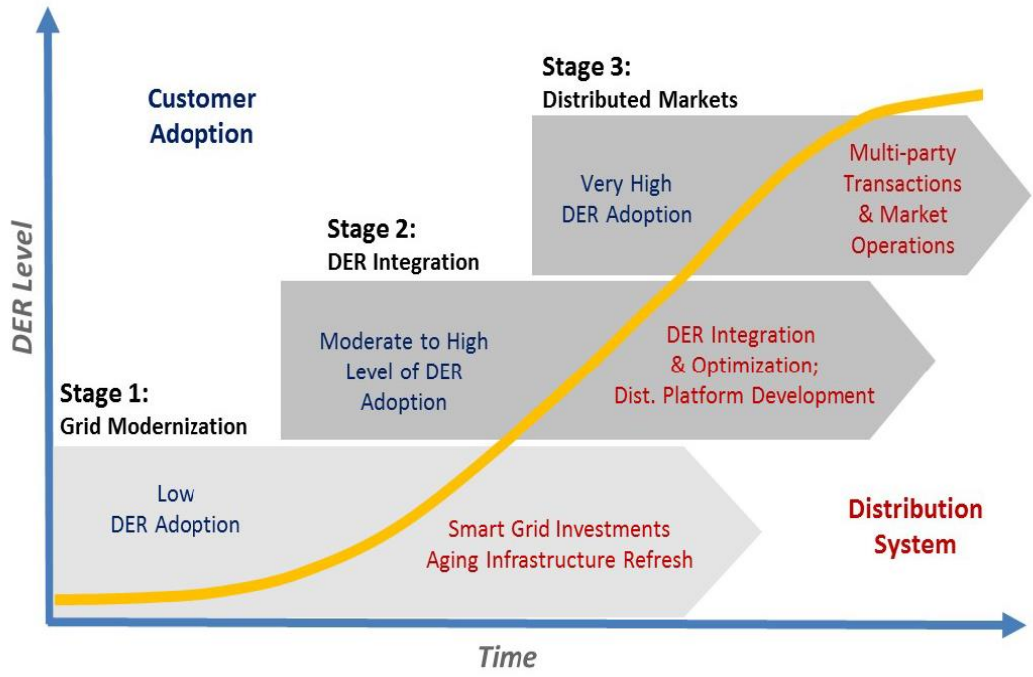
Integrating DERs into Ontario's electricity system in a way that maximizes their benefits to consumers and minimizes any negative impacts will require careful coordination of existing and new roles and responsibilities. Many of the roles discussed in this report didn't exist in a system designed when there were only a small number of large-scale generation resources and when centralized utilities responsible for all aspects of generation, transmission and distribution were the norm.

This paper includes an examination of options for the allocation of roles and responsibilities for DERs in Ontario, assisted by a framework developed by Lawrence Berkeley National Laboratory for its "Future Electric Utility Regulation" report series. In 2015, the first paper in that series proposed three stages of distribution sector evolution with each stage of adoption corresponding to increased DER uptake and the need for more complex public policy decisions to enable the transaction of DER-related services (see Figure 1).

Such policy constructs allow for the appropriate valuation of DER services to enhance reliability and ensure the economically efficient optimization of DERs for the benefit of consumers and the broader electricity system. What form this sector evolution might take and how this transformation could progress are key questions addressed throughout this paper.

This paper also examines the potential for conflicts of interest and synergies among the roles and responsibilities required for DER integration into Ontario's electricity system, and existing entities in Ontario's electricity sector. It considers which roles are most suited to a non-competitive monopoly and which roles are likely to generate the greatest value for consumers by being subject to competitive market forces.

Figure 1: Three stages of DER-related sector transformation[1]



During the development of this report, the Energy Transformation Network of Ontario (ETNO) discussed and examined issues associated with the integrated delivery of electricity and natural gas services. In addition, ETNO explored the synergies between the electricity system, hydrogen, synthetic natural gas production and other fuel cycles. While this report will focus specifically on the transformative impacts of DERs on the electricity system, it was not meant to preclude or dissuade other policy options.

Many of the structural components (e.g., distribution system operators, load-serving entities, community choice aggregations) examined in Section 3 of this report can be combined in various ways, and navigating these permutations can be a complex undertaking. This report attempts to shine a light on that challenge.

Table 1 summarizes ETNO's findings on the possible consequences of various policy options – and structural combinations of these options – and is intended to assist decision-makers in assessing options for the allocation of roles and responsibilities for DER integration into Ontario's electricity system.

[1] De Martini, P., Kristov, L. (2015, October). *Distribution Systems in a High Distributed Energy Resources Future: Planning, Market Design, Operation and Oversight*. Lawrence Berkeley National Laboratory, 8. https://emp.lbl.gov/sites/default/files/lbnl-1003797.pdf

Table 1: Policy options and associated ETNO findings

Policy Options	ETNO Findings
1. Local distribution company (LDC) and today's roles in Ontario • In Ontario, portions of the role of a distribution system operator (DSO) and a distribution owner (DO) are typically fulfilled by an LDC. • Currently, LDCs are not accountable for an open-access, distribution-level electricity market, such as the one operated by the IESO for Ontario's bulk electricity system.	• If the LDC model persists in Ontario over the long term, policy-makers and regulators will need to consider whether other entities should have responsibility for certain DSO functions – particularly if regulated DER markets are expected to form over the longer term.
2. Load-serving entity (LSE) • LSEs arrange for provision of energy to end-use customers. A number of variants exist; including those that own/operate distribution systems (see Section 3). • Widely implemented in the U.S., where they're generally private or publicly traded companies, LSEs buy energy and capacity (from bulk market, e.g., IESO in Ontario or local suppliers) and sell to customers (load) they are responsible for serving.	• LSEs could stimulate the growth of DER markets given their interest in meeting their capacity obligations through the most efficient means possible (i.e., through wholesale or local DER markets). • The potential benefits and challenges associated with different LSE models – and their potential impact on consumers – should be carefully examined and quantified before any commitment is made to their creation.
3. Community choice aggregation (CCA) • A CCA is a buying consortium that purchases electricity for customers that own/have opted into consortium based on preferences for electricity from certain generation types (e.g., local sources). • Legal in California and six other U.S. states, CCAs are unlike retailers, as all profits are devoted to lowering rates for consumers. • A CCA may exist within a defined segment of the service territory of a distribution company or LSE. Individual customers usually have the ability to opt out of a CCA and return to being a customer of the host distributor or LSE.	• Encourages customer investment in the types of electricity resources they want and reduces their dependence on the central grid. • Any consideration of the development of CCAs in Ontario should be preceded by an examination of how the costs of existing centralized assets would be managed to avoid stranding those assets or unfairly burdening other customers with those costs. • CCAs raise concerns regarding stranded assets given that DER-related power purchases by CCAs may be detached from network investment and system operation • A CCA's buying power within a certain part of the distribution system may also have to be regulated to ensure fair market access for all DER owners in that local area.

Policy Options	ETNO Findings
4. All-encompassing distribution companies • Proposed by the Electricity Distributors Association (EDA) in Ontario, this type of arrangement – if implemented – would be unique to Ontario. • Proposal would see LDCs maintain their existing role (i.e., infrastructure ownership, maintenance, physical operations, customer billing, interconnection approval), while assuming the functions of a distribution system operator and being permitted to own/operate DERs.	• Regulated and non-regulated companies with an interest in Ontario's electricity sector have strong differences of opinion on the merits of this model. • Policy-makers will need to consider which functions should be the purview of a natural monopoly and which will result in greater value for consumers through competition. • Regardless of how functions are divided, there will be a need to ensure fair and open access to local markets for all electricity service providers (e.g., by ensuring that the distribution system operator has a transparent process for connecting DERs).
5. Open DER markets at the distribution level • Various permutations of this option may involve the use of DSOs. In a manner similar to a wholesale electricity market, this model proposes a strict, regulatory separation of DSO duties from ownership of the underlying network (DO functions), and commercial trading of DER-related services. • Some have advocated that the DSO should be an entirely separate company from the DO to avoid conflict of interest (see Section 3 under "Enforced separation of functions"). • Another option would involve a regulated separation of function (see Section 3 under "Regulated separation approach") whereby the entity controlling the distribution system would have to ensure that DSO functions are kept entirely separate from other lines of business. This construct is common across the European Union (see Section 4).	• This model maximizes competition and open access to markets. • Some stakeholders have expressed concerns that this option would negate the ability of Ontario LDCs to realize new sources of revenue and could discourage distribution-level innovation. Others argue that it will maximize new investment and enable more innovation, while allowing LDCs to compete through their unregulated affiliates. • A strict separation of DSO, DO and commercial trading functions arguably sits at the end of a policy spectrum that prioritizes the widest possible competition and open access to markets. • As will be discussed in Section 3 of this paper, it also highlights one of the strongest differences in viewpoints between various segments of the electricity industry.

While perspectives on the allocations of roles and responsibilities vary, ETNO members continue to agree on the importance of maximizing consumer choice through competition, market access and open reliability standards. There is also consensus on the following points:

- However responsibilities for DERs are allocated, accountabilities for electricity system reliability, security and resiliency must be clear;

- Open standards for connecting DERs to the distribution system and open access to DER markets are essential to the prevention of artificial monopolies that would otherwise stifle consumer value that would be recognized by DERs.

Undertaking an objective, cost-benefit analysis of the options in this report should help guide policy-makers in determining how the roles and responsibilities for DERs may be allocated to maximize benefits for Ontario consumers. Given that these decisions will have consequences for Ontario residents and businesses for decades, they must be made fairly, objectively and based on evidence that supports the best interests of consumers. It is also essential that the conversation be widened to include potential new investors in the sector who will be needed to help ensure that consumers realize the full benefits of a more competitive electricity system.

Policy-makers will need to determine the point at which decisions about sector structural changes need to have been made. Many jurisdictions around the world have already embarked on this discussion. As will be discussed in Section 4, the European Union already requires any DSO with more than 100,000 customers to offer fair and open market access to third parties offering DER-related services. In Ontario, the IESO recently cited DERs as one of the largest reliability contingencies on the province's electricity system under certain circumstances.[2] Providing specific timelines for the implementation of a particular option for distribution evolution was never the goal of this report; instead, the discussions and considerations included in this report should provide policy-makers and regulators with a starting point to examine these critical topics in greater depth.

[2] Independent Electricity System Operator (2018, December 13). *Reliability Outlook: An adequacy assessment of Ontario's electricity system from January 2019 to December 2023*34. http://www.ieso.ca/-/media/Files/IESO/Document-Library/planning-forecasts/reliability-outlook/reliability-outlook-december-2018.pdf

Examples of differing viewpoints on DER integration

"The integration of DER ownership into LDC business models will further stimulate DER market development and create certainty with respect to achieving public policy goals, such as the reduction of GHG emissions, through coordinated DER planning."

Electricity Distributors Association, *Power to Connect: A Roadmap to a Brighter Ontario* (Feb. 2018)

"As experience with restructuring in the bulk power system has demonstrated, structural reform that establishes financial independence between distribution system operation and planning functions and competitive market activities would be preferable from the perspective of economic efficiency and would facilitate more light-handed regulation."

Massachusetts Institute of Technology, *Utility of the Future: An MIT Energy Initiative response to an industry in transition"* (Dec. 2016)

"Overall, the results of this analysis suggest that increasing DER capacity, if not properly accounted for, could cause reliability concerns for the bulk power system."

U.S. Federal Energy Regulatory Commission, *Distributed Energy Resources: Technical Considerations for the Bulk Power System* (Feb. 2018)

"Since an LSE will have more optionality to provide integrated solutions, it will be better equipped to adapt to the changing demands of electricity distribution, such as increased adoption of DERs."

Power Advisory LLC & Aird & Berlis LLP, *Policy Case: Recommendations for an Ontario Load-Serving Entity Model*. Ontario Energy Association. (Sept. 2018)

"Eventually, if enough new resources are connected to distribution systems, they will have to be dynamically managed similar to the bulk system. We may need a distribution system operator(s) with many of the capabilities of the IESO."

OEB Advisory Committee on Innovation, *Report to the Chair of the Ontario Energy Board* (Nov. 2018)

"Ultimately, the question comes down to what value-added product or service offering, offered by which entity — the utility or third-party provider — best benefits the consumer and provides maximum benefit to the public."

National Association of State Utility Consumer Advocates (NASUCA) as quoted in *Value-Added Electricity Services: New Roles for Utilities and Third-Party Providers,* Lawrence Berkeley National Laboratory (Oct. 2017)

"The first fundamental observation the reader should take from this report is that traditional modes of distribution system planning and operation are not adequate for a high-DER power system."

De Martini, P., Kristov, L. *Distribution Systems in a High Distributed Energy Resources Future*. Lawrence Berkeley National Laboratory (2015)

"Externalities, such as broader social policies associated with climate change, economic development, or other drivers, should not form part of fundamental rate design for DER."

Mowat Centre, *Emerging Energy Trends: Regulatory Responses to Ontario's Energy Future* (Dec. 2018)

Ontario **Other jurisdictions**

Section 1 – Introduction

In June 2018, over 350 delegates from across Ontario's electricity industry assembled in Toronto at the IESO's Electricity Summit. The conference attracted a wide cross-section of stakeholders, including current and prospective participants in Ontario's electricity markets. During the Summit, delegates were asked to rate their agreement on a scale of 1 (strongly disagree) to 10 (strongly agree) with the following statement:

"Enough is being done to prepare Ontario's electricity system for large-scale DER deployment."

The average score was 3.9 – indicating that most believe Ontario is unprepared for a high-DER future. This result also raised some troubling, second-order questions: Could the electricity system become a bottleneck to consumer investment and economic activity in these areas? Could unanticipated or unmanaged DER growth threaten the reliability of the electricity system? Could an inefficient market lead to a future stranded asset problem?

None of these concerns is new, or exclusive to Ontario. Much has been written regarding the future growth prospects of DERs, which include electric vehicles, smart appliances, stationary energy storage, distributed generation, building energy management systems, microgrids and controllable devices constituting the

Energy Transformation Network of Ontario

Since its establishment in 2009, the Ontario Smart Grid Forum (now ETNO) has released a series of papers containing a total of 53 public policy recommendations.

Most of these recommendations were a result of dialogue between member organizations of the Forum, and its Corporate Partners Committee to reach a consensus position. These recommendations have focused on a number of issues, including:

- Maximizing consumer choice through competition
- Developing success metrics for innovation in the utilities sector
- Open access to markets and data for third parties
- Integration of DERs into the electricity system and markets
- Open interoperability standards
- Formalized, rigorous cybersecurity standards
- Physical resiliency and safety of new smart grid equipment
- Operational monitoring of DERs

With a broad cross-section of energy industry representation, private sector input from the Corporate Partners Committee, and more than a decade exploring policy options for smart grid development, ETNO is now putting forward an examination of some of the key policy options that will help shape the future of our energy system.

Over the past two years, ETNO has examined various perspectives on the potential future structure of the distribution system – both inside and outside the province. This research has afforded ETNO and the Corporate Partners Committee the opportunity to understand differing points of view on this subject and explore options for mediating between them.

Internet of Things. The U.S. Energy Information Administration (EIA)'s *Annual Energy Outlook 2019* projects DERs to be the fastest-growing segment of America's electricity industry generating capacity for the next 30 years.[3] Even the EIA's potential future scenario projection, where clean energy policies are largely removed, sees little change in that trend.[4]

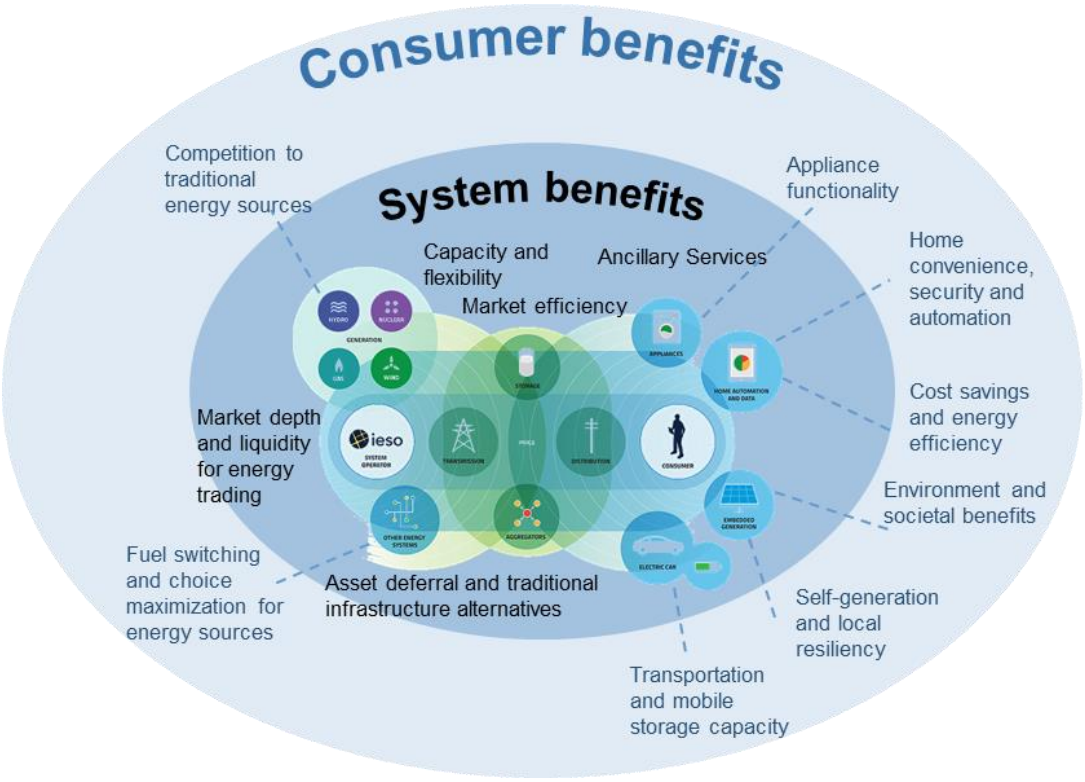
This paper will explore several factors that are converging on the electricity industry and the choices at hand for Ontario, including:

- **The growth of DERs resulting from consumer drivers:** Advocating for policies that encourage or discourage the growth of DERs is not a goal of this report. Indeed, many of the drivers of potential growth extend well beyond the traditional jurisdiction of the electricity industry. Consumer trends in automation, appliances, telecoms, transportation and non-electrical energy use are but a few of the factors influencing the potential demands that DERs may place on the electricity system and the associated prospective benefits (see Figure 2).
- **The benefits of coordinating the integration of DERs:** The nature of the DER challenge bears a striking resemblance to that faced by other industries that have had to coordinate competitive and non-competitive activities. As will be discussed in Section 2, this coordination is foundational to the findings of this report. DERs bring a whole new dimension of coordination considerations to this industry that follow the lines of the two-way electrical flows they enable.
- **A growing array of potential roles to play in the electricity sector:** Section 3 of this report examines various structural arrangements that could be employed to exploit the benefits that should be realized from mass numbers of DERs joining Ontario's electricity system if these roles are appropriately coordinated and allocated.
- **The intermediate steps required to reshape the industry and their potential implications:** It is not enough to simply choose a desired end state without considering the intermediate steps. Section 4 of this report explores potential intermediate paths that consider some of the unique aspects of Ontario's starting point. In addition, this section briefly examines changes to the landscape that may occur as the broader industry moves toward common interoperability standards and approaches to problems that are not necessarily unique to Ontario.

Increasingly, the industry discourse regarding DER growth has reached a higher level of abstraction. It is one that is less concerned with individual DER technologies, and more focused on the long-term transformative implications that DERs will have for the industry itself and, more important, for consumers.

[3] U.S. Energy Information Administration (2019, January 24). *Annual Energy Outlook 2019 with projections to 2050*. https://www.eia.gov/outlooks/aeo/pdf/aeo2019.pdf
[4] Ibid.

Figure 2: Overview of external drivers and DER-related benefits to consumers and the electricity system



ETNO Finding:

At stake in this discussion is the overall customer experience with the electricity system. This includes all facets of reliability, cost, consumer choice and realization of benefits from consumer-side investment (including benefits unrelated to energy use). More than at any previous point in its history, the electricity system is truly becoming a networked industry consisting of monopolistic, competitive, regulated and unregulated components. Theoretically, there are heightened social and economic benefits to be realized from the proper coordination of these activities. Practically, the realization of those benefits will be a daunting challenge.

The wide range of potential options for allocating these "roles and responsibilities" and rules to govern the interaction of resulting entities will be a major challenge for policy-makers in the coming years and could become even more urgent if the pace of DER uptake increases significantly. In examining many of the potential options, ETNO has reviewed the diverse policy positions of various groups and organizations inside and outside of Ontario that are either advocating for such divisions of responsibility, or otherwise implementing them (see Section 2 for examples). Some of these viewpoints will need to be reconciled to move forward at this crucial moment for an industry facing significant disruption.

Section 2 – Why should any of this matter?

If you recall the last time you passed through an airport, you can appreciate the type of structural policy challenge that a high-DER future presents to the electricity industry. As a customer using the airport, your overall experience was likely influenced by a number of factors – waiting times at check in, crowding, cleanliness, and the quality of restaurants and amenities – that were not under the control of a single organization. Indeed, an airport can be seen as a nexus of different types of activities and stakeholders, including for example:

- **Natural monopoly activities,** e.g., runways, air traffic control, baggage routing, security, customs, building maintenance. **Stakeholders**, e.g., airport authority, airport staff
- **Competitive, value-added activities,** e.g., competing airlines, online third-party ticketing services, ground services for aircraft, retail shopping, ground transportation. **Stakeholders**, e.g., airlines, retailers, online booking agents, taxis, buses and other ground transportation firms
- **Activities requiring common standards and regulations**, e.g., security standards, safety regulations, internationally recognized conventions for numbering runways and taxiways, food handling regulations, noise control standards. **Stakeholders**, e.g., government, regulators, security services, local municipalities

As a customer, you are part of a stakeholder group that experiences the cumulative impact of how competitive, monopolistic, and regulated activities together affect the overall customer experience. In fact, the International Air Transport Association (IATA) offers airports around the world an array of services to develop core, monopoly functions as part of its "level of service (LoS) concept"[5] and "non-aviation business performance assessment"[6] to ensure that the total customer experience is maintained and enhanced.

Many stakeholders in the above example benefit from the "network effect" of various synergies between competitive and non-competitive activities. Clearly it makes sense for multiple airlines to make use of a common network of airports, a common protocol for routing baggage, and allowing passengers to transfer between flights and airlines through a single location. These common elements translate into efficiencies for the airlines and cost savings for the customers taking advantage of multiple flight options competing for business at each major hub.

To understand the above example is to understand the approach that ETNO has applied to smart grid development over the past decade. During this time, the discourse across the entire electricity industry has moved from exploring the regulation of natural monopoly activities, to a more complex examination of the competitive and entrepreneurial opportunities that DERs present. Over its history,

[5] *Level of service concept*, International Air Transport Association, Retrieved February 10, 2019 from https://www.iata.org/services/consulting/airport-pax-security/Pages/level-of-service.aspx

[6] *Commercial non-aviation business*, International Air Transport Association, Retrieved February 10, 2019 from https://www.iata.org/services/consulting/airport-pax-security/Pages/airport-commercial-strategy.aspx

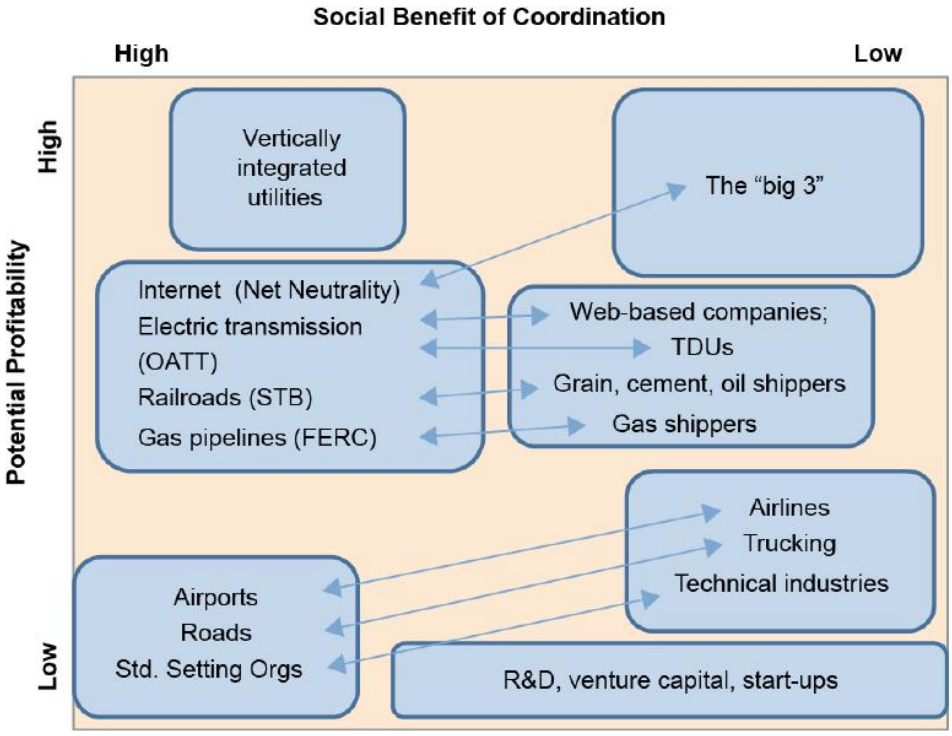
ETNO has consistently advocated for a holistic view of how these technologies might shape the overall customer experience with the electricity system – on everything from basic safety and security, to maximizing customer choice through a competitive marketplace.

In an electricity system with a high-penetration of DERs, the possibility of a similar network effect presents itself. Consider our airport example through the lens of the electricity system:

- **Natural monopoly activities,** e.g., bulk power system operations, distribution system operations, network asset ownership and maintenance. **Stakeholders**, e.g., bulk electricity system operators, transmission system owners, local distribution companies
- **Competitive, value-added activities,** e.g., local/on-site generation, building energy management systems, smart home devices and appliances, third-party demand response aggregators, efficient heating and cooling technologies, electric vehicle charging networks. **Stakeholders**, e.g., private industry, investors, technology developers, service providers, telecom network carriers
- **Activities requiring common standards and regulations**, e.g., open interoperability standards, electrical safety standards, cyber security, physical security, grid interconnection **Stakeholders**, e.g., government, regulators, law enforcement, inspection authorities

Like an airport, a failure of any single component can have a drastic effect on the overall customer experience.

Figure 3: Social benefits of coordination in various networked industries[7]



Over the past three years, ETNO has examined the broad concept of distribution system platforms to facilitate the operation of the system in a high-DER future. This has included a series of reports by Lawrence Berkeley National Laboratories. At the heart of these papers is the proposition that the key economic underpinning of an electricity system with a high penetration rate of DERs is the network effects, and resulting social benefits of coordination.

The Berkeley papers pointed to other networked industries, such as airports, railways and commodities, as examples where coordination of roles needs to be defined and facilitated (see Figure 3). The question is: how will such concepts translate into a more distributed electricity system?

ETNO Finding:

All stakeholders in a networked industry should have a vested interest in realizing the network benefits of optimal coordination. Ultimately however, it is the customer that realizes the cumulative benefits, or consequences, of those coordination choices – or lack thereof.

[7] Corneli, S., Kihm, S. (2015, November). *Electric Industry Structure and Regulatory Responses in a High Distributed Energy Resources Future.* Lawrence Berkeley National Laboratory, 12. https://emp.lbl.gov/sites/all/files/lbnl-1003823_0.pdf

Section 3 – A roles-based view of the problem

How might large-scale DER deployment affect the future structure of the electricity industry? This question is one of growing importance across the sector and among Ontarians – and one that ETNO has spent a great deal of effort examining in recent years.

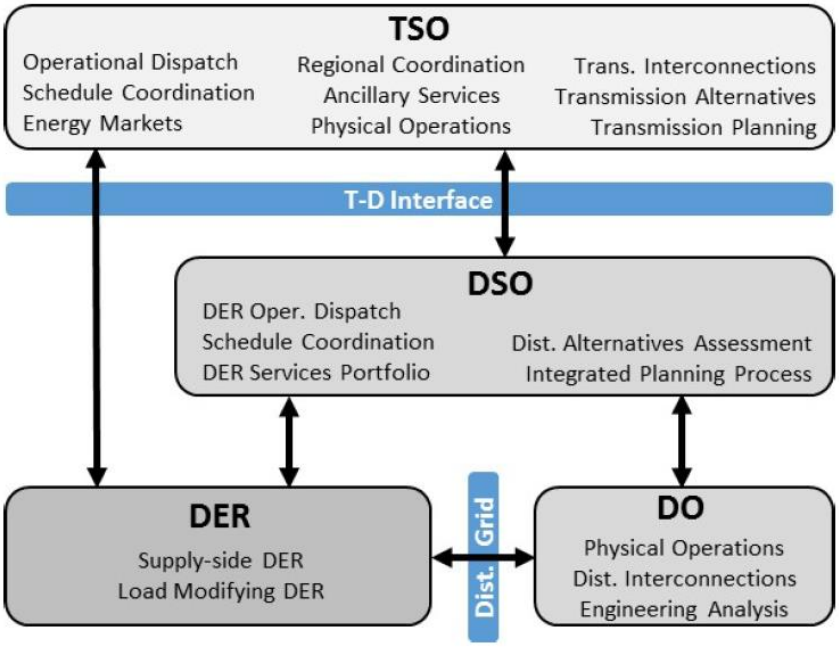
A series of papers published by Lawrence Berkeley National Laboratory present a generic view of a distribution system, and its various interfaces with transmission system operators (TSOs), distribution owners (DOs), distribution system operators (DSOs), and DER owners and operators. This construct has provided a useful framework for ETNO to assess the positions taken by different groups and organizations – both inside and outside Ontario – on the potential impacts of the assignment of roles and responsibilities for electricity in a high-DER future.

The pages that follow summarize some of the more prominent policy options, and technological concepts for facilitating the type of distribution structure that will be needed to accommodate mass numbers of DERs.[8] They examine both the structural arrangement that Ontario has in place today, and the growing array of alternatives that have been proposed by various groups and organizations.

Some of these options have been developed with a view to create greater market access for DER asset owners. Other options would evolve local distribution companies into organizations that fulfill the role of a DSO and/or a load-serving entity (LSE). ETNO has examined options addressing the "roles and responsibilities question," which is foundational to a multitude of second-order, technical questions that the industry will have to resolve.

[8] Throughout this section, an adaptation of Figure 4 is used to explain various policy concepts.

Figure 4: A generic set of roles governing an electricity system with a high penetration rate of DERs[9]



The importance of terminology

Before examining the various structural options for a high-DER future, it is important to recognize the role that terminology plays in this discussion. Here too, sometimes conflicting points of reference further complicate this discussion:

1. **Official definitions:** First, there is a body of official definitions that permeate the various codes, instruments and standards in place in Ontario and across North America. Organizations such as the North American Electricity Reliability Corporation (NERC) and the Ontario Energy Board (OEB) set out specific regulatory definitions for the types of entities examined in this paper, some of which are provided in the Glossary of Terms.
2. **Variations, emerging concepts and informal definitions:** The literature examined by ETNO to inform this report contains a multitude of variations on the official definitions. In some cases, entirely new arrangements have been proposed as well – often these variations reflect the commercial or strategic interests of their authors. While some of these concepts may be regarded as outright alternatives to each other, others could co-exist within the same electricity system.

Table 2 cross-references some of these official definitions to their variants and alternatives, which are explored further in this section.

[9] De Martini, P, Lorenzo, K (2015, October), *Distribution Systems in a High Distributed Energy Resources Future: Planning, Market Design, Operation and Oversight:* Lawrence Berkeley National Laboratory, 24. https://emp.lbl.gov/sites/default/files/lbnl-1003797.pdf

Table 2: Key structural concepts in place in Ontario today[10] cross-referenced to their variants and alternatives

Entity type	Key concepts in use in Ontario today	Variants and alternatives
Independent system operator (ISO)	The system operator, known in Ontario as the Independent Electricity System Operator (IESO), operates the wholesale electricity market and bulk electricity system independently of any market participant or interest in the wholesale market.	Some policy options propose that independent DSOs (see below) be given a similar mandate to operate electricity markets at the distribution level.
Local distribution company (LDC)	In Ontario, a local distribution company owns and operates a distribution system, but is not commercially responsible for the difference between the wholesale price it pays for electricity and retail price at which it is sold to retail customers. LDCs earn most of their revenues from the delivery of the underlying commodity as opposed to the wholesale/retail price spread.	Various groups have proposed that the role of LDC could expand to become one of the following: • DSO • Independent DSO • Load-serving entity • Fully integrated network orchestrator
Retailer	Licenced retailers in Ontario are allowed to earn a rate of return on a wholesale/retail price spread they are able to secure, but do not directly own or operate a distribution system.	Licenced retailers in Ontario could potentially compete alongside: • Third-party DER aggregators • Community choice aggregations (CCAs) • Microgrids • Peer-to-peer DER markets
Transmitter	Transmitters in Ontario own and develop the physical components of the province's bulk electricity system, and conduct physical operations under the direction of the IESO.	At the distribution level, some policy options would see a distribution asset owner (DO as depicted in Figure 4) divested of the system or market dispatch role – in much the same manner as transmitters operate in Ontario today.

[10] See also Glossary of Terms in this document.

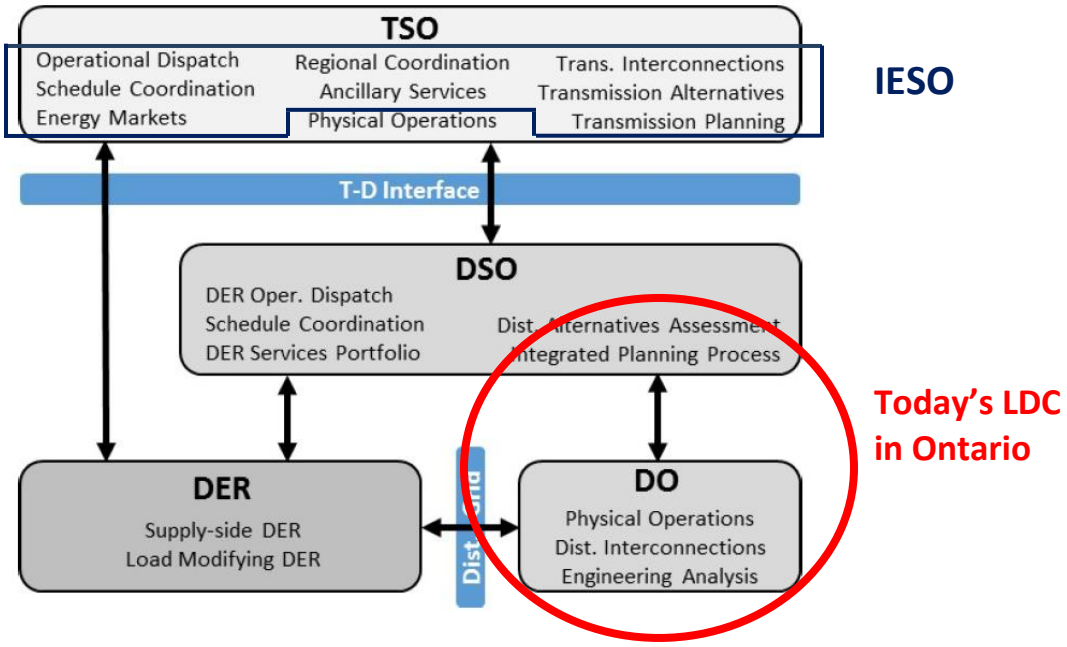
Table 3: Additional conceptual models explored in this section

Entity type	Definitions and concepts	Variants and alternatives
Third-party DER aggregator	A variety of non-utility third parties might operate an aggregation of DERs.	Examples might include electric vehicle service providers, telecom companies, home security companies, demand- response market participants and other entities that provide customer-facing products and services.
Community choice aggregation (CCA)	Formally defined in the state of California (see Glossary of Terms) and a small number of other U.S. states that allow community-level buying consortiums to purchase energy on their behalf. Unlike LSEs, however, CCAs typically don't have an obligation to secure an adequate amount of capacity or maintain the distribution network.	As an alternative to commercially segmented customer groups seeking to self-supply, microgrids are physically defined electrical areas containing load, generation and storage components that allow them to operate autonomously from, and interact with, the rest of the electricity system. Such arrangements allow groupings of customers to secure their own DER-related services and define their relationship with a distribution-level market. **Peer-to-peer DER markets:** Using novel technical arrangements, these markets could allow buyers and sellers to interact directly with each other to facilitate the commercial and/or physical aspects of electricity trading across a distribution system without intermediaries. To date, there are few industry-accepted standards as to how these could facilitate physical transactions, though some pilot projects exploring the commercial aspects of energy trading are currently underway.

Entity type	Definitions and concepts	Variants and alternatives
Distribution owner (DO)	The Berkeley Lab series of papers defines a distribution owner as a "state-regulated private entity, locally regulated municipal entity, or cooperative that owns an electric distribution grid in a defined franchise service area, typically responsible under state or federal law for the safe and reliable operation of its system."[11]	In Ontario, a distributor is "a person who owns or operates a distribution system"[12] – a definition that does not necessarily require the entity to be a distribution owner.
Distribution system operator (DSO)	A distribution system operator conducts physical dispatch of the distribution system to facilitate market access for DERs and may also undertake DER-related commercial activities.	**Fully independent DSO:** Like an ISO at the bulk electricity system level, a fully independent DSO conducts physical dispatch of the distribution system to facilitate market access for DERs. **Fully integrated network orchestrator (FINO):** Proposed by the Ontario Electricity Distributors Association, a FINO has the combined responsibilities of an LDC and a DSO, and may also be involved in commercial activities with respect to developing DER-related services and ownership.[13]
Load-serving entity (LSE)	NERC defines an LSE as the entity that "secures energy and transmission service (and related interconnected operations services) to serve the electrical demand and energy requirements of its end-use customers."[14]	As noted by NERC, informal definitions of LSEs differ. In some cases, LSEs may also encompass the duties of a DSO and/or a DO entity (see above and Glossary of Terms).

[11] De Martini, P., Kristov, L., (2015, October). *Distribution Systems in a High Distributed Energy Resources Future: Planning, Market Design, Operation and Oversight*. Lawrence Berkeley National Laboratory, vii. https://emp.lbl.gov/sites/default/files/lbnl-1003797.pdf
[12] *Electricity Act, 1998,* SO 1998, *c.15, Sched. A, section 2.,* https://www.ontario.ca/laws/statute/98e15/v8
[13] Electricity Distributors Association (2018, February). *Power to Connect: A Roadmap to a Brighter Ontario*, 8. https://poweroflocalhydro.ca/wp-content/uploads/2018/02/2018_EDA_Vision_Paper.pdf
[14] North American Electric Reliability Corporation (updated May 13, 2019*). Glossary of Terms Used in NERC Reliability Standards,* 17. https://www.nerc.com/files/glossary_of_terms.pdf

Figure 5: Today's roles in Ontario

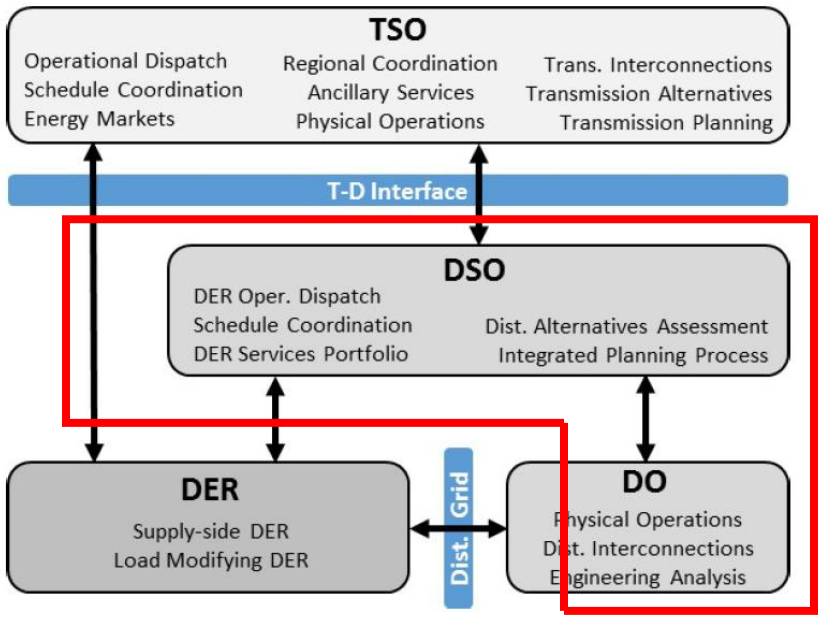


Description: In Ontario today, portions of the role of a DSO and a DO are fulfilled by an LDC. LDCs in Ontario typically do not take commercial responsibility for energy flows through their wires, but rather distribute electricity at a regulated rate. Currently, LDCs are not responsible for an open-access, distribution-level electricity market, such as the one operated by the IESO for Ontario's bulk electricity system.

ETNO Finding:

Should Ontario maintain the LDC model, regulators and policy-makers will need to consider whether some other type of entity should have responsibility for certain DSO functions – particularly if regulated DER markets are expected to form over the longer term.

Figure 6: Policy concept – load-serving entities (multiple model variants)



Description: LSEs are widespread throughout many jurisdictions in the United States and are generally privately owned or publicly traded entities. According to NERC, the "LSE arranges for the provision of energy to its end-use customers, but does not include distribution services ('wires')."[15] Multiple potential variants on this model are both proposed and in use. Some of these may not require the ownership of the network itself. A recent report commissioned by the Ontario Energy Association discussed the voluntary creation of LSEs from LDCs, following existing service territory boundaries.[16]

ETNO Finding:

While some discussions suggest that an LSE should follow the contours of an LDC service territory, there are numerous variations on this model, including those that:

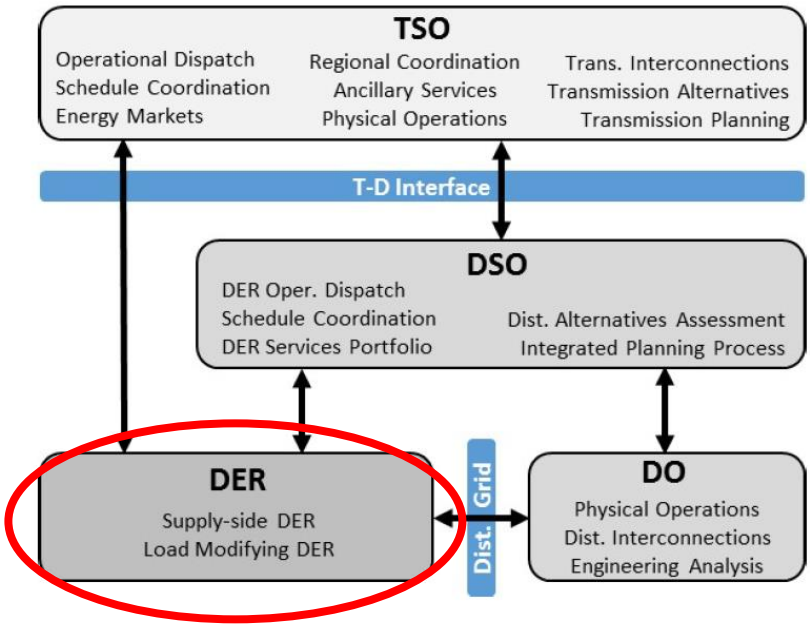
- Allow for open competition for customers among LSEs, retailers and CCAs, as in the U.S., UK and elsewhere
- Leverage technology to assemble customers across a geographically dispersed area
- Expressly separate commercial functions from system operations and asset ownership (see NERC definition of an LSE)

While LSEs could offer an important source of liquidity to the growth of DER markets, the numerous forms such entities might take warrant examination should Ontario consider regulatory changes to allow them.

[15] Functional Model Working Group (2008, August). *NERC Reliability Functional Model Technical Document - Version 4*: 24.North American Electric Reliability Corporation. https://www.nerc.com/pa/Stand/Pages/FunctionalModel.aspx

[16] Power Advisory LLC, Aird & Berlis LLP (2018, September). *Policy Case: Recommendations for an Ontario Load-Serving Entity Model.* Ontario Energy Association. https://energyontario.ca/wp-content/uploads/2018/09/OEA-LSE-Report-September-2018-Final.pdf

Figure 7: Policy concept – community choice aggregation models

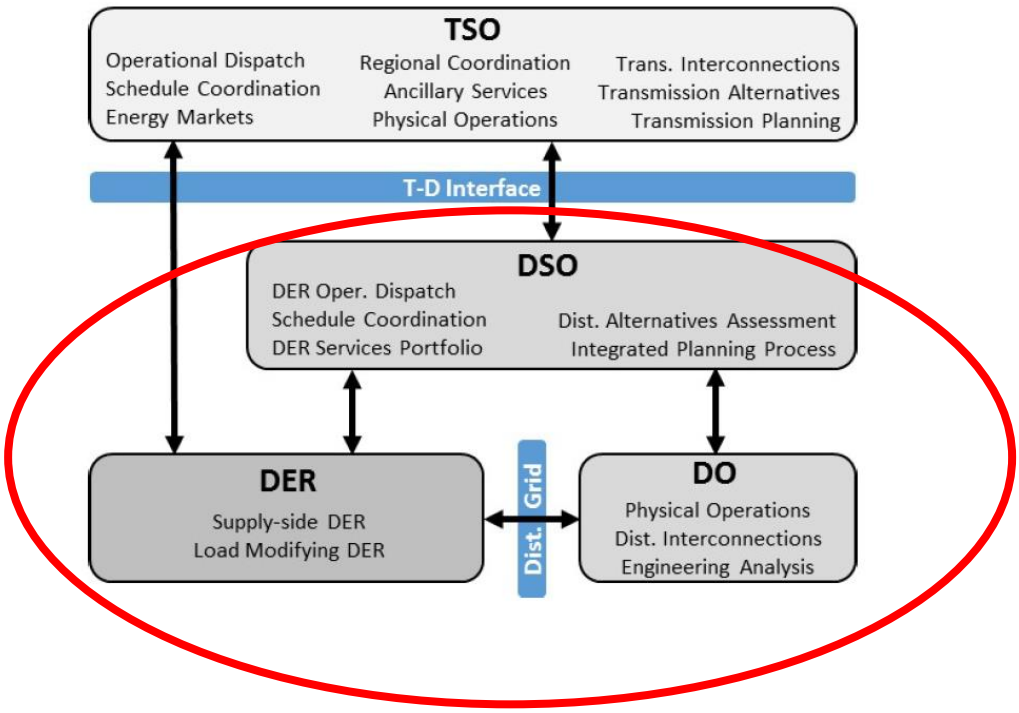


Description:
CCAs are predominantly used in the state of California and allowed by legislation in six other U.S. states. CCAs are buying consortiums, owned by the customers they serve, whereby any resulting profits are devoted to rate reduction. Often CCAs "buy local" from DERs residing within the municipal boundary demarking their service territories.

ETNO Finding:

CCAs, LSEs and other types of consumer aggregations are examples of economic arrangements in which customers might collectively invest in DERs to beat the cost curve offered by a centralized power grid. As with any other form of buying consortium, regulators are challenged to ensure that these aggregations are an enabler of competition and not an inhibitor. Any activities that allow consumers to "beat the cost curve" offered by the centralized grid also warrant an examination of how costs for existing centralized assets are managed to avoid stranding assets or unfairly burdening other customers with those costs (e.g., considering "exit fees" for those who leave the grid).

Figure 8: Policy concept – all-encompassing distribution companies



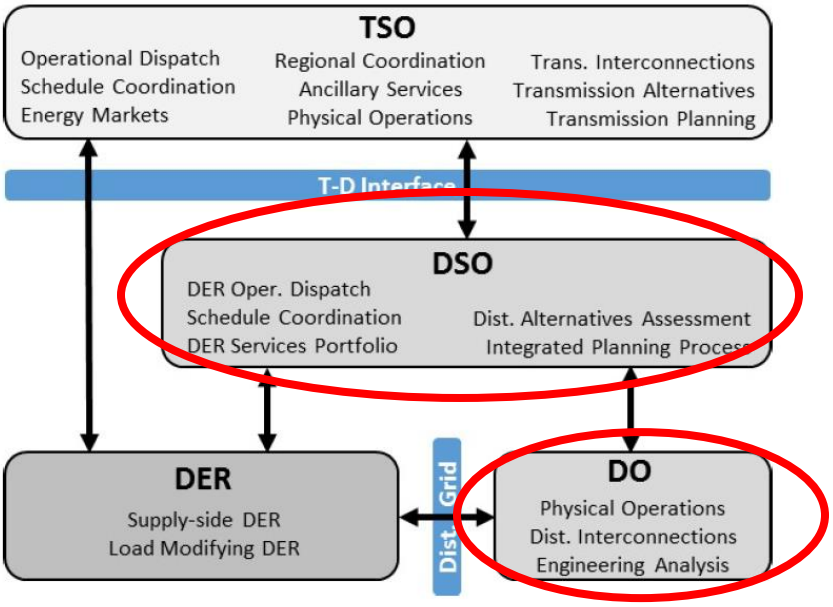
Description:
Some organizations, such as Ontario's Electricity Distributors Association (EDA) have advocated an all-encompassing role for fully integrated network orchestrators (FINOs). A FINO would serve all the functions of an LDC and a DSO and be at liberty to own and operate DERs. A wider role for distribution companies is part of a similar position taken by the Edison Foundation Institute for Electric Innovation, a U.S. umbrella organization that focuses on advancing the adoption and application of new technologies to strengthen and transform the grid.

ETNO Finding:

The industry is not unanimous on the merits of this model – with often sharp differences of opinion between regulated and non-regulated entities. While this model suggests the possibility of expedient creation of a distribution-level market for DER-related services to the grid – perhaps as a stepping stone to an established distribution-level DER market, policy-makers would likely need to consider:

- The extent to which this model affords sufficient competition in industry segments that do not constitute a natural monopoly and encourages investment of new sources of capital
- How to ensure fair and open access to local markets for non-regulated third parties
- The need to avoid unfair treatment/conflict of interest regarding DER connections that are not owned by a FINO
- The enforcement of interoperability standards to avoid the deliberate or accidental creation of artificial monopolies through technological lock-in

Figure 9: Policy concept – enforced separation of functions between distribution system operators and owners



Description:

Similar to a wholesale electricity market, this model proposes a strict, regulatory separation of the duties of a DSO from ownership of the underlying DO functions, and commercial trading of DER-related services. This position was taken by the MIT Energy Initiative's *Utility of the Future* paper, and is similar to a position adopted by the private sector umbrella organization, Advanced Energy Economy. Under this arrangement, one or more entities with functions similar to Ontario's IESO would have responsibility for providing open access to the province's distribution system segments.

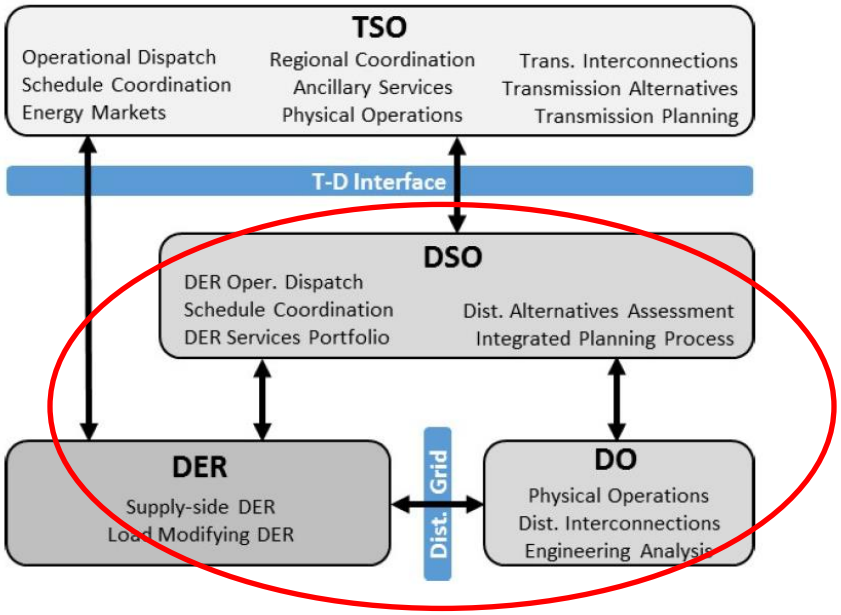
ETNO Finding:

A strict separation of DSO, DO and commercial trading functions arguably sits at the end of a policy spectrum that prioritizes the broadest possible competition and open access to markets. It also highlights one of the strongest points of difference between various segments of the electricity industry.

At the other end of the spectrum is the all-encompassing distribution company (e.g., FINO as described by Ontario's EDA) that fulfills all of the aforementioned functions (i.e., wires ownership, physical operations, dispatch, and participates in DER operations and commercial undertakings). Some public utility advocacy bodies in both Ontario and the United States endorse this model.[1]

It is also worthwhile to note that even if a fully-independent distribution market for DERs becomes Ontario's ultimate aim, regulators must consider a number of factors, including potential, intermediate steps to achieve a full-fledged distribution market – a process that might take many years to design and implement (see Section 4 of this report).

Figure 10: Policy concept – regulated separation approach



Description:

While strongly advocating for the separation of the DSO from other activities, the MIT Energy Initiative paper *Utility of the Future* left the door open to a rigidly enforced separation of functions to avoid conflict of interest. Under this model, any single entity performing a combination of DSO, DO or commercial DER functions would be subject to rigorous regulatory oversight and obligations to provide open access to the distribution network. Such entities would rely upon this oversight mechanism to avoid conflict of interest and ensure even-handed distribution-level market results. Aspects of this position were also advocated by the National Association of State Utility Consumer Advocates (NASUCA).[17]

[17] Blansfield, J., Wood, L., Katofsky, R., Stafford, B., Waggoner, D. (2017, October). *Value-Added Electricity Services: New Roles for Utilities and Third-Party Providers,* 51-75. Lawrence Berkeley National Laboratory.
http://eta-publications.lbl.gov/sites/default/files/feur_9_value-added_electricity_services_20171029_fin.pdf

ETNO Finding:

While not a preferred arrangement in the MIT paper, ETNO has examined views and opinions around this apparent intermediate position between the "all-encompassing utility" model and the "enforced separation of functions" model. The possibility of reaching a consensus on what is arguably one of the more divisive questions in the debate over the future of the distribution sector is one that regulators and policy-makers might consider.

During the 2018 IESO Electricity Summit, ETNO conducted a straw poll of the delegates, delineated by industry segment. Interestingly, the breakdown of opinions on the "Regulated Separation Approach" mirrored the positions taken in the source material ETNO reviewed in recent years with customers, energy-related businesses and academics less favourable of this option and distributors, generators and sustainability groups more favourable.

LDCs should generally be allowed to participate in distribution-level DER markets with a properly regulated separation of functions (0 = Strongly Disagree, 10 = Strongly Agree)

Electricity Summit Respondent Type	
Consumer	4.7
Distributor/Transmitter	8.6
Energy Related Business/Service	6.8
Generator	6.8
Other	6.9
Post-secondary Institution	4.0
Sustainability/Conservation Group	7.8

Structural concepts in summary

At the distribution level, many types of entities might exist, co-exist or otherwise supplant some of the functions in Ontario today in order to optimize the value of DERs for electricity consumers. In some cases, these new roles might be competitive in nature, and in others the nature of the entity proposed, or the role played, imply that an entity would have a monopoly over such activities. Table 4 summarizes the roles currently played in the market today, and activities that might transfer to new/proposed entities explored in this section.

Table 4: Summary of current and potential roles and responsibilities in distribution sector

	Distribution-level entities (present and future)											
Distribution-level functions	Independent system operator	Transmitters	Local distribution companies (LDCs)	Load-serving entities (LSEs)	Fully integrated network Orchestrators (FINOs)	Distribution system operators (DSOs)	Fully independent DSOs	Community choice aggregations (CCAs)	Microgrids	Third-party DER aggregations	Peer-to-peer DER markets	Retailers
Commercial responsibility for bulk energy purchases for customers	No	No	No	Yes – competitive activity	Yes – competitive activity	Yes – competitive activity	No	Yes – competitive activity	Yes – competitive activity	Yes – competitive activity	Yes – competitive activity	Today
Commercial responsibility for bulk capacity purchases for customers	Today	No	No	Yes – competitive activity	Yes – competitive activity	Yes – competitive activity	No	Yes – competitive activity	Yes – competitive activity	Yes – competitive activity	Yes – competitive activity	No
Distribution – alternatives assessment	No	No	Today	Yes – non-competitive activity	Yes – non-competitive activity	Yes – non-competitive activity	Yes – non-competitive activity	No	No	No	No	No
Integrated distribution planning process	No	No	Today	Yes – non-competitive activity	Yes – non-competitive activity	Yes – non-competitive activity	Yes – non-competitive activity	No	No	No	No	No
Schedule coordination with bulk power system	No	No	Today	Yes – non-competitive activity	Yes – non-competitive activity	Yes – non-competitive activity	Yes – non-competitive activity	No	No	No	No	No
Distribution operation and dispatch	No	No	No	Yes – non-competitive activity	Yes – non-competitive activity	Yes – non-competitive activity	Yes – non-competitive activity	No	No	No	No	No
Physical distribution grid operations	No	No	Today	Yes – non-competitive activity	Yes – non-competitive activity	Yes – non-competitive activity	Yes – non-competitive activity	No	No	No	No	No
DER operations	No	No	Today	Yes – competitive activity	Yes – competitive activity	Yes – competitive activity	No	Yes – competitive activity	Yes – competitive activity	Yes – competitive activity	Yes – competitive activity	Yes – competitive activity
DER ownership	No	No	Today	Yes – competitive activity	Yes – competitive activity	Yes – competitive activity	No	Yes – competitive activity	Yes – competitive activity	Yes – competitive activity	Yes – competitive activity	Yes – competitive activity
Distribution interconnections	No	No	Today	Yes – non-competitive activity	Yes – non-competitive activity	Yes – non-competitive activity	Yes – non-competitive activity	No	No	No	No	No
Engineering analysis of interconnection requests	No	No	Today	Yes – non-competitive activity	Yes – non-competitive activity	Yes – non-competitive activity	Yes – non-competitive activity	No	No	No	No	No
Commercial responsibility for DER services portfolio	No	No	Today	Yes – competitive activity	Yes – competitive activity	Yes – competitive activity	No	No	No	No	No	No

Activity is carried out by entity in Ontario today

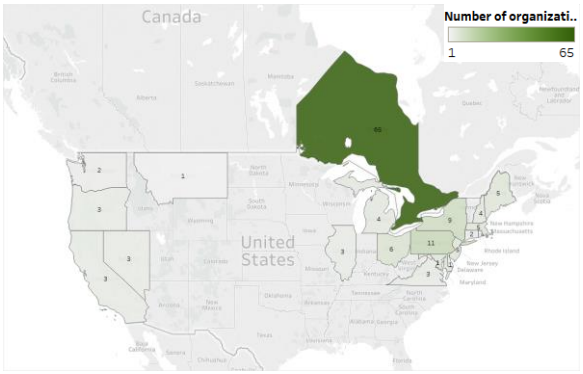
Activity would likely be competitive if this type of entity

Activity would likely be a monopoly if this type of entity

Role is incongruent to this type of entity

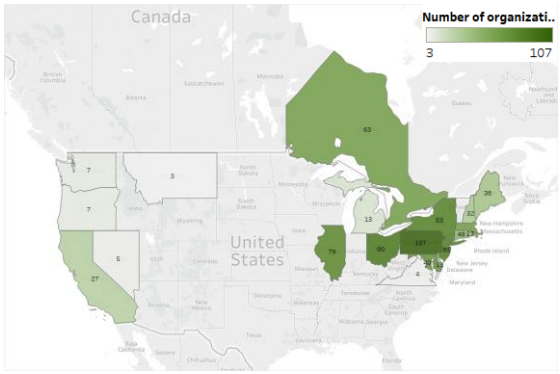
Figure 11: Current electricity business models in Ontario and the United States:[18] distribution-only, energy-only and bundled services (with Ontario context)

Entities providing delivery (distribution service) service only



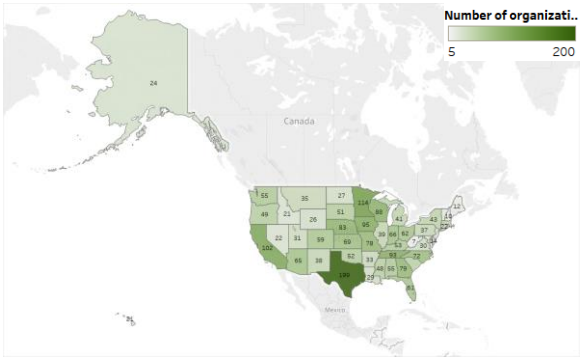
Ontario stands out as the only jurisdiction in North America where local distribution companies (LDCs) are the predominant form of distribution network ownership. LDCs do not take a commercial interest in the energy commodity and earn a regulated rate of return on distribution services.

Load-serving entities, retailers, CCAs, cooperatives, and other utilities providing energy services only



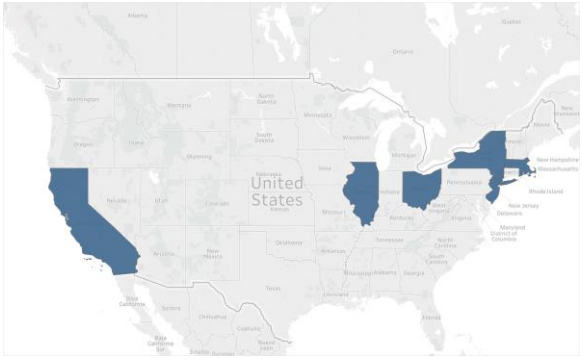
Ontario has an open access retail market with 63 licenced retailers who are able to secure a price spread between their bulk purchases and the retail price they offer consumers. Various forms of for-profit and not-for-profit, energy-only offerings are available in many U.S. jurisdictions.

Load-serving entities and other utilities providing bundled services (energy + delivery)



In most U.S. jurisdictions load-serving entities (LSEs), often investor-owned, are able to offer energy retail services in addition to realizing a return on investment in owning the distribution system. While there have been recent discussions of such models in Ontario, they are not the norm.

U.S. states with community choice aggregation legislation



A small number of U.S. states allow community-level buying consortiums to offer energy-only services, using the infrastructure owned by the local utility. Like Ontario LDCs, CCAs often follow municipal boundaries, but they derive their revenues from energy – not distribution services and are generally co-operatives or not-for-profits from which customers elect to purchase.

[18] U.S. Energy Information Administration (2017). Annual Electric Power Industry Report. Retrieved from https://www.eia.gov/electricity/annual/ and Ontario Energy Board (2018, August 23). *2017 Yearbook of Electricity Distributors.*

Section 4 – Mapping the course to new structural options

The level of complexity associated with restructuring the electricity industry is partly the result of the array of emerging choices – both in terms of structural and technical options to serve new business models and, more important, to serve customers. Ontario is unique in that it has, as the foundational model for its distribution system, the largest concentration of municipally owned and distribution-only utilities on the continent (see Figure 3).

Over the past few years, ETNO has examined the realities of a distribution landscape, in which the five largest LDCs now comprise 83 per cent of the retail customer base.[19] This breakdown also translates into the relative proportion of power and distribution revenues, with the top five earning 71.5 per cent of the provincial total in 2017.[20] Wide variations among Ontario's LDCs may have profound implications for how and when distribution-level solutions for DERs evolve over time. Given the varying intensity of customers, resources, and strategies across LDCs, there are a number of potential scenarios for how DER markets might evolve.

While ETNO has examined various structural policy options for the industry, policy-makers cannot simply choose a desired end state. Determining how to get there, how quickly, what intermediate steps are involved, and which principles should guide those decisions will be more pressing issues for the next few years.

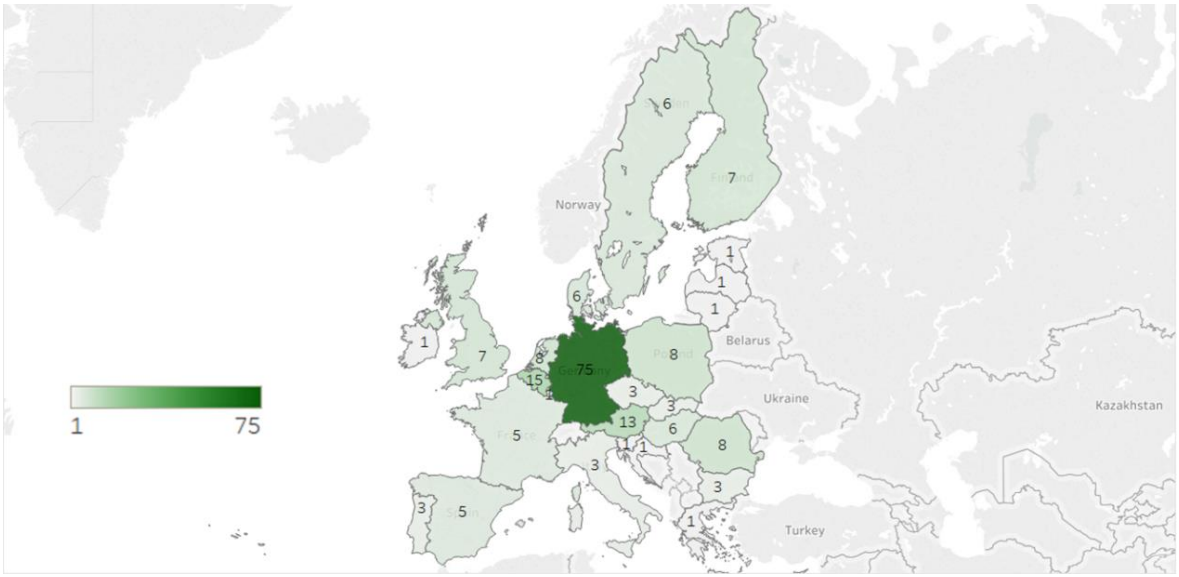
Applying policy options by number of customers served: the EU model

While the size of distribution companies across European Union member states varies widely, a crucial difference in the regulatory landscape is noteworthy, both for its market implications and its advanced implementation, spanning almost a decade. Under Directive 2009/72/EC, DSOs with more than 100,000 customers are required to unbundle their distribution services such that network access, market operations and dispatch are fully separated from other commercial functions.[21] This EU policy sets a mandatory framework where a sufficiently sized independent DSO can be created through a "regulated separation approach" (see Section 3). As of the most recent data,[22] almost every EU member state had at least one DSO in that category (see Figure 4).

> *"Where the distribution system operator is part of a vertically integrated undertaking, it shall be independent at least in terms of its legal form, organisation and decision making from other activities not relating to distribution. Those rules shall not create an obligation to separate the ownership of assets of the distribution system operator from the vertically integrated undertaking."*
>
> Directive 2009/72/EC of the European Parliament and of the Council, Article 26, Section 1

[19] Ontario Energy Board (2018, August 23). *2017 Yearbook of Electricity Distributors*. https://www.oeb.ca/oeb/_Documents/RRR/2017_Yearbook_of_Electricity_Distributors.pdf
[20] Ibid.
[21] In the EU, the application of this policy to DSOs with less than 100,000 customers is optional to the member state in which it resides.
[22] Flammini, M. G., Andreadou, N., Masera, M., Fulli, G.,; Vitiello, S., Prettico, G. (2019). *Distribution System Operators observatory 2018: Overview of the electricity distribution system in Europe.* European Commission - Joint Research Centre Science for Policy Report.

Figure 12: Distribution System Operators in the EU with more than 100,000 customers that are required to create an IDSO[23]



It is interesting to note that if this directive was applied in Ontario, only five LDCs would meet the 100,000-customer threshold for mandatory unbundling. The EU example is just one approach policy-makers in Ontario could consider with respect to future structural changes if LDCs ever evolve along the lines of DSOs or LSEs. Further analysis would be required to determine a relevant customer threshold in the Ontario context.

Figure 13: Ontario LDCs meeting the EU's threshold for mandatory unbundling[24]

Retrieved from: https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/distribution-system-operators-observatory-2018

[23] Flammini, M. G., Andreadou, N., Masera, M., Fulli, G.,; Vitiello, S., Prettico, G. (2019). *Distribution System Operators observatory 2018: Overview of the electricity distribution system in Europe.* European Commission - Joint Research Centre Science for Policy Report.

[24] Ontario Energy Board (2018, August 23). *2017 Yearbook of Electricity Distributors.*

For much of the past decade, a combination of public programs has served as a market-maker for DERs in Ontario – either through specific technology procurements and/or prescribed floor-price tariffs ("Feed-in Tariffs"). These constructs effectively provided a mechanism for some types of DER-related services to be provided to the electricity system. In their absence, Ontario will need to consider if, how and when a broader market for DERs might take form.

Should efficient DER markets be Ontario's ultimate goal, there will be a long journey ahead. Like most deregulated jurisdictions around the world, Ontario's current legislative and regulatory framework has drawn a sharp line between the wholesale and retail electricity markets over the past 20 years. The result is reflected in the principal information flows from each domain of the electricity system. Ontario's current electricity data topology is a far cry from the fully integrated smart grid architecture framework envisioned by the U.S. National Institute of Standards and Technology (NIST).

And it's about to get a lot more complicated. Even during the creation of this report, NIST was in the final stages of developing version 4.0 of its smart grid framework. This new framework will recognize the more complex interactions between third-party service providers, cloud computing services and the vast sphere of data flows residing outside the scope of traditional utility networks (see figure in Appendix 3), or the jurisdiction of the system operator or regulator. The technological dimensions associated with the DER question have not stopped expanding while ETNO has been considering this topic.

In Section 2 of this paper, we considered the network coordination benefits that can be realized in the interoperability layer between regulated and unregulated segments of the electricity industry. These benefits will not be realized without the correct industry structures in place. How this effort will be organized, however, leads back to the high-level policy questions that ETNO has been examining over the past several years.

ETNO Finding:

In addition to examining conceptual industry models, ETNO has also explored a wide range of emerging technological concepts for harnessing the aggregated capabilities of DERs (see Figure 6). Most of these concepts and ideas are useful to each of the industry structural options examined earlier in this paper.

It is also important not to lose sight of the basics: ETNO has advocated for open interoperability standards since 2011 and this issue will likely become more pressing than ever. Each interface in the

Figure 14: NIST Smart Grid Architecture Framework[25]

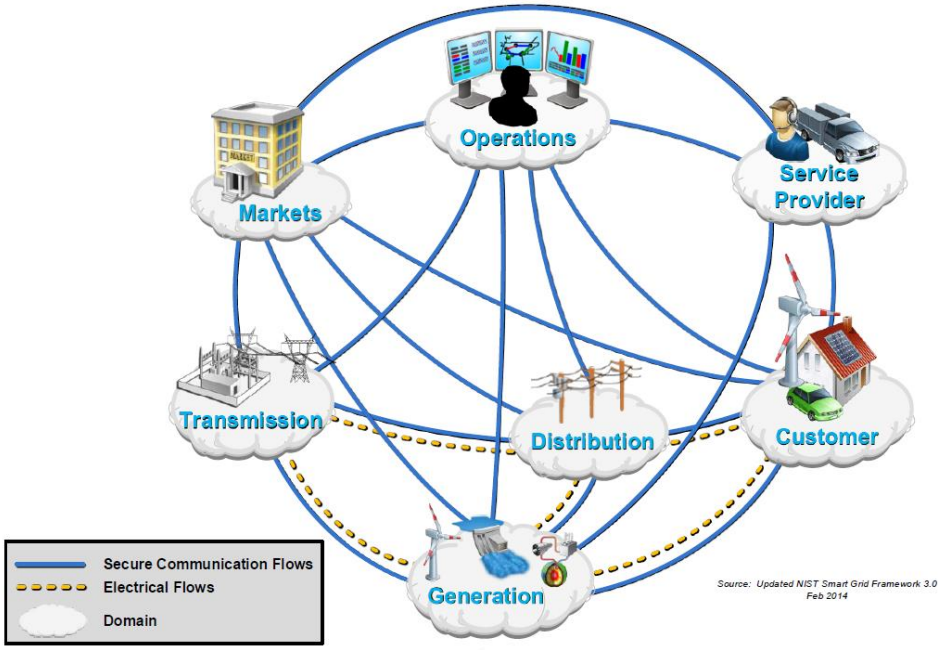
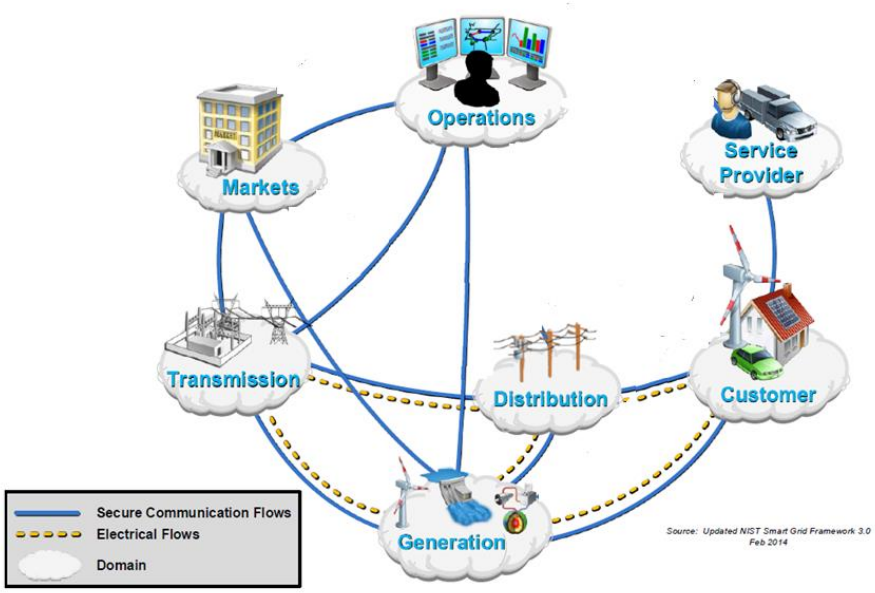


Figure 15: Principal communications flows in Ontario's current market model



[25] National Institute of Standards and Technology (2014, September). *NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 3.0*, NIST Special Publication 1108r3. https://www.nist.gov/sites/default/files/documents/smartgrid/NIST-SP-1108r3.pdf

While some technical solutions may be more conducive than others to the policies chosen to address roles and responsibilities, for the most part, they do not constrain the policy decisions Ontario needs to make. A clear delineation of responsibilities is first required to facilitate the type of fully-integrated smart grid framework conceptualized by NIST in its smart grid interoperability framework.

Cost allocation, governance, security and transparency are just a few of the issues that will need to be resolved to ensure that the electricity system unlocks the social benefits of coordination hypothesized in the Berkeley Labs papers examined by ETNO between 2015 and 2018. All of these questions will take time to resolve – both in the formal regulatory arena, and at a technical working level. As noted at the beginning of this section, in returning to the question of how Ontario might evolve its distribution-level marketplace, a number of potential paths have been put forward in recent literature originating both inside and outside of Ontario. Some potential intermediate steps are summarized in Figure 6. As discussed earlier, some groups are already advocating for the use of LDCs as the building blocks for the development of DER markets, and potentially evolving to a DSO or an LSE model. Others have advocated for a clear separation of functions, which would, in turn, require severing those functions from LDCs entirely.

ETNO Finding:

When considering intermediate options for creating a viable DER market in Ontario, policy-makers must choose between expediency and design elegance. Striving for either end of this spectrum comes with its risks. Near term, interim decisions can become entrenched as a permanent solution, both in terms of dominant players in the market and technological lock-in. On the other hand, implementing a full DSO platform might delay the creation of a DER market in the province for many years – to the detriment of customers, investors, and suppliers of DER technologies. Given Ontario's unique history with LDCs, the evolutionary paths examined (set out in Figure 6) result in two major approaches:

1) **An additive approach**, where today's LDCs take on more roles and responsibilities over time (e.g., DER commercial functions and DSO functions).

   Potential issues for regulators to consider:

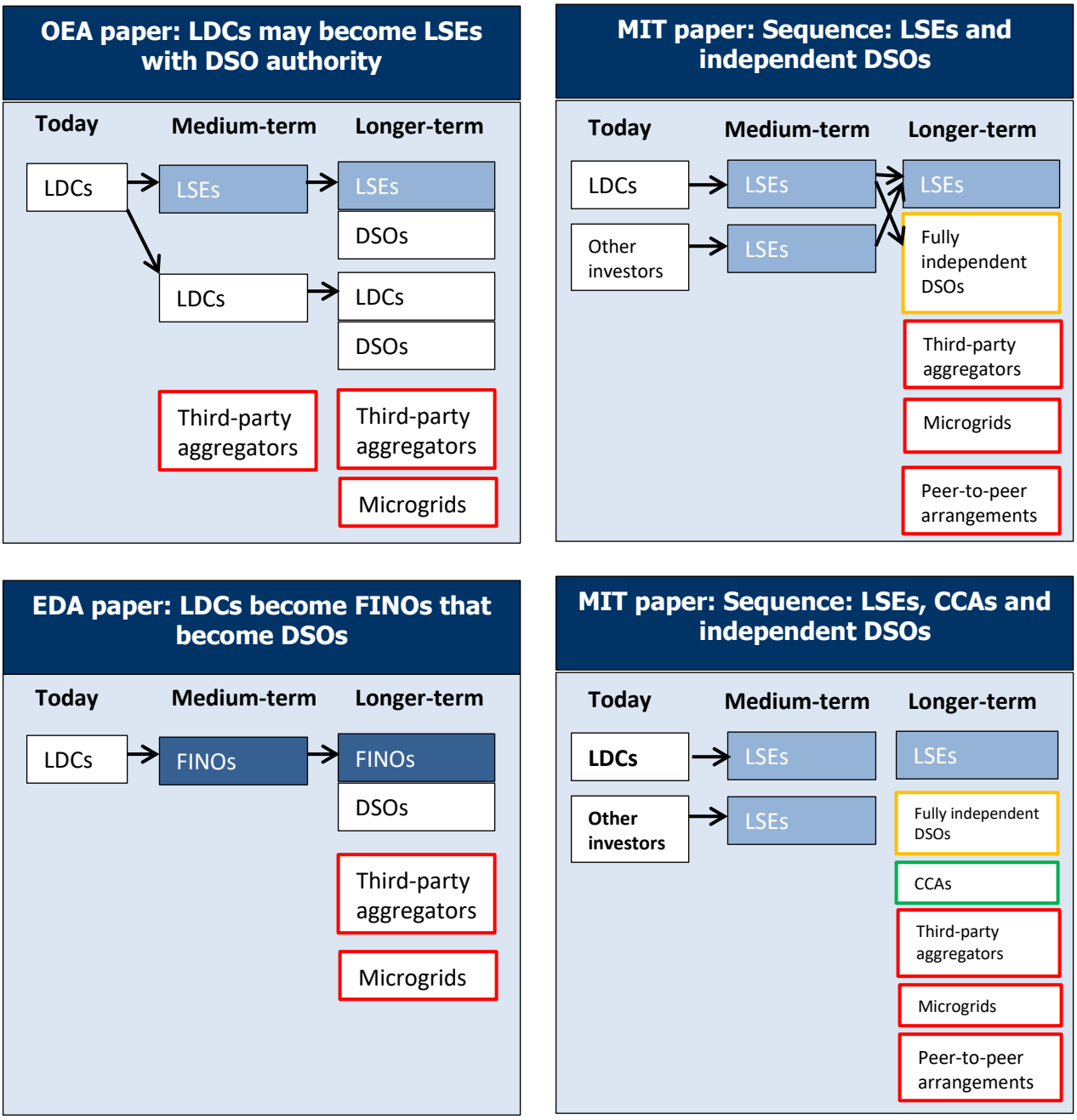
   - The expedient creation of DER markets using today's organizational structures
   - The adequate separation of functions and avoidance of conflicts of interest
   - The widely varying scale, financial resources and capabilities of LDCs in Ontario

2) **An unbundling approach,** in which distribution-level roles and responsibilities are divided in a manner similar to Ontario's bulk electricity system, with individual entities responsible for market administration, poles and wires ownership, system operations and generation. In this model, LDCs would fulfil their constituent roles (e.g., wires ownership, DSO operations) and could compete with others for roles that may benefit from greater competition (e.g., LSEs, CCAs, DER ownership/operation).

   Potential issues for regulators to consider:

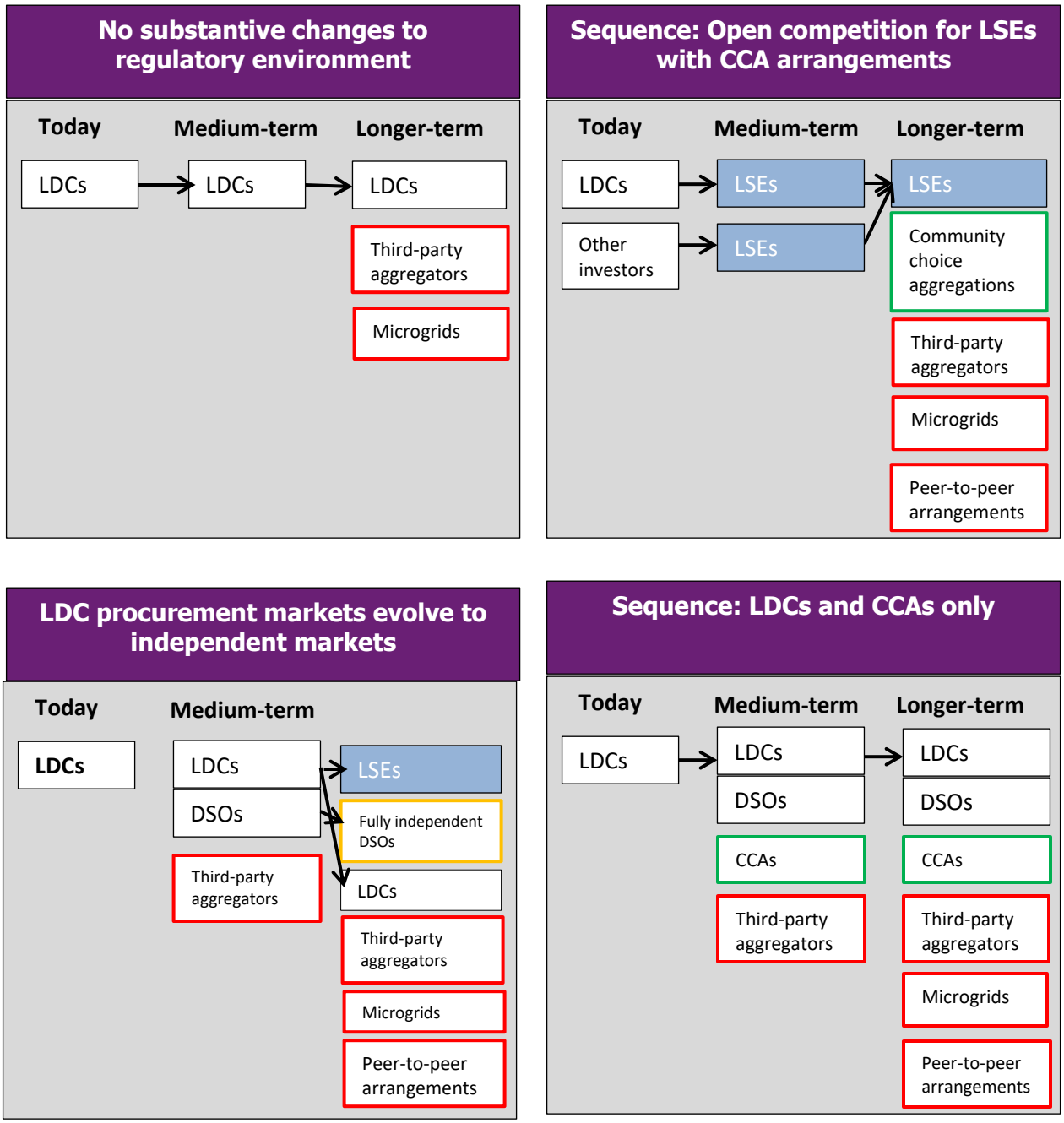
   - Complexity, time and cost of implementation
   - Ensuring sufficient market depth would warrant such an effort
   - Uniformity of implementation across the province

Figure 16: Potential intermediate pathways to distribution-level DER markets
Examples of various evolutionary steps set out in recent literature[26]



[26] Electricity Distributors Association (2018). *Power to Connect: A Roadmap to a Brighter Ontario*, and Massachusetts Institute of Technology (2016). *Utility of the Future: An MIT Energy Initiative response to an industry in transition, and* Power Advisory LLC, Aird & Berlis LLP (2018). *Policy Case: Recommendations for an Ontario Load-Serving Entity Model*. Ontario Energy Association.

Other potential development paths examined by ETNO



Section 5 – Summary of findings

A topic of growing importance

As this report was being completed, recent developments across North America continued to underscore the growing focus on how future DER expansion might affect the structure of the electricity industry. In addition to the growing body of literature with respect to how the electricity system, and particularly the distribution system, should be reshaped,[27] a number of industry organizations have made the role of DERs a priority:

- The U.S. Federal Energy Regulatory Commission is conducting an ongoing investigation regarding the potential participation of DERs in U.S. wholesale markets.[28]
- The U.S. National Institute of Standards and Technology is planning a comprehensive update to its smart grid interoperability framework – to catalogue the appropriate suite of standards to govern communications between utilities and DERs.[29]
- In its most recent *Reliability Outlook*, the IESO noted that, under certain system conditions, three quarters of DER production in Ontario can trip due to the effects of a transmission fault. This trip could be Ontario's single largest contingency (i.e., the single largest risk to reliability for which IESO needs to be prepared).[30]
- The North American Electric Reliability Corporation, which sets reliability standards for the continent's bulk electricity system, has recently constituted a cross-industry working group to examine key points of interest related to system planning, modeling, and reliability impacts to the bulk power system.[31]

In February 2019, the IESO published the draft results of its work conducted in conjunction with its Non-Emitting Resources Sub-committee (NERSC) and the Brattle Group. Among other things, the study explored how market prices may react under a range of scenarios, how future markets may interact, and what opportunities may exist for different electricity resources (including DERs) to compete to meet system needs.[32]

While not meant to be a predictive exercise in determining future DER growth, the NERSC report did investigate the potential implications of two decentralized future scenarios, involving high DER penetration and the attendant impact on future wholesale market prices. The differences in potential pricing outcomes between the "decentralized future" scenario and other scenarios presented in the

[27] See also, Section 3 of this report and References.
[28] Federal Energy Regulatory Commission (2018). *Participation of Distributed Energy Resource Aggregations in Markets Operated by Regional Transmission Organizations and Independent System Operators.*
[29] National Institute of Standards and Technology (2018). *Smart Grid Interoperability Framework Workshops* webpage. Accessed February 23, 2019. https://www.nist.gov/engineering-laboratory/smart-grid/smart-grid-interoperability-framework-workshops
[30] Independent Electricity System Operator (2018). *Reliability Outlook: An adequacy assessment of Ontario's electricity system from January 2019 to December 2023.*
[31] North American Electric Reliability Corporation (2019). *System Planning Impacts from Distributed Energy Resources Working Group (SPIDERWG)* webpage. https://www.nerc.com/comm/PC/Pages/System-Planning-Impacts-from-Distributed-Energy-Resources-Subcommittee-(SPIDERWG).aspx
[32] Independent Electricity System Operator (2019). *Participation in Ontario's Future Electricity Markets: A Non-Emitting Resource Subcommittee Report to the Market Renewal Working Group (DRAFT)*, 2.

report were significant.[33] However, as noted in the NESRC report, such scenarios would be dependent on customers being able to realize significant benefits from their DER investments in addition to any revenues they might realize from providing services to the electricity system. How that might actually happen in Ontario is not yet clear, but the potential stakes are significant.

The network effect

> *"Consumers should have the ability to obtain in-home energy management devices and services from their distribution utility, retailers or other providers of their choosing."*
>
> – Ontario Smart Grid Forum report recommendation, 2009

Much has been written about the transformation of the electricity system's traditional value chain spanning bulk generation, transmission and distribution. A common thread in this literature is the number of new stakeholder types entering the arena in a more distributed electricity system and one group that has always been there: the customer. The Lawrence Berkley National Laboratory's "Future Electric Utility Regulation" series of papers gives heavy weight to the potential network effect between regulated and unregulated segments of the industry. Ultimately, the customer should realize the net benefit of such an effect.

In its first public report in 2009, ETNO made a series of recommendations to maximize competition and choice for the benefit of consumers. In the decade since, the group's position has remained unchanged. See Appendix 2 for some of the group's past recommendations in areas ranging from data access to interoperability standards.

ETNO Finding:

ETNO sees no reason to change the stance it has maintained over the past decade to maximize consumer choice through competition, market access and open reliability standards. Many of these past recommendations are now more pressing than ever. What ***has*** changed, however, is a growing body of both policy and technical options for facilitating this goal.

In 2019, there has yet to emerge a formalized, standardized approach to facilitating DER markets and many of the latest technical concepts, such as blockchains, and transactive energy, have yet to be proven on a mass scale. A lack of clear standards in some areas may also serve to allow some market entrants to undermine the level of competition. Choices around roles, responsibilities and industry governance of these new marketplaces will be crucial in that regard.

[33] Independent Electricity System Operator (2019). *Participation in Ontario's Future Electricity Markets: A Non-Emitting Resource Subcommittee Report to the Market Renewal Working Group (DRAFT)*, 3.

Implications of policy decisions

Since 2009, discussions around the impact of the "smart grid" have focused on issues at the intersection point between the traditional electricity industry structure and an emerging market for DER-related products and services. Policy decisions around potential structural changes are particularly important and have been the main focus of this report. As discussed in section 3, there are significant and lasting implications for the each of these choices in terms of:

- **Competition and access to markets:** Similar to the debate over deregulation of the bulk electricity system 20 years ago, one of the most discussed issues in this paper is the proposition that wires ownership, market facilitation and DER commercial activities should be separated.
- **Reliability:** Unbundling the role of a distribution company may also diffuse responsibilities and accountabilities for the reliability of the electricity system, and recent events have shown that DERs can either have a positive or negative effect, depending on how they are utilized.
- **Developmental pace:** There are a number of potential, intermediate paths to get to a full-access market where DERs could compete to provide all manner of services to the electricity grid, such as capacity, energy, ancillary services, and asset deferral.
- **Over-investment risk:** Misreading the potential growth rate of DERs runs the risk of over-burdening the rate base of today's electricity system with elaborate policy mechanisms that may not be needed for a considerable period of time. This leaves the risk of stranded assets, consumer anger over rising costs, and an inappropriate level of public investment that serves a narrow range of interests.
- **Under-investment risk:** Conversely, there is the risk that DER growth may outstrip predictions, making the electricity system a bottleneck to consumer investment, and leaving a relatively uncompetitive market where the consumer is inadequately served.

- **Ontario's starting point:** As noted in Section 4, Ontario is unique in that it has different-sized, generally municipally owned LDCs. While uniformity in approach across the province has been a hallmark of Ontario electricity policy since 1906,[34] even Ontario's first legislation to institute the Hydro-Electric Power Commission of Ontario left each municipality to decide if and when to apply for an electricity supply agreement with the Commission.[35] Eventually however, that Commission became Ontario's monopoly provider for the next 90 years. Given the various sizes, resources, and DER penetration rates across Ontario's LDCs, serious consideration may need to be given to how, and when, various structural initiatives might take place across the province, and the lifespan of any intermediate measures.

ETNO Finding:

To help address some of the above considerations, policy-makers should take into account:

- **Reliability of the electricity system**: DERs are changing the scope of what an electric utility must do to maintain reliability.
- **Clarity of accountabilities for system reliability, security and resiliency:** No policy option or combination of policy options should leave unclear accountabilities over the core functions for running the distribution system. Here policy-makers could consider translating the NERC framework of roles and responsibility for the bulk electricity system onto the distribution system to ensure a clear and logical division of accountabilities for reliability-related functions, such as balancing, scheduling, planning, and interchange with neighbouring systems.
- **Financial accountability for DER investment:** Access to fair and efficient markets and competition should create a natural incentive for *all* potential DER investors (i.e., customers, third parties and utility companies) to signal their intentions to the marketplace regarding the size, price and capabilities of prospective investments and needs. Ensuring that the marketplace itself has the policy flexibility it needs to responds to those signals should be a crucial consideration. Establishing a clear separation between the entities that administer the markets and participate in them (i.e., own/operate DERs) is an essential consideration to maintaining investor confidence in those markets.

[34] With reference to *An Act to Provide for the Transmission of Electrical Power to Municipalities*, S.O. 1906, C. 15.
[35] Ibid. Section 7.

Section 6 – Next steps: reconciling competing viewpoints

This report began with a reference to the IESO's 2018 Electricity Summit, where delegates from across the electricity industry discussed Ontario's readiness for a high-DER future. As noted earlier, a survey of attendees suggested that more can and should be done in that regard – and that the entire industry has an interest in the next steps. The survey also addressed whether regulated utilities should be allowed to expand their business lines into DER-related services, a question that has resulted in sharp differences of opinion in the literature.

Regulated utilities should directly compete with third party providers of new value-added services...

Electricity Summit Participant Type	Always	Never	Only in market segments that are under-served by third parties	Only where additional value is created for the consumer	Only where such competition is regulated and fair
Consumer				1	2
Distributor/Transmitter	9	2		2	5
Energy Related Business/Service	5	2	2	7	14
Generator				3	5
GeneratorEnergy Related Business/Service	1				
Other	1		1	2	4
Post-secondary Institution				1	
Sustainability/Conservation Group			1		1

The response to this question hints at a possible consensus in the industry that would accept LDCs competing with third parties, provided competition is regulated and fair. With such a consensus comes perhaps the greatest challenge for regulators and policy-makers. Can and should incumbent utilities take on additional roles in facilitating DER markets and be a participant in those markets themselves? Ontario must not shy away from this question. It is of first order significance to choosing among the policy options presented in Section 3, the technical options presented in Section 4 and to determining whether or not Ontario should consider intermediate options for kick-starting a DER market in the province in a timely manner.

ETNO Finding:

A key next step to help guide policy-makers is to determine how roles and responsibilities for DERs may be allocated in the future. The aims should be to maximize benefits for Ontario consumers by undertaking an objective cost-benefit analysis of the options outlined, including an evaluation of the potential for stranded assets and cost shifting among consumers. The consequences of these decisions will be felt by Ontario homes and businesses for decades to come and must be made on more than the qualitative assessments of entities with vested interests in the outcomes. An exploration of financing models and approaches to stimulating new sources of investment and competition in the sector to optimize consumer benefits of DERs is also needed, along with a broadening of the policy dialogue to include potential new investors in discussions on electricity sector evolution.

Glossary of Terms – with citations from official definitions, where applicable

Definitions with formal legal standing in the province of Ontario, by right of legislation, regulatory instruments or NERC standards, appear in blue text.

Balancing authority: "The collection of generation, transmission, and loads within the metered boundaries of the balancing authority. The balancing authority maintains load-resource balance within this area.**"**[36]

Community choice aggregation: "For purposes of this chapter, ''community choice aggregator'' means any of the following entities, if that entity is not within the jurisdiction of a local publicly owned electric utility that provided electrical service as of January 1, 2003: (a) Any city, county, or city and county whose governing board elects to combine the loads of its residents, businesses, and municipal facilities in a communitywide electricity buyers' program. (b) Any group of cities, counties, or cities and counties whose governing boards have elected to combine the loads of their programs, through the formation of a joint powers agency established under Chapter 5 (commencing with Section 6500) of Division 7 of Title 1 of the Government Code. SEC. 3. Section 366.**"**[37]

Competitive retailer: "A person who retails electricity to consumers who do not take Standard Supply Service ("SSS")."[38]

Critical assets: "Facilities, systems, and equipment which, if destroyed, degraded, or otherwise rendered unavailable, would affect the reliability or operability of the Bulk Electric System."[39]

Critical cyber assets: "Cyber assets essential to the reliable operation of critical asset."[40]

Demand Side Management: "The term for all activities or programs undertaken by load-serving entity or its customers to influence the amount or timing of electricity they use."[41]

Distribution System Operator (DSO): "The entity responsible for planning and operational functions associated with a distribution system that is modernized for high levels of DERs. The term DSO is not intended to imply the need for a different entity from the existing utility." [42]

Distribute: "To convey electricity at voltages of 50 kilovolts or less."[43]

Distributor: "A person who owns or operates a distribution system."[44]

[36] North American Electric Reliability Corporation (2019*). Glossary of Terms Used in NERC Reliability Standards.*
[37] California State Assembly (2002). *An act to amend Sections 218.3, 366, 394, and 394.25 of, and to add Sections 331.1, 366.2, and 381.1 to, the Public Utilities Code, relating to public utilities.* C. 838.
[38] Ontario Energy Board (2019). *Distribution System Code*.
[39] North American Electric Reliability Corporation (2019*). Glossary of Terms Used in NERC Reliability Standards.*
[40] Ibid.
[41] Ibid.
[42] De Martini, P., Kristov, L., (2015). *Distribution Systems in a High Distributed Energy Resources Future: Planning, Market Design, Operation and Oversight*. Lawrence Berkeley National Laboratory.
[43] Ontario Energy Board (2019). *Distribution System Code*.
[44] *Electricity Act*, S.O. 1998, C.15, Sched. A. Consolidation Period: January 1, 2019 – March 25, 2019. Section 2.

Distribution owner (DO): "A state-regulated private entity, locally regulated municipal entity, or cooperative that owns an electric distribution grid in a defined franchise service area, typically responsible under state or federal law for the safe and reliable operation of its system."[45]

Distribution System: "A system for distributing electricity, and includes any structures, equipment or other things used for that purpose."[46]

Distributed energy resource (DER): "A resource sited close to customers that can provide all or some of their immediate electric and power needs and can also be used by the system to either reduce demand (such as energy efficiency) or provide supply to satisfy the energy, capacity, or ancillary service needs of the distribution grid. The resources, if providing electricity or thermal energy, are small in scale, connected to the distribution system, and close to load. Examples of different types of DERs include solar photovoltaic (PV), wind, combined heat and power (CHP), energy storage, demand response (DR), electric vehicles (EVs), microgrids, and energy efficiency (EE)." [47]

Independent DSO (IDSO) "An independent, state-regulated entity established to plan an integrated distribution system, procure DER services to operate the distribution system, and facilitate distributed energy markets in a non-discriminatory, open-access manner that ensures the safety and reliability of the distribution system. "Independent" means that the DSO is not affiliated with the buyers or sellers of wholesale or retail energy or capacity, or with the owners of the physical distribution assets. IDSO is a concept being discussed and not yet in operation."[48]

Load-serving entity: "Secures energy and transmission service (and related interconnected operations services) to serve the electrical demand and energy requirements of its end-use customers.**"[49]**

Microgrid: "A group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode."[50]

Retail: "(a) To sell or offer to sell electricity to a consumer (b) to act as agent or broker for a retailer with respect to the sale or offering for sale of electricity, or (c) to act or offer to act as an agent or broker for a consumer with respect to the sale or offering for sale of electricity." [51]

Smart Grid: "For the purposes of this Act, the smart grid means the advanced information exchange systems and equipment that when utilized together improve the flexibility, security, reliability, efficiency and safety of the integrated power system and distribution systems, particularly for the purposes of,

> (a) enabling the increased use of renewable energy sources and technology, including generation facilities connected to the distribution system;
>
> (b) expanding opportunities to provide demand response, price information and load control to electricity customers;

[45] De Martini, P., Kristov, L., (2015). *Distribution Systems in a High Distributed Energy Resources Future: Planning, Market Design, Operation and Oversight*. Lawrence Berkeley National Laboratory.
[46] *Electricity Act*, S.O. 1998, C.15, Sched. A. Consolidation Period: January 1, 2019 – March 25, 2019. Section 2.
[47] National Association of Regulatory Utility Commissioners. (2016). *Distributed Energy Resources Rate Design and Compensation,* 45.
[48] De Martini, P., Kristov, L., (2015). *Distribution Systems in a High Distributed Energy Resources Future: Planning, Market Design, Operation and Oversight*. Lawrence Berkeley National Laboratory.
[49] North American Electric Reliability Corporation (2019*). Glossary of Terms Used in NERC Reliability Standards.*
[50] Lawrence Berkeley National Laboratory (2019). *Microgrid Definitions* webpage. Retrieved from https://building-microgrid.lbl.gov/microgrid-definitions
[51] Ontario Energy Board (2019). *Distribution System Code*.

(c) accommodating the use of emerging, innovative and energy-saving technologies and system control applications; or

(d) supporting other objectives that may be prescribed by regulation"[52]

Wholesale market: In Ontario, the wholesale electricity markets are the "IESO-administered markets," which are the "markets means the markets established by the market rules." [53]

[52] *Electricity Act*, S.O. 1998, C.15, Sched. A. Consolidation Period: January 1, 2019 – March 25, 2019. Section 1.3
[53] Ibid. Section 2.

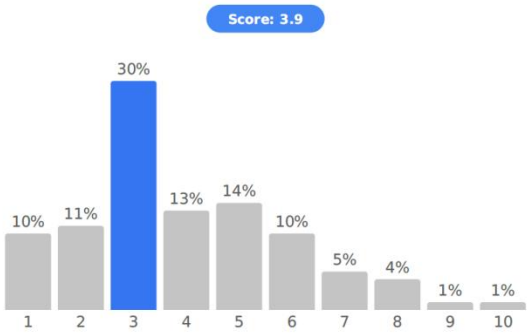
Appendix 1 – Survey results

Surveys conducted

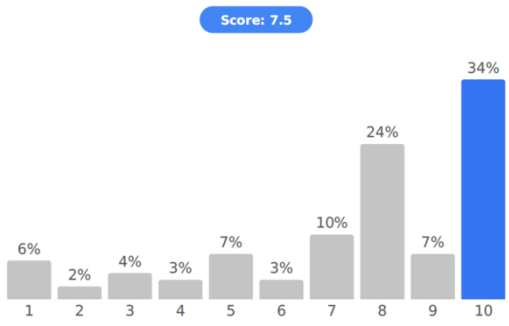
Survey and date	Sample size
Attendees at the IESO Electricity Summit (June 11, 2018)	n = 100 to 187 (varied by question)
Follow-up online survey sent to all IESO Electricity Summit attendees (June 12-15, 2018)	n = 82 (some questions not answered by various respondents)
Follow-up online survey for members of the Corporate Partners Committee (August 12-31, 2018)	n = 14

Survey 1 – Real-time survey of attendees at the 2018 IESO Electricity Summit

"Please rate your agreement with the following statement on a scale of 1 (strongly disagree) to 10 (strongly agree): Enough is being done to prepare Ontario's electricity system for large-scale DER deployment."



Please rate your agreement with the following statement on a scale of 1 (strongly disagree) to 10 (strongly agree): LDCs should generally be allowed to participate in distribution-level DER markets with a properly regulated separation of functions.



Survey 2 – Follow-up survey of attendees at the 2018 IESO Electricity Summit

Regulated utilities should directly compete with third party providers of new value-added services...

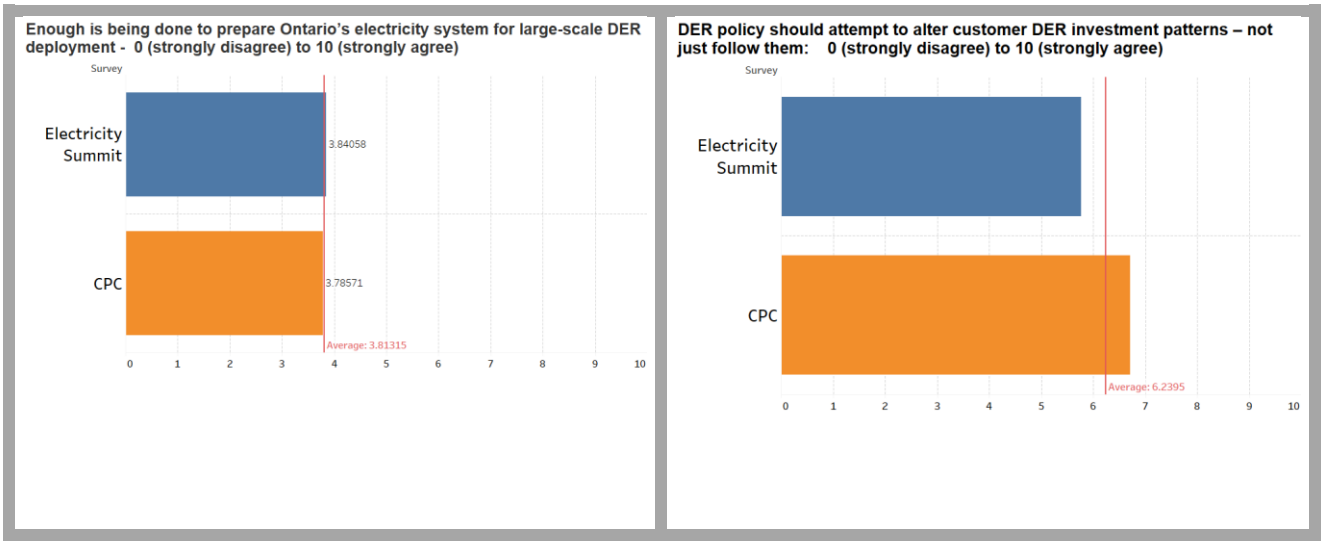
Electricity Summit Participant Type	Always	Never	Only in market segments that are under-served by third parties	Only where additional value is created for the consumer	Only where such competition is regulated and fair
Consumer				1	2
Distributor/Transmitter	9	2		2	5
Energy Related Business/Service	5	2	2	7	14
Generator				3	5
GeneratorEnergy Related Business/Service	1				
Other	1		1	2	4
Post-secondary Institution				1	
Sustainability/Conservation Group			1		1

Electricity Summit - Best Mechanisms for DER Participation - Average Score by Electricity Summit Participant listed in order of preference from one (highest preference) to six (lowest preference)

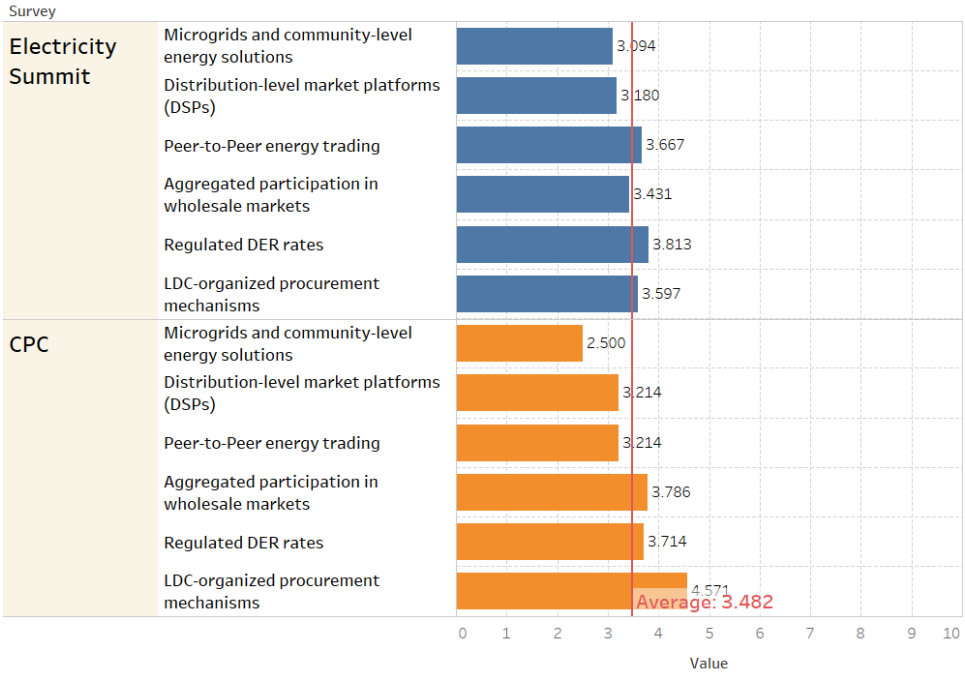
Electricity Summit Participant Type	Regulated DER rates	Aggregated participation in wholesale markets	Distribution-level market platforms (DSPs)	LDC-organized procurement mechanisms	Microgrids and community-level energy solutions	Peer-to-Peer energy trading
Consumer	4.000	1.000	5.000	4.000	4.000	3.000
Distributor/Transmi..	3.750	4.059	3.267	3.706	2.250	3.938
Energy Related Busi..	3.538	3.731	2.640	3.870	3.269	3.480
Generator	5.625	1.750	3.143	3.750	3.750	2.750
GeneratorEnergy Re..	4.000	3.000	2.000	1.000	6.000	5.000
Municipal Represent..						
Other	3.750	3.375	3.750	2.625	3.000	4.500
Post-secondary Insti..	1.000	4.000	6.000	2.000	3.000	5.000
Sustainability/Cons..	2.000	3.500	4.500	4.500	3.000	3.500
Grand Total	3.813	3.431	3.180	3.597	3.094	3.667

Survey 3 – Comparison of survey results of the Corporate Partners Committee (n= 19) with those of 2018 Electricity Summit attendees (n = 82)

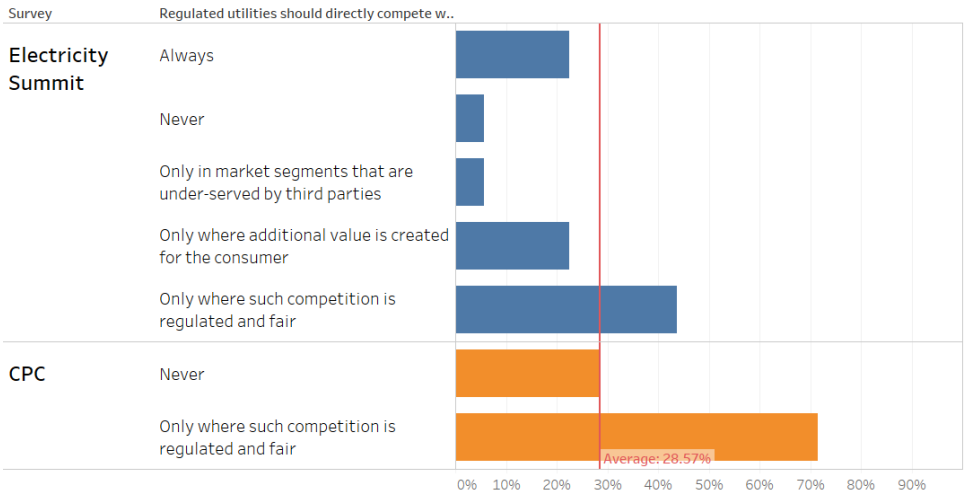
The illustrations below present the comparative results of four overlapping questions sent to delegates at the IESO Electricity Summit and the CPC Survey conducted the following month.



Best mechanisms for harnessing DER-related benefits Please rank the following list in order of preference from one (highest preference) to six (lowest preference):



Regulated utilities should directly compete with third party providers of new value-added services (please choose ONE):



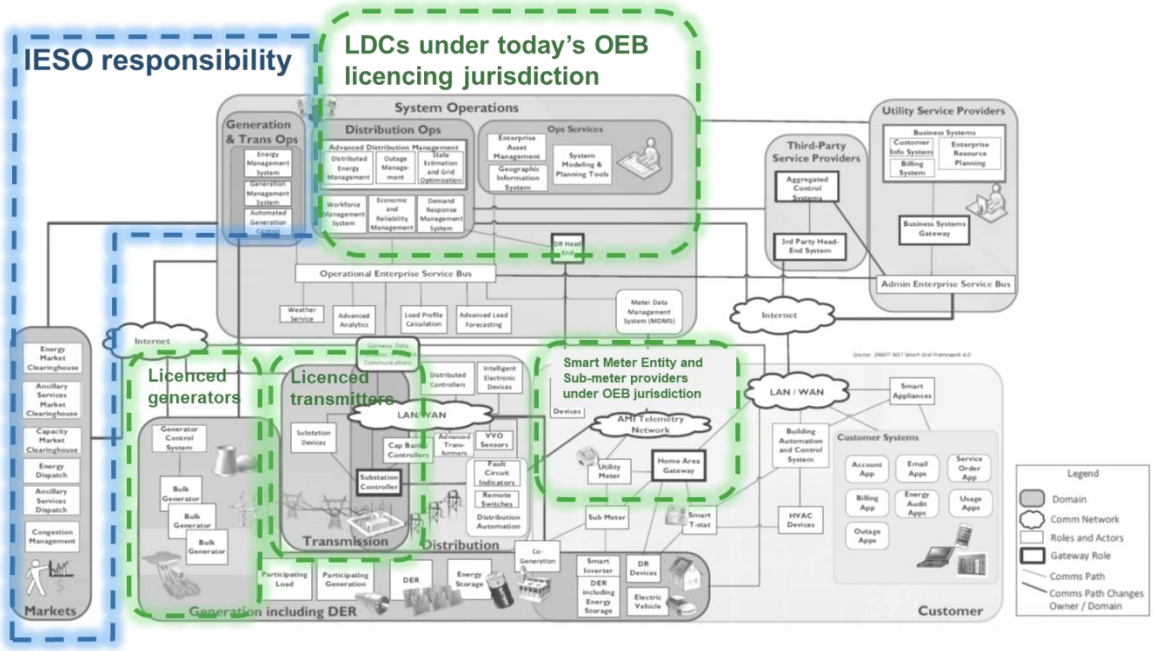
Appendix 2 – Previous Smart Grid Forum policy recommendations related to DERs and industry structure

ID No.	Recommendation	ETNO Report
N3	Barriers to facilitating third-party access to electricity consumers and their real-time consumption information should be addressed. The Forum and its Corporate Partners Committee will work with industry to resolve outstanding access issues, consistent with the Smart Grid Objectives set out in the government's directive to the Ontario Energy Board.	{From 2011 Forum Report}
N4	A test-bed environment should be established, devoted to furthering interoperability between emerging products and services, as well as the various proprietary Advanced Metering Infrastructure (AMI) systems deployed across the province as part of the Smart Metering Initiative. The Forum and its Corporate Partners Committee will work with industry to investigate the best path forward.	{From 2011 Forum Report}
N5	Industry and government should work toward meeting the development timelines established in the Smart Home Roadmap to bring greater control, choice, market participation and other benefits to electricity consumers. The Forum will monitor developments.	{From 2011 Forum Report}
N8	The Forum will promote and advocate activities that assist utilities with smart grid understanding, priorities, planning business change and leveraging their information advantage.	{From 2011 Forum Report}
N9	The Ontario Ministry of Energy should conduct an annual smart grid consumer engagement survey to gain insight into how smart grid products/services are benefiting consumers and influencing consumption behaviour. The results of this survey should be shared with industry .	{From 2011 Forum Report}
N10	The Ontario Ministry of Transportation should track the registration of electric vehicles and ensure that necessary information is provided to the electricity industry in a meaningful and timely manner. Where necessary, legislation and regulatory changes that facilitate this information exchange and protect consumer privacy should be made.	{From 2011 Forum Report}
N11	The source of accurate and timely information about the installation of Level 2 and higher charging stations should be identified and made available to assure the safe and reliable operation of LDC networks. The Forum will work with the automotive and electricity sectors to identify and recommend the appropriate parties and mechanisms for supplying this information.	{From 2011 Forum Report}
N12	The Ontario Power Authority (OPA) and Independent Electricity System Operator (IESO), in consultation with industry and the Ontario Energy Board (OEB), should jointly develop a framework to promote the integration of distributed energy storage with the grid where it is cost-effective.	{From 2011 Forum Report}
D3	In order to plan and operate the grid reliably and efficiently, distributors, transmitters, the OEB, OPA and the IESO should work together to:	{From 2009 Forum Report}
D3a	Develop requirements for and propose sufficient monitoring of distribution connected generation, energy storage, and responsive load	{From 2009 Forum Report}
D3b	Determine the authority necessary to direct the operation of these facilities, the conditions under which their operation could be directed and any compensation that would be provided to the facility	{From 2009 Forum Report}
D3c	Propose contractual and pricing arrangements with distribution connected generation, energy storage, and responsive load that support efficient grid operations and are consistent with the operation of the wholesale electricity market	{From 2009 Forum Report}

ID No.	Recommendation	ETNO Report
D3e	Coordinate the development and implementation of grid control and information systems to facilitate the actions listed above.	{From 2009 Forum Report}
N15	Industry and government, in collaboration with the Forum, should facilitate the gathering of data to support the early benchmarking and ongoing tracking of smart grid "success metrics." These metrics will be used to assess, over time, whether smart grid investments are delivering promised benefits.	{From 2011 Forum Report}
I1	To date, few success metrics related to smart grid-related innovation have actually been formalized or put under institutional ownership to track over time. This could and should be a crucial first step toward resolving the problem of mismatch between risk-return motivations between various entities involved in the innovation process.	{From 2015 Report}
N2	The Ontario Information and Privacy Commissioner should begin tracking smart grid-related consumer complaints with respect to how utilities and third parties use their information.	{From 2011 Forum Report}
N6	The interactions between LDCs and third-party service providers in each area of the smart grid value chain should be examined with an eye to removing barriers to consumer service adoption. The Forum and its Corporate Partners Committee will work with industry to facilitate this effort.	{From 2011 Forum Report}
N7	The role that aggregators can play in delivering benefits to consumers via the smart grid should be investigated and, where appropriate, specific recommendations should be developed to facilitate their participation in the market. The Forum and its Corporate Partners Committee will work with industry to address this issue.	{From 2011 Forum Report}
N13	Industry should take advantage of widely used interoperability standards for defining smart grid specifications. Attention should be paid to the upcoming national recommendations from the Canadian National Committee of the International Electrotechnical Commission and its Task Force on Smart Grid Technology and Standards (facilitated by the Standards Council of Canada), which is monitoring international standards discussions.	From 2011 Forum Report}
F2	To ensure the widest range of technological choices, entities investing in Ontario's electricity system and those developing home energy management systems should continue to work with standards organizations, such as IEC, IEEE, Zigbee and Home Plug, to develop and promote open communications standards.	{From 2009 Forum Report}
CR	Consumer recommendations are intended to assist consumers in making informed choices on electricity consumption and enabling them to manage their consumption in response to prices or to reflect other values. • Consumers and their designated representatives should have access to timely information on their consumption and the price they are being charged from a smart meter with two-way communication capability or via the internet. Consumers should pay prices that reflect the cost of energy at different times. • Consumers should have the ability to obtain in-home energy management devices and services from their distribution utility, retailers or other providers of their choosing. • The impact of home energy management systems should be tested through research and demonstration undertaken by those providing these systems. The non-proprietary results of these efforts should be widely shared. • The Ministry of Energy and Infrastructure in consultation with distributors, retailers and their providers of in-home devices and services should develop consumer education materials designed to explain how such devices and services can help manage electricity costs, improve comfort, help the environment and promote the reliability of the electricity system.	{From 2009 Forum Report}

C6	Immediate action should be undertaken to address the technical, legal, regulatory, commercial and institutional issues associated with developing a framework for micro-grid investment and the integration of microgrids with Ontario's electricity system – starting with a requirements gathering exercise by the utilities sector, consumers and private companies and aided by the regulator.	**{From 2009 Forum Report}**
D8	Distributors should continue to develop innovative demand response programs that will facilitate the cost-effective provision of distribution service or the deferral of distribution system investment.	{From 2009 Forum Report}
D9	The OPA, distributors and aggregators should strive to expand the range of demand response products available to maximize opportunities for all customer types to participate in demand response.	{From 2009 Forum Report}
E2	The IESO should continue exploring ways in which the market can evolve to take advantage of benefits enabled by the smart grid.	{From 2009 Forum Report}

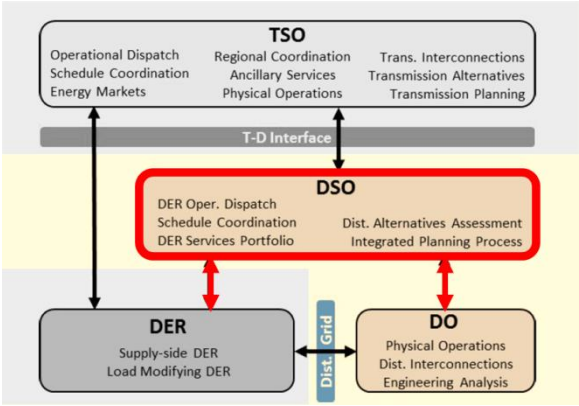
Appendix 3 – NIST "High-DER Communications Pathway Scenario", currently under consideration for inclusion in version 4.0 of the NIST Smart Grid Interoperability Framework as of February, 2019[54]



[54] Modified image from National Institute of Standards and Technology (2018). *Smart Grid Interoperability and Cybersecurity Workshop.*

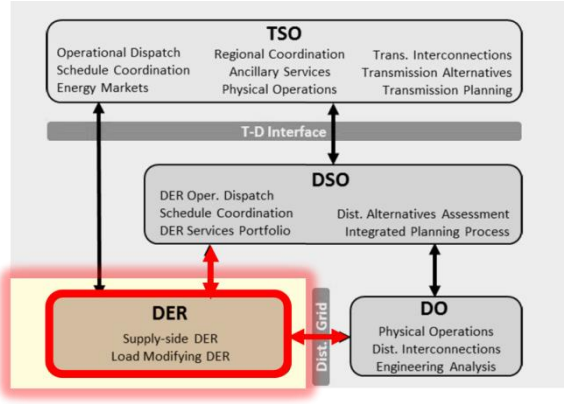
Appendix 4 – Examples of technical arrangements for harnessing mass numbers of DERs

DER procurement markets:



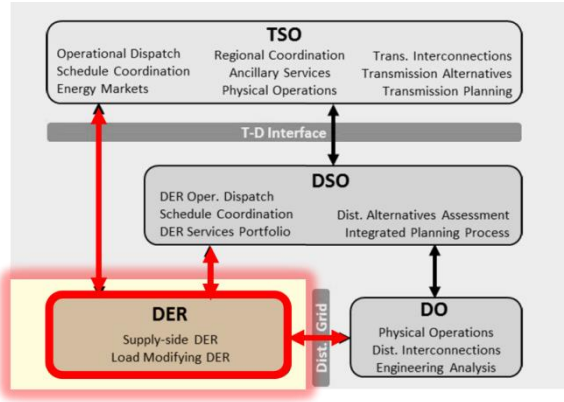
Key concept: Localized procurement markets orchestrated by DSO to procure specific services from DERs. The IESO will explore these concepts in the York Region Non-Wires Alternative Pilot.

DER-specific regulated rates:



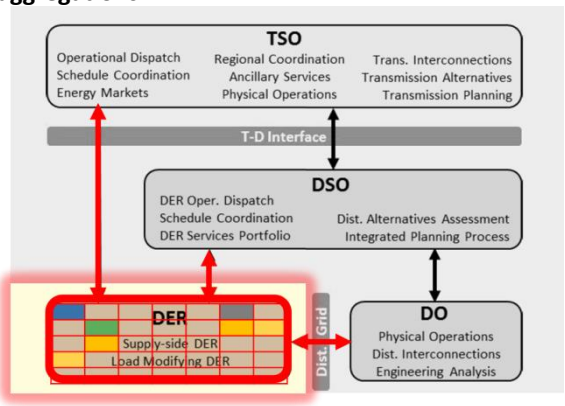
Key concept: Regulated rates specific to different types of DERs, tailored to incentivize certain types of services provided back to the electricity system.

Bifurcated DER rates:

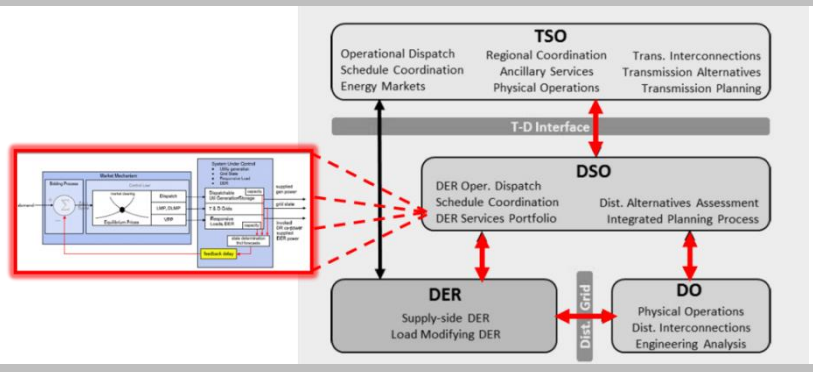


Key concept: Separation of network access fees from pricing of DER-related services sold to the electricity system.

Microgrids, Virtual Power Plants & DER aggregations



Key concept: Various types of aggregations at the community, microgrid, and virtual power plant (VPP) level harnessed to provide services to all levels of the electricity system.



Transactive Energy:

Key concept: Locational, dynamic pricing reflecting the value of system conditions, investor signals and DER owner choices at all nodes of the system. Can be used in conjunction with the concept of peer-to-peer energy trading, and/or organized DER markets at the distribution level.

Appendix 5 – ETNO members and CPC organizations

Members of the Energy Transformation Network of Ontario

Peter Gregg, President and CEO, IESO, and Chair, Energy Transformation Network of Ontario

David McFadden, Chair, Toronto Hydro Corporation and Vice-Chair, Energy Transformation Network of Ontario

Darlene Bradley, Vice-President, Planning, Hydro One Inc.

Nicolle Butcher, Vice President Strategy & Acquisitions

David Collie, President and CEO, Electrical Safety Authority

Scott Dodd, Director of Business Development, Enbridge Gas. Inc.

Jonathan Dogterom, Practice Lead, Cleantech, MaRS Discovery District

Mark Fernandes, Chief Information and Technology Officer (CIO), Hydro Ottawa Limited

William Milroy, Vice President, Engineering and Operations, London Hydro

Dr. Jatin Nathwani, Professor and Ontario Research Chair in Public Policy and Sustainable Energy Management, Faculties of Engineering and Environmental Studies, University of Waterloo

Alexandre Prieur, Smart Grid Project Leader, Innovation and Energy Technology Sector, Natural Resources Canada (NRCan)

Neetika Sathe, Vice President, GRE&T Centre, Alectra Inc.

Katherine Sparkes, Director, Innovation, Research and Development, Independent Electricity System Operator

Francois Trofim, Director, Technology & Innovation, Union Gas Limited (to the end of 2018)

Raymond Tracey, CEO, Essex Power

Joe Van Schaik, Electric Power Market Manager at Tormont Cat

Terry Young, Vice President, Policy, Engagement and Innovation, IESO

Observer members:

Karen Clark, Director Distribution and Agency Policy, Ontario Ministry of Energy, Northern Development and Mines

Brian Hewson, Vice President, Consumer Protection & Industry Performance, Ontario Energy Board

Members of the ETNO technical working group:

Edward Arlitt, IESO

Raed Abdullah, Hydro Ottawa

Normand Breton, Electrical Safety Authority

Member companies of the Corporate Partners Committee, facilitated by the Ontario Energy Association

Ron Dizy, Corporate Partners Committee Chair

Linda Wainewright, Corporate Partners Committee Vice-Chair

129 Group	Kangaroo Group
Accenture	Landis+gyr
Aird & Berlis LLP	MaRS
Alpha	Ontario Centres of Excellence
Aztech Inc.	Ortech
Certicom	Peak Power
Clear Results	Prolucid
CSI Software	PwC Canada
Direct Energy	QUEST Canada
Ecamion	RIM
Ecobee	Rotman – UoT
Electrovaya	Sandc
Elster	Siemens
Enbala	Sky Energy Consulting
Enel X	Soft Grid Analytics
Energate Inc.	Summitt Energy
Energent	Sustainable Resources Management Inc.
Erth Corp	Temporal Power
General Electric	Total Energy Advice & Management Ltd.
General Motors	TRCA
Hydrogenics	Union Gas
Hydrostor	Util-Assist
IBM	Wainewright Consulting Ltd.
iGen Technologies	Zero Footprint

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