Innovation and Sector Evolution White Paper Series

Exploring Expanded DER Participation in the IESO-Administered Markets

PART 1 – CONCEPTUAL MODELS FOR DER PARTICIPATION

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Contents

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LIST OF ABBREVIATIONS

Abbreviation	Description
CAISO	California Independent System Operator
DER	distributed energy resource
DR	demand response
DRA	demand response auction
FERC	Federal Energy Regulatory Commission
FIT	Feed-in Tariff
IAMs	IESO-administered markets
ICI	Industrial Conservation Initiative
IESO	Independent Electricity System Operator
ISO/RTOs	independent system operators/ regional transmission organizations
LDC	local distribution company
MRP	Market Renewal Program
NERC	North American Electric Reliability Corporation
NYISO	New York Independent System Operator
OEB	Ontario Energy Board
OR	operating reserve
T-D	transmission-distribution

Executive summary

Distributed energy resources (DERs) are transforming the electricity sector in Ontario and in other jurisdictions around the world. Traditionally, electricity systems have relied on power from large generators, transmitted across long distances into communities, businesses and homes. DERs are beginning to upend this traditional framework. Drivers like decreasing costs and emerging customer preferences are converging to make smaller distribution-connected resources an increasingly viable alternative to the status quo.

In Ontario, these drivers and past policy objectives have resulted in tens of thousands of DERs being connected to the low-voltage distribution system. Together these resources already represent approximately 10 per cent of installed capacity in the province – and the volume of DERs continues to grow.

DERs have the potential to provide substantial value to Ontario's electricity system. There are, however, many questions that must be answered in order to maximize the benefit that DERs can deliver. One key area for exploration is how DERs can best be integrated into the electricity markets administered by the IESO.

About this paper

This white paper is the first in a two-part series that will identify high-level options for integrating DERs into the IESO-administered markets (IAMs).

The focus of this white paper is twofold: to set out the participation models that exist for DERs in wholesale markets in general and in the IAMs today; and identify the range of options that exist for expanded participation in the future. In addition, this paper provides a working definition of DERs, sets out principles for integrating them into wholesale markets, offers an initial review of participation models in other jurisdictions, and identifies key barriers that may limit DER participation in the IAMs.

This white paper is intended as a discussion paper. The IESO invites stakeholder feedback to inform development of the companion paper, which will identify potential options for integrating DERs into the IAMs in the near to mid-term, longer-term options that require further exploration, and areas where demonstration projects would be beneficial.

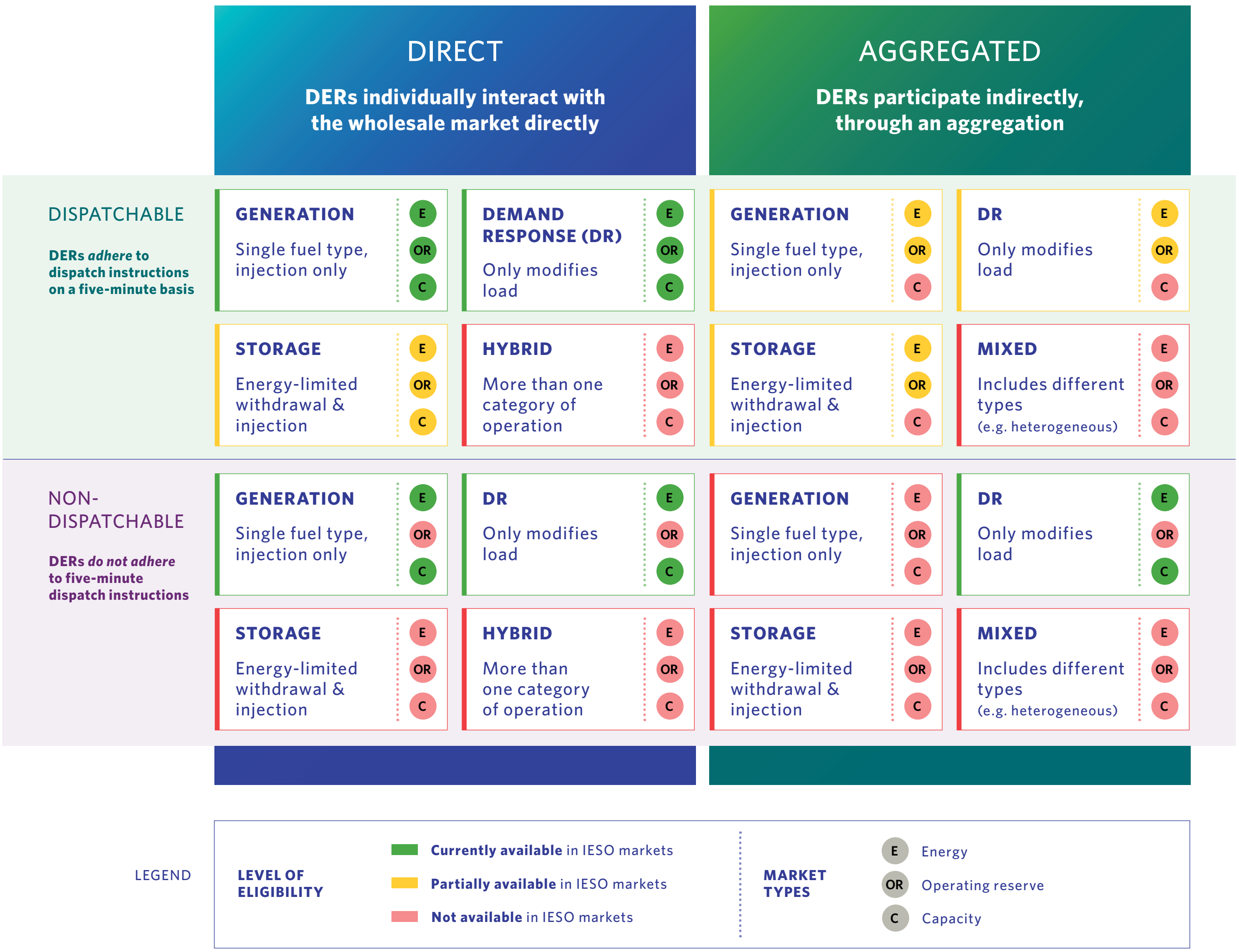
Key findings

As illustrated in Figure 1, there are many potential participation models for DERs in wholesale markets, but only a small subset is fully enabled in Ontario today. Generally speaking, only directly participating generators, directly participating demand response (DR) and aggregated non-dispatchable DR resources currently have fully enabled participation models.

Limited options currently exist for DERs to participate in the IESO-administered markets (IAMs)

Certain other models are partially enabled, including directly participating storage and – in some limited circumstances – aggregated dispatchable generation, DR and storage. Still other participation models, like aggregations of multiple resource types, are not enabled at all.

FIGURE 1: OVERVIEW OF EXISTING AND POTENTIAL DER PARTICIPATION MODELS IN ONTARIO



Note: Participation models listed as currently or partially available, are only open to resources that meet the IESO's current minimum-size threshold of 1 MW. A resource's participation through these models is also subject to additional requirements and considerations.

> *Key barriers need to be examined to identify practical approaches for expanding DER participation in the IAMs*

As a foundational principle, the IESO is committed to enhancing competition within the IAMs. For specific technologies, such as energy storage and demand response, the IESO has processes in place to explore enhanced participation. As a result, the white papers in this series focus on barriers that apply to broad groups of DERs, regardless of technology.

Stakeholders in Ontario, and experience elsewhere, have helped to uncover key barriers that limit DER competition today. The most substantial of these relate to the minimum-size threshold and rules for aggregation. Because DERs are often relatively small resources, they may not qualify for direct participation in wholesale markets. Reducing the minimum-size requirement for direct participation is one way to address this barrier. Another option is to allow groups of DERs to participate through an aggregation. Both of these approaches come with challenges and benefits. A thorough exploration of these and the other barriers identified within this report is crucial to identify practical approaches for expanding DER participation in the IAMs.

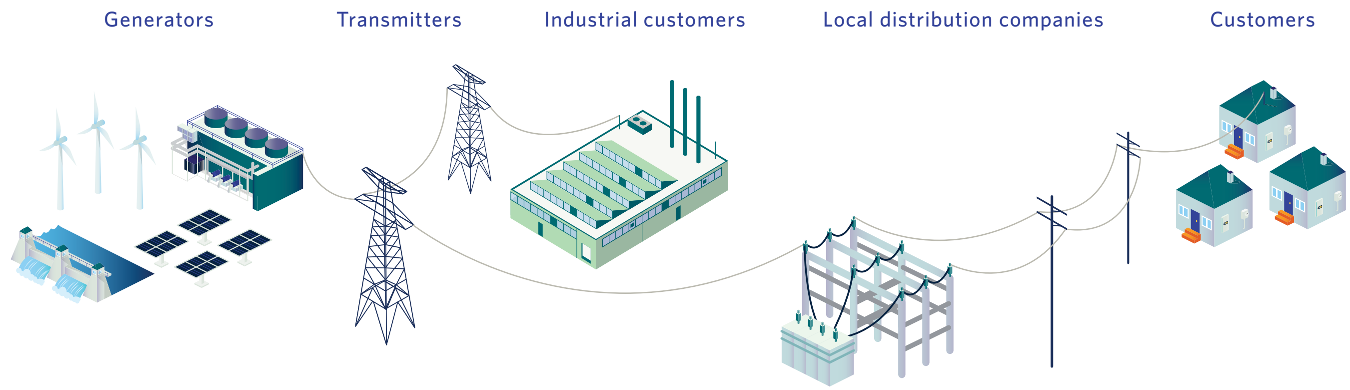
Next steps

The IESO is seeking stakeholder feedback on this discussion paper to inform the exploration of options for integrating DERs into the IAMs. In particular, the IESO is seeking stakeholder feedback on the barriers set out in this report, as well as any lessons learned resulting from the experience of other jurisdictions in addressing those barriers.

1. Introduction

Traditionally, electricity has been supplied through large centralized generators that connect to the high-voltage transmission system (e.g., hydroelectric, natural gas, and nuclear facilities). With the exception of very large consumers of electricity, the demand for electricity has historically been somewhat inflexible – with smaller consumers either not exposed to market signals and/or not able to react to them.[1]

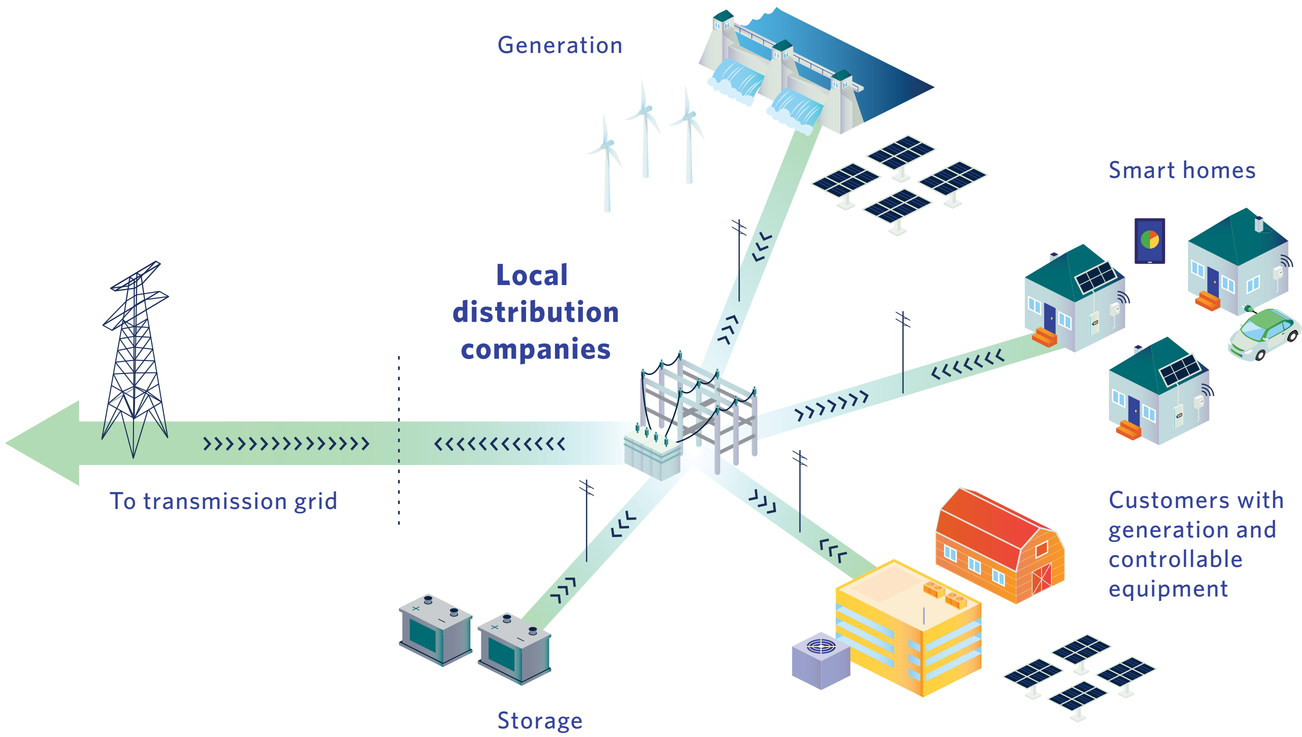
FIGURE 2: THE TRADITIONAL TOP-DOWN MODEL OF THE ELECTRICITY GRID



The dynamic shown in Figure 2 is in the process of being upended, in large part due to the rapid growth of distributed energy resources or DERs. Connected within the electricity grid's distribution system as opposed to the high-voltage transmission system, DERs are energy sources or loads that interact dynamically with the electricity grid. DERs include devices, such as rooftop solar panels, smart thermostat-connected air conditioners and home batteries, that generate or store electricity, or control load. The emergence of DERs gives consumers and communities more choice with respect to the types of resources that produce their electricity (e.g., local and clean generation), and the level of reliability (e.g., through back-up power). As DERs proliferate, their collective ability to influence conditions on the electricity grid increases – in ways that were not envisioned when electricity systems and markets were designed.

[1] In 2006, Ontario's local distribution companies (LDCs) began rolling out "smart" electricity meters, allowing broad implementation of time-of-use electricity prices for residential and small business customers. However, studies on the impacts of this rate structure have indicated only modest changes in consumption patterns [16]. In 2018, the Ontario Energy Board (OEB) and LDCs began piloting more advanced time-varying rate structures, including those intended to be paired with DERs and automation, to evaluate their impacts on consumption patterns [32].

FIGURE 3: DISTRIBUTION GRID CONTAINING DISTRIBUTED ENERGY RESOURCES



Electricity system operators are taking note of the potential of DERs

Due to their potentially large impacts, DERs are receiving greater attention from independent system operators/regional transmission organizations (ISO/RTOs), which have a mandate to administer electricity marketplaces that ensure reliability and provide the best value for ratepayers.

Other ISO/RTOs in North America are making proactive efforts to integrate DERs into their electricity markets. The New York Independent System Operator (NYISO) is seeking to support DER uptake to meet its system needs and satisfy state public policy objectives.[2] The California Independent System Operator (CAISO) is also pursuing DER integration in its markets[3] to better manage the already large – and growing – volume of DERs in the state. The Federal Energy Regulatory Commission (FERC), which governs ISO/RTOs[4] in the U.S., has also issued orders requiring the integration of subtypes of DERs (particularly demand response[5] and electricity storage[6]), and may issue further orders for DER integration, compelling compliance by ISO/RTOs.[7] Generally speaking, FERC's regulatory goal is to ensure that ISO/RTO markets treat DERs equitably by enabling fair market participation and compensation for services they are technically capable of and willingto provide.

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[2] For an overview of the NYISO's DER integration activities, see [34, pp. 38-46]

[3] For a list of the CAISO's DER integration activities, see [26]

[4] ISOs refer to independent system operators; RTOs refer to regional transmission organizations. While they both control, coordinate, and monitor the operation of the bulk power system, RTOs cover a larger multi-state geographic area than ISOs, which typically encompass a single state or province. For the purposes of this paper, their functionality in the administration of the bulk system and electricity markets is considered to be similar, and they are referred to collectively as ISO/RTOs.

[5] See FERC Order 719 in [18] and FERC Order 745 in [30]

[6] See FERC Order 841 in [28]

[7] While it was initially expected that FERC would issue an order for DERs in conjunction with the order on storage, the regulatory body instead opted to hold a technical conference on DERs to study the issue further; see [23]. At the time this document was published, it had not indicated that an order for DERs was pending.

Ontarians are early adopters of DERs

Ontario has also made progress on incorporating DERs into the electricity system. This growth in DERs has been largely driven by policy, rather than through electricity market integration. Mechanisms that have supported DERs in the province have included:

- Feed-In Tariff (FIT) and micro-FIT programs, which provided a fixed rate per kWh injected into the grid
- The provincial net metering regulatory framework, which allows customers to use electricity they generate from renewable energy to offset their consumption, and receive credits on their electricity bill for electricity they provide to the system
- Conservation programs that support behind-the-meter generation projects
- Time-of-use pricing, which allows customers to benefit from shifting their consumption from higher-priced to lower-priced periods
- The Industrial Conservation Initiative (ICI), which has driven large electricity consumers to manage consumption during peak hours to lower their electricity bills
- The IESO's demand response auction (DR auction)

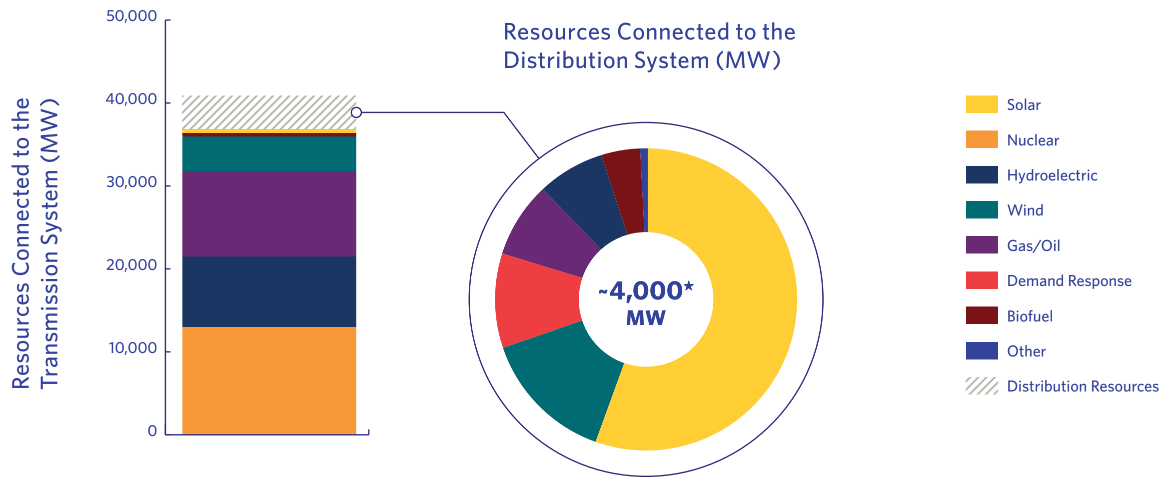
The combined impact of these mechanisms has led to a large number of DERs on Ontario's electricity system. Today, the IESO estimates that DERs make up more than 10 per cent of the province's installed capacity.

The IESO's demand response auction

The DR auction was the IESO's first competitive market for capacity. Since launching in 2015, the auction has succeeded in increasing competition among demand-response providers (including industrial, commercial, and residential), using a variety of technologies, and significantly reducing the costs as a result.[8]

[8] The DR auction demonstrated reduced costs when compared to previous experiences by the IESO in contracting for DR. Furthermore, successive iterations of the DR auction have seen substantial cost declines – dropping 43 per cent since the first auction period [25].

FIGURE 4: DER PENETRATION IN ONTARIO



*Includes projects that are in service and under development

Currently, limited visibility into DERs impacts the ability of the IESO and local distribution companies (LDCs) to plan and operate the electricity grid

DERs operating outside of the IAMs represent a growing proportion of potential grid resources that are not visible to the IESO. This inability to know what DERs exist, where they are located, how they are behaving and how they are capable of behaving, can increase system costs in several ways:

- The IESO's control room operations, which occur in real-time, may over- or under-schedule resources to account for ambiguity surrounding the real-time performance of DERs
- Additional assets (or additional performance from existing assets) may be needed to account for uncertainty around DER operations – for example, the IESO may choose to schedule additional operating reserve (OR)
- The efficiency of long-term resource planning – for example, the determination of resources the IESO needs to acquire to ensure reliability – may be compromised
- The capabilities and potential benefits of DERs may not be adequately accounted for and leveraged in the planning process

Similar concerns may also affect the distribution portion of the electricity grid managed by Ontario's LDCs.

DER participation can unlock value *within* IAMs

If existing DERs could participate more easily in the IESO-administered markets for energy, operating reserve and capacity, they would become more visible and available to the IESO, without requiring the construction of new infrastructure. Many commercial buildings have building automation systems that can manage loads from lighting and HVAC systems; others have resources for back-up power that are seldom used. Enhancing participation models would enable these resources to compete against traditional resources in offering cost-effective and reliable energy solutions within the IAMs. Eligibility to compete in the IAMs would also influence owners' decisions to invest in new DERs, by enabling them to take advantage of revenue opportunities that were not previously available. DER integration can also allow existing contracted DERs, such as FIT and microFIT projects, to compete to deliver value to the electricity grid when their contracts expire.

DER participation can unlock value *beyond* IAMs

Since DERs are located on the distribution system, and often behind the meter of an electricity customer, they have the potential to provide value across the entire electricity system, including at the:

- Customer level by managing electricity bills, providing back-up power and fulfilling a customer's preference for a certain resource type
- Distribution level by providing local backup (e.g., a micro-grid), and either deferring or avoiding the need to invest in distribution infrastructure, and fulfilling a community's preference for a certain resource type
- Transmission level by providing energy, back-up energy (i.e., OR), capacity, and either deferring or avoiding the need for transmission infrastructure investment

In Ontario, the IESO and others, including the Ontario Energy Board, are focused on determining how to unlock these multiple value streams, to pave the way for DERs to compete and be compensated for the services they can provide. In allowing DERs to *stack value* and *compensation* appropriately, DERs can become an increasingly cost-effective solution for the growing categories of services they can provide.

This white paper focuses on the pathways for enabling DER participation in three particular wholesale markets: energy, operating reserve and capacity. However, it's important to note that doing so would facilitate DER opportunities to provide a broad range of other services by virtue of contributing to the value stack.

Successful DER integration is not without challenges

One overarching challenge to the effective integration of DERs relates to the ability of DERs to comply with the rules and processes established by ISO/RTOs. While these rules and processes are imposed to ensure the reliability of the bulk electricity system, compliance with them typically benefits from economies of scale. For example, ISO/RTOs might require resources to have telemetry (e.g., the periodic communication of the resource's output), along with a secure network connection – an expense that might be out of reach for small resources.

Similarly, the IESO faces costs and challenges in adapting its rules, processes and systems for smaller, new and more numerous resources like DERs. For example, the IESO may need to make costly upgrades to its computer systems and modelling software to accommodate DERs. Potential operational conflicts may arise between the IESO-controlled bulk power system, and the distribution systems to which DERs connect. Without adequate coordination, for example, DERs dispatched to meet a need on the transmission system could end up worsening conditions on the distribution system, and vice-versa, compromising the benefits case (see Section 8.5). This complex topic will be addressed in more detail in the IESO's forthcoming white paper on transmission-distribution interoperability.

About this paper

In developing a framework for understanding the options for DER participation in wholesale markets, this paper investigates how Ontario's current market participation models and systems accommodate DERs, and reviews those being considered or implemented in other jurisdictions. Additionally, it focuses on identifying barriers, including market rules, tools and processes, that either inhibit the participation of DERs, and/or prevent the IESO from achieving its principles with respect to DER integration.

Finally, this paper sets the course for subsequent and more detailed work that can lead to the eventual integration of DERs. This future work includes developing high-level options to integrate DERs and overcome integration barriers (the topic of the second white paper), evaluating those options against one another and against other potential IESO projects or market enhancements and, pending the outcome of those evaluations, proceeding with solutions.

2. What are distributed energy resources?

While the interest in and promise of DERs continues to grow, there is no universal agreement on what constitutes a DER, since most definitions tend to reflect the purpose to which they apply. For example, in 2014, New York State's Reforming the Energy Vision process – a strategy to build a clean, resilient, and affordable energy system for all New Yorkers, used the following definition:

> *"Distributed energy resources (DER) is used in this context to include energy efficiency, demand response (DR), and distributed generation (DG)."* [1]

The definition above notably includes energy efficiency, an important tool that results in persistent load reductions, and that can also be targeted to meet capacity needs at the bulk and local levels. Unlike the other resources listed in this definition, energy efficiency does not inject electricity into the grid, and cannot be scheduled or dispatched to meet system needs. As such, it has typically not been incorporated in the definitions that ISO/RTOs use for their DER integration efforts, which are focused on enabling participation in the energy markets.[9]

For example, in scoping the definition of DERs for the purposes of integrating them into its electricity markets, the New York Independent System Operator (NYISO) used a narrower definition:

> *"The NYISO defines DER as a resource, or a set of resources, typically located on an end-use customer's premises that can provide wholesale market services but are usually operated for the purpose of supplying a customer's electric load. DER can consist of curtailable load (demand response), generation, storage, or various combinations aggregated into a single entity."* [2]

Once specific market rules are developed, the definition of DERs can become even more precise to navigate the legal and defined terms that make up an ISO/RTO's market rules. To illustrate the degree of technical specificity used, the NYISO adopted the following definition in its market rules:

> *"(i) a facility comprising two or more resource types (excluding the aggregation resource type) behind a single point of interconnection with an injection limit of 20 MW or less; or (ii) a demand side resource; or (iii) a generator electrically located in the NYCA with an interconnection limit of 20 MW or less, that is electrically located in the NYCA."* [3]

[9] Despite this exclusion, several ISO/RTOs have made energy efficiency eligible for participation in their capacity markets. Other ISO/RTOs have elected to remunerate energy efficiency for the value it provides to the system in other ways.

To guide its own DER market integration work, the IESO proposed a working definition that maintains the principle of technology neutrality, in alignment with the IESO's ongoing market reforms:

A distributed energy resource is a resource that:

1. Is directly connected to the distribution system, or indirectly connected to the distribution system behind a customer's meter; and
2. Generates energy, stores energy, or controls load

This definition groups distribution systems that share a common and distinct set of challenges relative to transmission-connected resources (e.g., distribution system impacts, modelling). This working definition excludes resources connected directly to the transmission system, those behind the meter of transmission-connected customers, and imports into the province. Such resources are already integrated in and capable of participating in the IAMs.

The above definition also accommodates the individual or combined operational capabilities of generators, energy storage devices, and load-control devices – all of which have the ability to change the dynamics and expected behaviour of the system by changing power flows, and modifying net demand and loading of network equipment. Although the working definition does not include energy efficiency, the IESO recognizes its value and is exploring competitive procurement opportunities through the *energy efficiency as a capacity resource pilot auction*.

While all resources that meet the above requirements can be considered DERs as per the working definition, not all are capable of participating or eligible for participation in the IAMs for reasons explored later in this white paper.

3. What markets are being considered for DER integration?

While ISO/RTOs manage several bulk system products, this paper focuses on the three markets the IESO currently administers: energy, operating reserve and capacity.[10] These bulk system products are described here briefly. Section 7 will look at whether and how DERs are able to participate in these markets in Ontario.

3.1 Energy market

Energy markets are foundational to ISO/RTOs because they reliably and efficiently match the supply of electricity with the demand for electricity. All ISO/RTOs have real-time markets, which match supply and demand in real-time, and most have day-ahead markets, which allow participants to lock-in prices a day in advance of operation. Ontario currently has a real-time energy market, and is developing a day-ahead market as part of the IESO's Market Renewal Program. Typically, ISO/RTOs schedule most supply in the day-ahead market, and the real-time market is used to balance any deviations that occur between the day-ahead and real-time periods. For most ISO/RTOs, eligibility to participate in the energy market is a prerequisite to participation in the other market types described later in this section.

Participating in the energy market means registering with the ISO/RTO as a market participant for:

- Buying and/or selling energy in the wholesale market
- Submitting bids/offers and responding to dispatch instructions through the energy market, to earn revenue in another wholesale market (for example a capacity market)[11]

ISO/RTOs typically set a minimum-size threshold for resources participating in the energy market (as well as other requirements that will be discussed in Section 8). If a resource's participation in other markets hinges on energy market participation (e.g., for operating reserve or capacity), then the energy market minimum-size threshold typically also impacts those other markets.

[10] Other products, like black start (the ability to restore the grid during complete outage) and regulation (balancing slight differences in supply and demand on a second-by-second basis) are acquired by the IESO through procurements and not through markets. Further, the IESO requires minimal volumes of these products relative to energy, operating reserve and capacity (which are acquired or plan to be acquired through markets). While DERs may be technically capable of delivering such products, exploring such participation is outside the scope of this paper.

[11] For example, hourly demand response (HDR) participants in IESO's demand response auction bid into the energy market, but don't purchase or sell energy in the market; rather they earn auction revenue (effectively a payment for the capacity they provide); see [24].

3.2 Operating reserve

Having enough energy available to meet demand is a critical component of reliability. While ISO/RTOs like the IESO schedule sufficient supply to meet forecasted demand, certain events can lead to an imbalance between supply and demand, including:

- Sudden or unexpected increases in demand
- Generation loss, or several generators not being able to follow dispatch instructions
- Loss of a transmission element

To mitigate the impacts of such events, ISO/RTOs use operating reserve (OR), which is a readily available source of stand-by energy that can be called upon with short notice. ISO/RTOs are required to schedule a minimum amount of OR to meet the standards set by reliability councils.[12]

There are typically multiple markets for OR, which are distinguished by:

- The time required to bring the energy into use (e.g., 10 minutes or 30 minutes)
- Whether the source of energy is "spinning" (i.e., an energy source that is already on-line and synchronized with the grid), or "non-spinning" (i.e., an energy source that is not synchronized to the grid)

Participation as a dispatchable resource in the energy market is typically required for participation in the OR market, as is the case in the IAMs.[13]

The IESO recently expanded the role of its operating reserve market

In May 2018, the IESO allowed for the broadened use of OR to meet the need for additional system flexibility. As well as using OR for the events listed above, the IESO can now schedule and use OR to address significant and abrupt changes in the output of variable generation (i.e., ramping events), material differences in variable generation output relative to forecasted output, or material differences in electricity demand relative to forecasted demand [38].

[12] The IESO is under the jurisdiction of the Northeast Power Coordinating Council (NPCC), as well as the North American Electric Reliability Corporation (NERC).

[13] Many ISO/RTOs, including the IESO, have joint optimization (also known as "co-optimization") of the energy and OR markets [40]. In such markets, OR market participants must also participate in the energy market.

3.3 Capacity

Capacity refers to a resource's availability to provide energy or reduce load when required. To operate a reliable electricity system, ISO/RTOs must ensure that adequate capacity is available to meet peak demand. In most jurisdictions, the forecasted revenues from energy markets alone are regarded as insufficient to ensure that adequate capacity is built and maintained. While energy market revenues may help supply resources recover their marginal costs of operating, they do not ensure that fixed costs can eventually be recovered. Consequently, most ISO/RTOs compensate resources for their capacity contributions.[14] Mechanisms to acquire capacity can include competitive procurements for resources traditionally known to provide reliable capacity (e.g., gas generation), and, increasingly, technology-agnostic competitive procurements. Demand response is a common method of obtaining capacity from DERs in ISO/RTO markets. While demand response participation models rely on DERs being available to reduce customer load when called upon by an ISO/RTO, in exchange for a capacity payment, they do not typically allow any contributing resources (e.g., behind-the-meter generation or storage) to inject energy into the electricity grid, and so may not be viable for generation, storage or hybrid resources. Another mechanism commonly used by ISO/RTOs is a capacity market, which is used to acquire capacity in a technology-neutral manner, at the lowest cost to consumers. Capacity markets can allow participation from both load-modifying resources (like demand response), as well as generation resources (that inject energy into the grid).

While the IESO has previously used targeted procurements to acquire capacity resources, it has recently begun to acquire additional capacity, on a shorter-term basis, through competitive auction processes. This approach was first introduced through the IESO's demand response auction, and going forward, will be accomplished through capacity auctions.

[14] In energy-only markets, resources typically recover their fixed costs through price spikes in the energy market. For resource owners, the long-term revenues from these price spikes may be hard to predict. Regulators may impose caps on energy market prices to protect consumers from volatility; this has the effect of supressing revenues from the energy market. For prospective generators, this is referred to as the missing money problem. For a detailed explanation of the rationale for capacity markets over energy-only markets, see [35].

4. Principles for integating DERs into IAMs

To guide the process of integrating DERs into the IAMs, the IESO has developed seven principles.

DER integration should seek to:

1. **Provide an appropriate level of visibility into the resources operating within the distribution system**
   Distribution-connected resources operating outside of the IAMs represent a growing segment of dynamic load and supply that is challenging to predict. The IESO and Ontario's electricity distributors often lack information about where these resources are located, what they are, and what factors underpin their behaviour (which can modify net demand, affect loading of network equipment, and change power flows). In the future, this lack of visibility could also impact distribution system operators that could emerge to manage larger volumes of DERs. Improving the visibility of DERs would enhance the IESO's ability to efficiently and reliably operate the bulk electricity grid and perform resource and transmission planning. Integrating DERs into the wholesale markets is one way the IESO can gain visibility and insight into these resources, while shaping their behaviour – through market price signals – to meet system needs. The IESO may not require (or want) the same level of visibility for DERs as it does for transmission-connected assets. However, appropriate visibility enables more effective coordination between the transmission and distribution systems, which is necessary to maintain the reliability and safety of both.

2. **Enable increased competition by removing unnecessary barriers that limit the ability of DERs to compete in wholesale markets**
   Competition is the cornerstone of efficient electricity markets, and enabling competition is one of the IESO's primary interests. A growing number of examples show that DERs can compete with traditional transmission-connected resources, reducing the costs of electricity for the system and, ultimately, for all electricity consumers.[15,16] However, certain IESO rules, requirements, and processes may act as barriers to DERs by preventing market entry, limiting their eligibility to participate or by adding costs that negatively impact economic viability. Such rules, requirements and processes may hamper the ability or willingness of DERs to compete in markets alongside traditional resources. Where DERs would otherwise be cost-effective in the provision of grid services, and are technically capable of providing these services, market rules, requirements and processes that act as barriers should be reviewed. This review must take place in the context of continuing to maintain system reliability.

[15] While demand response has been particularly cost-competitive relative to transmission-connected generation (this includes IESO's experience with the DR auction), new DER success stories are emerging, e.g., distributed solar plus storage in the ISO-NE market [31].

[16] Cost-competitiveness relative to transmission-connected resources (which benefit from economies of scale) may hinge on a DER's ability to stack additional revenue from services delivered to the distribution system.

3. **Expose resources operating within the distribution system to economic signals reflecting the conditions and needs of the bulk system**
   Since DERs operating outside the wholesale markets may not be exposed to economic signals that reflect real-time bulk system conditions, they may not have the incentive to operate in alignment with bulk system needs. Instead, these DERs may be exposed to flat electricity prices, time-of-use prices (that reflect trends in system conditions as opposed to real-time system conditions), or an hourly price of electricity (that does not reflect the value or cost of capacity). Alongside parallel efforts to improve price signals,[17] the integration of DERs can motivate these resources to operate in ways that benefit rather than degrade the conditions of the bulk system. For example, during oversupply periods, controllable loads may be motivated to increase consumption as electricity prices drop. DERs could also be situated to take advantage of locational price signals, such as locational marginal price, to reduce demand in sections of the grid experiencing congestion.

4. **Maintain an appropriate level of system reliability**
   The safe and reliable operation of the IESO-controlled grid underpins everything the IESO does. Some potential DER participation models may not align with established practices that have been put in-place for traditional transmission-connected assets to maintain reliability. These DER participation models might include less complex and costly requirements to make participation more feasible for small resources and, in doing so, introduce uncertainties into system operations and planning. At increased volumes of DER penetration, these uncertainties can have a material impact on system reliability. For example, participation models that allow for the aggregation of DERs across larger areas introduce uncertainty into how and where power will flow. The rules and requirements related to the aggregation of DERs across multiple locations must therefore weigh the benefits of allowing DER aggregation (e.g., increased competition) against potential impacts to reliability. As DER penetration increases, the IESO must ensure that markets and operations can adapt to maintain an appropriate level of system reliability. The additional costs of maintaining reliability as a result of integrating DERs must also be considered when investigating options for enhanced participation.[18]

5. **Consider and respect the potential impacts on the distribution system**
   Since DERs are located within the distribution system, efforts to integrate and dispatch them through the IAMs should consider and respect how their behaviour impacts – both positively and negatively – distribution system operations and infrastructure. High levels of DER penetration will require enhanced communication and coordination of operations between the IESO and the distribution system. These issues are currently being explored by the IESO through two white papers,[19] forthcoming demonstration projects,[20] and the IESO-led Grid-LDC Interoperability Standing Committee [4].

6. **Prioritize initiatives with the greatest benefits**
   Integrating DERs into the IAMs will involve initiatives that require time and resources from both the IESO and stakeholders. In deciding which options to pursue, the costs should be weighed against the benefits. For example, is a market rule and system change likely to result in material DER participation? Will that level of participation have a material impact on system costs? Will the benefits resulting from that participation outweigh the expenditures associated with market

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[17] As is being pursued through the single schedule market proposed under the IESO's Market Renewal Program [20].

[18] Reliability concerns and considerations relating to DERs are being investigated by the IESO and other ISO/RTOs through the NERC SPIDER WG [41].

[19] These are the non-wires alternative markets white paper [22] and the transmission-distribution interoperability white paper [21].

[20] These include the IESO York Region Non-Wires Alternatives Demonstration Project and the Opus One/Veridian/Marshall Homes Project.

rule and system changes? Even in cases with clear net benefits, options for expanded DER participation will need to be prioritized to ensure that resources are being allocated to projects with the greatest value for ratepayers.

7. **Support sector evolution that enables transparency and competition at all levels of the system**
   As Ontario's electricity sector evolves to leverage the capabilities of a wider variety of resources, the mechanisms or markets that use these resources must reflect the IESO's commitment to transparency and enabling competition. Transparency and competition can help mitigate market power, avoid conflicts of interest and ensure that electricity consumers can access the most cost-effective services.

5. A conceptual framework for DER participation models

Before DERs can offer their capabilities into the market, avenues for market participation – referred to in this white paper as *participation models* – must be available.

This section introduces and defines a conceptual framework for DER participation, which can then be used to: (1) determine which participation models are hypothetically possible within any ISO/RTO, (2) identify which participation models are available within specific ISO/RTOs, and (3) help identify and communicate which participation models may be considered in Ontario.

While there are several *possible* options for DER participation models within ISO/RTO markets, these options may or may not be offered in practice. Where they are offered, eligibility may be limited to DERs in certain ***operational categories***, or to particular ***market types***. Even where participation models are offered, barriers may inhibit the DERs from successfully leveraging the participation model (these barriers will be described in Section 8 of this paper).

What is meant by *operational categories*?

Operational categories refer to the manner in which a DER operates in the market. DERs can operate as **generation** (of a single fuel type) only, **demand response**[21] (a load-modifier that does not inject), **storage** (an energy-limited withdrawal or injection) or as a **hybrid** (combining more than one operational category or generation of multiple fuel types). These operational categories are illustrated schematically in Figure 5.

FIGURE 5 – DER OPERATIONAL CATEGORIES

GENERATION	DEMAND RESPONSE (DR)	STORAGE	HYBRID
Single fuel type, injection only	Only modifies load	Energy-limited withdrawal & injection	More than one category of operation

What is meant by *market types*?

As described in Section 3, the market types of interest in this white paper are the markets for **energy**, **operating reserve** and **capacity**, illustrated in Figure 6.

[21] The demand response operational category may incorporate behind-the-meter devices that generate electricity, control load or store energy, provided that these resources are only used to manage the electricity customer's demand and not to inject power into the grid.

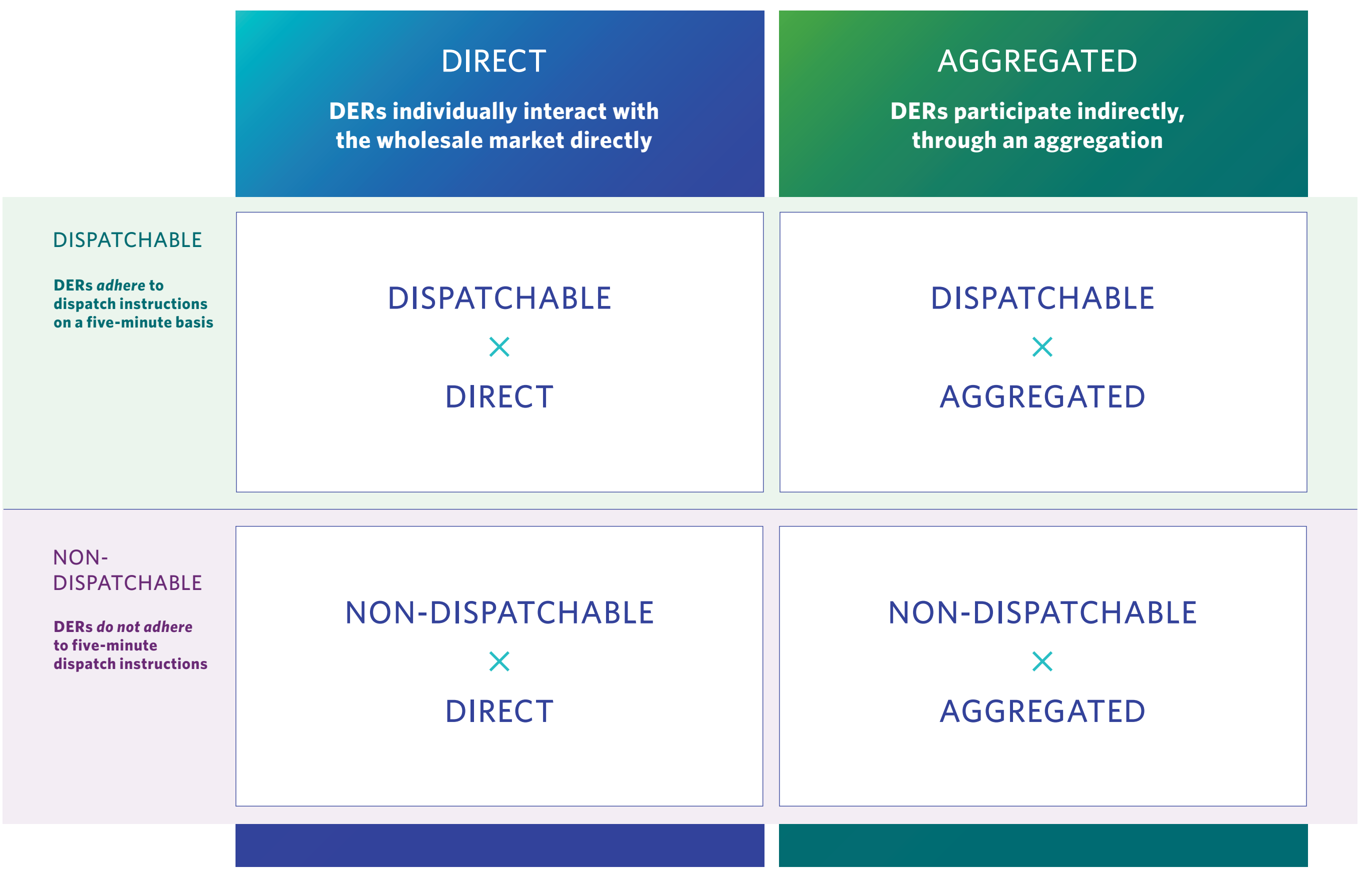
FIGURE 6 – MARKET TYPES

What are the possible DER *participation models*?

Possible DER participation models include a **direct** participation model, an **aggregated** participation model, a **dispatchable** participation model and a **non-dispatchable** participation model. These options are illustrated schematically in Figure 7, and described in greater detail in subsequent subsections.

Please note that this paper outlines dispatchable participation at a high level. How a dispatchable resource participates will also be dependent on the resource type, its operational requirements (e.g., start-up and minimum run times), as well modelling, unit-commitment and dispatch processes. These elements will be explored further in Part II of this white paper series.

FIGURE 7 – HIGH-LEVEL CONCEPTUAL PARTICIPATION MODELS FOR DERS



5.1 Direct

A DER can interact with an ISO/RTO **directly**, as a singular resource, to comply with its market obligations. A direct participant connects its facility to a single connection point to the distribution system; however, the facility may be comprised of multiple resources from the same operational categories (e.g., a generation facility consisting of multiple wind turbines), or resources that have different operational categories (e.g., a hybrid consisting of solar and storage). ISO/RTOs restrict direct market participation to resources above a minimum-size threshold (typically between 100 kW and 1 MW). For example, a threshold of 1 MW for direct market participation would mean that a 1 MW solar facility would be eligible, while a 10 kW rooftop solar system would not be eligible.

5.2 Aggregated

Instead of individual DERs interacting directly with the ISO/RTO, an aggregation of DERs can act as a single market participant, leveraging the cumulative capabilities of many smaller individual DERs – connected to different points on the distribution system – in order to meet performance obligations and eligibility requirements such as a minimum-size threshold. In this arrangement, the aggregator is the market participant, securing DERs and coordinating their operations. By allowing a third party to manage the complexities of market participation, aggregations can enable smaller resources to gain efficiencies of scale. An aggregation participation model may also simplify an ISO/RTO's operations and administration by reducing the number of individual resources an ISO/RTO needs to interact with.

5.2.1 Homogenous aggregations

Aggregations can be either homogenous or mixed. Homogenous DER aggregation models restrict participation within the aggregation to resources of the *same* operational category, namely generation of the same fuel type, DR or storage. An example is an aggregation comprised of only solar photovoltaic resources. Since similar resources may share certain capabilities and attributes, it can be easier for ISO/RTOs to build participation and compensation rules around homogenous resources.

5.2.2 Mixed aggregations

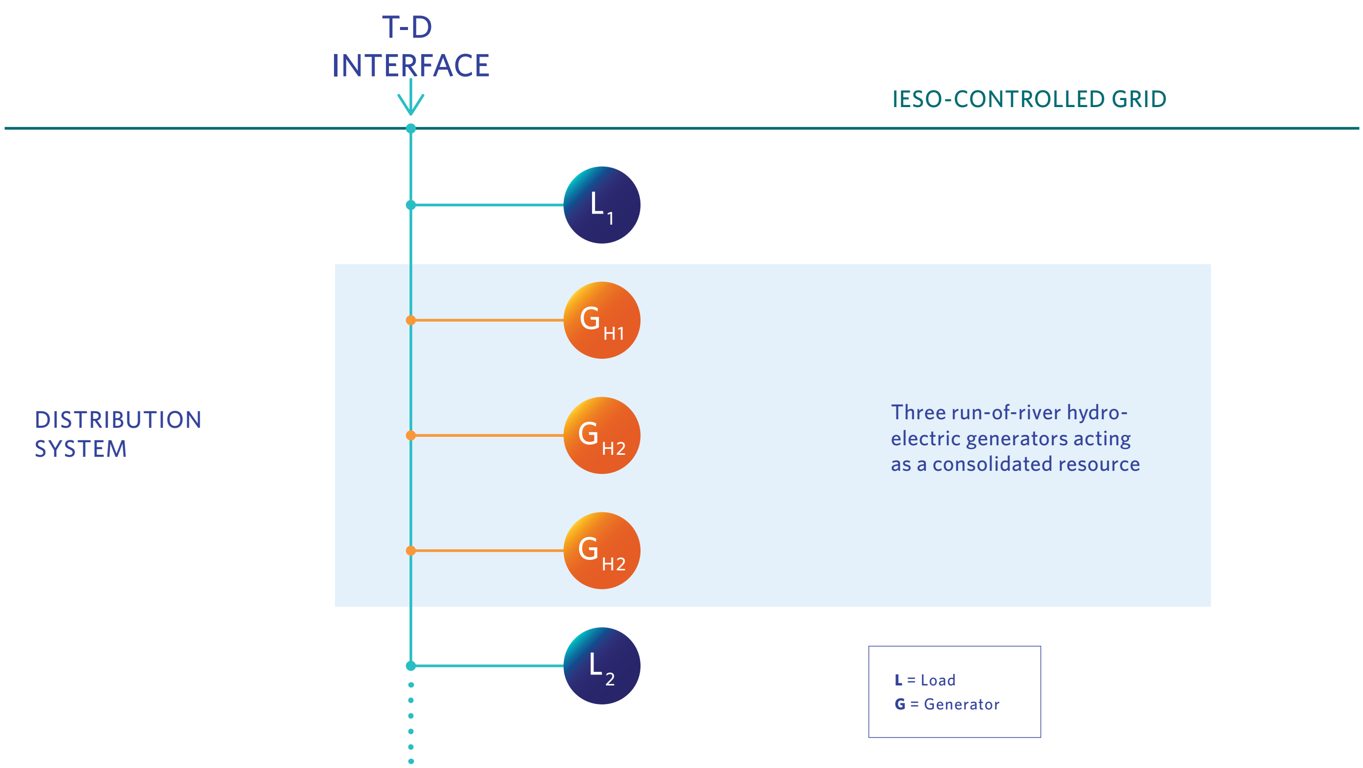
Alternatively, mixed (or heterogeneous) DER aggregations allow resources of *different* operational categories to pool their contributions within a single aggregation. For example, a heterogeneous DER aggregation may allow a combination of solar photovoltaic and wind resources.

Consolidated resources versus aggregated resources

Consolidated resources

ISO/RTOs may refer to some market participants as operators of consolidated resources. Consolidated resources consist of multiple facilities (whose operations are often interdependent) with the same owner, connected to the transmission system or distribution system at the same point or immediately adjacent points, such that they can be represented electrically as being connected to the same point. An example of a consolidated resource is three run-of-river hydroelectric facilities along the same river, connected to the distribution system at points adjacent to each other. ISO/RTOs typically have processes in place for the integration of consolidated resources. The IESO permits consolidations for generation resources having the same fuel type. This white paper considers a distribution-connected consolidated resource as a directly connected resource rather than an aggregation.

FIGURE 8 – A CONSOLIDATED RESOURCE ON THE IESO-CONTROLLED GRID



Aggregated resources

An aggregated resource describes resources that are not connected to the same point on the distribution system, are not necessarily connected to adjacent points on the distribution system, and can not necessarily be accurately represented as a single point of connection to the distribution system. For example, hundreds of air conditioning units paired with smart thermostats, each owned by a homeowner, spread across a single city, and bid into the market and controlled by a single market participant, is an aggregated resource and not a consolidated resource.

This white paper differentiates between consolidated resources and aggregated resources, as the latter category is more directly applicable to DERs and has gaps in participation eligibility in ISO/RTO markets.

5.3 Dispatchable

DERs that are market participants can either participate as five-minute dispatchable resources (i.e., dispatchable) or not five-minute dispatchable (i.e., as non-dispatchable resources). A dispatchable participation model requires the market participant to comply with dispatch instructions sent by the ISO/RTO, dictating the operating point (either generation or consumption) that should be maintained for each five-minute interval of the day. This participation model requires a resource to have control systems to meet the operating point, as well as adequate telemetry, so that the ISO/RTO is aware of the resource's operating state (e.g., to ensure that the resource is following their instructions). In helping to balance the grid in five-minute intervals, this model, which settles market participants on a five-minute market clearing price, plays an essential role in maintaining grid reliability.

Dispatchable participants take part in the energy market by submitting bids and offers that indicate:

- **In the case of an energy supplier:** how much energy they are willing to sell and at what price
- **In the case of an energy consumer:** how much energy they are willing to buy and the price they're willing to pay for it[22]

As in the case of direct participation, ISO/RTOs also typically require dispatchable participants to meet a minimum-size threshold (as well as other requirements, some of which are outlined in Section 8).

Dispatchable market participants can manage costs or earn revenue by taking advantage both of price changes that occur on a five-minute basis, and the opportunity to earn revenue in the OR market.

[22] In the IAMs, a dispatchable consumer of energy is referred to as a dispatchable load.

5.4 Non-dispatchable

This broad category includes all scheduling and settlement participation models that occur at timescales longer than the five-minute dispatchable model. These models exist so that the ISO/RTO can accommodate, gain visibility into and extract value from resources that:

- Are unable or unwilling to adjust output or consumption on a five-minute basis
- Do not have metering and telemetry approved by the ISO/RTO for five-minute dispatchability
- Do not meet the minimum-size requirements for five-minute dispatchability

This category can leverage resources with a range of capabilities, such as those that respond to instructions on an hourly basis, a sub-hourly basis for periods longer than five minutes, or in blocks of time (for example in four-hour blocks). Non-dispatchable resources can also include self-scheduling resources, or variable generators, such as wind or solar, whose output is typically determined by environmental conditions.[23] DERs in this category may be scheduled through the energy market, but may not necessarily be settled through the energy market. In the latter case, their energy consumption or generation may instead be subject to settlement at retail rates and accompanied by some form of capacity payment.[24] Since this category does not require resources to maneuver and demonstrate compliance on a five-minute basis, non-dispatchable participants have less stringent (and less costly) requirements for control systems and telemetry relative to dispatchable participants, but typically cannot participate and receive revenue from OR markets.

[23] ISO/RTOs may have the capability to dispatch down or off (on a five-minute basis) variable renewable generation when deemed uneconomic or for reasons that include congestion or safety. Where such capabilities exist, these variable renewable generators can be classified as dispatchable. Such capabilities may be imposed by ISO/RTOs on variable renewable generators, particularly if they are large in size. The ability to dispatch down or off can be extended to smaller DERs as a result of technological improvements (for example through inverters that can control the output of solar photovoltaic resources).

[24] This is the case for hourly demand response (HDR) participants in the IESO's demand response auction and forthcoming capacity auctions.

5.5 Application of the conceptual framework

In Section 6 of this white paper, this conceptual framework is applied to investigate participation models being developed in other jurisdictions. Section 7 uses this framework to outline in detail both the participation models currently available in Ontario, and those contemplated under Ontario's Market Renewal Program and the capacity auction. Finally, additional participation models or enhancements to participation models will be identified for further investigation.[25] The options proposed for further investigation are based on the participation models currently enabled in Ontario relative to other jurisdictions and with consideration for stakeholder priorities. These options are also intended to avoid duplication of processes and engagements already underway at the IESO.[26]

[25] The participation models identified for further consideration in this white paper will be investigated in more detail in the second white paper of this series.

[26] For example, the IESO is currently investigating issues related to DR through the DR Working Group (DRWG), and issues related to storage through the Energy Storage Advisory Group (ESAG).

6. DER participation models in other ISO/RTOs

6.1 NYISO-administered markets

What is NYISO's overarching DER initiative?

In early 2017, the NYISO released a DER Roadmap [2], designed to reduce barriers to DER participation in its markets and pave the way for its comprehensive DER integration agenda. To enable expanded DER participation, the NYISO is now stakeholdering detailed rule changes that are intended to be fully implemented for 2021 [5]. Until these take effect, DER participation in NYISO markets is limited to current demand response programs and a behind-the-meter net generation program.[27]

What DER participation models is the NYISO focusing on enabling?

Beyond the currently available DR and behind-the-meter generation offerings, the NYISO is planning to offer dispatchable resource models for a wide variety of direct participant and aggregated resources. These dispatchable resource models would allow the participation of generation, DR, and storage – all of which will be eligible to participate in the markets for energy, OR and capacity provided they meet the minimum-size threshold of 100 kW.

With respect to aggregations, the NYISO will permit both homogenous and heterogeneous aggregation. However, to participate in NYISO's OR markets, all component resources within an aggregation must be technically capable of supplying that OR service. Take, for example, an aggregation consisting of storage resources (which are technically capable of providing 10-minute spinning OR) and generation resources (technically capable of providing 30-minute OR). Under the NYISO's proposed rules, such a heterogeneous aggregation would only be permitted to provide 30-minute OR, as it would be limited by the technical capability of the generators within the aggregation. The components of an aggregated resource must be behind the same transmission node (which is defined by the NYISO to reflect a collection of electrically similar facilities to which individual DERs may aggregate) [6]. Enabling the NYISO's aggregation model is the most involved component of its DER integration initiative, and the primary focus of its efforts.

The NYISO also offers non-dispatchable participation models for both direct and aggregated participation, which are limited to reliability-based demand response programs. These DR programs can, but do not need to, participate in the energy markets, and can be considered a form of capacity product. However, since these resources are not dispatchable, they are not eligible to provide OR. In this regard, they are similar to the IESO's demand response auction for hourly demand response (HDR) resources (explained in Section 5.3).

Figure 9 provides an overview of the NYISO's priorities for its DER integration work.

[27] DR programs consist of economic DR programs (that place bids into the energy market) and reliability-based DR programs, the latter of which permits aggregation. The behind-the-meter net generation program (BTM:NG) is the only NYISO DER participation model that permits injection, but aggregation is not permitted. See [36].

FIGURE 9 – FOCUS OF DER INTEGRATION EFFORTS AT THE NYISO

NEW YORK INDEPENDENT SYSTEM OPERATOR

	DIRECT **DERs individually interact with the wholesale market directly**	AGGREGATED **DERs participate indirectly, through an aggregation**
DISPATCHABLE **DERs *adhere* to dispatch instructions on a five-minute basis**	HIGH FOCUS Enabling participation in energy, capacity, and Operating reserve (OR) markets	HIGHEST FOCUS Enabling participation of homogenous and mixed resources in energy, capacity, and OR markets
NON-DISPATCHABLE **DERs *do not adhere* to five-minute dispatch instructions**	MEDIUM FOCUS Enabling participation in energy and capacity (reliability-based Demand response (DR))	MEDIUM FOCUS Enabling participation in energy and capacity (reliability-based DR)

6.2 CAISO-administered markets

What is the CAISO's overarching DER initiative?

In 2016, the California Independent System Operator (CAISO) launched the Energy Storage and Distributed Energy Resource (ESDER) omnibus initiative, with the goal of reducing market barriers and enhancing the ability of storage and DERs to participate in the market. This initiative is implementing changes to enhance DER participation in phases.

The CAISO's markets differ from those of other ISO/RTOs:

- Instead of a capacity market, California has a resource adequacy program that requires load-serving entities to procure capacity so that it will be available when needed. The CAISO can also implement mechanisms to compensate resources that provide resource adequacy [7].
- In addition to the five-minute dispatchable market common among ISO/RTOs, the CAISO also has a 15-minute dispatchable real-time market. These markets apply to both energy and ancillary services; the latter includes OR. A 15-minute dispatchable market accommodates California's ramping needs, while taking advantage of the capabilities of resources with better-than-hourly responsiveness, but that are not capable of meeting five-minute dispatch [8], [9].

What DER participation models is the CAISO focusing on enabling?

The CAISO has established several participation models and is planning to make others available to all operational categories in the framework used in this white paper. The CAISO will allow direct and aggregated – both homogenous and heterogeneous – resources to participate in energy and OR markets. Market eligibility hinges on a 100 kW minimum-size threshold for energy, and 500 kW for OR.

The CAISO has also created DER Provider, a tailored program for DER aggregations that specifies that no single contributor to the aggregation can exceed 1 MW, and the total aggregation size must be below 20 MW. Also, all component resources within the aggregation must be on the same side of a CAISO-identified transmission constraint, known as a sub-load aggregation point (sub-LAP).[28] These aggregation rules help the CAISO model an aggregation with sufficient accuracy and ensure dispatch has a predictable impact on the bulk system. As shown in Figure 10, the CAISO is focusing on dispatchable DER participation (both direct and aggregated) because such models can leverage the region's vast and growing amount of DERs for real-time balancing of supply and demand – something the CAISO requires because of its high penetration of variable renewable resources, particularly solar power [10], [11].

[28] Sub-LAPs are areas within default load aggregation points (LAPs) that group electrical buses with similar grid impacts. See [19].

FIGURE 10 – FOCUS OF DER INTEGRATION EFFORTS AT THE CAISO

CALIFORNIA INDEPENDENT SYSTEM OPERATOR

	DIRECT **DERs individually interact with the wholesale market directly**	AGGREGATED **DERs participate indirectly, through an aggregation**
DISPATCHABLE **DERs *adhere* to dispatch instructions on a five-minute basis**	HIGH FOCUS Enabling participation in energy and Operating reserve (OR) markets	HIGHEST FOCUS Enabling participation of homogenous and mixed resources in energy and OR markets
NON-DISPATCHABLE **DERs *do not adhere* to five-minute dispatch instructions**	MEDIUM FOCUS Enabling participation in energy and OR markets	MEDIUM FOCUS Enabling participation in energy and OR markets

6.3 PJM-administered markets

What is PJM's overarching DER initiative?

In 2016, PJM[29] actively engaged with stakeholders on market rule changes to better integrate DERs. These stakeholder consultations resulted in the launch of their Wholesale DER (W-DER) initiative with the focus of enabling the aggregation of dispatchable resources. However, PJM suspended development of the W-DER program in 2018, waiting instead for FERC to take action on DER integration.

What DER participation models is PJM considering?

Under PJM's current market rules, DERs can participate as demand response resources or as front-of-the-meter generators in the markets for energy, OR, capacity and ancillary services. However, under the proposed W-DER initiative, an expanded set of operational categories, as well as aggregations, would be eligible to participate in these markets. These include DERs that inject, interact with retail customers (e.g., behind the meter of retail customers), and have multiple fuels (e.g., hybrid resources). The W-DER program proposed a minimum-size threshold of 100 kW – consistent with PJM's general market eligibility requirements. For aggregations, PJM proposed a 1 MW maximum aggregation size cap to mitigate possible congestion issues within the distribution system [12], but permitted aggregation across a distribution utility's entire service territory. While W-DER aims to enable a variety of DER participation models, it is not possible to confirm current priorities, given that the program is now on hold.

Generally, the ISO/RTOs that are integrating DERs in their markets are focusing their efforts on enhancing dispatchable participation models, and on mechanisms to enable aggregations to participate as dispatchable resources. DER stakeholders in all these ISO/RTO service territories have lobbied for both a dispatchable aggregation model and a reduction in the minimum-size threshold for market participation.

[29] PJM is the RTO that serves all or parts of 13 U.S. states, as well as the District of Columbia.

7. DER participation models in IESO-administered markets

In this section, the conceptual framework for understanding DER participation models and associated terminologies (presented in Section 5) is used to describe the current participation models available or being planned in the IAMs.

7.1 Overview of available DER participation models in the IAMs

Overall, the IESO requires market participants to be a minimum size of 1 MW to participate in the IAMs. The IESO adopted formal rules for aggregations of non-dispatchable DR resources within a single electrical zone.[30] Dispatchable generation, load, and storage[31] are technically permitted to aggregate below a single transmission-distribution (T-D) interface, but the IESO does not currently have systems in place to adequately screen such applications in a way that ensures that bulk system reliability. For this reason, applications of this nature are assessed on a case-by-case basis and approved at the discretion of the IESO. At this time, the direct participation of storage resources is possible if the resource registers as both a dispatchable load and a generator; however, the IESO's systems and software cannot currently accommodate storage resources as a standalone resource category.

[30] The IESO's service territory is divided into ten electrical zones. See [37].

[31] Storage acting as a generator and a load separately. See Section 7.3.

7.2 Detailed descriptions of available DER participation models in the IAMs

This sub-section will examine participation models that are available in the current and proposed IAMs[32] for each operational category and market type outlined in Section 5.

FIGURE 11 – AVAILABILITY OF PARTICIPATION MODELS WITHIN THE IAMS

A GREEN BORDER

Indicates the participation model is *available* (notwithstanding barriers).

- Participation model is a recognized avenue of participation
- Processes and systems are or will be in place

A YELLOW BORDER

Indicates the participation model is *partially enabled*.

- Unresolved issues may remain
- Formal processes for participation may not have been established

A RED BORDER

Indicates the participation model is *not available*.

- Participation is not permitted
- No channels or processes exist (either formal or ad-hoc) to permit participation

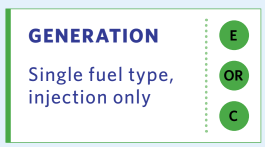
[32] This proposed state includes the capacity auction and IESO's Market Renewal Program.

7.3 Dispatchable – direct participation model

What is available in the IAMs?

For generation

Generation DERs are eligible to participate in all three of the IAMs. To be eligible for OR participation, generation must also participate in the energy market as a dispatchable resource. Under the IESO's Market Renewal Program, generation will be eligible to participate in the newly created day-ahead energy market. Generation was unable to participate in the IESO's DR auction; however, dispatchable generation will be eligible to participate in the capacity auction planned for December 2019 [13].



Under the dispatchable direct participation model, generation is eligible to participate in markets for energy, operating reserve and capacity

For demand response

Dispatchable loads (large market participant consumers) are able to participate in the IAMs for energy and all classes of OR and may elect to provide capacity as demand response (previously through the DR auction and in the future through the capacity auction).

Under the dispatchable direct participation model, DR is eligible to participate in markets for energy, OR and capacity

For storage

While storage has the same eligibility as generation for IAM participation, its operations are presently limited by IESO's dispatching system, which does not adequately account for its state-of-charge or ability to withdraw and inject as a single resource (i.e., it is modelled separately as a generator and a load). Today, a storage resource must participate, under interim operating guidelines, as both a dispatchable load and generator and manage its operations accordingly. Storage has not previously been enabled in the IESO markets for capacity (e.g., the DR auction), but is expected to be eligible to participate in the capacity auction held in June 2020. For this reason, this storage participation model is denoted as only partially available.[33]

STORAGE

Energy-limited withdrawal & injection

E
OR
C

Under the dispatchable direct participation model, storage is partially enabled in markets for energy, OR and capacity

For hybrid

Hybrid resources consist of more than one operational category, such as a solar plus storage facility that withdraws electricity and also generates power. Hybrid resources are not accommodated in the IESO's markets, systems and registration processes, and this operational category is not currently under consideration in the capacity auction.

HYBRID

More than one category of operation

E
OR
C

Under the dispatchable direct participation model, hybrid resources are not eligible for market participation.

[33] The limitations specific to storage resources are being investigated through the IESO-led Energy Storage Advisory Group [27], and these efforts will not be duplicated in this paper.

7.4 Dispatchable – aggregated participation model

What is available in the IAMs?

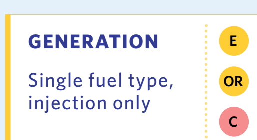
The IESO has moved away from allowing any aggregation of dispatchable resources that exist at different points of the transmission system (e.g., at different T-D interfaces). Given the current tools employed in real-time and near real-time, the aggregation of such resources would inhibit the IESO's ability to make planning and operating decisions to ensure the reliability of the IESO-controlled grid.

The IESO may permit aggregations of dispatchable resources under the same T-D interface; however, in reality, most points of connection to Ontario's distribution systems are supported by more than one T-D interface.[34] In these cases, the actual impact of a DER aggregation on the bulk system is complex, and would depend on the real-time configuration of the distribution system, which the IESO currently has no visibility into and is not capable of modelling. Without modelling capabilities, the IESO cannot accurately predict the power flows that may occur at the associated T-D interfaces.

Due to the complexity described above, the IESO currently does not have formalized processes or systems in place to adequately screen proposals for the aggregation of dispatchable resources. The IESO is only able to approve simple aggregations where it can be assured that the reliability of the bulk system would not be compromised. Over the long term, if interest in such forms of aggregation increase, existing tools and ad-hoc processes will need to be replaced with a more formal, enduring solution.

Aggregations of dispatchable resources are not currently being contemplated for eligibility in the IESO's capacity auction.

For generation



Under the dispatchable aggregated participation model, generation is partially enabled for energy and OR, and not enabled in markets for capacity.

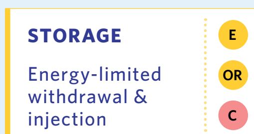
[34] This is typically the case in Ontario, with the exception of rural or remote areas. Distribution circuits supported by multiple T-D interfaces can mitigate distribution customer outages and increase reliability.

For demand response

Under the dispatchable aggregated participation model, DR is partially enabled for energy and OR, and not enabled in markets for capacity.

For storage

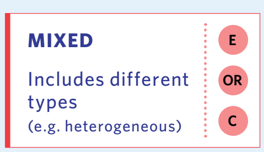
As indicated previously, the limitations of the IESO's systems and processes require the IESO to model and dispatch storage as both a generation resource and a load resource.



Under the dispatchable aggregated participation model, storage is partially enabled for energy and OR, and not enabled in markets for capacity.

For mixed resources

Due to the IESO's inability to adequately model aggregations of mixed resources, they are not permitted to participate in any of the IAMs.



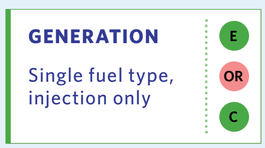
Under the dispatchable aggregated participation model, mixed resources are not eligible to participate.

7.5 Non-dispatchable – direct participation

Depending on the operational category (i.e., generation, DR, storage, or hybrid), the non-dispatchable direct participation model may be available for the IESO's markets for energy and capacity, but not for the OR markets.[35]

For generation

Non-dispatchable generation[36] can participate in the energy markets, and is being considered for the capacity auction.



Under the non-dispatchable direct participation model, generation can participate in the energy markets and in future markets for capacity.

For demand response

DR resources are permitted to participate directly through the HDR category, which was available through the IESO's DR auction and will be available through the capacity auction. The DR auction and capacity auction require participation in the energy market, including meeting the 1 MW minimum-size requirement.

Under the non-dispatchable direct participation model, DR can participate in the energy markets and in current and future markets for capacity.

[35] Participation in the IESO's OR market is restricted to dispatchable resources.

[36] This includes self-scheduling generators (that submit schedules to the IESO indicating the amount of energy they will be providing and when they will provide it) and intermittent generators (that have variable output as a result of factors outside of the operators' control, such as weather conditions).

For storage resources

Storage resources are not eligible for participation as non-dispatchable resources and future eligibility is not currently considered.

STORAGE
Energy-limited withdrawal & injection
E
OR
C

Under the non-dispatchable direct participation model, storage resources are not eligible to participate.

For hybrid resources

The hybrid operational category is not currently eligible for participation in the IAMs and future eligibility is not currently being considered.

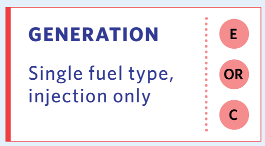
HYBRID
More than one category of operation
E
OR
C

Under the non-dispatchable direct participation model, hybrid resources are not eligible to participate.

7.6 Non-dispatchable – aggregated participation

With the exception of aggregated demand response, aggregations of non-dispatchable resources are not permitted to participate in the IAMs.

For generation



Under the non-dispatchable aggregated participation model, generation is not eligible to participate in any markets.

For demand response

In the IESO's previous DR auction and upcoming capacity auction, aggregations of demand response resources are permitted as HDR. For HDR, aggregations must achieve the minimum-size threshold of 1 MW, and all the contributing resources within an aggregation must be located within the same electrical zone. HDR aggregations may be composed of contributors with IESO-revenue metering and with LDC metering.[37]

Under the non-dispatchable aggregated participation model, DR is eligible to participate in the markets for energy and capacity.

[37] HDR aggregations that contain LDC-metered contributors are considered to be a virtual resource, because the precise electrical location of the resource and its real-time status is unknown to the IESO. The IESO models a virtual HDR resource to one transmission station within a zone. While reliability is manageable with low levels of virtual HDR, it may be compromised at higher penetrations. For this reason, the IESO imposes virtual zonal limits that cap the total amount of virtual resources permitted to be acquired in each zone through a capacity auction. See [13, p. 21].

For storage

Storage aggregations are not currently eligible for participation in the IAMs and future eligibility is not currently being considered.

Under the non-dispatchable aggregated participation model, storage is not eligible to participate in the IAMs.

For mixed resources

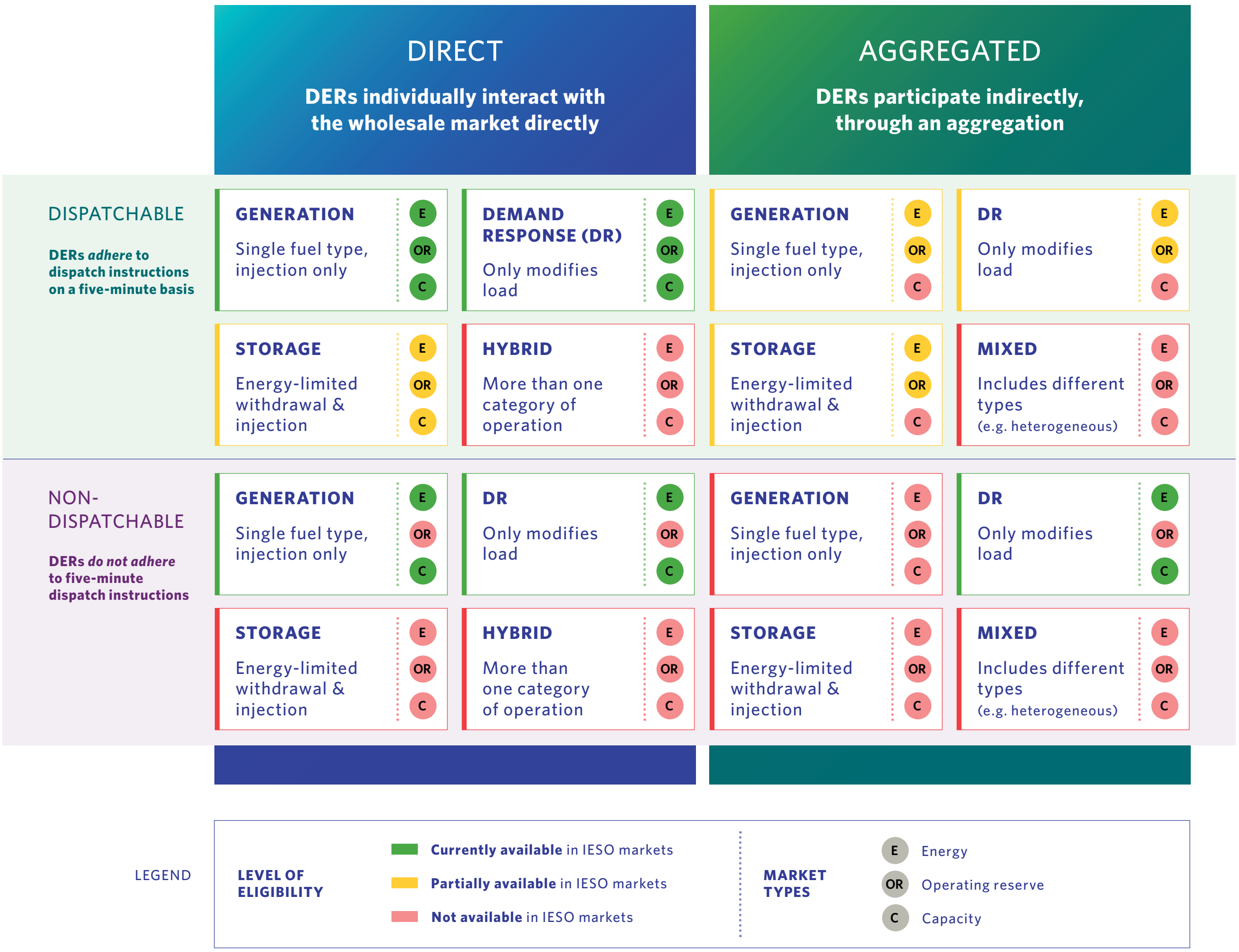
Mixed resource aggregations are not currently eligible for participation in the IAMs and future eligibility is not currently being considered.

Under the non-dispatchable aggregated participation model, mixed resources are not eligible to participate in the IAMs.

Summary

Figure 12 summarizes all of the participation models that are possible and that exist within current and planned IAMs.

FIGURE 12 – DER PARTICIPATION MODELS AVAILABLE IN CURRENT AND PLANNED IAMS



Note: Participation models listed as currently or partially available, are only open to resources that meet the IESO's current minimum-size threshold of 1 MW. A resource's participation through these models is also subject to additional requirements and considerations.

7.7 Gaps in the IAMs and priorities for DER integration

Building on Section 6, this section highlights the relative gaps within the IAMs and identifies participation models the IESO may consider enabling or enhancing – a subject that will be the focus of Part II of this white paper series. While this summary is based on the experience of DERs in other jurisdictions, it aligns closely with the barriers and Ontario stakeholder perspectives set out in Section 8 below.

The IESO should explore *enhancing* the direct participation model by reducing the minimum-size threshold

Like other ISO/RTOs, the IESO permits direct participation by DERs in the IAMs. However, the IESO's minimum-size threshold is 1 MW, while other jurisdictions have lowered their threshold to 100 kW. The rationale for the IESO's current minimum-size threshold is worth examining to determine whether it's necessary vis-à-vis current systems, and the potential consequences and benefits of reducing the threshold.

The IESO should explore *enabling* and *enhancing* the aggregation participation model

A common aspect of ISO/RTO efforts to integrate DERs is the development and enhancement of DER aggregation models, which allow multiple smaller resources to pool their capabilities into one market participant resource. These efforts involve a substantial dedication of time and resources by the ISO/RTO and stakeholder community to ensure that market rules and systems are in place and functional. However, other ISO/RTOs, including the NYISO and CAISO have clearly determined that the time and resources required to explore these changes are worth the benefits of enabling DER aggregations in their wholesale markets.

With the exception of non-dispatchable DR resources, the IESO does not have a formal process (or plans to develop one) that would allow the aggregation of DERs at scale, either as five-minute dispatchable resources or otherwise. The IESO should, therefore, investigate opportunities to enable and enhance aggregations of dispatchable and non-dispatchable DERs.

Enhancing energy storage and demand response participation

Efforts are already underway at the IESO to uncover and address participation barriers specific to certain types of DERs. These efforts are being undertaken by the:

- Energy Storage Advisory Group
- Demand Response Working Group
- Market Development Advisory Group, through the Expanding Participation in Energy and Operating Reserve research initiative - that will investigate short-term options to enable certain participation models outlined in this white paper

In future work to integrate DERs, the IESO will avoid duplication of efforts already underway through these initiatives.

8. Common barriers to DER participation in wholesale markets

A multitude of barriers – often related to an ISO/RTO's market rules, technical requirements and systems and processes – can prevent DERs from being integrated into, or effectively participating in, wholesale markets. These barriers can restrict participation altogether, or add costs and complexity that limit a DER's ability to compete in the market. Identifying and categorizing the barriers to DER integration is the first step in formulating a path forward. Also, some barriers lie outside the control of the ISO/RTO and can inhibit an ISO/RTO's ability to effectively integrate DERs, if they are not addressed.

This section describes seven key barriers to DER integration at a high level, while exploring how other jurisdictions are addressing these barriers, where examples are available. This white paper focused on DER integration barriers that prevent:

- An ISO/RTO from enabling or enhancing a participation model
- Prospective market participants from effectively participating, even when a model is enabled

8.1 Minimum-size thresholds

What are minimum-size thresholds and why are they in place?

ISO/RTOs require resources to be above a certain size in order to provide products to the bulk electricity system or be a wholesale market participant. Minimum-size thresholds vary by the ISO/RTO, and may be further differentiated by the *type* of wholesale product (e.g., ancillary services may have a higher minimum-size requirement than capacity for technical reasons).[38,39] While the IESO has a minimum size threshold of 1 MW, many ISO/RTOs in the U.S. have recently set their minimum-threshold requirements at 100 kW. Where U.S. operators have set a lower threshold, it was most likely done to ensure that markets are aligned with FERC[40] requirements. Numerous IESO stakeholders, representing a variety of DER technology types, have advocated for a reduction in the 1 MW minimum-size threshold imposed by the IESO market rules [14], [15].

[38] For example, the CAISO has a higher minimum-threshold requirement for OR than for energy market participation (500 kW versus 100 kW).

[39] Many ISO/RTOs have systems that adjust ancillary services like OR in increments that are, at a minimum, 100 kW or higher. These system limitations preclude resources 100 kW in size from maneuvering beyond an on-off state.

[40] FERC has ruled that DR and storage participation be eligible for resources 100 kW in size or greater. For consistency, ISO/RTOs may have chosen to apply the same threshold to other categories of DERs.

8.1.1 Simplification of operations

By setting minimum-size requirements, an ISO/RTO can ensure that the number of resources being managed is within its operational capability, and that its controller dispatch activities will have a material impact on system conditions. For example, an action by an ISO/RTO to dispatch a 1 MW resource will have a greater material impact on system conditions than an action to dispatch a 100 kW resource. It is not uncommon for communications, including dispatch instructions, to take place between individuals in the control room and generators by phone. While scheduling and some aspects of dispatch are automated, current software tools used by ISO/RTOs to perform these tasks may not be capable of incorporating a significantly higher number of resources without significant upgrades to accommodate the increased processing requirements. Adding large numbers of additional resources (i.e., orders of magnitude more) may potentially overwhelm control room operations – both manual and automated.

8.1.2 Simplification of resource administration

By limiting the volume of resources that can offer products, minimum-size thresholds reduce the administrative burden of running procurements or markets. For example, allowing 100 resources to aggregate as a single market participant will require the ISO/RTO to complete the registration process for a single market participant instead of 100 separate market participants.

Minimum-size thresholds can also direct several smaller resources to pool their efforts into an aggregation, which may simplify the ISO/RTOs' ability to leverage such resources collectively.

How do minimum-size thresholds act as a barrier?

Minimum-size thresholds disqualify smaller resources from delivering bulk system products and services directly, or require that they participate in the markets through an aggregator (if aggregation is permitted). Aggregators act as intermediaries and receive a portion of market revenues for their services. This arrangement has implications for the overall economic viability of aggregations, as DER owners may not receive enough compensation to incent them to participate. Aggregators may also face difficulties gathering sufficient resources to meet the minimum-size threshold, especially if they face additional constraints from other rules (e.g., requirements for homogenous resources, geographic/electrical constraints on aggregation boundaries) that limit their ability to compete.

8.2 Aggregation-specific rules

What are aggregation-specific rules and why are they in place?

An ISO/RTO may have specific rules governing aggregated resources. Since aggregations involve resources connected to different points in the distribution system, their impact on the bulk system is less predictable than that of direct market participants with a single connection point. An ISO/RTO must determine where the aggregated resource appears and how it behaves within the power system model.[41] An ISO/RTO's capabilities and constraints around power system modelling may influence the market rules around aggregation.

Aggregated resources are commonly subject to rules that govern:

- The types of resources that can form an aggregation
- Whether individual DERs within an aggregation can be either homogenous or mixed, i.e., consist of different resource types, such as generation and DR. When mixed resource aggregations are allowed, larger aggregations can form within a geographical or electrical boundary, creating economies of scale. However, because a mixed aggregation contains resources with inherently different behaviour, they may complicate the ISO/RTO's ability to correctly forecast the performance of the mixed aggregation.[42]
- The geographic boundaries of an aggregation

Aggregations can incorporate resources spanning different areas, and ISO/RTOs tend to have rules dictating the boundaries of component resources that can form an aggregation (e.g., within a zone, under a transmission bus).

Rules that restrict an aggregation to a single resource type (homogenous aggregation) provide more certainty to the ISO/RTO about the aggregation's behaviour – since different technologies can have different characteristics and influences on the electricity system.

More precise geographic or electrical boundaries for aggregation can improve modelling and reliability, and allow ISO/RTOs to perform more precise dispatching and mitigate adverse system conditions, such as congestion. More precise boundaries can also facilitate interoperability and coordination with the distribution utility.

How are aggregation-specific rules a barrier?

Rules that narrow the electrical boundaries of resources that can participate in an aggregation and those that prohibit mixed resources have the net effect of reducing the pool of resources an aggregator can draw upon. These restrictions can inhibit an aggregator both from achieving economies of scale, and from meeting the minimum-size threshold for market participation. Stakeholders have indicated that the IESO's electrical aggregation boundary rules (e.g., the requirement for an aggregation to be at the same connection point to the IESO-controlled transmission grid in the case of a dispatchable resource) make it difficult to gather the resources to form an aggregation, and point to the benefits of larger aggregation boundaries used by other ISO/RTOs [14].

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[41] A power system model helps system operators predict how the operations of electricity system components influence each other, and an accurate power system model helps the system operator operate the grid predictably and reliably.

[42] The challenges determining performance characteristics pertain to (1) extremely short-duration impacts on electricity equipment (transient impacts), (2) short-term operational behaviour (e.g., ramping characteristics), and (3) ensuring compliance with ISO/RTO instructions. To counteract this, the system operator may apply more stringent telemetry and operational data requirements, as well as measurement and verification.

Limited aggregation boundaries can also lead to fewer aggregator market participants, which can also limit options and choice for DER owners. A DER owner may not have a choice of which DER aggregator to sign up with, and may not be offered fair compensation. Whether this scenario represents a material barrier may depend on the magnitude and type of loads that exist within a proposed point or zone of aggregation.[43]

[43] For example, if an aggregation point or zone contains a large amount of peak demand (e.g., 500 MW), it may be easy for multiple aggregators to find sufficient homogenous DER capacity to meet a 1 MW threshold. However, if the aggregation point or zone contains a small amount of peak demand (e.g., 100 MW), it may be much more difficult for aggregators to find sufficient DERs to build their aggregation portfolio.

8.3 Operational data and telemetry requirements

What are operational data and telemetry requirements and why are they in place?

Resources that deliver and are compensated for bulk system services are required to collect operational data through appropriate metering so that the resource's performance can be accurately determined by the ISO/RTO. The data collected is used to determine settlement, measurement and verification and, in some instances, to enhance forecasting capabilities. ISO/RTOs also use the data to increase visibility and situational awareness of DERs to better manage the grid.

Resources that provide more dynamic bulk system services, such as five-minute dispatchable resources, are monitored in near real-time so that ISO/RTOs can maintain reliability and ensure they are complying with instructions. For such services, the ISO/RTOs impose telemetry requirements for the automatic measurement and transmission of data to provide visibility of these resources and their performance. Operational data typically required to be delivered via telemetry includes real and reactive power output or consumption, and can also include state-of-charge for energy-limited resources, such as electricity storage.

Requirements can vary in terms of whether telemetry is required at all, what specific operational data is required, whether aggregated data is acceptable, the rate at which it is collected, and the maximum tolerable delay in transmitting this information (latency). For bulk system services that must react to instructions on a second-to-second or sub-second basis (such as regulation), low latency is particularly important. For an aggregation with component resources that can reasonably be expected to perform in a similar fashion, a sample of telemetered data may be acceptable.

For resources without dispatch capability, including most types of intermittent generation, telemetry is less critical and the ISO/RTOs may simply require time-stamped revenue meter data, provided at a later date, for the purposes of measurement and verification or settlement.

How are operational data and telemetry requirements a barrier?

Adhering to operational data collection requirements can necessitate advanced electricity metering of a certain precision (i.e. approved revenue-grade metering). Likewise, adhering to telemetry requirements can require DERs to establish a network connection with an acceptable level of latency and security.[44] Given the cost, such equipment and subscription services benefit from economies of scale. Stringent requirements could be prohibitive for smaller resources, compromising their ability to successfully compete against larger resources in wholesale markets or procurements.

ISO/RTOs are using various approaches to address such barriers. In the early stages of DER integration, ISO/RTOs may exempt telemetry requirements altogether, particularly for non-dispatchable resources below a certain size threshold, on the basis that the volumes of exempted resources are too small to disrupt the reliability of the electricity grid. While this may be an expedient resolution in the short-term, a higher volume of DER uptake may, over time, compromise grid reliability.[45] Some jurisdictions, including the NYISO and the CAISO, suggest that an acceptable level of visibility and reliability can be maintained through advanced metering for a subset of resources of the same type within the aggregation, if the resources can be assumed to behave similarly

[44] Telemetry data need not be as accurate as the data used for settlement, and therefore the metering associated with telemetry may be relatively less expensive.

[45] Reliability can be compromised if there is a lack of visibility and control.

(e.g., for wind resources within the same wind regime).[46] It is also possible to leverage smart meters or interval meters for telemetry. Some ISO/RTOs including the IESO are starting to evaluate the use of alternatives to the data from traditional utility meters (e.g., obtaining data directly from electric vehicles or building devices).

[46] The IESO currently uses weather data and telemetry from large variable renewable generators to forecast the behaviour of smaller variable renewable generators that lack telemetry.

8.4 Measurement and verification requirements

What are measurement and verification requirements and why are they in place?

Measurement and verification (M&V) are the processes that quantify the energy and demand savings of load-modifying resources. Load-modifying resources alter a customer's consumption profile – and potentially injection profile – relative to a baseline state. These processes are relevant to demand response, either alone or in combination with behind-the-meter generation and/or electricity storage that is capable of injection.

In addition to determining the actual energy or energy savings delivered by a DER, M&V can determine a resource's unit capacity (how much capacity it can deliver) when operating in peak periods (when capacity is needed most). M&V also provides ISO/RTOs with an estimate of how much capacity is available from a load-modifying resource in real-time, so that the ISO/RTO can use such resources if needed. Financial settlements can also be determined for the load-modifying resource based on what the resource delivered, relative to the baseline state. M&V can effectively evaluate resources after-the-fact, to ensure the resource delivered what it was paid to deliver, and to determine what the resource may be capable of delivering in the future.

How are measurement and verification requirements a barrier?

Compliance with M&V requirements calls for appropriate metering and administration, which, depending on the stringency, can be technically challenging and prohibitively costly for small resources or aggregations of small resources. Smart meters at the point of interconnection are technically capable of being leveraged to provide data for these purposes, but aggregators can face barriers acquiring that data in a timely manner.[47] This can affect the aggregators' ability to comply with ISO/RTO M&V and telemetry requirements. Also, depending on the M&V rules applied, DERs can be undervalued (i.e., become de-rated because they are viewed as less reliable).[48]

[47] This issue has been noted by DR aggregators in Ontario. Although smart meters can transmit telemetry, the data is stored in a data warehouse and only accessible to aggregators through local distribution companies.

[48] An ISO/RTO can de-rate a resource by lowering the capacity the resource is allowed to bid into the ISO/RTO market. De-rating typically results from an ISO/RTO assessment that the resource is underperforming.

8.5 Interoperability requirements

What are interoperability requirements and why are they important?

DERs that respond to instructions or price signals from the ISO/RTO may operate in conflict with distribution system needs, exacerbating rather than reducing issues, such as congestion, at the distribution level.

Standards or processes for coordination can help prevent conflicts between the bulk system and distribution system, and allow DERs to be leveraged to serve customer, distribution and bulk system needs. Facilitating DERs' ability to meet distribution system needs may enable them to acquire revenues for their distribution services, increasing their competitiveness in bulk system markets through value-stacking.

How are interoperability requirements a barrier?

Both distribution system operators and ISO/RTOs may be reluctant to allow DER integration into wholesale markets if reliability cannot be assured. Some ISO/RTOs have developed relatively simple processes to address interoperability concerns, including:

- Coordinating with the distribution system operators on the boundaries of aggregation zones
- Sharing the details of individual resources that comprise an aggregator's portfolio
- Communicating the day-ahead schedule of DERs with the distribution system operator

While the above measures are meant to mitigate negative impacts to the distribution system that could result from DERs that operate in the wholesale market, these measures are not designed to deliver the additional value to the distribution system that DERs may be capable of providing.

8.6 Registration and commissioning requirements

What are registration and commissioning requirements and why do they matter?

Entities interested in participating in wholesale electricity markets are required to register with their ISO/RTO. Additional information is required to authorize participation in specific markets and services. This information can include verification of legal, financial, technical and operational requirements (such as telemetry, metering, and M&V plans) of the DER operator and its resource(s). This information helps the ISO/RTO know exactly what the resources are, who is responsible for them, how they will be connected and their performance characteristics. These requirements also help ensure that the participant is liable and financially accountable for any potential lack of performance.

Prior to operating in the bulk system, new resources must also go through a connection assessment and commissioning phase to ensure the grid can operate reliably once they are integrated. ISO/RTOs may set requirements based on the size of the resource applying to connect and on the geographic area in which it is seeking to connect.[49] Generally, the requirements for larger resources are more complex and costly to meet than the requirements for smaller resources.

How are registration and commissioning requirements a barrier?

Completion of market registration and participation requirements can be a costly, lengthy and complex process that favours economies of scale. As a result, small resources and aggregations can face challenges relative to larger resources.

Also, ISO/RTOs may not have the processes and systems in place to properly register DERs according to their unique attributes – a concern particularly relevant to hybrid resources, aggregations, and especially aggregations of mixed-resource types. ISO/RTOs must decide where to model these resources electrically on the bulk system, and how to model their behaviour and performance, which may not be consistent if aggregations include multiple technologies. The IESO's stakeholders have indicated their preference to combine multiple technologies (either through directly connected hybrid resources or through an aggregation of mixed resources), because this arrangement would help DERs smooth their generation profile, increase resource availability and allow for market participants to capture additional revenue streams in the IAMs [14].

[49] For example, a proposed connection point that's near to its operational limits may require a more thorough connection assessment.

8.7 Other barriers[50]

Other barriers outside the control of the ISO/RTO may impede DER integration or market participation. These are highlighted because they represent important topics of discussion for stakeholders, ISO/RTOs and other relevant parties.

8.7.1 Retail rate structure interactions

Differences between retail price structures and wholesale market prices create mixed signals for the operations of DERs. The existence of multiple retail rate structures within an ISO/RTO market may also complicate M&V for DERs that modify load.

8.7.2 Impediments to accessing other value streams

Currently, DERs cannot be compensated for the breadth of services and attributes they may be capable of providing (e.g., distribution system benefits, environmental benefits and resiliency). Access to these other value streams could lower the incremental costs of participating in ISO/RTO markets, potentially making DERs a cost-competitive resource option relative to traditional centralized supply.

8.7.3 Metering requirements set by outside agencies

Metering requirements set by outside agencies can impose high costs on DERs – an expense that stakeholders have identified as a significant barrier to the participation of small DERs.

Measurement Canada revenue-grade metering requirements

Measurement Canada is a federal agency responsible for "ensuring accuracy in the selling of measured goods, developing and enforcing the laws related to measurement accuracy, approving and inspecting measuring devices and investigating complaints of suspected inaccurate measurement." All electricity meters that are used in Canada for the financial settlement of electricity must have metering approved by Measurement Canada. Even without connectivity (e.g., Wi-Fi), these electricity meters can cost several hundreds of dollars.

Through its Grid Innovation Fund, the IESO is encouraging projects that facilitate the collection of data from DER pilots to better understand alternatives or supplementary options to Measurement Canada meter data.

8.7.4 Requirements imposed by distribution system operators

In addition to requirements imposed by the ISO/RTO, distributors impose their own requirements on certain resources connected to their systems (e.g., rules for network protection and safe operation). Fulfilling these requirements can add substantial costs for DER projects.

[50] Barriers outside the IESO's control are noted in this section, but more detailed investigations of these external barriers are outside the scope of this white paper series.

9. Conclusion and next steps

This white paper sets the stage for action to integrate DERs into Ontario's electricity markets in a rational manner by discussing the conceptual models for DER participation in wholesale markets and identifying barriers to enhanced participation. The range of participation models currently available in the IAMs are also identified. As a result of this analysis, the IESO believes that the most substantial barriers to integrating distributed energy resources into the market are the minimum-size threshold of one megawatt or greater, and the rules and processes for distributed energy resource aggregations.

Options for *enhancing* the direct participation model

Like many other ISO/RTOs, the IESO permits DERs to directly participate in its markets. However, the IESO currently restricts participation to resources 1 MW or greater, while other jurisdictions have lowered the threshold to 100 kW. Part II of this white paper series will examine the necessity of the IESO's minimum-size threshold and the consequences of adjusting it.

Options for *enabling* and *enhancing* the aggregation participation model

With the exception of demand response resources, the IESO does not have formal processes to permit the aggregation of DERs at scale, either as dispatchable resources or otherwise. The IESO will investigate opportunities to enable and enhance the participation of DER aggregations.

The IESO acknowledges that parallel efforts are underway to uncover and address the participation barriers for specific DER categories, namely:

- Energy storage, which is investigated through the Energy Storage Advisory Group (ESAG)
- Demand response, which is being explored through the Demand Response Working Group (DRWG), as well as the stakeholder engagement on energy payments for economic activation of demand response resources
- Opportunities to expand participation of existing resources in the energy and OR markets, which is being addressed through the Expanding Participation in OR and Energy initiative as part of the Market Development Advisory Group

The next white paper will avoid duplicating these efforts.

This white paper is Part I of a two-part series, and feedback from industry stakeholders is invited to inform Part II which will present high-level options that the IESO could employ to allow more distributed energy resources to participate in its markets, with the goal of identifying the simplest, most cost-effective changes that could have the most benefit.

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