Non-Emitting Resource Request for Information - Phase 1

Summary of Written Submissions

November 6, 2018

Introduction

The IESO posted the Phase 1 Non-Emitting Resource (NER) Request for Information (RFI) on March 21, 2018 with a submission deadline of May 4, 2018. The goal was to gather information on NER technologies, projects and facilities at various stages of development and operation to understand both the products and services that can or are being provided and any potential barriers to participation in the current or future electricity market. In response, the IESO received 29 submissions, representing over 10,000 MW of existing and potential projects, from a variety of NER participants. Submissions were received from project developers, facility operators, industry associations, transmitters and technology software providers. The NER technologies discussed in the submissions included solar PV, wind, waterpower, battery energy storage, pumped hydro storage, nuclear, demand response (DR) and biomass. The IESO would like to thank all of the respondents for the information and feedback provided.

The purpose of this document is to provide a summary of the information provided in the 29 submissions. The information in this summary document has been grouped based on the sections and order of the questions in Appendix B of the RFI. As this document is meant to serve as a summary, some specific details that were included in individual submissions may not be included. Furthermore, identifying information is not included, nor are any responses that were marked as confidential. This summary document is provided for information purposes only. The IESO provides no guarantee, representation or warranty, express or implied, with respect to the quality, accuracy or completeness of this document or the information contained herein and disclaims any and all liability in connection therewith. This information is not binding on the IESO and in no way varies or impacts the interpretation of any IESO contract or any of the market rules or market manuals. This summary is not intended to be, and should not be construed as, a reflection of the views or opinions of the IESO or agreement by the IESO with respect to any matter or thing contained herein. This summary does not constitute, nor should it be construed to constitute, a guarantee, agreement, representation or warranty on behalf of the IESO.

Current Market Opportunities and Challenges – IESO Markets General

Question 1:

Supplement Appendix A with information describing what service/products your resources can currently provide.

Responses to question 1 were varied and included both confidential information and general overviews of respondents' facilities and technologies. The information provided as part of Question 1 has been used to supplement the information collected through Appendix A and has been shared on a confidential basis with other relevant IESO staff.

Question 2:

Identify any limitations to resource participation in the IESO administered markets, as outlined in the IESO Market Rules, Chapter 7.

Respondents identified a number of limitations in the IESO Market Rules (Chapter 7) that respondents indicated may prevent full or partial participation of their resource in the IESO administered markets. A number of these identified limitations were general in nature, applying to NERs as a whole, while some of the limitations identified were resource, facility or respondent specific.

A majority of respondents advocated for the removal of size limitations for facilities, in order to allow those resources/facilities with capacities of less than 1 MW to participate in the market and to receive dispatch instructions. In addition to the flagging of the size/capacity requirements, a number of respondents pointed to the current limitations in the Market Rules as they pertain to resource aggregation. It was pointed out that aggregation at the same connection point is difficult to achieve under the current rules, limiting the ability to extract potential additional value out of a number of smaller, geographically dispersed resources.

Furthermore, a number of respondents representing behind the meter resources (including behind the meter solar PV generation) indicated that they are currently limited in their participation as they must rely on the willingness of a site host who is, or can become, a market participant to connect and participate in the market.

For those respondents representing energy storage facilities, a number of limitations within the Market Rules were identified. One comment regarding Section 2 of Chapter 7 of the Market Rules indicated that the rules do not specifically address the registration requirements for storage facilities. Some respondents indicated that the rules were unclear in their treatment or consideration of energy storage facilities. Finally, one respondent suggested that the IESO should enact changes to the Market Rules that are similar to Federal Energy Regulatory Commission (FERC) Order 841, which supports the full participation of energy storage facilities in U.S. based Regional Transmission Operators (RTOs) and Independent System Operators (ISOs).

Question 2a:

Specific requirements are listed within Chapter 7 of the Market Rules for generators considered self-scheduling facilities and intermittent generators. If your facility is considered either self-scheduling or intermittent, what additional limitations exist (if any), that may limit participation in IESO markets?

Several comments were provided by respondents representing intermittent generators (solar and wind) regarding the IESO administered markets. These responses stated that the Market Rules do not currently account for a number of products that solar or wind could provide, such as fast ramping and load following. Additionally, several respondents answered this question by specifically highlighting that distribution connected resources faced barriers to participation in the market(s) under the Market Rules, such as market registration limitations for behind the meter resources and the inability of some distributed resources to receive dispatch instructions.

Question 2b:

Are there any Market Rules outside of Chapter 7 that limit your resource from participating in the IESO markets?

Some respondents indicated that in order for additional products to be provided into the market, changes to the IESO's prudential requirements and the dispatch algorithm would be required.

Respondents representing energy storage facilities advocated that the IESO define the specific compliance, inspection, testing and monitoring obligations and requirements for those energy storage facilities that aim to supply a range of energy products. In this context, some respondents inquired as to how an energy storage facility could submit both energy offers and energy bids in a given hour within the current market design. Some respondents requested changes or clarity in the Market Rules to clarify how the rules would treat those generation facilities that integrated storage technology. One comment indicated that the current floor prices for variable generators reduce the effectiveness of the combined resources of a storage plus intermittent generation facility.

Some general comments regarding the Market Rules suggested a desire for changes that would enable the broader supply of regulation, Operating Reserve (OR), Reactive Support and Voltage Control (RSVC) and other ancillary services from a wider array of resources, including those at interconnections or from other jurisdictions. Some respondents identified changes to the IESO network model and general IT tools as being necessary in order to allow more resources to provide non-energy services, which would also lead to changes in the settlements process to account for the provision of multiple non-energy products by some intermittent generators.

For resources located in neighbouring jurisdictions that would be willing to provide services through interties, respondents raised the question of how those resources in neighbouring jurisdictions could provide ancillary services if they are not permitted to become market participants under the Market Rules. In addition, some neighbouring jurisdiction respondents indicated that mechanisms that govern

any markets or products provided by resources in neighbouring jurisdictions (for example, a possible forward capacity auction) should be firmly enshrined in the Market Rules and not Market Manuals.

Question 3:

Is the energy profile of your facility firm or variable? If variable (self-scheduling or intermittent generators for example), what measures could be considered to provide a more firm energy profile?

Respondents representing biomass generation, nuclear generation and transmitters indicated that they have a firm generation profile. Those respondents representing waterpower facilities indicated a firm supply in one case, and variable in other cases. Those waterpower facilities with a variable profile indicated that external factors such as weather and regulatory requirements contribute to the variability of their energy profile or water flow.

Solar, wind and solar or wind plus storage resources indicated that they have a variable energy profile. Pairing solar or wind with storage technologies was highlighted as a factor that could be used to firm-up a facility's energy profile. Both solar and wind generators also indicated that co-locating (in addition to pairing with storage technologies) is a way to lessen the variability of those energy profiles.

Question 4:

For variable non-emitting resources, what type of resource forecasting do you perform? What is the level of accuracy day-ahead, 1-hr ahead, 5-min ahead? If you do not perform forecasting, why not?

Most comments were supportive of the IESO's current, centralized role in forecasting in its general role as the system operator. Some indicated that improved or additional forecasting on a zonal basis would be acceptable as well.

Respondents representing a number of resources indicated that forecasting for extreme weather is done by some generators. Additionally, information was provided that forecasting by individual solar generators was possible using certain external software providers, which can provide forecasts several days in advance. The responses stated that forecast accuracy was dependent on timeframes; 1 hour-ahead forecast accuracy is within a 5% margin of error and a day-ahead forecast has an 8% margin of error. Different forecasting methodologies were identified for different time frames. For example, those respondents utilizing forecasting indicated that intra-hour forecasts leverage statistical persistence, short-term forecasts (1-6 hours ahead) use a blend of statistical and Numerical Weather Prediction (NWP) models, and medium term (day-ahead) would use NWP with correction for systemic biases.

Current forecasting for wind facilities is completed by the IESO, in a centralized role; a role that was supported by wind generator respondents. Resource specific forecasting is available for wind generators as well. Using the tools available today, the average day-ahead error for a wind single facility is 8-10%, and 4% for system-wide. Forecast errors are affected by a number of factors, including time horizon, local geography (e.g., complex topographies increase error), geographic diversity and data quality. Wind

forecasts become more accurate in shorter timeframes (e.g., 3-4% one-hour ahead, and within 1% five-minutes ahead).

For hydroelectric or waterpower facilities, hydro flow forecasting is available and is based on prevailing water conditions, weather conditions and external agency requirements. The level of accuracy day-ahead can vary significantly because of external factors. The level of accuracy for 1-hour and 5-minute ahead will normally be very accurate except under unusual, extreme and/or forced conditions.

Question 5:

For variable non-emitting resources, does or can your technology perform self-adjustments to smooth or normalize the energy profile or generation curve? Please describe or explain why not.

Respondents representing solar facilities that currently hold contracts with the IESO indicated that they currently have no incentive to smooth or normalize their energy profile under IESO contracts. Additionally, those respondents stated that IESO contracts limit changing the contracted capacity of a given facility by oversizing or by adding storage to the existing facility.

Respondents indicated that pairing with energy storage facilities would benefit most non-emitting resources in smoothing the energy profile.

Question 6:

For existing facilities (currently operating in IESO markets): are there any modifications, expansions or reconstructions of a facility or facilities that may enable participation in additional IESO (or other) markets or revenue streams? If yes, provide details and explanations of how this would be enabled. Identify any relevant examples from other jurisdictions.

Some respondents indicated that adding a small gas fired generator to their facility could allow for the facility to provide black start services to the IESO.

Those respondents representing resources from outside of Ontario indicated that expanding transmission intertie capacity could allow for greater participation of resources from neighbouring jurisdictions.

Most intermittent resources currently operating in Ontario indicated that pairing with energy storage technology is a modification that would smooth their energy profiles and open up opportunities for additional revenue streams in a market.

Respondents representing DR that is operating in the market today through the DR auction indicated that such DR is currently capable of providing OR and that, in order to facilitate this participation, certain updates to telemetry at the participating load locations may be required.

Respondents highlighted frequency control upgrades, runner upgrades, turbine replacements, end of life redevelopments, and capital investment in equipment such as automated generation control (AGC) as potential investments that could allow for additional market participation.

Question 7:

For existing or proposed energy storage facilities, what is the maximum duration of service that your facility is capable of providing?

The majority of energy storage respondents indicated that their facilities were flexible within the duration of service that they could provide, based on the total capacity of the storage facility installed.

Question 8:

For new build facilities, what is the lead time required for your facility to reach commercial operation in Ontario and participate in the IESO markets?

A range of responses for the various resources represented was provided to the IESO, as follows:

Facility Type	Lead Time	Notes
Rooftop solar	6-12 months	
Groundmount solar	18 months to 3 years	Due to additional permitting requirements
Nuclear	10+ years	
Wind	3-5 years	
Energy Storage (battery)	18-24 months	

One respondent provided the following estimated connection assessment lead times:

LDC CIA Process	2 months
Hydro One CIA Process	2 months
Connection Estimate and LDC Agreement	2 months
Installation on Hydro One Schedule	6-9 months

Current Market Opportunities and Challenges – Ancillary Services

Question 9:

Does your resource currently provide any of these ancillary services in Ontario?

A number of respondents with existing facilities indicated they are providing ancillary services in Ontario.

Some respondents representing nuclear generation and renewable biomass have indicated that their facilities currently provide, or have provided RSVC.

Those respondents representing hydro generation facilities indicated that their facilities currently provide, or have provided, regulation, RSVC and OR services.

Question 9a:

If not, are there any limitations that currently prevent your resource or technology from providing any of the market's ancillary services?

Many respondents indicated that a contract with guaranteed payments is required to ensure positive economics for providing ancillary services. Behind the meter storage facilities indicted that their ability to provide ancillary services was limited by registration requirements in the Market Rules that do not allow behind the meter, small scale (<1MW) or aggregated resources to register. Additional comments from a number of different resources indicated that the Market Rules should allow for facilities to register as simultaneously providing multiple services in the IESO markets. In particular, energy storage facilities raised the notion that they are currently not able to participate in the energy market if they are contracted as ancillary services providers, providing regulation services. Respondents indicated that the IESO will need to consider how these resources are dispatched and scheduled (day ahead and real time) in the future.

Question 9b:

Specifically, identify any Market Rules or requirements that limit participation in a particular type of ancillary service (e.g., regulation service).

Comments that represented distributed energy resources (DERs) identified the following Market Rules as requiring amendment in order to facilitate the supply of ancillary services by DERs:

1) Permitting broader standards and applications of A/S – Ch. 5, S. 4.2 and 4.3
2) Permitting broader supply of regulation, OR, and RSVC – Ch. 5, S. 4.4 to 4.6
3) Testing requirements for a broader range of facilities regarding their capabilities in providing A/S – Ch. 5, S. 4.9 and 4.10

Furthermore, respondents highlighted that the definitions of resources that are permitted to provide Ancillary Services do not include aggregated resources.

One respondent expressed concern regarding transparency under the Market Rules with respect to the price paid for current ancillary services contracts. This respondent indicated that lack of insight into existing contract prices and when they may expire, may limit the ability of future participants to bid into any potential future procurement for ancillary services. One respondent suggested that the Market Rules be revised to include a more defined subset of ancillary services that can be provided (e.g., inertia response, fast frequency response and primary frequency response).

Respondents representing external jurisdiction resources and intertie transmission infrastructure suggested that the Market Rules be revised to allow for the provision of ancillary services from outside of Ontario, including RSVC and black start capabilities.

Question 9c:

If you do not believe there are limitations and your resource does not currently provide these services, why not?

Some respondents indicated that high demand charges are an economic disincentive to those parties wishing to provide certain ancillary services. For smaller facilities, the cost of wholesale metering requirements was identified as being potentially economically prohibitive.

Question 10:

Are there aspects of your resource that you believe could be of benefit to the ancillary service market? If so, please provide details and, if available, other jurisdictions where these are currently being leveraged.

Most respondents representing solar, wind, storage and waterpower generators, in addition to those representing DR technologies, indicated that their resource can provide some existing ancillary services, or new potential ancillary services, such as flexibility, as the deployment of distributed energy resources continues.

Some respondents representing solar generation indicated that solar resources are able to provide RSVC, even when not generating, by using the facility's power electronics. However, they indicated that current IESO energy contracts do not provide incentive to provide this service, due to potential revenue claw-back provisions. Some respondents representing solar generators identified other jurisdictions, such as the Southern Power Pool (SPP), that allow for dispatchable variable energy resources (including solar) to qualify and provide regulation-down ancillary services.

Wind generator respondents also identified the ability of their facilities to provide RSVC, even in situations where the facility's output is near zero. In addition, wind resources identified flexibility service as a potential ancillary service that could be provided.

Energy storage respondents (representing both pumped storage and battery) identified regulation service as an ancillary service that they currently provide in the Ontario market, in addition to RSVC, and other services, such as OR and flexibility. These respondents noted that in PJM Interconnection, the simultaneous provision of these multiple ancillary services occurs in conjunction with a resource's participation in energy markets.

DR resource respondents indicated that with aggregation, their resources could provide ancillary services and OR as they do in other jurisdictions, such as in ISO New England (NE). These respondents indicated that aggregated DR resources are able to provide OR to ISO-NE, OR and frequency response to the Alberta Electric System Operator (AESO), and frequency response to New Zealand and the Electric Reliability Council of Texas (ERCOT).

The following examples of other jurisdictions that have enabled the provision of multiple services were also provided:

- SPP - dispatchable variable energy resources may qualify to provide regulation-down ancillary service (must be greater than 0.1 MW)
- SPP - DR can provide ancillary services, provided it can sustain output for at least 60 minutes
- New York ISO (NYISO) - energy storage resources registered as an Energy Limited Resource can provide regulation service, if greater than 1 MW
- Midcontinent Independent System Operator (MISO) - energy storage can be qualified as a 'stored energy resource', which is: a resource capable of supplying regulating reserve, but not energy, contingency reserve, up ramp capability, and down ramp capability through the short-term storage and discharge of electrical energy in response to set point instruction

Current Market Opportunities and Challenges – Operating Reserve Markets

Question 11:

Is your facility or technology currently operating, in the OR market?

The majority of respondents indicated that they are not currently operating in the OR market. Some stated that once their facilities were constructed, they will have the ability to operate in the OR market. Other respondents with existing facilities indicated that they are not participating in the OR market for a number of reasons, emphasizing that under their existing energy contract they are not able to participate in the OR market.

Of those resources that were identified as currently providing OR, one is a hydroelectric facility and two are biomass facilities.

Nuclear generators indicated that because their facilities currently act as Ontario's baseload generation, those facilities have limited manoeuverability. These respondents indicated that the integration of energy storage for the collection of excess energy could enable them to provide OR or other ancillary services.

Question 11a:

If not, what barriers (if any) prevent your technology/facility from operating in the OR market?

The following were variously identified as barrier by respondents: Market Rules that require a minimum one hour of OR to be provided, limiting energy storage facilities with lower durations; current contract provisions that limit the supplier to providing energy; behind the meter facilities being unable to become market participants; and DR resources being unable to participate in the OR market.

Question 11a (i):

If they exist, are they economic, technological or market based? Explain.

The majority of those respondents indicating that OR barriers exist, identified the barriers as market based, with less comment provided on the technical barriers faced by resources. The perceived barriers identified for energy storage facilities, included questions regarding the potential to register as OR providers, the barriers to behind the meter facilities registering as market participants and limits to aggregation that do not allow smaller facilities willing to aggregate and provide OR. Less comments were provided on the technical barriers inherent to participation in the OR market, i.e. the requirement to provide a minimum of one hour of OR when called upon in the market, which limits the ability of some energy limited facilities to participate.

One respondent identified an economic barrier, related to the relatively high cost of installing revenue metering infrastructure that is compatible with IESO metering requirements on smaller facilities.

Some of the barriers that were identified were technological in nature and largely had to do with the variability of generation for some existing resources. The variability of solar generation was identified as a challenge in guaranteeing OR as were the limits placed on the flow of some hydro facilities and the natural variability of run of river hydro facilities.

Respondents representing resources outside of Ontario and intertie transmission infrastructure suggested that the Market Rules be revised to allow for the provision of ancillary services from outside of Ontario, including OR, enabling resources from outside of Ontario to be dispatched and participate as registered facilities in the Ontario market.

Question 11a(ii):

If you do not believe there are limitations and your resource does not currently operate in this market, why not?

Some facilities that are not yet constructed indicated that once operational, they would be able to provide OR, including a pumped hydro storage facility.

Market Renewal Program – Capacity

Question 12:

Based on the proposed ICA design work to date, are you considering including your resource or technology in an incremental capacity auction? Please explain either why or why not.

Across most technology types there was general interest in participation in the ICA, but many respondents indicated that challenges exist that might limit participation by NERs. There was broad recognition that although contracted and rate regulated facilities would not be able to participate in the

ICA, there will be useful life in these facilities post contract and that these facilities may then be able to participate.

Respondents across technologies identified challenges with certain ICA design elements that may impact revenue, such as short commitment periods and defining capacity as Unforced Capacity (UCAP). Connection constraints at the distribution system and potentially prohibitive requirements with respect to resource aggregation were also identified as elements that may impact participation. Eligibility of upgrades to existing facilities (contract amendment processes/certainty) was identified as a concern for some respondents.

Waterpower respondents generally stated that new build facilities would not be able to be financed in the current ICA design due to the long and complex development timelines in Ontario. One respondent indicated that PJM has specific provisions for "Capacity Storage Resources", which include run-of-river hydroelectric facilities and that similar rules in Ontario might facilitate the participation of run-of-river facilities.

A specific concern identified in respect of biomass facilities was the availability of fuel and the facility operator's ability to secure it without the certainty of a contract.

Some DR aggregators suggested the following revisions to the ICA design to facilitate DR participation: changes to size thresholds, limitations on event lengths and changes to enrollment and identification requirements.

Question 13:

To the best of your ability, describe your resource's availability in detail?

Respondents indicated that due to the intermittent nature of their fuel sources, wind, solar and waterpower resources are subject to constraints in availability. Waterpower resource respondents indicated that the regulatory, safety and environmental constraints in which they operate may affect flow levels and thus availability.

Energy storage and biomass respondents each indicated that unlimited availability was possible, subject to fuel availability for biomass and state of charge for energy storage.

DR aggregators indicated that availability is tied to above average warm or cold weather and that frequency of calling on residential loads will be a limiting factor as high usage could result in a poor customer experience. Limits on length of the response and number of responses in a day or over a period of time would have to be constrained.

Nuclear respondents indicated a capacity factor of 85-95%, with historical capability factors in excess of 95%.

Pumped storage respondents indicated availability of 95%.

Transmission interconnection respondents indicated a 99.5% availability.

Question 13a:

How many hours per day can your capacity be available?

Responses were provided as follows:

Technology	Hours
Biomass	24
Nuclear	24
Solar	Up to 14 hours (during summer months)
Storage	2-24
Transmission	24
Waterpower	24 (depending on water availability)
Wind	24

Question 13b:

During what months/seasons?

Responses were provided as follows:

Technology	Months/Season
Biomass	All year
Nuclear	All year (Highest efficiency in Jan)
Solar	All year (increased availability in summer)
Storage	All year
Transmission	All year
Waterpower	All year (one respondent indicated summer only)
Wind	All year

Question 13c:

How many times can it be called on? (Identify the timeframe in your response)

Solar, wind and waterpower respondents all stated there is no limit on how many times they could be called on, subject to availability of fuel. Energy storage resources and other technologies paired with energy storage stated the same, with the addition of limitations on the storage facilities' state of charge.

Biomass respondents indicated they could be called on multiple times a day but are limited by ramp rates and minimum runtimes.

DR respondents indicated maximum thresholds for daily and annual limits as well as limits on consecutive days. As indicated above these limitations are tied to ensuring that residential costumers' experience remain positive.

Transmission interconnected respondents indicated no limit on the number of times they could be called upon.

Question 13d:

Could your resource be reconfigured to provide capacity in more hours?

Many respondents stated that pairing technologies would increase the number of hours a facility would be available.

Question 13e:

Can your resource be paired with another technology or resource in order to change or increase availability?

Nearly all respondents indicated that their technology could be paired with another technology in order to change or increase availability. Many indicated storage could be paired with their technology.

Question 13e(i):

If so, does it need to be co-located in order to achieve this increase?

Most respondents indicated that co-location is not necessary, but would be dependent on decisions related to facility aggregation.

Question 13f:

On average, how many hours per year does your resource need to go on outage for regular maintenance?

Biomass respondents indicated that facilities would require weeks of maintenance outages. Nuclear respondents indicated over 300 hours of maintenance outages. Solar respondents indicated that they rarely require outages and maintenance could be completed during periods where the facility is unavailable (overnight). Battery storage respondents indicated that a few days of maintenance outages per year would be likely. Pumped storage respondents indicated that they could be on full or partial outage for a handful of days in a given year with some rare longer maintenance outages during the life of the facility. Responses from waterpower facilities varied depending on the age and type of facility.

Market Renewal Program – Energy Market

Question 14:

Based on engagement with the IESO on the design of the Single Schedule Market (SSM), Day-Ahead Market (DAM) and Enhanced Real-Time Unit Commitment (ERUC), identify any design gaps for non-emitting resources.

A broad range of respondents suggested the Market Rules be amended to widen the qualification of energy storage to participate in all IESO markets (e.g., provision of ancillary service), along with changes to the IESO's network model, IT tools and infrastructure that would allow for these resources to be incorporated into scheduling and dispatch instructions as well as price formation and settlements.

Storage respondents noted that a facility's state-of-charge is not incorporated into the SSM, DAM, or ERUC. Storage respondents also raised the fact that MRP has yet to explore a market to value environmental attributes (EAs), which would provide a valuable revenue stream.

Biomass respondents indicated that the DSO only accepts a single OR ramp rate and that the ability to submit multiple ramp rates would enable both DAM and ERUC engines to provide a solution with more accurate inputs.

Solar respondents indicated that there needs to be a better understanding of the impacts on distribution-connected projects and their ability to participate in the IESO-administered markets, which would include clarity with regards to the data and technical requirements to integrate within the dispatch/scheduling models.

Pumped storage respondents indicated that the decision to remove the adjustment pass for energy limited resources from the present day-ahead commitment process (DACP) scheduling process will further complicate the scheduling process for storage in the DAM. They also indicated that the development of market power mitigation processes could have adverse consequences for pumped storage facilities.

Question 15:

Based on experience in other electricity market jurisdictions with comparable market design to the MRP, identify best practices for non-emitting resources.

Solar respondents indicated that energy revenues should reflect the value of non-emitting generation. Respondents noted that other regions have used Renewable Portfolio Standards (RPS) to help ensure that the environmental value is recognized in the energy rate. Respondents also noted that other jurisdictions enable participation from smaller scale resources (100 kW minimum) and/or enable aggregation within zones (e.g., ISO-NE, NYISO, PJM, CAISO, MISO and SPP).

Solar and Wind developers both noted that certain other jurisdictions use centralized forecasting with respect to solar (in MISO) and wind output (in MISO, ISO-NE, NYISO, and PJM).

Wind respondents provided the following descriptions of to two U.S. jurisdictions – ISO-NE and MISO – that are able to dispatch wind. In 2016, ISO-NE launched the Do Not Exceed (DNE) dispatch project. This system allows transmission congestion to be managed by dispatch software systems, not manually by system operators. MISO has a similar mechanism. Wind can be dispatched through its Dispatchable Intermittent Resource (DIR) process. The resource is included in the day-ahead and real-time co-optimization and is eligible to set prices. The resource can submit energy offers and will clear between a minimum and maximum limit.

Waterpower respondents noted market designs currently contemplated in other jurisdictions like carbon pricing in NYISO, and the Competitive Auctions with Sponsored Policy Resources (CASPR) initiative in ISO-NE. A waterpower respondent also noted that PJM allows for "Capacity Storage Resources", which include run-of-river hydroelectric facilities. Respondents indicated that the adoption of these rules could allow our run-of-river hydro to participate more broadly in the markets available.

Some energy storage respondents pointed to the unbundled ancillary service market in the United Kingdom and the long commitment period for new build resources under that country's capacity market design as being desirable and beneficial to their resources.

Transmission interconnection respondents noted that certain ISOs (e.g., PJM and NYISO) have amended their market design and rules to only schedule energy transactions up to the limit of the respective contracted high-voltage direct current (HVDC) interconnections, in order to avoid 'free-riders' that do not have transmission capacity on the interconnections for the purposes of power flows; therefore, the ISOs ensure the shippers who own of transmission capacity on these interconnections can use or competitively sell transmission capacity as a return on their investments.

Distributed energy resource respondents indicated that other jurisdictions enable participation from smaller scale resources (100 kW minimum) and/or enable aggregation within zones (e.g., ISO-NE, NYISO, PJM, CAISO, MISO and SPP).

Question 16:

What risks would you face in committing your resource in the day-ahead market and thus receiving a financially binding schedule?

Many respondents indicated the inherent financial risks, which are created when deviation between the day ahead and the real time schedules exists, may dissuade participation by some NERs. In addition, respondents indicated that forecasting based on meteorological information creates a risk of over or under production.

Biomass respondents indicated that one risk factor would be fuel management where there is a change in the real time schedule.

Storage respondents noted the fact that the DAM is not considering state of charge could cause a risk that the supplier might not be able to meet all parts of the day-ahead schedule.

Question 16a:

What risks would you face in committing your resource hours ahead in a real time market?

Responses were similar to Question 16, relating to forecasting and differences between day ahead and real time schedules.

Future Markets – Continued Evolution

Question 17:

Are there any services/products that your resource could provide that are not yet compensated for in the current market by the IESO? If so, list jurisdictions where this service is being, or will be, provided.

Many respondents across technologies repeated their concern that there is currently no mechanism to value the EAs produced from renewable generation, indicating that other jurisdictions have RPS as well as voluntary markets for Renewable Energy Certificates (RECs).

Transmission interconnection respondents noted that in markets such as PJM, a facility can be "pseudo-tied" to the system and provide capacity, energy, and ancillary service of an internal generator of the same attributes. These respondents also noted the lack of valuation of EAs stating they should be relative to the contributions of each resource to the grid.

A solar respondent noted that in ISO-NE, solar can participate in the Forward Capacity Market (FCM) as a demand resource. Another respondent noted that combined solar and storage facilities are not compensated for ramping or 5 minute OR in Ontario.

A storage respondent stated that electric vehicle battery storage integration with the grid is under development in California (CAISO) and other ISOs in North America.

Biomass respondents indicated that there is currently no market in Ontario that compensates resources for flex ramping (as in CAISO) and broader system flexibility. A respondent also noted that disposal of wood waste from local mills, wood from forest management activities, and wood waste from legacy bark piles is not compensated in Ontario.

DR respondents stated that load resources are currently not paid utilization payments for their load contributions during DR events under the current Market Rules for the DR Auction.

Nuclear generators indicated that a number of the resources' attributes are not compensated by the IESO markets, including grid stability services, price stability, community benefits (jobs), and the support of the healthcare sector (medical isotopes) amongst others.

Question 17a:

If your resource is currently providing a service or product to an IESO administered market, what changes if any (i.e. to your facility) could increase the amount of this service or product currently provided?

Transmission interconnected respondents indicated that transmission interties, as well as Ontario's internal transmission infrastructure, is often constrained, and could be upgraded to allow greater external facility participation.

A solar and storage respondent noted that energy storage paired with solar can increase the amount of energy, capacity and ancillary services a facility can provide and that this pairing can facilitate the delivery of firm power, provided that the revenues and ongoing commitment (term) are sufficient for the deployment of capital.

Question 18:

Are there opportunities to pair technology types in order to facilitate participation in any future market? If yes, please explain and provide supporting examples.

A number of respondents (including solar, waterpower and wind) noted that pairing technologies, in particular with battery storage, can facilitate participation in the market. Respondents pointed to the Xcel Energy 2017 RFP which provides examples of pairing variable generation with other resources.

In addition, respondents pointed to facility aggregation as an option to pair technologies and further participation in the market.

Question 18a:

Identify any factors that may limit the pairing of technologies.

Multiple respondents pointed to cost as a limiting factor. In addition, some respondents indicated that the ability to add storage to existing facilities is complicated by Ontario's Renewable Energy Approval requirements (amendments would be required). Demand charges were pointed to as a financial barrier to pairing storage with existing facilities.

System Flexibility

Question 19:

How quickly could your facility or technology provide flexibility either through ramping speed or start-up requirements (coming online if offline) to the Ontario Market?

Biomass respondents provided start up times that varied depending on the state of the unit (cold, warm or hot).

Nuclear respondents indicated that the facilities are manoeuvrable, but the ability to divert the excess energy from manoeuvering to storage or conversion for future use would extend the economic viability of manoeuvring.

Solar, storage, wind and transmission respondents indicated that they could provide flexibility immediately with response times ranging from fractions of a second to a few minutes.

Question 20:

Is the ramping profile of your facility linear in nature, or does it have a different ramping profile?

Solar, storage, wind and waterpower respondents indicated their facilities had a linear ramping profile.

Biomass respondents indicated both linear and non-linear ramping depending on the nature of the facility.

Question 21:

Where available, please provide details of ramp direction and speed. For example in 30 minutes, how quickly could your resources ramp up?

Responses were provided as follows:

Technology	Ramp Information
Wind	Ramp up: 74 MW/min Range of 10 to 617 % of nameplate capacity / min Ramp down: 13 MW/min Range of 6 to 200% of nameplate capacity / min Average: 60 MW/min
Solar	Ramp up: 10 MW/min Ramp down: 10 MW/min Average: 100% of nameplate capacity / min
Hydro	Ramp up: 3 MW/min Ramp down: 3 MW/min Range: 2 to 26% of nameplate capacity per minute
Pump hydro storage	Range: 100 to 600 MW/ min
Nuclear	Respondents indicate a substantial ramping ability through the facility's rejection of steam.

Question 21a:

For existing or proposed facilities: how many MWs of flexibility can your facility provide?

Question 21b:

For existing or proposed facilities: how long can your facility provide the flexibility services?

Responses to questions 21 a and b were varied and include both confidential information and general overviews of respondents' facilities and technologies.

The information provided as part of Questions 21 a and b has been used to supplement the information collected through Appendix A and has been shared on a confidential basis with other relevant IESO staff.

Question 22:

What restrictions, if any does your technology or facility have in providing these services?

Most respondents indicated that they would be limited by the availability of fuel. Storage respondents indicated they would be limited by the state of charge.

Biomass respondents indicated that facilities are limited by the ramp rates of the fuel and boilers.

Wind and solar respondents indicated that providing flexibility services may not be economic, especially with upward response as facilities under contract would be operating at full capacity.

Waterpower respondents indicated the restrictions are facility dependent, but are subject to seasonal fuel availability (i.e. water levels). It was noted that run-of-river hydro has limited flexibility given operational and environmental restrictions.