Expanding Participation in Operating Reserve and Energy

IESO Participation Requirements, and Misalignments with Models of Participation

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Acronym List

ACE – Area Control Error

ADE – Availability Declaration Envelope

AGC – Automatic Generation Control

BA – Balancing Authority

CER – Canada Energy Regulator

DACE – Day-Ahead Commitment Engine

DACP – Day-Ahead Commitment Process

DER – Distributed Energy Resource

DR – Demand Response

DSO – Dispatch Scheduling and Optimization

EPOR-E – Expanding Participation in Operating Reserve and Energy

ESAG – Energy Storage Advisory Group

ESR – Energy Storage Resource

HDR – Hourly Demand Response

IAM – IESO Administered Market

LDC – Local Distribution Company

MDAG – Market Development Advisory Group

MLP – Minimum Loading Point

NAESB – North American Energy Standards Board

NERC – North American Electric Reliability Corporation

NPCC – Northeast Power Coordinating Council, Inc.

NQS – Not-Quick Start

NSQS – Not-so Quick-Start

OEB – Ontario Energy Board

OR – Operating Reserve

ORA – Operating Reserve Activation

PD – Pre-Dispatch

PPA – Power Purchase Agreement

QS – Quick Start

RT – Real-Time

SDP – Storage Design Project

VEE – Validation, Estimating and Editing

VG – Variable Generation

1. Purpose

Expanding Participation in Operating Reserve and Energy (EPOR-E) is a research initiative that was launched in early 2020. The initiative's purpose is to explore potential market development options to enable further technology participation in the OR and energy markets. EPOR-E had the following objectives: (1) undertaking an assessment of energy and OR requirements in relation to the participation models of identified technology and resource types and highlighting the misalignments; (2) exploration of potential options that could enhance the participation of the identified technologies or resources in the energy or OR market; and (3) evaluate the options to determine high value opportunities to be considered for future development.

The purpose of this report is to address the first objective of the initiative by: 1) detailing the participation requirements for the energy and operating reserve[1] (OR) market; 2) identifying the misalignments between those participation requirements and how different technologies and resource types currently participate in the IESO-administered markets (IAMs) and 3) determine which requirements are within the IESO's authority to change. This report establishes the foundation for current and prospective market participants to understand the requirements to participate in the IESO's energy and OR markets, as well as how different technology types participate within the current market framework. The misalignments between the requirements to participate and each respective technology participation framework will be used to understand potential areas for future market evolution to enable further participation. The benefits of increased participation include:

1. Increased competition leading to lower costs
2. Improved grid resilience and reliability through greater supply quantity and diversity

The IESO will use the findings of this report as a first step in enabling greater resource participation and competition in the energy and OR markets. Potential future changes would include future projects that may adjust IESO requirements, tools and/or processes; allowing resources to meet requirements in a different way; and/or identifying where a resource type's participation model can be adjusted to enable further participation.

Market participants must still consult IESO Market Rules and manuals to gain a comprehensive understanding of the requirements to participate in the IAMs.

[1] See Appendix 1 for more details on operating reserve requirements

2. Background

Many different technology types compete to provide reliability services needed to meet electricity demand of Ontario consumers. The IESO constantly works with stakeholders to understand the evolving capabilities of existing and new resource types that might impact IESO markets and the interconnected grid. The IESO, provincial government, and stakeholders have worked together over the years to expand Ontario's supply mix from long standing technology types like hydro, nuclear, and natural gas to include new technologies such as wind, solar, and energy storage. Through this collaborative process the IESO attempts to extract the maximum reasonable value from resources by understanding and optimizing, where possible, resources operating characteristics.

Stakeholders representing different technology and resource types have reached out to the IESO to explore how their technologies and resource types can enhance their participation in the IAMs today and in the future. One of the primary forums that the IESO has used to engage with their stakeholders to evolve markets and resource participation is the Market Development Advisory Group (MDAG). This forum was designed to leverage stakeholder expertise to support IESO efforts to evolve the electricity market beyond Market Renewal. In alignment with the IESO's core strategies of: drive business transformation, advance sector leadership, ensure system reliability, and enable competition, the IESO requested stakeholders submit potential market development proposals to enable participation of new and evolving technology and resource types in the IESO markets. Through discussions at the MDAG and other stakeholder forums (such as Energy Storage Advisory Committee, Stakeholder Advisory Committee, and the Demand Response Working Group), and submitted market development proposals, stakeholders and the IESO established mutual interest to explore how to enable certain technology and resource types to participate or participate more fully.

To investigate those certain technology and resource types, the IESO launched the EPOR-E initiative in early 2020. A Scope of Work was developed for EPOR-E to describe the different stages of the project and what outcomes would be achieved. These outcomes were split into three phases which included: (1) the development of this report summarizing the findings of requirements and misalignments of certain participation models; (2) memo(s) that would define options that could enhance the participation of identified technologies or resources in the energy or OR market; and (3) memo on the evaluation of the options to determine high value opportunities to be considered for future development.

The IESO and its stakeholders agreed to assess the following technology, resources and resource types as part of the EPOR-E:

- Hourly Demand Response (HDR)

- Gas generators – "Not-So-Quick-Starts" (NSQS) - resources that have operating characteristics that fall in between Quick Start (QS) and Not-Quick Start (NQS) resources
- Hybrids – generator utilizing storage
- Imports – OR imports over the interties
- Regulation Service Providers[2]
- Variable Generators (VGs) – solar and wind resources

The IESO continued to work through the deliverables of the Scope of Work through MDAG meetings, individual teleconferences and other forums. As part of the April 2, 2020 MDAG webinar[3], the IESO provided a presentation that corresponded to the first objective and phase of EPOR-E. This presentation provided stakeholders with a detailed overview of the current requirements to participate in the energy and OR markets, as well as to settle their market activities. The IESO also presented the misalignments between those requirements and the participation models of the EPOR-E technology and resource types. Following this meeting, the IESO determined that a dedicated stakeholder engagement separate from the MDAG was required due to the detailed nature of this initiative and its high priority as identified by stakeholders which led to the launch of the EPOR-E engagement in May 2020. The feedback and information collected through these engagement forums has contributed to the findings of this report.

Since the launch of this engagement, feedback from stakeholders has indicated that the IESO needs to expedite the process of enabling greater resource participation in the IAMs. Based on the feedback received, the IESO intends to revise its engagement approach to build on EPOR-E research conducted through this engagement, bring together learnings from other engagement forums, such as the Innovation and Sector Evolution White Paper Series, and expedite the establishment of a concrete work plan to enable emerging and evolving resource types. This work plan and expanded engagement will build upon the findings of this report. The IESO will introduce the details of the expanded engagement and work plan in the first quarter of 2021. This report will be a foundational reference source to support the future work on enabling resources mentioned above. This document provides an understanding of the requirements to participate in the energy and OR markets, respective authority over the participation requirements, and identifies the misalignments between those requirements and the identified resource/technology's participation models.

[2] Regulation is an ancillary service product, it is described in section 5.6 of this report. The IESO explored the participation model of resources that provide Regulation service and the opportunity to provide OR.

[3] http://www.ieso.ca/-/media/Files/IESO/Document-Library/engage/mdag/mdag-20200402-presentation.pdf?la=en

3. Approach to Completing Objectives

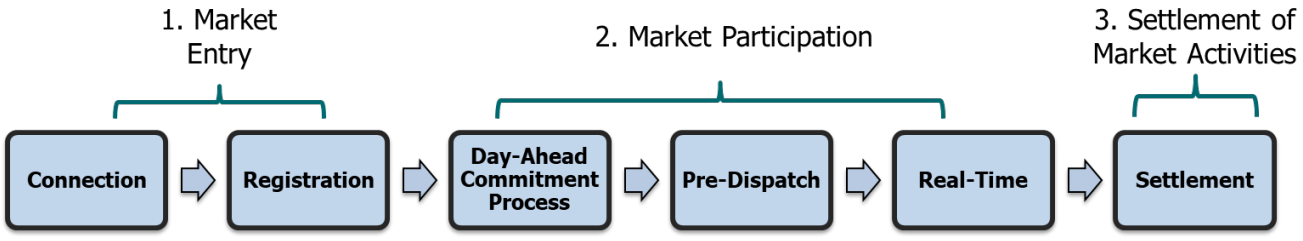
To establish a common understanding of requirements and misalignments, the IESO developed this report and determined the objectives as threefold: (1) detail general requirements to participate in the IESO energy and OR markets; (2) identify potential opportunities to address misalignments in current models that restrict participation of the EPOR-E technology and resource types; and (3) determine which requirements are within the IESO's control to change. The IESO developed a methodology to approach and complete each of the objectives to finalize this report. Below details the approach for each of those objectives.

3.1 Requirements to participate

Through the review of IESO market rules, manuals, and other related material, the IESO developed a summary of the market requirements to participate in the energy and OR markets. Specific requirements can vary from resource type to resource type therefore, the IESO used a Quick Start (QS) resource as an illustrative example to detail general requirements. The IESO believes the participation model of a QS resource is a good example to explain the general requirements because QS resources are considered fully enabled by the IESO in most of the IESO-administered markets (IAMs), as well as have a long history of providing grid services to the IESO. The QS resource is referred to as the baseline participation model in this report.

The IESO detailed the requirements to participate by organizing them into specific steps (see Figure 1. Process to Participate). There are three timeframes involved for a resource to fully participate, which are: (1) market entry, (2) market participation, (3) settlement of market activities. These three timeframes are further organized into their sub categories, as each step has specific requirements that must be met to allow IESO tools to model resources to provide energy and OR, as well as ensure the reliability and stability of the grid.

Figure 1. | Process to Participate



3.2 Identify misalignments/areas of opportunity

Using the QS resource type's participation model as a baseline, the IESO studied unique participation frameworks for each of the identified technology/resource types as discussed with

stakeholders at the MDAG forum - NSQS gas, imports, VGs, and HDR resources. Through the review of IESO materials and discussions with stakeholders, the IESO identified the areas of misalignment between the current IESO participation requirements and participation models of the specific resource and technology types. Further to this, the IESO explored two additional technology/resource types stakeholders showed strong interest in understanding opportunities for participation: (1) hybrids, which currently have no participation model[4]; and (2) enabling Regulation service providers to provide OR.

3.3 Determine which requirements are within the IESO's control to change

To determine requirements under IESO's control, the IESO conducted a review of acts, standards, and requirements imposed by outside organizations. The IESO than compared that with IESO requirements to determine items under the IESO's authority. To provide additional clarity, outside organizations (e.g. Northeast Power Coordinating Council (NPCC), North American Electric Reliability Corporation (NERC), and the Ontario Energy board (OEB)) are responsible for a number of market and reliability standards that the IESO must adhere to. The IESO develops its requirements to ensure they can meet these broader standards, while also developing further requirements that best fits the Ontario market. The IESO is generally able to adjust requirements if they do not interfere with its ability to meet outside entities' standards. The IESO articulated to stakeholders that the focus of the work in this report is on the requirements that are under the IESO's authority without compromising the IESO's own ability to meet those standards.

[4] Hybrids currently do not have a participation model within IESO markets, and through potential development in upcoming work the IESO may consider DERs and storage in its development. DERs and storage are being reviewed through other forums (the Innovation and Sector Evolution Whitepaper Series and the Energy Storage Advisory Group) and will not be covered in this document.

4. Requirements to Participate

The IESO and other regional and regulatory organizations are responsible for developing requirements and standards for market participation. Not all requirements are set by the IESO but are instead coordinated among these various regional and regulatory organizations. These standards and requirements attempt to align the safety and reliability of the grid with its efficient market operation. Market participants must meet the market participation requirements or risk putting the interconnected system in jeopardy. The requirements are constantly evolving to accommodate changing demand, new technologies, various regulatory changes, among other changes. To accommodate this constant evolution, the IESO routinely updates its market rules, tools, and manuals to address the needs of the grid and its market place.

The Requirements to Participate section will detail the current participation requirements that must be met in order for resources to participate in the IESO's energy and OR markets. Some of these requirements may be adjusted for certain resources, on a case-by-case basis, but still ensures no one facility compromises the reliability and stability of the grid. This section uses a Quick Start (QS) resource to explain the requirements and process to participation. The QS resource is used because, generally speaking, QS resources meet the requirements to fully participate in the energy and OR markets. This report classifies the QS resource as the baseline participation model.

The following colour coding legend is used to display how certain resource types covered in this report participate in the energy and all classes of OR markets.

Fully enabled **Partially enabled** **Not enabled**

4.1. Baseline Participation Model – Quick Start Resource:

As per the definition in the IESO Market Rules, a Quick Start facility is - *A generation facility whose electrical energy output can be provided to the IESO-controlled grid within 5-minutes of the IESO's request and is provided by equipment not synchronized to the IESO-controlled grid when the request to start providing energy is made.*

Most of the QS resources in Ontario are hydro, although a QS unit can utilize different technology types to provide energy. Hydro resources have historically provided a large portion of the installed capacity (currently representing 23%, or 9,060 MW) as well as many grid services in the province. The baseline resource in this report does not specifically focus on hydro resources and is being used for illustrative purposes.

QS resources do not have a Minimum Loading Point (MLP)[5] and can ramp up or down flexibly, allowing them to provide many system services (including energy and OR) to the IESO and are considered fully enabled by the IESO.

The current status of how a QS participates in the IAMs is detailed below:

Energy	OR – 10S	OR – 10N	OR – 30
Fully Enabled	Fully Enabled	Fully Enabled	Fully Enabled

4.2 Market Entry

Before resources can participate and begin commercial operations in the IESO administered markets, facilities and potential participants must connect and register to the electricity system. The IESO works with the participant through the connection and registration processes and conducts an approval process for all participants that participate in the IAMs to ensure there is no risk to the grid or market operations. The market entry process can take anywhere from a few months for small modifications to existing facilities, to more than three years for major modifications or to connect new facilities.

Connection

Connection is the process of connecting a facility to the grid. In order to become an IESO market participant a facility must first gain approval from the IESO to connect to the IESO controlled grid or to a distributor's system. This is required for physical facilities wishing to operate within the IAMs. This step is not required for boundary entities.

What the IESO does during this time:

The IESO assists potential participants through the connection process, reviews the connection assessment application and approves if it determines that the resource will not negatively impact the IESO-controlled grid.

Participant Requirements:

There are generally three main requirements to complete the connection process: (1) prepare an application, (2) obtain conditional approval to connect, and (3) build the facility. If the participant intends to register a facility to participate in OR, the system impact assessment will

[5] (MLP) means the minimum output of energy specified by the market participant that can be produced by a generation facility under stable conditions without ignition support.

assess the resource's ability to reliably provide the ancillary service. These steps are required to allow the IESO to accurately confirm the location of the facility as well as assess its impact on reliability at the connection point and its ability to provide energy and ancillary services (if the participant opts to participate in those markets, of which includes the OR market).

Registration

The registration process is used to authorize participation of the market participant and facility in the IAMs, ensuring the resource meets technical reliability requirements, and ensure the IESO can monitor the facility to safeguard the reliability of the IESO-controlled grid. This step provides the participant with their resource ID and the IESO with the necessary information to begin accepting a resource's bids/offers in the markets.

What the IESO does during this time:

The IESO reviews and approves market participant and facility registration, in addition to ensuring the IESO systems are in place to ensure visibility and dispatchability of resources. This includes, but is not limited to: building network models; securing regulatory approvals; securing agreements with other jurisdictions (if applicable); testing operational telemetering; ensuring dispatchability; and configuring settlement systems. Through this stage, the IESO collects and uses information as inputs into the Day-Ahead Commitment Engine (DACE) and Dispatch Scheduling and Optimization (DSO) algorithm to ensure that resources can be scheduled in the markets.

Participant Requirements:

There are generally three main participant requirements to register – (1) complete market participant authorization, (2) complete facility registration, and (3) validate performance of the installed resource(s).

When undergoing the market registration process, the participant selects from a number of registration types to register their facility. For example, a QS resource will register with the IESO as a dispatchable generator (other registration types include dispatchable load, or self-scheduling resource). As a dispatchable generator, resources can fully participate in energy and OR (facilities must be registered as dispatchable to participate in OR (i.e. self-scheduling resources cannot participate in OR). Further to this the resources must hold an applicable OEB license, be a minimum of 1 MW in size, and be able to settle with the IESO, which includes working with a Meter Service Provider to install and register a wholesale revenue grade meter that meets Measurement Canada requirements as well as holding sufficient financial collateral with the IESO in case of default.

The resources that complete the participant authorization, facility registration, and are installed are tested to validate their performance. This confirms the technical capabilities with generator requirements of the resource and the resource operates as expected.

4.3. Market Participation

The IESO works at the heart of Ontario's power system as the system operator – directing the flow of electricity across the grid and administering the wholesale electricity market. The wholesale electricity market is where suppliers compete to provide electricity to meet consumer needs. Ontario's Real-Time electricity market is a 24/7 operation, with the intersection between offers to supply electricity and bids to consume, setting a wholesale price every five minutes. Resources compete in this market and the IESO selects the least cost options to meet demand and have the necessary reserves available. Both the energy and OR markets are co-optimized, meaning that offers and bids for resource are evaluated for energy and OR at the same time to find the lowest possible cost of production to serve both markets. Dispatchable resources, including QS resources, provide hourly offers/bids into the markets to be considered for dispatch. The matching of the bids/offers to demand set the market clearing price every 5-minutes as well as the Hourly Ontario Energy Price[6]. OR price for all classes of OR are also set every 5-minutes based on the market clearing price of OR offers submitted to the IESO. There are three steps in the process to participate in the market, which are: participating in the Day-Ahead Commitment Process, pre-dispatch, and Real-Time.

Day-Ahead Commitment Process

The Day-Ahead Commitment Process (DACP) allows certain resources to submit bids/offers so the IESO can begin scheduling and committing resources for real time. The DACP provides a view of the next day's available supply and anticipated Ontario demand. By resources submitting bids and offers into the market it allows the commitment of certain resources and improves the efficiency of the market through advanced optimization and scheduling of resources.

What the IESO does during this time:

The IESO runs the Day-Ahead Commitment Engine (DACE), which is designed to minimize total commitment costs and optimize market schedules over a 24-hour period. An output of this process is a schedule of record and Availability Declaration Envelope (ADE). The ADE provides criteria, such as the MW limits and the hours of availability a resource can submit and resubmit bids/offers when participating in the Real-Time (RT) market. The IESO also schedules Regulation as an ancillary service during the day-ahead.

Participant Requirements:

The process requires resources that wish to participate in the market for a specific day to submit offers into the market, which are used to provide resources with a corresponding ADE.

[6] This price is the average of the twelve five-minute market clearing prices during the hour.

OR offers can also be submitted through the DACP as the scheduling of OR and energy is co-optimized. It is important to note however that in the DACP timeframe OR schedules are not binding, unlike RT. The scheduling of OR and energy in the RT energy market is co-optimized to ensure the most efficient outcome for the market.

Pre-Dispatch

The pre-dispatch process establishes prices and schedules for committed resources over a number of future hours providing an overview of when dispatchable resources are likely to be dispatched. In addition to providing an indication of a resource's dispatch in real time, it provides resources with information to determine if they should update their bids/offers into the market to attempt to become economic or to update their availability. In this timeframe participants are prepared to follow dispatch instructions. This also provides a mechanism for Non-Quick Start resources to obtain commitments as well as schedules import and exports the hour before RT.

What the IESO does during this time:

The IESO uses the DSO to produce pre-dispatch schedules and project market prices, which facilitates the efficient and reliable operation of the market by allowing participants to anticipate conditions for the coming hours and following day.

The DSO is run hourly in pre-dispatch, projecting prices and schedules over the future hours for a dispatch day. It also determines schedules for imports and exports for the next hour and allows eligible NQS generators to request a Generation Cost Guarantee.

Participant Requirements:

During the pre-dispatch timeframe, participants can revise bid and offer data and prepare for dispatch if scheduled. Participants can modify this information up to the mandatory window, which is two hours before dispatch. Resources that receive preliminary schedules during pre-dispatch must prepare to ensure that they comply with the dispatch instruction. When a resource is scheduled for OR, its schedule advises the participant of the amount of energy required on standby. Further, resources may be scheduled for any class of OR type (10S, 10NS, 30R), or subsequent lower class[7], depending on their offers (i.e. if offering for 10S, a resource could be scheduled for 10S, 10N or 30R). If a resource is unable to meet their schedule prior to the start of the mandatory window, they are required to update their offer information to reflect their updated capabilities. Additionally, participants are able to notify the IESO of necessary

[7] Lower class refers to the subsequent class in which OR is activated. The IESO will start first with activating 10S, and then move down to subsequent lower classes (10N and then 30R) if further reserve activation is still required.

amendments to the offer quantity within the mandatory window if this is a result of equipment, safety, or reliability concerns.

Real Time

During RT the IESO transmits dispatch instructions for the required amount of energy to be injected or withdrawn from the IESO-controlled grid and sets the market clearing price. Resources follow these instructions to meet demand.

What the IESO does during this time:

The IESO uses the DSO to produce RT market schedules and prices. The RT schedules reflect the actual generation, reserve allocation and dispatchable load levels that achieve secure operation at a minimum cost, subject to the system operator's assessment of the reliability of the network. The IESO issues dispatch instructions according to the RT schedules. The RT market prices are used - unless administered prices are necessary - to settle the market. To maintain reliability, the IESO may contact facilities directly if there is a need to deviate from dispatch instructions from the RT schedules.

Participant Requirements

As RT approaches, resources are sent dispatch instructions for energy and/or OR with the required amount of energy injected or withdrawn from the IESO-controlled grid. Dispatchable facilities are expected to respond to dispatch instructions that are determined every 5-minutes. The market clearing price used for financial settlement of dispatchable facilities is set every 5-minutes, matching each dispatch interval through the unconstrained schedule.

The participant may receive an OR activation instruction in the event of a contingency. This will be reflected through their energy dispatch instructions as specified by the IESO and the participant will be paid their energy offer. These steps are required to ensure that the IESO can dispatch the least cost options to meet demand for the energy market and safeguard the reliability of the IESO grid.

4.4. Settlement of Market Activities

Resources that participate in the market, must be settled by the IESO. The IESO reconciles the wholesale charges between supply and demand, balancing these payments to market paticipants. This provides the resources with the revenues required to provide services to loads on the interconnected grid.

Settlement

During this stage, the IESO settles the physical and financial markets with market participants. The participants either receive payment for providing into the market or are required to pay the IESO for services received.

What the IESO does during this time:

The IESO collects meter data automatically through the IESO meter interrogation system and the participant revenue wholesale meter. This data allows the IESO to perform the Validation, Estimating and Editing (VEE) process. First, the validation tests the raw metering data to ensure that it is consistent with previous data and the alternate meter. Next, the estimation takes place in cases where the meter data has communication gaps or failed validation. Finally, editing is completed when there are adjustments required to estimated values. The results in the VEE process is "settlement-ready" metering data suitable for use in determining settlement amounts.

The metering data is used by the settlement process to provide a detailed breakdown of all the financial calculations performed by the IESO concerning a market participant's activity in the IAMs. This service allows market participants to review and reconcile these calculations and pursue any apparent disagreements over such calculations with the IESO. The review and reconciliation is accomplished through the issuance of preliminary settlement statements and final settlement statements to market participants. Included in these statements is data for each dispatch day, accompanied with invoicing of all settlement amounts.

Participant Requirements:

A market participant is required to be enabled for settlement before participating in the IAMs, however, the settlement process itself takes place after a resource has been scheduled in the market. Once active in the markets a participant could be required to pay an invoice to the IESO if requested, or meet specific timing requirements if the participant intends to dispute the settlement amount. Additionally, market participants are recommended to review their respective settlement statements to ensure accuracy and the correct compensation.

5. Misalignments/Opportunities

Some resource types are limited in their participation in IESO markets and cannot fully participate like a Quick Start resource. Technological limitations, where they are unable to meet current requirements, or limitations of IESO systems and tools could restrict participation in certain markets. Nascent or developing resource types may also not have the pathways currently available to them in IESO markets as the IESO needs to better understand their capabilities and augment IESO tools to identify their unique characteristics in the day-ahead, pre-dispatch and Real Time scheduling algorithms.

The MDAG facilitated conversations with stakeholders to focus in on the specific resource types that stakeholders were interested in discussing that are not currently fully enabled in either the energy and/or OR markets to better understand where misalignments could exist for those resources. These resource types are NSQS gas, imports, VGs, and HDR.

In addition to the resources detailed above, the IESO and stakeholders identified two other areas of opportunity that warrant further exploration. One is hybrids, which do not have a participation framework in Ontario and are not defined in the market rules. Another is enabling Regulation service participants to provide OR. Today, Regulation service providers are generally fully enabled in the IAMs, however, Regulation service providers cannot provide OR and Regulation simultaneously from the same resource.

The following tables provide an overview of technology/resource types reviewed through this exercise and the current status of their ability to participate in energy and OR markets.

Review of Misalignments

Technology/Resource Type	Report Section	Energy	OR – 10 minute - Spinning	OR – 10 minute - Non-Spinning	OR – 30 minute
Gas (Not-So-Quick Start)	5.1	●	△	△	△
Imports	5.2	●	✕	△	△
Variable Generators	5.3	●	✕	✕	✕
Hourly Demand Response	5.4	△	✕	✕	✕

● **Fully enabled** △ **Partially enabled** ✕ **Not enabled**

Exploration of Opportunities					
Technology/Resource Type	**Report Section**	**Energy**	**OR – 10 minute - Spinning**	**OR – 10 minute - Non-Spinning**	**OR – 30 minute**
Hybrids[8]	5.5	**N/A**	**N/A**	**N/A**	**N/A**
Regulation Service Providers[9]	5.6	●	✖	✖	✖
● **Fully enabled** ▲ **Partially enabled** ✖ **Not enabled**					

5.1 Gas (Not-So-Quick Start)

Gas resources in the IAMs fall into one of the two formal classifications of resources: Quick Start (QS), or Not-Quick Start (NQS). The term "Quick Start Facility" is a defined term in Chapter 11 of the Market Rules and which can be summarized as a generation facility that can provide output to the grid within 5-minutes, even if not synchronized (the full definition is provided in section 4.1 of this memo).

QS resources do not have a Minimum Loading Point[10] (MLP) and are dispatchable on a 5-minute basis. This is in contrast to NQS generators who, while not defined in the market rules, are generally assumed to require more than one hour to become dispatchable. Most of the gas resource fleet fall into either a QS or NQS category and are fully enabled to participate across all market revenues streams (energy, all OR classes). However, there are a select few gas resources who are not 5-minute dispatchable but are able to respond within one hour. These resources are not defined in the market rules but have been referred to as Not-So-Quick-Start (NSQS) for the purposes of this report.

Similar to the other gas participation classifications, NSQS resources are able to participate in the energy and OR markets but are different in that there are limitations to this participation. These limitations are a result of a unique set of operational characteristics and the lack of a defined participation model to address those characteristics.

The current status of how NSQS resources participate in the IAMs is detailed below:

[8] Although a resource that meets the IESO's hybrid definition could be participating through other participation models, the IESO does not currently enable any resources formally or informally specifically through a hybrid participation model.

[9] Regulation service providers can participate in OR markets when not providing Regulation. This participation overview is indicative of current Regulation service participants while they are providing Regulation to the IESO.

[10] Minimum Loading Point is the minimum output required by the facility so it can reliably operate

Energy	OR – 10S	OR – 10N	OR – 30
● Fully Enabled	▲ Partially Enabled	▲ Partially Enabled	▲ Partially Enabled

NSQS resources are fully enabled to participate in the energy market and participate in the same manner as a QS facility. Due to the nuances of their facilities and the absence of a formal participation model, NSQS are required to register as NQS or QS resources, and in the case of registering as NQS, inadvertently limits their ability to provide OR. For example, a NSQS resources will not be scheduled to provide OR until they have achieved MLP, at which point the resource becomes dispatchable and is able to respond to 5-minute dispatch instructions. In fact, some NSQS resources may be able to provide 30-minute OR from an offline state. When registered as a QS, NSQS may provide OR from an offline state (if they are technically capable), however, the scheduling algorithm does not recognize that the resource needs to be at MLP in order to provide 10-minute OR (if applicable). If the NSQS resource can only offer 10-minute OR once it has been scheduled at MLP, it will be unable to adjust its offers due to the mandatory window restrictions.

Connection

NSQS resources connect in the same manner as the baseline resource.

Registration

NSQS resources are required to register within the same framework as the baseline resource.

Misalignment:
No Formal Participation Model Specific to NSQS: Generators in the NSQS category are subjected to the same market participation requirements for both QS and NQS resources. These do not always match their capabilities when registering and, as a result, the day-ahead, pre-dispatch and RT alogrithims may not recognize that the NSQS is capable of providing certain services based on current configurations required to provide those services. Certain manual modifications need to be modeled to allow participation in OR such as utilizing different MLP's, as stated in "Day-Ahead" section below. NSQS resources have varying capabilities and share similar characteristics among both QS and NQS categories. Therefore, NSQS resources have been partially enabled in the IESO market in a way that does not fully align with the framework outlined in the market rules designed for QS and NQS resources. This limits the NSQS' ability to participate in the OR markets despite being operationally capable of providing all classes of OR. This misalignment extends across all subsequent steps to participate, creating other issues including optimization of this resource.

Day-Ahead

NSQS resources may have an MLP utilized for scheduling by the day-ahead scheduling algorithm; in this case, OR could be scheduled in DACP only if the NSQS resource is economic for energy at MLP or greater in day-ahead. If the day-ahead scheduling algorithm utilizes MLP = 0, the NSQS resource could be scheduled for any OR product for which it is capable, meaning that there is no minimum MW requirement for injection before it can be used for OR, which is in the same way as the baseline participation model.

Pre-Dispatch

NSQS resources operate in the same way as the baseline resource in the pre-dispatch timeframe. Similar to other resources, a NSQS that is unable to provide energy or OR in a given hour due to equipment limitations must remove their applicable offers.

Real Time

NSQS resources registered as a NQS must achieve MLP and become dispatchable in order to provide OR, similar to NQS resources. NSQS resources registered as a QS must be physically capable to provide the OR products for which they offer, similar to QS resources.

Settlement

NSQS are settled in the same way as the baseline resource.

5.2. Imports

The IESO-controlled grid is connected to five neighbouring jurisdictions with intertie transmission lines, and is able to import and export energy to and from these neighbouring jurisdictions. The focus of this section is on "imports", which involves moving energy from another jurisdiction/control area into Ontario for use by Ontario's consumers. Imports can be either system-backed or resource-backed. The primary difference is for a system-backed import the jurisdiction where the energy originates "backs" the megawatts from the transaction. Where as a resource-backed import is required to support their own transactions and the jurisdiction will not guarantee the flow of energy offered by the resource. This section describes the process for system backed imports, as the IESO currently does not have any resource backed imports, but some of the misalignments could apply to resource backed imports.

There are many nuances when it comes to how imports participate in the IESO-markets due to the interaction with other jurisdictions and moving energy across the interties. One of these nuances is that importers may participate in the IESO Financial Transmission Rights market. Transmission rights allow importers to compete to purchase a financial instrument to hedge against the risk of congestion on the interties for which they trade. Intertie transactions also receive a different price than resources internal to Ontario. Intertie transactions receive the intertie zonal price that is a combination of the market clearing price (that internal resources

receive) and the intertie congestion price that is unique to the zone for which the import flows through.

The current status of how imports participate in the IAMs is detailed below:

Energy	OR – 10S	OR – 10N	OR – 30
 Fully Enabled	 Not Enabled	 Partially Enabled	 Partially Enabled

Imports are fully enabled to participate in the energy market and are a significant supply resource, providing 6.6 TWh of energy for Ontario in 2019. For OR, the market rules only allow the IESO to obtain non-spinning OR from imports. However, this is restricted to interties where the IESO has an agreement with the neighbouring control area that allows these transactions to be treated as OR. Currently the IESO only has this agreement in place with Quebec and is piloting the use of OR across the interties with this jurisdiction.

Connection

There are no direct IESO connection requirements for imports.

There are requirements placed on the transmitter and the neighbouring jurisdiction to ensure the reliability of energy flow across interconnection. One of the precursory requirements is a need for an interconnection agreement between Ontario and the neighbouring jurisdiction to allow the flow of energy across jurisdictions. These interconnection agreements set the guidelines for transacting energy, capacity, and in certain cases OR across jurisdictions.

Misalignment:
Lack of Interconnection agreements for OR: Aside from Quebec, current interconnection agreements do not facilitate OR across interties, and is not typically considered as part of the interconnection agreement. There is a reliance on the other jurisdiction to ensure that the power is able to flow from a specific resource and respects system limits, therefore OR transactions must be backed by the other jurisdiction. These agreements are difficult to negotiate between two jurisdictions due to various requirements imposed by each system area.

Registration

Many of the requirements that are applicable to a facility located in Ontario are not necessary or practical for facilities in other jurisdictions. These resources register as a boundary entity, which

could further require licencing from the Canada Energy Regulator (CER) to wheel[11] electricity over the interties as well as NERC tagging (also called e-Tag[12]) and CER permits to support trades.

Since these resources exist outside the Ontario system, they do not need to conform to the typical metering (telemetry and settlement), dispatch workstation or performance validation requirements described in the baseline participation model. Instead these are typically detailed in the interconnection agreement between jurisdictions, and meters are installed directly on the interties to confirm aggregate flows of all resources flowing through them.

Misalignment:
Telemetry is not facility specific: IESO telemetry on imports is only available on the interties and not connected on any specific facility within another jurisdiction. This presents a challenge of not knowing which aggregated facility is providing output in RT. For a resource to provide OR, they have a dispatch workstation and the IESO typically ensures it has visibility into whether resources are following dispatch instructions as the IESO is bound by NERC and NPCC requirements to meet strict contingency event response conditions. The IESO recognizes that for imports attaining the same level of telemetry would be a challenge to attain to the same level of as resources located in Ontario. Requirements on telemetry between jursidictions are typcially dicated in the interconnection agreements. This requirement does not apply to system backed imports as all aggregated flows come from a single market participant.

Day-Ahead

Importers are not required to participate in the DACP but have the option should they choose. When submitting offers, importers must include information on which intertie they will flow through. Import offers that clear the market are eligible to receive an intertie offer guarantee[13] (they can receive this guarantee in the day-ahead or in pre-dispatch).

Pre-Dispatch

If an importer has not submitted offers into the DACP, it can do so during pre-dispatch prior to the mandatory window. Importers are eligible for the intertie offer guarantee if they are scheduled.

[11] "wheel" means to move energy from one jurisdiction, through Ontario, to a different jurisdiction.
[12] e-Tag is used to track a transaction on the North American bulk electricity market that is scheduled to flow within, between or across jurisdictions.
[13] The intertie offer guarantee ensures that, over the course of the hour, an importer will receive at least the average price of their offer, i.e. they will not suffer a negative operating profit

Importer transactions compete economically in pre-dispatch, and hourly schedules for imports are determined by the DSO in the pre-dispatch run 1 hour prior to RT (PD – 1) since the IESO currently schedules intertie transactions on an hourly basis. In contrast, internal dispatchable resources are scheduled every 5-minutes. Interjurisdictional trade is co-ordinated between the IESO and other balancing authorities using hourly interchange schedules, and if scheduled imports are fixed for the full hour (unless a change is needed for reliability reasons). These import schedules are communicated via E-tag to external balancing authorities.

Misalignment:
Importers do not receive 5-minute dispatch instructions: Imports are scheduled on an hourly basis while internal resources are scheduled for OR on a 5-min basis. Considering that OR could be activated intra-hour, it is necessary for OR providers to be able to meet OR targets within 10-30 minutes of notice as per the class of OR that are set by NERC and NPCC.

Real Time

Imports are fixed for the duration of an hour in RT, therefore its schedule should not fluctuate from what was stated in the PD-1 schedule.

Settlement

Import transactions are settled on the same timelines and through the same process as resources internal to Ontario, but as previously stated in this section, they receive different types of settlement payments than other types of resources (i.e. the intertie zonal price, and payouts from purchased transmission rights). They are also settled based on scheduled flow (assuming that the transaction does not fail) instead of actual flow, as a result of metering on the interties instead of the facility.

5.3. Variable Generation

For the purpose of this document, variable generation (VG) refers to solar and wind resources. In Ontario, wind represents 12% (4,486 MW) of transmission connected capacity, while solar represents approximately 1% (478 MW). In terms of embedded resources, solar represents the largest amount of generation on the distribution system with 2,163 MW installed compared to 591 MW of wind.

VGs are unique in that they are required to participate in the IESO's Centralized Forecasting Program. This allows the IESO to forecast production from these resources to incorporate into the DSO and entail a requirement to submit their full capacity available for production (minus outages) into the energy market. The forecast provides the IESO with an estimate of their availability 48 hours up to 5-minutes before real time. Forecasts are used in conjunction with the demand forecast to determine if it could be necessary to dispatch these resources to a different output level than their ambient conditions. Even though they are dispatchable

resources, VGs operate based on ambient conditions, meaning they do not necessarily get dispatched to a specific output level, but operate based on the availability of fuel and the maximum production capability in real time.

The current status of how VG's participate in the IAMs is detailed below:

Energy	OR – 10S	OR – 10N	OR – 30
Fully Enabled	Not Enabled	Not Enabled	Not Enabled

VGs connected to the transmission system are registered as dispatchable resources and provide energy to the IESO. At this time, they are not enabled to participate in OR due to the intermittent and uncertain nature of their supply capability.

Connection

The connection process for VGs is the same as the baseline participation model but there are specific system impact assessment forms that must also be completed.

Registration

VGs go through the same process to register their organization as the baseline participation model, but through the registration of participation and facility registration they must also consent to participate in IESO's Centralized Forecasting Program which involves forecasting their operation to mitigate VG uncertainty and requiring that they submit their full production capacity that is available (minus any outages). These forecasts are run to provide an estimate of VG's production 48 hours up to 5-minutes before real time. Through this program a VG must meet the conditions to allow operational and meteorological data, providing telemetry to the IESO specific to their wind or solar resource.

Day-Ahead

VGs follow the same process in day-ahead as a baseline participation model. This entails submitting offers into the day-ahead, but ensuring offer prices do not exceed specified VG price floors set by the IESO (for wind and solar that is no less than $3/MWh, excluding the last 10% of winds resources available capacity, which must be offered at no less than $-15/MWh). As mentioned previously, as a condition of participating in the Centralized Forecasting program, if offering into the market VGs must offer up to their total installed capacity net of any derates or outages for only the energy market. These resource typically have limited marginal costs due to renewable fuel, which allows them to be selected earlier in the supply stack for their full capability.

During the day-ahead the IESO collects forecast data in order to deem a resource's operational certainty for the hours offered by the participant. This information is used in conjunction with

the VG's offers through the course of scheduling resources. Generally, the IESO will schedule these resources based on economics up to the lesser of their offer and forecast quantity.

Pre-Dispatch

VGs continue to follow the same process as the typical baseline participation model besides certain limits imposed on their offers, as mentioned in the section above. Additionally, the IESO is required to extract forecast data from each resource to get the most up-to-date information on their operational certainty. The forecasts are used to develop anticipated schedules for VGs, and the forecast cannot be modified by the participant, but they can adjust their total capacity available for real time. Typically, electricity demand and prices are high enough where a VGs schedule will indicate operating based on ambient conditions and the availability of their fuel, this generally does not result in any anticipated dispatch action outside of operating to their full capability. If demand and prices are low enough it may indicate to VG resources they will receive a dispatch instruction to lower their output, meaning the IESO will not require all of their capability based on ambient conditions and the availability of their fuel.

Further to this, the forecasts on VGs continue to be factored in the IESO's pre-dispatch and real time optimization algorithm and determination of other supply required to meet demand, enabling the IESO to estimate and prepare other resource types for dispatch in RT.

Real Time

A VG's production is limited by the availability of their fuel in RT and the IESO's ability to accurately forecast their potential output. During RT VGs production will generally vary from the forecast as there is no certainty of the availability of these resources' fuel at all times, but are still able to operate based on ambient conditions. As mentioned previously the IESO manages around these resources by factoring VG forecast into the scheduling of all resource types.

In RT, VGs receive one of two notifications, either a "mandatory" or "release" notification. If the resource is limited because of either economic or reliability reasons they will receive a "mandatory" dispatch. If the VG resource is not limited by economics or reliability they will receive the "release" dispatch and are free to produce based on ambient conditions. In other words, the IESO cannot dispatch these resources up and down to specific outputs. The IESO can only dispatch these resources down to a specific output from ambient conditions (mandatory notification), or otherwise permit the resource to provide their maximum output based on ambient conditions (release notification). These resources typically receive a release notification in RT where they operate on ambient conditions, this is due to their lower marginal costs which results in being dispatched for their full capability. Their full capability is dictated by their fuel availability in real time.

Misalignments:

Uncertainty of operation: Considering that VGs are dependent on availability of their "fuel" (wind or solar energy), the IESO collects forecast information to better predict how these resources will operate in RT. However, this forecast does not provide enough certainty that specific resources will meet that forecast in real time, hypothetically be available to provide OR if activated, and ramp up to meet a particular output. In addition, there is no certainty that the resource can sustain a consistent output for up to one hour due to the fluctuations in availability of their fuel.

Tool constraint: The IESO does not have the ability to dispatch VGs up and down like a typical dispatchable resource, which is inherintely tied to the uncertainty of their operation described above. Generally, VGs output is based on ambient conditions, however, the IESO does have the ability to issue a dispatch signal for VGs to reduce their output for either economic or system reliability reasons. At this time, the IESO does not have the ability to pre-emptively curtail VG resources' output so that it can be on standby to provide OR when needed. Also, in order for VGs to provide OR, the IESO requires the ability to increase VG output on demand for OR activations. Therefore, VGs are not able to be scheduled or activated for OR.

Settlement

VGs follow the same process as the baseline participation model for settlement but could have differing payments as per their Power Purchase Agreement (PPA)[14].

Misalignment:

Contract incentives: Ontario's fleet of VGs are currently under contract with PPAs beginning to expire in 2026. These contracts incentivize VGs to maximize their MWh output in the energy market to secure the prices included in their contract and also compensate them for forgone energy in certain circumstances. As such, there appears to be limited incentive for VGs to curb their output to participate in the lower priced OR market currently.

[14] A PPA is an agreement that the IESO has entered into with a counterparty which generally defines the terms and conditions for the sale of electricity between the counterparty and the IESO. VG's with a PPA are typically paid a fixed price per kWh provided irrespective of market prices.

5.4. Hourly Demand Response

Demand Response (DR) refers to the change in end-use electricity consumption patterns in response to price or reliability signals. There are currently two different types of DR participants in the IAMs; dispatchable loads, who are fully enabled to participate in energy and OR, and Hourly Demand Response (HDR).

The focus of this section will be on requirements and misalignments for HDR resources since dispatchable loads are already enabled in the energy and OR markets.

The HDR resource type design was developed in collaboration with stakeholders through an engagement process at the Demand Response Working Group (DRWG). DR resources were transitioned from the previous Demand Response 3 program, a contract-based DR program for commercial and industrial enterprises, to the HDR participation model. This model was designed to enable their participation in the IAM and be governed by IESO Market Rules. Since this initial transition process, enhancements have been made to the HDR resource participation model through ongoing engagement with DR stakeholders. The HDR resource participation model that is in place today reflects a balance between DR resources' operating characteristics and the requirements to participate in the energy market as a capacity resource. The IESO recognizes that some DR resources' technical capabilities may extend beyond how this current participation model enables them to participate. The misalignments for HDR resources described in this document reflect the history of the development of this participation model, the enhancements that the IESO has implemented with stakeholder input over the years, and the balance between the operating characteristics of the resource and the requirements to participate.

HDR does not participate in the energy market like a baseline QS resource. First, HDR resources are required to participate in the capacity auction and secure a capacity obligation, which sets the basis for how they participate in the IAMs. Unlike a QS resource, HDR resources do not meet the dispatchability requirements. Instead, to be utilized, HDRs follow a unique set of activation parameters, which include standby and activation notices and require a much longer lead time to prepare for an activation. HDRs do not receive the typical 5-minute dispatch instructions that the baseline resource receives and instead receive activation instructions for a MW quantity to reduce by relative to historical consumption levels. The unique process and timing that is in place to activate these resources limits their ability to fully participate in the IAMs.

There are two types of HDR resources: physical (revenue-metered) and virtual (e.g. aggregated and not revenue-metered). HDR resources typically consist of an aggregated number of facilities referred to as contributors, which can be residential, or commercial & industrial. HDR resources participate according to their capacity obligation set by the capacity auction. The capacity obligation sets their maximum energy market participation limit. The HDR participation model defines when and how they are required to enter bids into the market, and places limits on bid price, when they are required to submit bids, remove bids, and how many times they can be activated. The prescribed rules associated with this participation model enables HDR resources to participate in the energy market in order to satisfy their capacity obligation and

demonstrate their availability to provide capacity. As a result, HDR resources only receive availability payments for being available to curtail their load if called upon based on market economics or reliability.

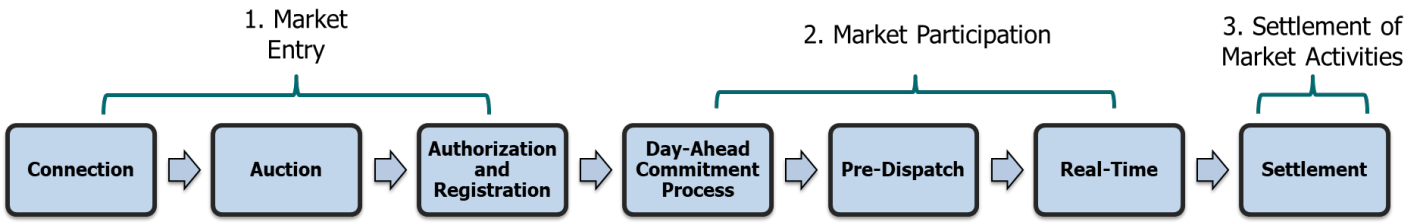
The current fleet of HDR resources are primarily made of contributors who are located on the distribution system. These contributors are required to meet the IESO requirements of a contributor of an HDR resource, but are also subject to the requirements of the LDC for which they are located.

The status of how HDR resources participate in the IAMs is detailed below:

Energy	OR – 10S	OR – 10N	OR – 30
⚠ Partially Enabled	✖ Not Enabled	✖ Not Enabled	✖ Not Enabled

Due to differences in how they participate compared to QS resources, this section (5.4) includes other steps in the process to participate, providing additional information on the HDR resource's participation model. Figure 2 below details the steps for an HDR resource to participate, to describe the differences in this model compared to the baseline resource. For some clarity on one of the primary differences, an HDR resource must first clear a Capacity Auction prior to being authorized to participate in the energy market.

Figure 2. | HDR Resource Process to Participate



Connection

With most resource types that provide generation (injection into the grid), a connection assessment may be required to assess whether there may be an adverse impact to the IESO-controlled grid. HDR resources are load reducing resources that are made up of one or more contributors. Contributors are existing loads that are either connected to the transmission or distribution system. All contributors must go through a connection process, whether that is to connect to the distribution or transmission system. Although, reducing load (including HDR) does not typically lead to an adverse impact to the grid and as such a connection assessment is not required for DR resources for the purpose of capacity auction participation.

Misalignment:
No Connection Assessment: although there is typically no connection assessment for load reducing resources to participate in the energy market to meet a capacity obligation, there is a requirement for a connection assessment that all resources must complete before participating in any ancillary services, including OR. HDR resources are currently precluded from participating in OR due to the other misalignments discussed in this section, and are thus generally omitted from the requirement for a connection assessment.

Auction

To participate in the energy market, HDR resources must register, submit offers and secure a capacity obligation through a capacity auction before proceeding with further participation requirements. To register for an auction, the prospective participants complete a pre-authorization registration process, which is similar to the typical pre-requisite registration process for market participants. The prospective participants also specify the MW quantity and obligation periods they intend to submit into the auction. In addition to this, HDR resources are required to be authorized as a load class.

Through the pre-authorization process the HDR resource must provide further detail on the type of obligation (physical or virtual) and contributor (residential or commercial & industrial), in addition to their zonal location. Importantly, HDR resources must consist of only one obligation type, one contributor type, and all contributors behind a single HDR resource must be stationed within one zone. The IESO requires this to ensure it can reasonably model these resources and evaluate their response without compromising on system security. Virtual resources are made up of many contributors and, although they can be spread throughout one zone, the IESO models them at a single node.

Once completing the above steps to authorize, HDR resources can participate in a capacity auction. Participants submit capacity auction offers for each of their resources in an attempt to clear the auction and receive a capacity obligation. These auction participants can include up to 20 price-quantity pairs within each offer, and must indicate if their full or partial capacity offered can clear the market. The IESO takes this information, determines the auction clearing price for each zone and assigns a capacity obligation for each obligation period to capacity auction participants as well as their resources based on offers submitted at or below the clearing price.

Authorization and Registration

When HDR resources clear the auction and secure a capacity obligation they are authorized to register as a capacity market participant. As noted in the "Auction" section above, both physical and virtual HDR resources are required to register as an HDR resource. Registering as an HDR resource indicates they are not able to respond to the IESO's 5-minute dispatch instructions,

will not receive IESO dispatch instructions and will instead go through the HDR activation process detailed in subsequent steps.

In the registration process, HDR resources are required to provide information regarding their individual contributors and are responsible for keeping their registry of contributors up to date throughout the obligation periods. For physical HDR resources, the information required is limited to the resource ID and MWs provided. In contrast, virtual resources are required to provide additional information that will enable the IESO to complete its evaluation of how resources responded to IESO dispatch instructions.

In terms of metering, physical resources are already connected to the IESO controlled grid and follow the same requirements as baseline resources (requiring operational and revenue meters), whereas virtual resources are located on the distribution system, are not operationally or revenue metered by the IESO and are omitted from the wholesale metering requirements as per IESO market rules.

Misalignments:
HDR resources are not dispatchable: HDRs are not dispatchable resources; HDR is activated ~2.5 hours prior to Real-Time and only if they have been put on stand-by by 7 am. HDR resources are not dispatched on a 5-minute basis, therefore they are not able to respond to 5-minute dispatch instructions and are ineligible to provide 10 or 30 minute OR. This misalignment exists because of the fundamental design of the HDR participation model which was created to allow these resources to compete to provide capacity in Ontario.

Telemetry: virtual resources are not subject to IESO telemetry requirements because, in most cases, they consist of multiple contributors with different connection points on the distribution system. Without telemetry in place, the IESO cannot monitor the real time consumption patterns of these resources as part of grid operations practices. The IESO requires this visibility for dispatchable resources and those who intend to provide OR to confirm that they are adhering to their OR activation instructions. If this is not in place, the IESO puts itself at risk of not meeting strict regulatory requirements set by NERC and NPCC. Currently, virtual HDR resources provide historical consumption data, which typically takes 1-2 months after an HDR activation event to be received by the IESO.

Day-Ahead

In the day-ahead timeframe HDR resources submit bids into the energy market in accordance with their capacity auction obligation and above a price floor of $100 set by the IESO. As HDR resources are not dispatchable resources they are omitted from providing OR offers.

Pre-Dispatch

If these resources are economic in the day-ahead timeframe and pre-dispatch prices are above a certain threshold the IESO may issue a standby notification to HDR resources by 7 am day-at-hand. Further to this and if pre-dispatch prices continue to remain high, the IESO may opt to issue an activation notice up to approximately 2 hours and 30 minutes and at least 2 hours in advance of RT. This notice will provide the number of hours they are required (up to 4 hours) as well as the targeted reduction in energy to be withdrawn for each dispatch hour. These notifications are provided to HDR resources in lieu of 5–minute dispatch signals that are generally received by other dispatchable resource types.

Through the design of the HDR resource participation model, stakeholders informed the IESO that only a subset of HDR resources would be able to respond to standby and activation signals in a more immediate timeframe. Thus stakeholders and the IESO agreed to the current timing constructs of an HDR resource.

Misalignment:
HDR standby and activation timeframe: HDR resources are not able to respond to 5-minute dispatch instructions and require both a standby notification by 7am day-at-hand and activation notice in the approximate 2.5-hour timeframe and at least 2 hours before dispatch. As such, HDR resources are not configured to meet contingency events on a short notice (10 or 30 minutes).

Real Time

HDR resources are expected to achieve their target of the activation notice by the end of the first 5-minute interval of each hour specified and maintain it for the duration of the hour. HDR resources can be activated only once per day.

Misalignment:
Tool constraint - fixed schedule: If activated, HDR resources are expected to provide load reduction for at least one full hour and up to 4 full hours. They are considered an hourly resource, and current tools will not allow activations to be delivered in less than full hour increments or OR to be scheduled.

Settlement

The value HDR is primarily derived from providing capacity to the market and are settled through the IESO based on their availability to provide capacity. In most cases, HDR resources and their contributors are not directly metered by the IESO; generally, all other resources that participate in the IESO market are metered by the IESO directly. Those HDR resources that are not metered by the IESO, the contributors are connected and settled through their Local Distribution Company (LDC) for their consumption. The IESO confirms compliance towards this

obligation and tests participants up to twice per obligation period. In order to do so, the IESO conducts a baseline comparison, where it compares consumption at times when an activation did not occur against data when the resource was activated. The granularity of the data may not correspond to interval by interval changes that the IESO typically uses to measure an OR activation (i.e. 5 min vs. 60 min interval). If compliance is not met, HDR resources may incur non-performance charges.

5.5. Hybrids

With the advancement of storage technology, including lower technology costs and the ability of resources to co-locate/couple technologies with differing operating characteristics, stakeholders have expressed interest in the development of a hybrid participation model in the IAMs. Through upcoming work, the IESO will begin to explore opportunities for hybrid resources and determine the benefits they can contribute to Ontario consumers and the IESO controlled grid as well as how they could potentially be integrated in the IAMs.

The IESO believes introducing a hybrid participation model could bring benefits to the grid and participants, which include:

- enhancing existing technologies' capability to participate in the IAMs. One example is a VG resource leveraging the storage to mitigate operational uncertainty to better deliver in the energy market;
- increasing capacity value for resources and meet IESO resource adequacy requirements more effectively. If resources can cost effectively modify their facilities with an additional generator unit with reliable operation, it could potentially improve capacity value;
- enhancing dispatch flexibility of resources on the grid by improving various resources characteristics, e.g. ramp rates, minimum load point, reduction in output fluctuationsetc.;
- and providing a clear path for entry and operation in the IESO grid for resources that are emerging in other jurisdictions.

Hybrids in Other Jurisdictions

Many other ISOs have been exploring hybrid participation in their markets, two examples being CAISO and NYISO proposing a tentative path for enabling hybrids. With the introduction of grid scale battery storage, there has been a growing interest from market participants to couple multiple types of technologies. This has manifested in other ISOs with an influx of coupled resources in their interconnection queues. Other ISOs have been quickly developing coupled resource participation models to enable these resources in their markets, ensuring that the market participants have a clear framework to participate.

The advancement of hybrids in the United States has primarily stemmed from the: (1) declining costs of renewable and battery technology; (2) modular nature of batteries to quickly and cost effectively adapt facilities; and (3) opportunity to site battery technology with renewable

resources and take advantage of US investment tax credits (investment tax credits are not applicable in Canada). There is general agreement among ISOs and market participants that these resources could provide system benefits and improve competition as described in the section above. This work is still developing as US ISOs continue to discuss hybrid definitions and configuration that would best serve their respective markets.

One jurisdiction that appears further along than most on this topic is CAISO. They have developed a straw proposal[15] for both Hybrids and co-located[16] resources, and propose to begin integrating co-located resources into their markets this Fall. Further plans on an enduring hybrid design for the Californian market will be forthcoming later in 2021.

The IESO will be continue to liaise with our US counterparts and remain abreast of hybrid development in other jurisdictions as this work unfolds.

Hybrid Participation in IAMs

The IESO does not currently have a resource type dedicated to hybrid resources. While a formal participation model for hybrid resources will be developed, hybrid participation could be enabled to a certain extent within existing participation frameworks on the demand side where dispatchable load and HDR resources can utilize behind-the-meter generation in the energy market, but the IESO has not informally referred this as a hybrid participation model. The IESO will continue to liaise with stakeholders on further enabling hybrid technology into the IAMs. For clarity, a hybrid resource is not able to participate in any market through a hybrid participation model, either formally or informally, therefore it is classified as not applicable in the overview table below providing an overview of hybrids participation across the IESO markets.

Energy	OR – 10S	OR – 10N	OR – 30
N/A	N/A	N/A	N/A

IESO Working Definition of Hybrids

To initiate discussion with stakeholders on enabling hybrids, the IESO proposed a working definition to stakeholders to establish a common starting point. The IESO's working definition for hybrids presented at the April 2nd MDAG meeting was:

[15] CAISO, Revised Straw Proposal – Hybrid Resources. December 10, 2019.
http://www.caiso.com/InitiativeDocuments/RevisedStrawProposal-HybridResources.pdf

[16] Although definitions can vary depending on the jurisdiction, co-located resources generally refers to two resources behind a single interconnection point that operate independently in the electricity market(s).

"A combination of multiple resource technologies, at least one of which is generation, that has a single point of connection and is represented by a single market resource ID. This excludes the aggregation of the same or similar technology resources."

Stakeholders appeared supportive of this work, however, the IESO acknowledges that further collaboration is required before a definition of a hybrid resource can be finalized within the Ontario markets. With that in mind, the above definition will continue to evolve through further research, analysis and stakeholder discussion to be conducted in upcoming phases on hybrid integration in Ontario.

5.6. Regulation Service Providers

Regulation service acts to match total system generation to total system load - including transmission losses - and helps correct variations in power system frequency. This service corrects for real-time changes in electricity use that might affect the stability of the power system. Regulation service is provided by generation facilities with Automatic Generation Control (AGC) capability, which provides the IESO with the ability to directly adjust the facilities' output. The AGC signal is provided as a MW quantity to generators at a frequency of up to once every two seconds.

The following are characteristics of IESO's Regulation service:

- resources are schedule to provide a specified level of ± (up or down) MW of Regulaiton service;
- Market Rule requirement for a minimum of ±100 MW of Regulation scheduled at all times; and
- Market Rule requirement for a minimum overall ramp rate of 50 MW/minute.

Regulation service also provides the IESO a means to ensure compliance with certain applicable NERC standards. The IESO is a Balancing Authority (BA) and is responsible for computing and managing the Area Control Error (ACE)[17] within the BA area. Resources contracted to provide Regulation service are utilized to assist in maintaining ACE.

Today, Ontario has seven generation facilities contracted to provide Regulation service to ensure system reliability. Most of these resources are quick start units that are fully enabled to participate in all markets when not providing Regulation to the grid, but become ineligible for OR once providing Regulation. For clarity, the below table provides an overview of a Regulation service providers resource participation across energy and OR when providing Regulation, where they are not enabled to provide OR at the same time.

[17] ACE is the mismatch between internal supply and demand requirements within a BA area and the unintended inflows/outflows to the interconnected BA. There is an obligation to maintain the computed ACE value within defined limits.

Energy	OR – 10S	OR – 10N	OR – 30
Fully Enabled	Not Enabled	Not Enabled	Not Enabled

Participation

Contracted Regulation service providers submit proposed Regulation service schedules to the IESO for each resource seeking to provide Regulation service between 06:00 EST and 09:00 EST during the DACP. The IESO confirms the Regulation service scheduled for each resource.

Resources that provide Regulation compete in the energy market and submit offers into the market to receive an economic dispatch. When a resource is economically dispatched in the market, a "basepoint" of operation (MW output) is determined. The determined basepoint will respect the upper and lower bounds of the resource's operating range as well as the resource's ramp rate while incorporating the amount of Regulation service a resource is scheduled to provide. Refer to the following examples.

Example #1:

1. A resource has a maximum capacity of 100 MW
2. The resource is scheduled to provide ±20 MW of Regulation
3. The resource is economically dispatched to 100 MW in the energy market

The resource will have a determined basepoint of 80 MW. With a determined basepoint of 80 MW, the maximum capacity of 100 MW is respected.

Example #2:

1. A resource has a maximum capacity of 90 MW and a minimum loading point of 35 MW
2. The resource is scheduled to provide ±25 MW of Regulation
3. The resource is economically dispatched to 65 MW in the energy market

The resource will have a determined basepoint of 65 MW. With a determined basepoint of 65 MW, the maximum capacity of 90 MW is respected.

The IESO sends an AGC signal requiring the unit to adjust its output either above or below the basepoint up to the limit of the scheduled Regulation Service. This point becomes the unit's "setpoint". In Example #2 above, the setpoint of the resource could range from 40 MW to 90 MW, respecting both the upper and lower limits of the resource.

Eligibility and Requirements for Participation for Grid Level Service

- Must be dispatchable.

- Resources must be capable of receiving and responding to dispatch signals once every 2 seconds.
- Resources must have AGC capability, which permits a resource to vary output automatically in response to signals sent by the IESO.
- Resources are not eligible to be scheduled to provide Regulation in the same hours as OR.
- Resources must be certified by the IESO. The certification process consists of:
  - raise test to verify maximum Regulation capability and ability to ramp at stated rate;
  - lower test to verify minimum Regulation capability and ability to ramp at stated rate; and
  - communications check to ensure that dispatch instructions are received.

Regulation Service and OR Limitations

Currently, Regulation service providers are not eligible to provide OR at the same time they are providing Regulation. Although, facilities with 2 or more resources that can be dispatched separately may have a resource with no Regulation requirements able to participate in OR.

There are two issues that contribute to the limitation in providing OR at the same time as Regulation, which include:

1. The IESO is unable to co-optimize between energy, OR and Regulation due to IESO system and tools limitations. When a Regulation service provider offers their Regulation they are also participating in the energy market, if they were to also provide OR it would require co-optimization across all three services – energy, OR and Regulation. The optimization across the three services and would require significant changes to implement this feature.
2. When a resource that is providing Regulation receives a new economic dispatch that would require it to ramp up or down, it can only complete the movement if it will not cause any further exacerbation of the ACE that is outside an acceptable deadband (typically +/- 20 MW). If a resource was to receive an Operating Reservie Activation (ORA), ramping to meet an ORA may override any Regulation requirements for a resource and the IESO will no longer have the required Regulation availability to maintain acceptable ACE levels. The IESO currently has the requirement in our tools that Regulation must be maintained at all times.

6. Authority of Requirements

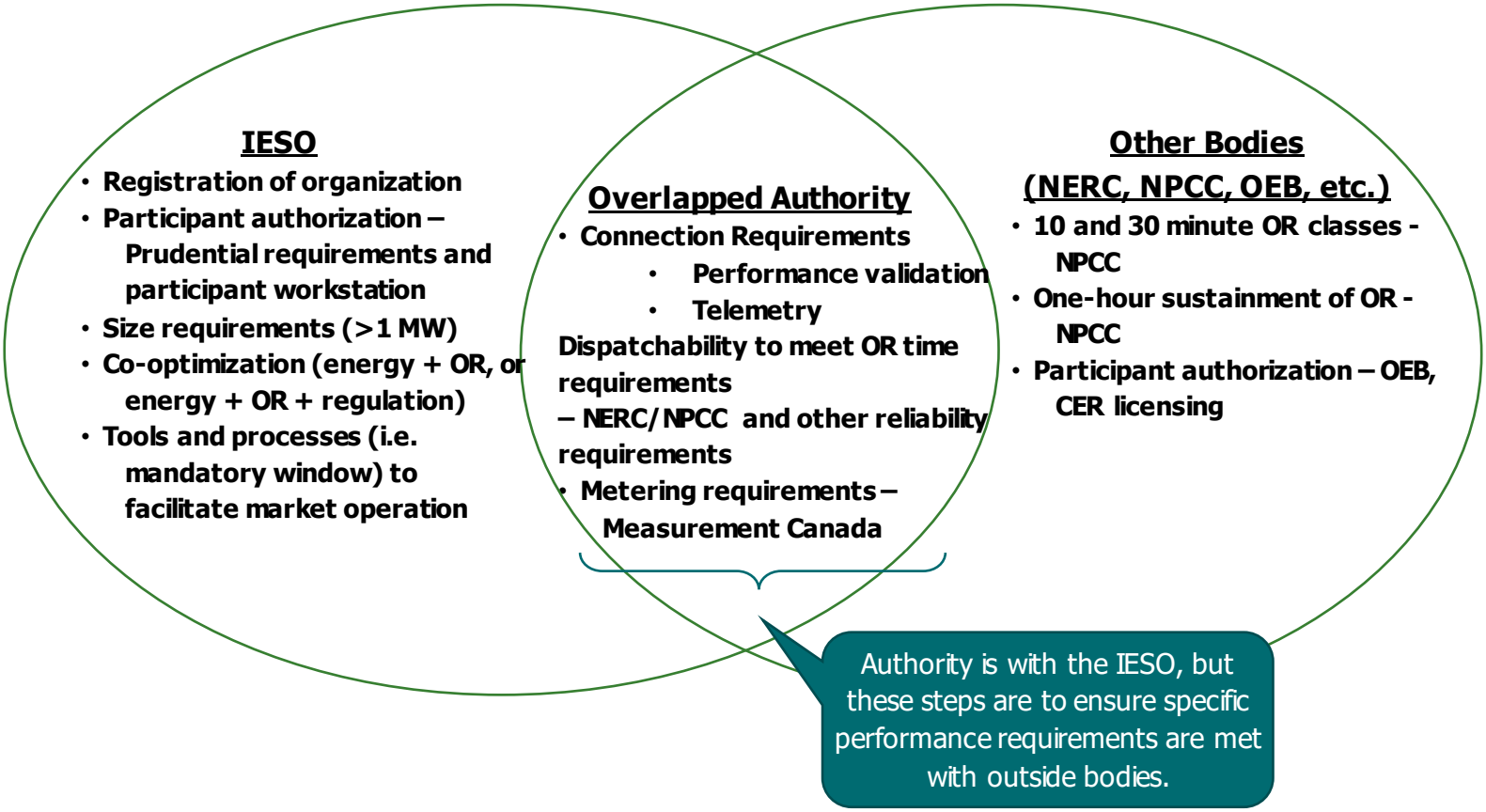
6.1 Overview

The IESO's primary mandate is to ensure the reliability of the IESO controlled grid. The IESO's reliability requirements include those of other regulatory bodies, such as the North American Energy Standards Board (NAESB), NERC and NPCC, plus considering Ontario specific requirements on market participants, such as from the OEB. NERC and NPCC are responsible for establishing standards applicable across the interconnected grid (the larger network of transmission systems across North America). NAESB establishes some additional requirements around buying and selling electricity. As a result, certain requirements impacting participation may not be within the IESO's authority to change.

This section provides a high level overview of where the authority to make changes to the requirements generally lies with further description of those requirements.

The IESO has the option to review and update items under its authority (left side of figure 3 below), with limited to no ability to directly change items under other regulatory bodies (right side of figure 3 below). In some cases, particular requirements are designed specifically to ensure that they are aligned to meet the requirements of other regulatory bodies (middle of figure 3 below). The IESO will also look for opportunities to review and update items where the IESO has overlap with other regulating bodies. Although these opportunities could present more of a challenge to implement because of the coordination with other regulating bodies.

Figure 3. | Authority of Requirements



6.2 Items under IESO authority

Further description of the requirements under the IESO's authority (from figure 3) are provided below. It should be noted, changes to these requirements typically require a stakeholdering process to determine the impacts to industry members.

- Registration of organization – The IESO sets the requirements for what a organization needs to provide in order to register with the IESO. The online application forms, their requirements, and the process to approve an organization are set by the IESO.
- Participant authorization – the IESO has authority over the general process to authorize participation, and most, but not all (covered in section 6.3 below), of the prequisite requirements of participant authorization in the IESO market. These generally include prudential requirements and the requirements of the participant workstation. The prudential requirements are determined to cover any potential default situations, and the calculations are determined by the IESO, but they do use some inputs from other bodies (i.e. the OEB) to make the determination. The IESO also makes the determiation of technical requirements of dispatch workstations, which are used to interact with the IESO.

- Size requirements – the IESO has established what the minimum size requirements of participants are in all markets. For example in the energy market the IESO sets the minimum at 1 MW for participants.
- Co-optimization – Currently the IESO co-optimizes between energy and OR markets. Going forward the IESO has the authority to include regulation services a third market in the co-optimization. This effort would require further stakeholdering, external and internal.
- Tools and processes to facilitate market operation – The IESO has discretion on what tools in designs to facitlate market operation, such as algorithims to schedule resources, as well the processes, such as how to offer/bid and the mandatory window, which sets how participants interact with the markets.

6.3 Other Bodies Authority (NERC, NPCC, OEB, Etc.)

Further description of the requirements under the authority of other bodies are provided below. The IESO is generally member or a stakholder to these organizations and can participate in the review as well as the proposals to change these requirements.

- 10 and 30 minute OR classes – The NPCC sets specific requirements for a jurisdiction to respond to a contingency event. These are passed onto the participants, in the form of the OR classes, who provide the reserve in contingency events.
- One-hour sustainment of OR – The NPCC also sets the requirements for OR sustainment, and that requirement is currently set at one-hour.
- Participant authorization – depending on the type of participant, certain licensing or permits are required to participate in IESO markets. These can include licencing from the OEB and permits from the CER. The participants are subject to the requirements to fullfill and obtain those licences and permits.

6.4 Overlapped Authority

The below provides further description of authroity that is overlapped between the IESO and other bodies. Typically the IESO has authority over the developing these requirements, but they implement them to ensure they meet standards of these other bodies.

- Connection – the IESO develops connection requirements so it can assess for any potential adverse effect on the reliability of the electricity grid and its existing customers due to addtion of a new facility or a modification to an existing facility. Adherence to these requirements ensures that the IESO is able to comply with the NERC/NPCC standards.
- Performance validation – The IESO determines how it will validate performance, testing on specific performance metrics such as active power, automatic voltage regulation, among others. These are generally based on the IESO obligation to ensure the reliability of the grid as per NERC and NPCC requirements.

- Dispatchability to meet OR time requirements – The IESO requires that resources are dispatchable and can respond to 5-minute signals to participate in certain markets and products to ensure the IESO can meet certain NERC and NPCC reliability requirements. An example of a product is OR, where the IESO has a 5-minute dispatchability requirement to ensure that the IESO can recover its ACE within timeframes specified by NERC. The IESO also develops the operational telemetry requirements so that it can monitor resource performance and response to IESO signals.
- Metering requirements – The IESO develops its own revenue metering requirements, but it must ensure that any requirements will allow participants to attain Measurement Canada verification, and as well as American National Standards Institute standards for electricity meters on perfromance and accuracy.

7. Interrelated Work

There are several recently completed or ongoing projects and stakeholder engagement initiatives that have interrelated work which could provide further areas for exploration or overlap with potential future market enhancement projects. These primarily include Energy Storage Advisory Group (ESAG) /Storage Design Project (SDP), as well as Distributed Energy Resource (DER) analysis that is being completed through the IESO's Innovation and Sector Evolution White Paper Series. This section provides a brief overview of these projects.

7.1. Storage

Through the ESAG, the IESO worked with stakeholders to identify obstacles for storage resources in Ontario. The IESO identified the key priorities within the IESOs purview of: (1) clarifying the treatment of storage resources within the Market Rules and Manuals; (2) further enabling storage resources to compete to provide non-overlapping wholesale services; and (3) addressing wholesale uplift charges (within the IESO's mandate). The SDP was initiated with a focus on addressing these priorities. The SDP developed an interim design to enable direct-connected storage participation in the IAMs within the IESO's existing tool set. The SDP also developed a long-term vision to provide the foundation for further storage integration when tool limitations can be addressed. The long-term vision can be considered by the IESO and stakeholders through more detailed work and implementation at a future date[18].

Specifically, over the course of Q1/Q2 2020 the SDP communicated an interim design for direct connected storage participation in the IAMs, and proposed red-lined amendments to IESO market rules and manuals that encompass 13 design features and these are expected to be implemented in January 2021. Further to this, a new section has been added to Chapter 7 in the draft market rules that details market registration requirements and submission of dispatch requirements in the Energy and OR markets. The interim design provides guidance on how electricity storage is expected to participate in the IAMs. Among other things, this includes the no-overlap rule, which prevents equal or overlapping bid/offer prices from a single storage facility, in addition to enabling the participant to modify the MW quantity of state of charge-limited bids and offers within the mandatory window[19].

[18] Further information on the SDP can be found on the IESO's ESAG webpage - http://www.ieso.ca/en/Sector-Participants/Engagement-Initiatives/Engagements/Energy-Storage-Advisory-Group

[19] Additional information on the draft Market Manual amendments can be found on the following link - http://www.ieso.ca/-/media/Files/IESO/Document-Library/engage/esag/esag-20200624-Guide-to-Draft-Market-Manual-Amendments.pdf?la=en

During Q3, 2020, the IESO published an enduring vision for storage participation[20], documenting long-term design work conducted through the SDP.

7.2. Distributed Energy Resources

The IESO's Innovation, Research and Development team is conducting research into the potential role of and barriers to DER participation in Ontario's wholesale electricity markets. This research is being conducted through the Innovation and Sector Evolution White Paper Series. The first of these white papers, Part 1 – Conceptual Models for DER Participation, released in October 2019, provided a working definition of DERs, established a framework for understanding potential DER participation models, assessed the extent to which DERs are enabled to participate in the IAMs today, and identified barriers to enhanced DER participation. A second white paper, Part 2 – Options to Enhance DER Participation, explores options to address the barriers identified in the first white paper, evaluate the potential impacts of those options from a cost benefit perspective, and provide key insights and considerations to inform any future market design work related to DERs. A draft of this whitepaper has been published in November 2020.

The IESO will consider the findings captured in the two whitepapers along with stakeholder feedback in order to finalize the second white paper and determine next steps for DERs. The IESO intends to publish a DER roadmap in the spring of 2021, which will clearly articulate a set of objectives and initiatives for its future DER integration efforts. These integration efforts could also effect further enablement opportunities discussed in this report, such as variable generators and hybrids.

[20] The Long-term design vision document for electricity storage was published on the ESAG webpage on September 16, 2020. http://www.ieso.ca/en/Sector-Participants/Engagement-Initiatives/Engagements/Energy-Storage-Advisory-Group

8. Summary and Next Steps

8.1 Summary

The table below provides a summary of key misalignments identified between the IESO's participation requirements and existing participation frameworks across technologies reviewed in this report. As this work progresses, these misalignments will help inform on areas of opportunity and potential market enhancements to be explored further.

Technology	Misalignment
Gas – Not-So-Quick-Start	There is a subset of gas resources that are unable to respond within the IESO's 5-minute dispatchability requirement, but take less than one-hour to ramp up when called upon. Through this initiative these few resources have been referred to as "Not-So-Quick-Start" resources. In the absence of a standalone participation framework for NSQS resources, they are required to register as either a QS or NQS resource. Although NSQS resources do have access to provide energy and OR, their ability to provide their full range of OR is inadvertently limited when registered as a NQS resource. It has therefore been identified that introducing a participation framework that captures the unique characteristics of NSQS resources could enhance their participation in OR when online.
Imports	As with all other electricity markets, interties are an important resource to meet both system reliability needs and maximize economic efficiency. While imports are traded actively in the IESO's energy market there are a number of misalignments preventing their participation in OR. For example, interconnection agreements are needed between the IESO and neighboring jurisdiction specifically for OR. Other misalignments include the telemetry not being facility specific (for resource-backed) on the import, and their inability to receive 5-miniute dispatch instructions. Despite these misalignments the IESO is cognizant of imports' potential to provide an additional reliable source of OR, and any additional import interconnection agreements the IESO is able to leverage will provide the IESO with additional MW's on the system

Technology	Misalignment
	that could potentially compete in the 10-minute and 30-minute OR markets.
Variable Generation	Ontario has a substantial amount of variable generation resources that are either directly connected to the bulk grid or embedded within the system. Most directly connected VGs are wind fueled resources that are under contract and beginning to expire starting in 2026. These resources are not dispatchable in the traditional sense, where they are either dispatched to their full capability based on ambient conditions and the availability of their fuel, or dispatched down to a specific output, below ambient conditions due to economics or reliability. The variable nature of their fuel limits their ability to be dispatched both up and down and maintaining certain outputs over extended periods of time. VG resources are also incentivized to maximize output in the energy market through their contracts. Therefore, the variable nature of their output prohibits their ability to participate in OR and relatively low revenues available for remaining on standby limits the relevance to participate in OR. As VGs issues are primarily driven by their uncertainty in operation, through optimizing with electricity storage it may remove some of the limitations that VG facilities experience with meeting OR participation requirements and could allow them to participate through a paired facility. The IESO will be exploring opportunities for a co-located and/or hybrid participation model and will look to engage with the VG community as this work develops. This work could potentially lead to additional opportunities for VG in the energy and OR markets.
Demand Response – Hourly Demand Response	Stakeholders have informed the IESO that there are a number of HDR contributors that, if modelled differently, could meet the performance requirements to participate in OR. Currently, the existing HDR participation model has a number of parameters that hinder contributors' ability to meet requirements to be dispatched by the IESO, such as: lack of real-time telemetry on virtual resources, the requirements to receive a standby notice and thereafter, an activation notice ~2.5 hours prior to real-time to be utilized, and existing IESO tools constrain HDR resources to fixed hourly schedules. Due to the misalignments between the requirements to be dispatched by the IESO and the participation model of the HDR resource type, these resources are unable to provide OR and other reliability services. It is unlikely that additional changes will be made to the existing HDR framework in order to enable OR participation, however, the IESO

Technology	Misalignment
	could consider exploring a new participation framework for more flexible HDR contributors or exploring opportunities to facilitate greater participation in the existing Dispatchable Load participation model (which presently enables OR participation). Depending on capabilities, this could open up opportunities within the OR market to participation for a subset of current HDR contributors.

This table below provides a summary on the supplementary opportunities that the IESO explored through this report.

Technology	Opportunities
Hybrids	With recent advancements in storage, the IESO and stakeholders recognize potential benefits this technology can bring to the grid. While still an emerging technology, the IESO is in the process of enabling direct connected electricity storage resources to provide a range of grid services. Building off this, the IESO recognizes the potential of hybrid resources – most commonly connected as a generator paired with battery storage – to provide additional benefits to the grid. One of the primary benefits that have been proposed in other markets includes providing additional MWs available to the grid and the availability to compete in OR through the paired storage resource. Since this is a new and evolving field, at this time the IESO does not have a formal definition or participation model for hybrid resources yet. Further exploration planned in 2021 in partnership with stakeholders is needed to help understand the potential benefits both in the short term, and longer term within Ontario. Additionally, the various known modes of hybrid and/or co-located configurations should be evaluated to determine the value to both asset owners and the grid operator. The IESO looks forward to engaging with the stakeholder community as this work evolves.
Regulation Service Providers	Existing Regulation service providers are currently prevented from providing Regulation and OR simultaneously due IESO tools and systems being unable to co-optimize across energy, OR and Regulation. As the initiative progresses the IESO may explore opportunities for Regulation service resources to also provide OR through tool and system changes, market rule changes, new participation models, or a combination of these options

8.2 Next Steps

The IESO is committed to engaging with stakeholders on the work required to enable resources to participate more fully in the IAMs. The IESO intends to build upon the information in this report to develop a work plan to enable emerging and evolving resource types including an expanded engagement. The IESO will introduce the details of the expanded engagement and work plan in the first quarter of 2021. This work plan development will consider the relative magnitude of the opportunities presented by potential enablement initiatives and the related resource requirements.

Next steps and further engagement with stakeholders will be communicated as part of the conclusion of this report.

Appendix I - Operating Reserve

This appendix provides a general overview of OR. It details the markets, requirements to market participants, as well as the requirements the IESO must meet to ensure compliance with NERC and NPCC regulations.

I.I. Operating Reserve Markets

OR is stand-by power or demand reduction that can be called on with short notice to deal with an unexpected mismatch between generation and load. Through the administration of OR markets, the IESO ensures that additional supplies of energy are available should an unanticipated event take place in the RT energy market.

The three types of OR classes that can be offered by dispatchable generators and dispatchable loads are:

- 10-minute synchronized (spinning) reserve
- 10-minute non-synchronized (non-spinning) reserve
- 30-minute reserve (non-synchronized)

Dispatchable participants may offer into one or all three classes of OR. Even if their offer is selected but not activated, they will receive stand-by payments for all megawatts for which they were selected without having to make changes to their production schedule.

A price for each class of this reserve energy is determined every 5-minutes based on offers in the market. All accepted offers are paid the market clearing price for that class. When the OR is activated, the suppliers are paid for the energy provided.

I.II. Operating Reserve Requirements

For participants to offer operating reserve, they must:

- be a dispatchable generator or load – the IESO needs to recover the ACE as per NERC BAL-002-3. Resources need to receive the dispatch signal, respond, and meet OR activation target; therefore, they are needed to be dispatchable;
- be able to provide the energy within the time frame specified by the class of OR involved (either 10 minutes or 30 minutes) - *set by NPCC Directory #5 – R1 and R2; also in IESO Market Rules, Chapter 5 Appendices*;
- sustain supplying operating reserve energy for up to one hour - set by NPCC Directory #5 R6: Operating Reserve; also in IESO Market Rules, Chapter 5 Appendices; and

- offer equal or greater amounts of energy into the RT market - the scheduling of OR and energy in the RT energy markets are co-optimized to ensure the most efficient outcome for the market.

For the IESO, OR requirements must adhere to reliability standards established by the NERC and NPCC — specifically:

- have enough 10-minute reserve to cover the single largest contingency. Currently 25% of the total is covered through synchronized reserve and remaining 75% through non-synchronized reserve; and
- have enough 30-minute reserve that is equal to greater of: half of the second largest contingency or the largest commissioning generating unit.

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