Annual Acquisition Report

April 2022

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Table of Contents

Table of Figures

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Executive Summary

Ontario's electricity sector is undergoing a period of significant transformation. New decarbonization policies coupled with rapid growth in the mining, greenhouse and industrial sectors are accelerating electricity demand growth across the province and heightening needs in certain regions.

The IESO's most recent Annual Planning Outlook (APO) reflects these trends. It projects a steady rise in electricity demand that highlights the strengths of Ontario's communities and economy to navigate the challenges of the pandemic, pursue electrification and support economic growth.

To address this changing environment, the IESO established the Resource Adequacy Framework in 2021 to provide a flexible and cost-effective approach for competitively securing the resources necessary to meet demand. Within the framework's annual cycle, the APO's 20-year forecast identifies Ontario's power system needs, while the Annual Acquisition Report (AAR) specifies the mechanisms that the IESO will use to meet them.

Since initiating the framework, the IESO has responded to Ontario's needs by growing the annual capacity auction for short-term commitments, and making substantial progress on designing and implementing competitive procurements to ensure reliability in the coming decade and beyond.

The 2022 AAR continues on this path, defining actions to address reliability needs identified in the most recent APO. It also responds to the pace of change in Ontario's electricity sector through updated demand and supply forecasts, incorporating the latest information on decisions and potential risks into this year's adequacy assessment of Ontario's electricity resources. It accounts for a range of events and uncertainties, as well as more resource-specific information such as location, technological capability and energy or fuel limitations.

The results show that capacity needs in the years up to and including 2024 are expected to be met through existing resources and the plans already identified in the 2021 AAR. Needs emerging in 2025 based on increased demand, the retirement of the Pickering Nuclear Generating Station and expiring contracts, however, will require action beyond what was projected last year. The broad trends of these needs have been reflected in previous forecasts, but their specific timing and magnitude continues to evolve as plans and policies of consumers and governments change.

Initiatives identified in last year's AAR, like the first medium-term RFP, are currently underway and will contribute to meeting the mid-decade need. In addition, a number of accessible options to secure more supply already exist, including the potential for nuclear operators to adjust outage schedules and using capacity from the Hydro Quebec Capacity Sharing Agreement. The possibilities for additional energy efficiency and new procurements will also be discussed in greater detail with sector participants and Indigenous communities.

Further needs, described in last year's AAR, emerge in the late 2020s and will require the acquisition of incremental capacity, including new-builds, expansions and upgrades of existing resources. The IESO is currently engaging with sector participants, municipalities and Indigenous communities on the first Long-Term RFP, with a focus on ensuring new investment in the province.

The IESO will continue to work with sector participants and communities to ensure that decisions made and approaches taken are collaborative efforts. The bridging mechanisms of this year's Medium-Term I RFP, and the addition of multiple future procurements, are direct responses to feedback received and are aimed at facilitating a fair and transparent transition for resources into a competitive environment.

This year's AAR is responding to sector participant feedback by including additional information and topic areas, such as how the IESO sets targets and incorporates uncertainties into assessments. It also highlights linkages to parallel work such as the progress of enabling new technologies to compete in the electricity market, which will increase competition in future procurements for all timeframes.

Similarly, future AARs will incorporate updated forecasts and policy commitments, potentially reflecting the results of other ongoing work. This includes the study of possible future hydroelectric supply, Distributed Energy Resources (DERs) and other new technologies, as well as the IESO's Pathways to Decarbonization project, which is exploring potential avenues to reach a decarbonized supply mix for Ontario's grid.

2022 AAR Highlights

- Capacity needs in the years up to and including 2024 are expected to be met through the planned actions identified in the 2021 AAR, including continued growth of the capacity auction, and resources secured through bilateral negotiations.
- While some of the capacity needs identified in the 2021 APO for 2025 and 2026 are expected to be met through last year's planned actions, more supply is needed. The IESO intends to make use of the existing Hydro Quebec Capacity Sharing Agreement, and other options include:
    - adjustments to nuclear outage schedules
    - additional energy efficiency programs
    - re-contracting existing biomass facilities
    - opportunities to broaden the scope of the capacity auction
    - using existing or additional procurements to target resource expansions and earlier delivery of new resources
    - opportunities for additional medium-term commitments, such as an enhanced capacity auction
- As demand grows, Ontario is seeing the need for new resources. This fall the IESO will be initiating the first in a series of long-term commitment procurements to satisfy reliability needs anticipated in the late 2020s and 2030s.

Planned Actions

Short-Term Commitments

The IESO's capacity auction will continue to play an increasingly important role in meeting the province's supply needs in a flexible and cost-effective manner. The next auction, to be held in December 2022, will set a target of 1,200 MW for the 2023 summer obligation period and 750 MW for the 2023-24 winter obligation period.

Medium-Term Commitments

The first medium-term RFP for a core delivery period of 2026 to 2029 has been issued, with proposals expected by April. In response to sector participant feedback, a bridging approach will be employed to extend existing contracts to the next April 30 date to align with the start of a capacity auction obligation period or the Medium-Term I RFP commitment period. In addition, resources will have a flexible five-year commitment period where suppliers can choose any five-year term between 2024 and 2031.

The IESO is employing a cadenced approach to medium-term commitments and will execute the second medium-term RFP in 2024 for a five-year term, with a core delivery period of 2029 to 2032, and based on lessons learned from Medium-Term I RFP and on updated system needs.

The IESO is also considering new procurements that could include an enhanced multi-year capacity auction for a medium-term commitment.

Long-Term Commitments

The IESO has begun working with sector participants, municipalities and Indigenous communities to design the first long-term RFP, which will secure an anticipated 2,500 MW for delivery by 2027 or earlier. The procurement is expected to target incremental capacity for a minimum 10-year commitment period to address multiple reliability needs. A second long-term RFP is anticipated to acquire an additional 1,500 MW by 2030.

In addition, the IESO will explore opportunities to develop two new competitive processes for acquiring incremental capacity - the first from expansions of existing facilities and the other from new-build resources. Both will seek services to be in place by 2025.

Possible Solutions for Reliability

Background

Ensuring Ontario's electricity system is reliable today and into the future requires the consideration and planning of a broad range of elements. The 2021 AAR initiated a number of planned actions to address Ontario's ability to meet demands in the future. The IESO's planning and procurement processes are continually evolving and adapting to changing conditions.

The reliable operation of Ontario's electricity system requires the coordination of many participants providing a variety of services. To ensure that the right amount of electricity is available when and where it is needed, the IESO procures various electricity services, administers real-time electricity markets, forecasts and plans for future system needs, and recommends the development of transmission infrastructure. Over the past two decades of operating Ontario's energy market, it is apparent that transparency and communication are a critical component of a well-functioning market. With this in mind, the IESO has evolved its planning processes, beginning with the introduction of the Annual Planning Outlook (APO) in 2019. The APO is an annual report that identifies future system needs and helps to inform the decisions that will lay the foundation for a reliable and affordable energy future in Ontario. The APO was followed by the release of the IESO's first Annual Acquisition Report (AAR) in July 2021, an annual report that identifies the mechanisms and targets that the IESO will employ to acquire the services of resources to satisfy Ontario's future reliability needs. In addition, the IESO engaged with sector participants and communities to develop an Integrated Bulk System Planning Process to improve how transmission needs are identified and resolved; the first iteration of this process will begin in 2022.

Figure 1 | Activities Conducted to Ensure Reliability

Adherence to Reliability Criteria

The actions proposed in this report are based upon and subject to various provincial and North American standards and are intended to ensure Ontario's ongoing compliance with the applicable standards and criteria.

The recognized standards authorities, the North American Electric Reliability Corporation (NERC) and the Northeast Power Coordinating Council (NPCC), define the minimum reliability requirements for planning and operating within the interconnected North American bulk electric system. The IESO's Ontario Resource and Transmission Assessment Criteria lists the technical criteria used to assess the adequacy and security of the IESO-controlled grid, and clarifies how the IESO applies relevant NPCC Directories and NERC Reliability Standards in Ontario.

Status of 2021 AAR Planned Actions and Policy Decisions

Much has been accomplished to execute the planned actions described in the 2021 AAR, and a number of government policy decisions related to resource adequacy have been made.

Capacity Auction

Annual capacity auctions serve as a flexible balancing mechanism and secure the capacity needed to meet near-term peak demands, with a diverse range of resources competing to be available for summer and/or winter obligation periods.

The 2021 AAR outlined the targets for the December 2021 capacity auction as 1,000 megawatts (MW) and 500 MW for the summer 2022 and winter 2022-2023 obligation periods, respectively. Building on the success of previous capacity auctions, the IESO secured capacity from a diverse range of resources, including industrial and commercial consumers providing demand response, imports from jurisdictions outside of Ontario, generation and energy storage. Through this competitive mechanism, 1,286.7 MW cleared for the 2022 summer obligation period and 841.9 MW cleared for the winter 2022-2023 obligation period.

Medium-Term Commitments

Medium-term commitments serve as a mechanism to secure services from resources that may require longer forward periods or multi-year commitments (three to five years).

The medium-term RFP represents a meaningful step in the IESO's transition away from resource-targeted procurements, to acquiring the services of resources based on their ability to meet system needs. On January 27, 2022, the IESO received a directive from the Minister of Energy (Minister), as approved by the Lieutenant Governor in Council, providing the IESO with the authority to execute the first medium-term RFP (Medium-Term I RFP), for the procurement of capacity from existing generation and storage facilities. The Medium-Term I RFP was launched on January 31, 2022, and is intended to be the first in a cadence of medium-term RFPs.

The 2021 AAR had initially anticipated that the first medium-term RFP would seek up to 750 MW. Using information from the registration stage of the medium-term RFP process, which provided the IESO with greater clarity on the anticipated level of participation, the target capacity has been updated to 475 MW to ensure that a robust competition can be maintained. To address the residual capacity needs to maintain future reliability, the IESO will continue to use other procurement mechanisms such as the capacity auction, requests for proposals, and targeted programs.

Long-Term Commitments

Long-term commitments serve as a mechanism to secure services from resources that require very long forward periods or commitment periods, such as new-build facilities.

The 2021 AAR signaled the potential launch of a long-term RFP in fall 2022, with the aim of acquiring at least 1,000 MW of incremental capacity to satisfy long-term system needs. The IESO initiated engagement with sector participants and communities for the first long-term RFP (Long-Term I RFP) in October 2021, and on January 27, 2022 the government issued a directive to the IESO to design the Long-Term I RFP to procure at least 1,000 MW of capacity, determined primarily on an Unforced Capacity (UCAP) basis. The directive recognized that the amount of capacity, electricity products and services procured will be factors in ensuring long-term procurements attract investment in a way that benefits ratepayers. The directive also requires that the IESO initiate a Request for Qualifications (RFQ) in advance of the first long-term RFP, to ensure that potential participants have sufficient financial capability and experience to deliver the projects submitted under the long-term RFP.

Bilateral Negotiations

While the IESO aims to use competitive mechanisms as much as possible, bilateral negotiations secure resources to satisfy needs that cannot be addressed in a practical and timely way through competitive processes.

The 2021 AAR recognized that prior to the development of the Resource Adequacy Framework, the IESO negotiated a bilateral agreement for firm imports with Hydro Quebec. The 2015 Hydro Quebec Capacity Sharing Agreement provides the IESO with an option for 500 MW of summer capacity to be delivered by Quebec to Ontario when requested by the IESO in any one summer before 2030. This capacity can benefit the system's global adequacy needs and locational requirements in Eastern Ontario.

The 2021 AAR identified the need for two bilateral negotiations (for Brighton Beach Generating Station and Lennox Generating Station) as a transitionary approach where significant and urgent reliability needs in specific regions of the province were unable to be addressed in a timely manner through competitive processes. The IESO has completed a transitional contract with Ontario Power Generation (OPG) for the continued operation of the Lennox Generating Station. The new contract runs from October 1, 2022 to May 1, 2029, with the intent for the contract end dates of both bilateral arrangements to align with a period when there may be increased competition.

Government Policy and Program Decisions

Government policies and programs work together with the Resource Adequacy Framework to contribute to meeting overall reliability needs.

The Resource Adequacy Framework will continue to be informed by government policy. Over the course of 2021 and early 2022, the Minister issued several directives and letters to the IESO. The most recent directive, issued on January 27, 2022, directed the IESO to enter into a contract for the continued availability of the Calstock Generating Station, as well as to design a program to provide for the continued availability of existing small hydroelectric resources.

As part of the government's unsolicited project assessment framework, the IESO was directed to enter into a contract with a 10-year term for the 250 MW/1,000 MWh (nameplate rating) Oneida Energy Storage Project, for the provision of capacity and regulation services.

In addition, Ontario Power Generation (with the Government of Ontario's support), is working with GE Hitachi Nuclear Energy to deploy a small modular reactor (SMR) at OPG's Darlington nuclear site. The SMR, with a capability of approximately 300 MW, is projected to be completed as early as 2028.

Understanding Ontario's Reliability and Resiliency Needs

Ontario, like many jurisdictions in North America, is experiencing changes in electricity supply and demand, creating new needs. As Ontario embarks on a period of procuring services from existing and incremental resources, acquisitions will be tailored to ensure reliability needs are met. Beyond ensuring Ontario has resources available on peak (capacity) to serve demand, the IESO anticipates additional needs where it will be important to have confidence that resources can deliver energy for a sustained period of time. Resources located in areas where demand is growing, such as west of London, and those that can improve the operability and resilience of the power system will play an important role in the future.

This section describes the reliability needs considered in this iteration of the AAR. Further details on reliability needs and the methodologies to determine reliability needs are described in the 2021 APO, which covers a forecast period of 20 years. Recognizing the wide range of uncertainties that arise in developing forecasts, this AAR focuses on actions to address needs over the first 10 years of the 2021 APO forecast period.

Resource Adequacy Needs

Adequacy is defined in the IESO's Market Rules as the ability of the electricity system to supply electrical demand and energy requirements at all times, taking into account scheduled and unscheduled outages of equipment or components. The IESO assesses the adequacy of its resources by applying the resource adequacy design criterion specified by NPCC.[1]

Adequacy is often divided into two assessments: the first, *capacity adequacy,* assesses the system's ability to serve peak loads; the second, *energy adequacy,* assesses the system's ability to serve load in all hours, while taking into consideration the availability of fuel and operational characteristics of resources.

Capacity refers to a resource's maximum ability to provide energy or reduce load when required. To plan a reliable electricity system, the IESO must ensure that adequate capacity is available to supply the peak demand, taking into account scheduled and reasonably expected unscheduled outages of system components, with sufficient margins in reserve.

In addition, recognizing the transformation that the entire North American electricity grid is undergoing, the IESO conducts a more focused assessment of energy adequacy. This is an expansive assessment that recognizes that a resource's ability to satisfy peak demands does not guarantee its availability to supply energy requirements at all times.

[1] Further details of this requirement are provided in NPCC Directory #1 and the Ontario Resource and Transmission Assessment Criteria.

Traditional resource adequacy assessments have focused primarily on ensuring adequate capacity to serve peak demand periods. This simplification was satisfactory at a time when electricity fleets across North America included a large amount of dispatchable facilities that were available when needed, no matter the duration of need (e.g. one hour or 10 hours). Today, consistent with industry trends, broader energy adequacy assessments are a focus for NERC,[2] acknowledged in the 2021 Electric Reliability Organization (ERO) Reliability Risk Priorities Report.

Recognizing the transformation that the entire North American electricity grid is undergoing, the IESO continues to evolve its approach to assessing energy adequacy and incorporating this important reliability element into its planning processes.

The electricity fleet in Ontario is expected to face a transformation starting in the middle of this decade, driven by the retirement of the Pickering Nuclear Generating Station (NGS), refurbishments of nuclear units and the potential retirement of aging assets. With this transformation, the backbone of the system – supply resources whose fuel is always available and can deliver for long hours at a time – is expected to change. While no reliability standards currently exist for assessments of energy adequacy, the IESO assesses potential unserved energy as a means of determining Ontario's energy adequacy. In addition, the IESO takes into consideration the duration of resource adequacy risk periods in its assessments,[3] to inform duration and availability requirements for its acquisitions.

Energy, from a reliability planning perspective, refers to a resource's ability to provide electricity over a specific period of time. The IESO works to ensure that there are resources available to meet demand across all hours of the year, taking into consideration uncertainties related to fuel availability, including the variable nature of wind and solar resources.

Recognizing that the NPCC design criterion focuses on the ability to serve peak loads, the IESO has focused past acquisitions primarily on procuring capacity from individual resources. In most jurisdictions, the forecasted revenues from energy markets alone are regarded as insufficient to ensure that adequate capacity is built and maintained. Consequently, most resources in Ontario as well as other jurisdictions are also compensated for certain fixed costs which energy market revenues alone are not sufficient to cover. These costs could be recovered through contracts, rate regulation or commitments from a capacity auction.

As outlined in the 2021 APO and as required by the Market Rules and NPCC Directory #1, the IESO calculates capacity requirements by performing a probabilistic resource adequacy assessment, which compares the demand forecast with anticipated resource performance to simulate a range of possible future system conditions. The 2021 APO reference demand forecast represents a notable increase from the 2020 APO forecast. The increase is primarily driven by economic recovery from the pandemic and government policy on climate change mitigation, leading to higher demand.

[2] More information on energy adequacy, its importance, and the development of industry practices are being developed by the NERC Energy Reliability Assessment Task Force. Information on modernizing resource adequacy assessments are well described in the ESIG Report: Redefining Resource Adequacy for Modern Power Systems.

[3] Resource adequacy risk periods are considered to be periods when the IESO's resource adequacy models identify times when supply is insufficient to serve a portion of Ontario's load.

The 2021 APO indicated that capacity needs appear in summer 2023 and continue to be greater in the summer than in the winter. More significant summer capacity needs emerge in 2025 and continue for the duration of this outlook period, driven by the retirement of Pickering NGS, and continue to grow as a result of nuclear refurbishments, resources reaching end of contract and increases in demand. While the capacity deficit increases over the 2021 APO's outlook period, the need is sustained and relatively constant from 2027 to 2034. Energy requirements emerge in the mid-2020s, with needs increasing in the event that existing resources exit the market following the end of their contracts.

Duration of Resource Adequacy Risk Periods

Periods of resource adequacy risk identified in the 2021 APO tend to be sustained for multiple hours. The 2021 APO scenario that considered the continued availability of existing resources demonstrated an adequacy need for incremental resources in 2029, that have the ability to provide continuous energy to address risk periods lasting from one hour to one week. **Figure 2** shows the duration of risk periods from the 2021 APO. This assessment shows that the length of risk periods can vary greatly. Looking at the entire range of outcomes observed in the IESO's probabilistic assessments can inform future procurements on the value of resources that are capable of providing energy for a sustained period of time, particularly in preparation for the potential for severe weather conditions:

- 30% of events persist for up to four hours;
- 20% of events persist for more than 4 and up to 8 hours;
- 25% of events persist for more than 8 and up to 16 hours; and
- 25% of events persist for more than 16 hours.

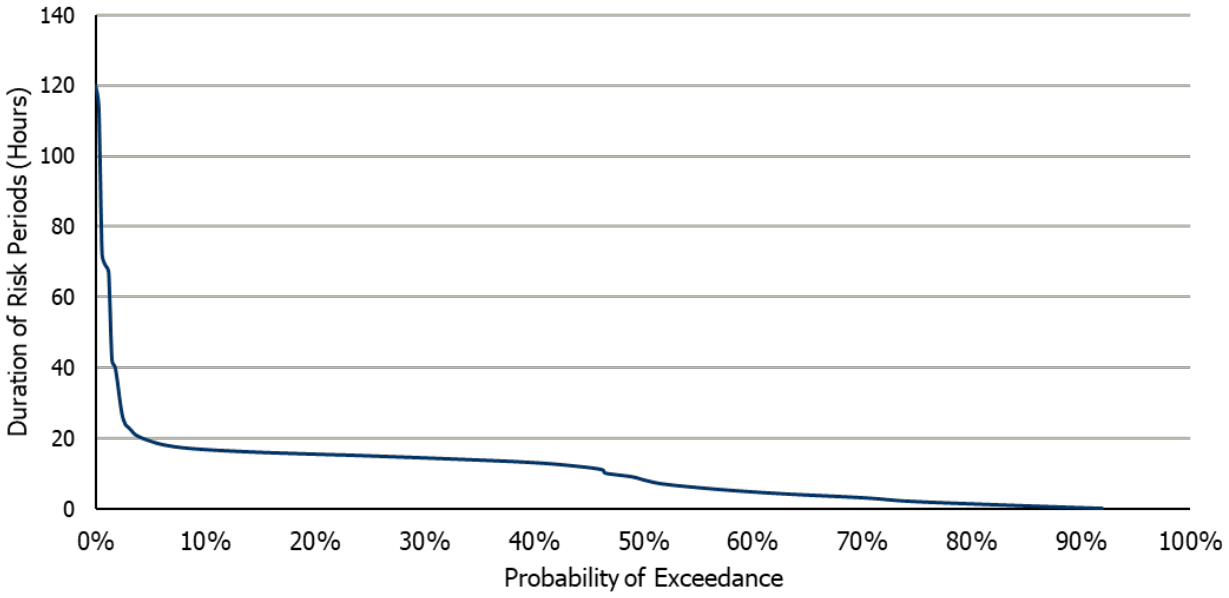

Figure 2 | Duration of Resource Adequacy Risk Periods, 2029

Time of Day of Resource Adequacy Risk Periods

The timing of resource adequacy risk periods is impacted by changes over the course of a day, as well as anticipated demand curve shapes that depend on factors such as day of week or periods of sustained demand (often in response to unseasonably hot or cold temperatures). In addition, the availability of supply resources can also impact the time of day when risks emerge. For example, the availability of solar generation varies over the course of the day and is not always in alignment with periods of high demand.

Using the 2021 APO's adequacy assessment which considers the interplay between demand and supply to identify risk periods, further analysis affirmed that future risk periods are aligned with the availability windows of the capacity auction and Medium-Term I RFP.

Analysis indicates that in 2029, as resource adequacy risks increase, the hours of the day with the highest risk to reliability occur between 15:00 to 21:00 EST primarily from July to September, and to a lesser extent between 07:00 to 12:00 EST in May and October, as shown in **Figure 3**. In the winter, the highest risks occur twice during the day; the first occurrence around 08:00 to 9:00 EST and the second around 17:00 to 22:00 EST, as shown in **Figure 4**.

As shown in the figures below, the availability windows of the capacity auction[4] are aligned with the hours where the highest risk to reliability occur. A longer availability window, which aligns with the Medium-Term I RFP requirement of 07:00 to 23:00 EST on business days, addresses the hours with the highest risk to reliability in the summer. Given the profile of winter needs, the IESO will consider updates to the availability window during this season to separately target the morning spike and the larger and longer need in the evening in the design of future procurements.

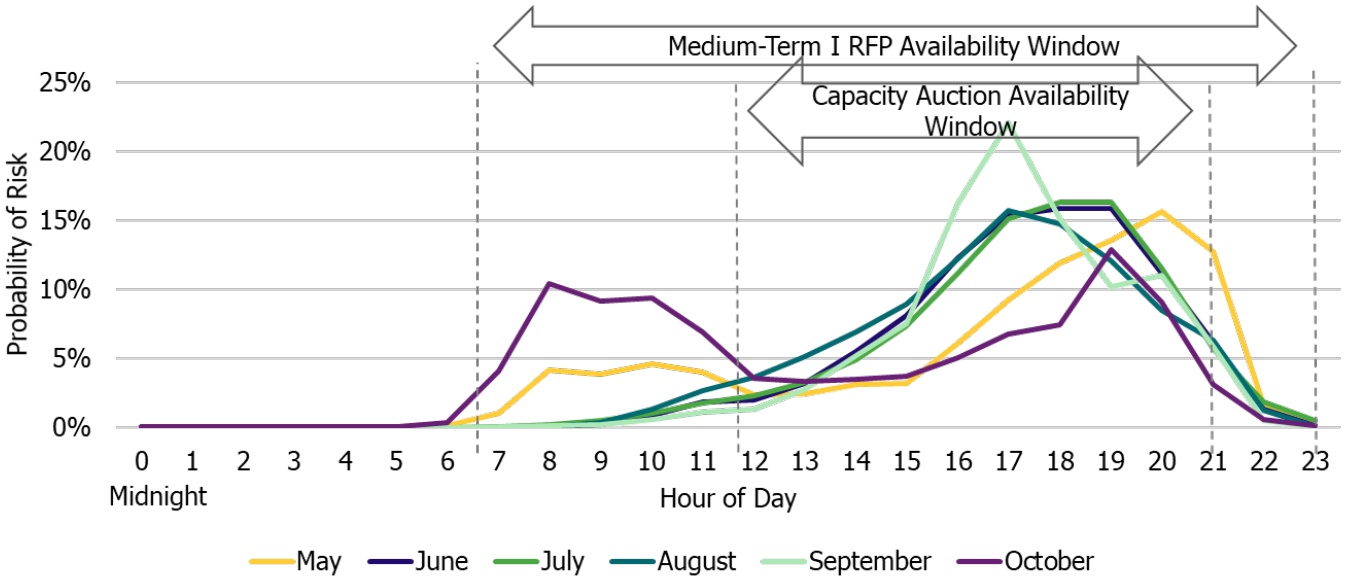

Figure 3 | Probability of Risk, Summer 2029

[4] The availability windows for the capacity auction are 12:00 to 21:00 EST (summer) and 16:00 to 21:00 EST (winter), on business days.

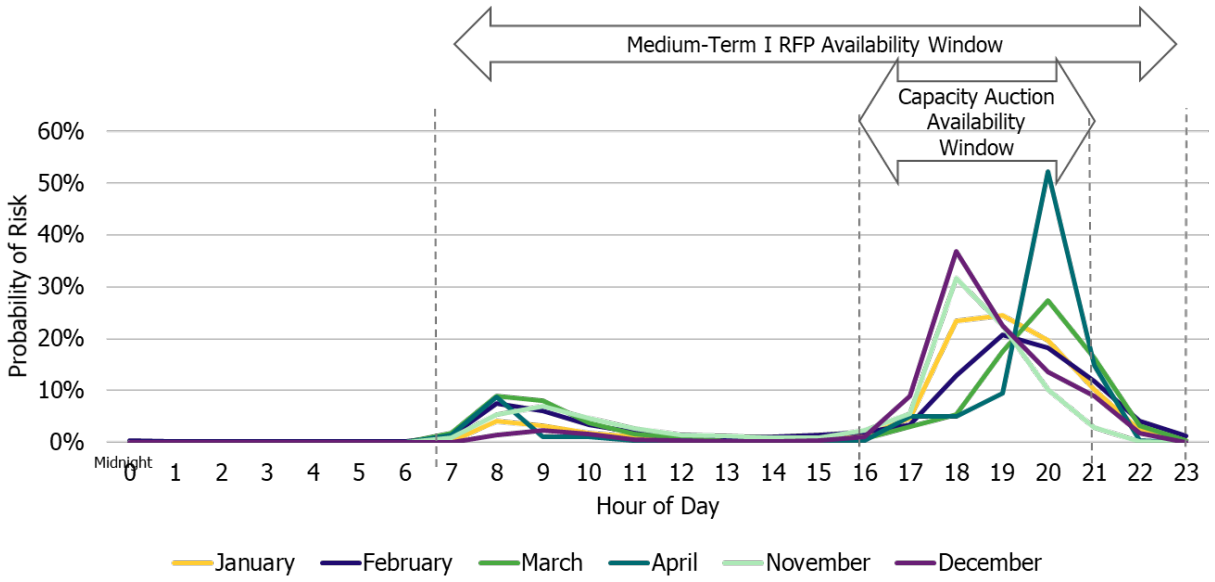

Figure 4 | Probability of Risk, Winter 2029

Defining Locational Needs – Responding to Transmission Security Needs

Locational capacity requirements may be driven by both resource adequacy criteria and transmission security criteria. Locational requirements for resource adequacy exist due to limitations on the transmission system, typically specified through "transmission transfer capability limits" over transmission interfaces. Accounting for transmission transfer capabilities across Ontario's interfaces, the IESO specifies the minimum and maximum incremental capacity amounts required in certain regions of the province. Transmission security criteria ensure that the system can withstand sudden disturbances, such as the loss of system components. The IESO has an obligation to ensure the bulk transmission system meets the requirements of the NERC Reliability Standards, NPCC Directories, IESO Market Rules and Market Manuals. Transmission security studies determine locational capacity needs by comparing forecasted demand within a zone to the total amount of resources and transmission interface transfer capability into the zone.

Transmission Security refers to the system's ability to withstand sudden disturbances such as electric short circuits or loss of system components. In the planning time frame, transmission security assessments highlight specific geographic areas where capacity may need to be sited or transmission infrastructure upgraded, in order to meet transmission planning standards.

The 2021 APO identified the combined locational requirements for resource adequacy and transmission security. The sections below discuss key locations where needs for capacity, either from existing or new facilities, have been identified.[5,6]

West of London

Both regional and bulk plans focusing on the Windsor-Essex and West of London areas have sought to address localized capacity needs which are being driven by the rapid expansion of agricultural greenhouses. The West of London Bulk Report, published in September 2021, describes the need and the following multi-pronged recommendations to address it:

- Consistent with the 2021 AAR planned action, continued operation of the Brighton Beach Generating Station to support the immediate localized need in the near-term until the Lakeshore to Chatham line is in-service.
- A new double-circuit 230 kV line from Lambton Transformer Station (TS) southwards to Chatham Switching Station (SS) (the St. Clair Line), to be in-service no later than 2028.
- A new single-circuit 500 kV transmission line from Longwood TS to Lakeshore TS, to be in-service by 2030.
- Acquiring 1,975 MW of local resources in the West of London area (with 550 MW located in the Windsor-Essex and/or Chatham-Kent area), to address a local capacity need starting in 2030 and progressively increasing up to the requirement in 2035. In addition to the potential to re-acquire resources whose contracts have expired, incremental capacity from new resources can satisfy this need starting in 2030. There is an opportunity for the long-term RFPs and/or future medium-term commitments to acquire this capacity to satisfy both global and locational needs.

East of FETT Interface

Over the next few years, supply capacity east of the Flow East Toward Toronto (FETT) interface[7] is expected to decline due to nuclear retirements and refurbishments, with potential to decline further towards the end of the decade as contracts for generation facilities reach the end of their terms. The Richview x Trafalgar Upgrade Assessment, posted in July 2021, specifies necessary upgrades to the transmission line between north Oakville (Trafalgar TS) and Pearson Airport (Richview TS) by 2026. In addition, the contract for Lennox GS, which is located east of FETT, has been renewed until April 2029 to address the locational need east of FETT.

The 2021 APO identified a capacity gap east of the FETT interface emerging in the mid to late-2020s, as shown in **Figure 5**, which results from a slightly higher demand forecast as well as generation retirements. Figure 5 shows the total need in this area, of which a portion can be addressed using

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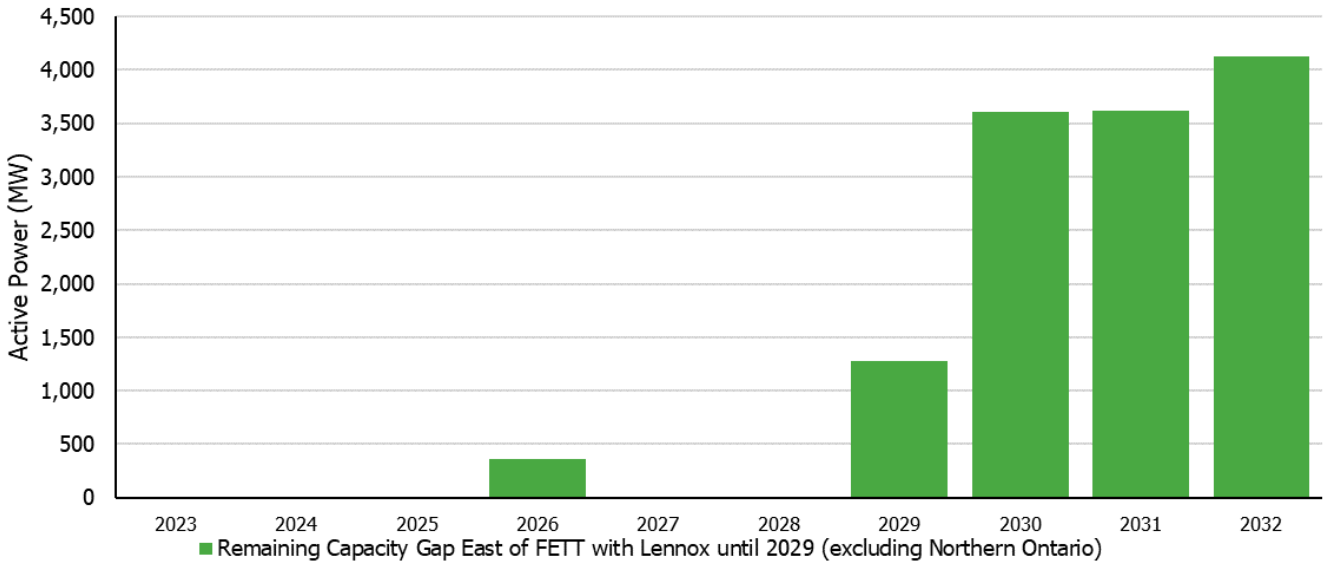
[5] Zonal constraints are provided in the 2021 APO - Table 4: Incremental Summer Zonal Constraints, without Continued Availability of Existing Resources and Table 5: Incremental Winter Zonal Constraints, without Continued Availability of Existing Resources.

[6] Transmission security criteria are concerned with the system's ability to withstand sudden disturbances, such as the loss of system components. Transmission security needs are assessed using a deterministic approach and are represented as active power, as shown in the figures below. Active power describes the highest capacity available from a resource without the impact of seasonal variations or forced outages.

[7] Details on the Ontario's interfaces, including FETT, are provided in the IESO's Annual Planning Outlook: Ontario's Transmission Interfaces and Interties document.

existing resources that will come off contract. The capacity gap that appears in 2026 of almost 300 MW may be reduced if incremental capacity from resources situated east of FETT is acquired through procurements for 2026, potentially through the Medium-Term I RFP or capacity auction. An alternative solution to meet this locational need is to use the 500 MW firm import option under the Hydro Quebec Capacity Sharing Agreement, which will also help to address global adequacy needs in summer 2026. As additional locational needs emerge in the early to mid-2030s, existing or new resources situated east of FETT should be valued in future acquisitions, including Long-Term I RFP and subsequent medium-term commitments.



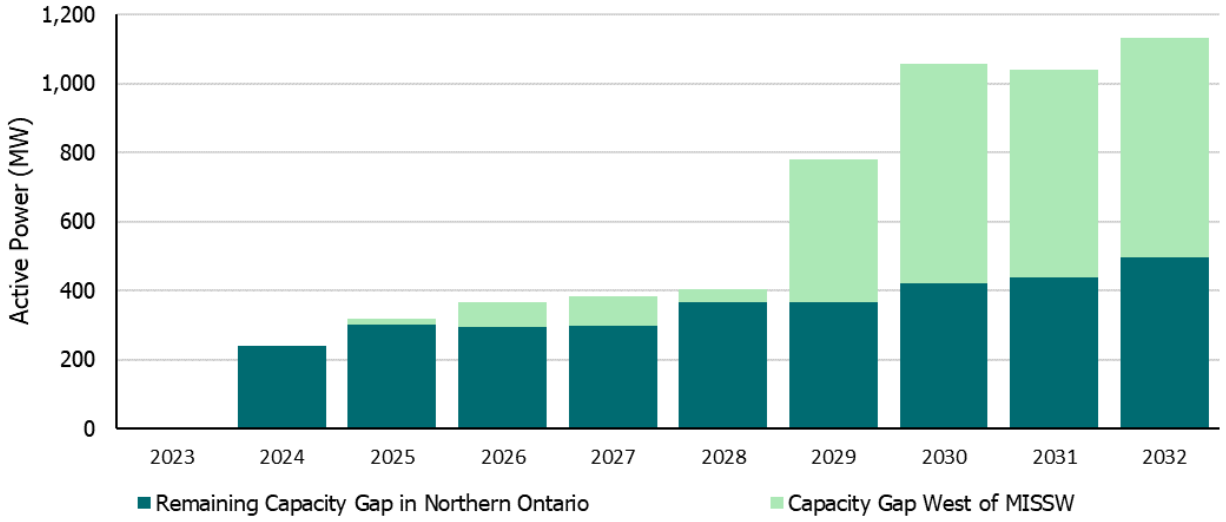
Capacity shown as active power, which is the highest level of capacity available to be used in reliability assessments

Figure 5 | Capacity Gap

Northeast

Locational needs in Northeast Ontario are assessed by reviewing the transmission security outlook for the system west of the Mississagi Flow West (MISSW) and Flow North (FN) interfaces. The 2021 APO identified that for the area to the west of the MISSW interface, a capacity gap begins to emerge beginning in 2025, and increases sharply in 2029 as a result of the projected connection of new industrial loads in Northeast Ontario. In addition to the area west of MISSW, there is a broader capacity gap forecast for the rest of Northern Ontario due to steady industrial growth and expiring contracts of local resources. Without the reacquisition of existing resources, this gap could emerge as early as 2024. The extensions of biomass facilities approaching contract expiry and the reacquisition of other existing assets can help to reduce this gap.

A bulk power system plan for Northeast Ontario is under development to address the capacity gap shown in **Figure 6**, and is anticipated to be completed in Q3 2022. The outcomes of the bulk power system plan for Northeast Ontario may inform whether future procurements for generation are warranted to address needs in this area.

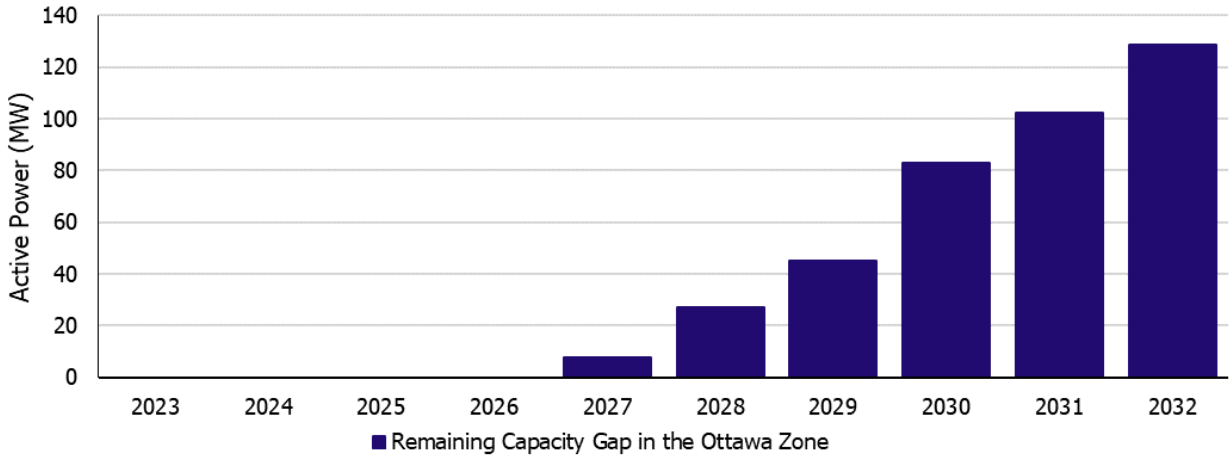


Capacity shown as active power, which is the highest level of capacity available to be used in reliability assessments

Figure 6 | Capacity Gap in Northern Ontario including MISSW (Winter)

Ottawa

The 2021 APO identifies a locational capacity need emerging in 2027 based on the capability of the Flow Into Ottawa (FIO) interface, shown in **Figure 7**, driven by growth in the Ottawa area. The Gatineau Corridor End-of-Life bulk study, which is currently underway, is intended to assess options that may defer this locational need to the longer-term period. The study is anticipated to be completed in Q3 2022, with potential for the outcomes of the study to inform whether procurement decisions are required in the next decade. Additional capacity in the Ottawa zone will also help to address the capacity need east of the FETT interface.



Capacity shown as active power, which is the highest level of capacity available to be used in reliability assessments

Figure 7 | Capacity Gap in the Ottawa Zone (Summer)

Operability Needs

Operability refers to the IESO's ability to manage a variety of conditions on the power system as they occur in real-time. The IESO works to ensure that the power system is reliable under changing system conditions, variability of supply and fluctuation in load, while respecting thermal, voltage and transient stability limits on the system. Operability is assessed in advance to ensure that the power system is adequately prepared for expected real-time conditions, while also having the ability to absorb and adapt to unexpected changes.

Operability is achieved by having a diverse and flexible set of resources with a balance of characteristics that allow the power system to respond to changing conditions. Recognizing that not all facilities in a power system can (or need) to have an entire set of characteristics that contribute to an operable system, the IESO's approach is structured in order to acquire specific, unbundled services where required, allowing competition between facilities that are capable of providing the services specified. Diversity of the supply mix ensures that the risks inherent in each technology and fuel type are mitigated, and helps the power system to withstand a wide variety of conditions, including short-term extreme weather, mid-term environmental extremes and fuel delivery challenges. The ability of the system to respond to a sudden loss of supply requires a sufficient amount of resources that are able to contribute to the Eastern Interconnection's primary frequency response and system inertia capability, in order to maintain system stability. As the set of resources on the power system evolves, the IESO's procurement design, market design and existing set of tools and processes may need to be updated to ensure that the capability exists to manage an increasingly dynamic system.

Resources with one or more of the following attributes help to enhance the operability of the system:

- Flexibility is the ability of the system to respond to intra-hour circumstances or conditions that arise in real-time, depending on the supply and demand balance that materializes. Flexible resources, at minimum, are required to be dispatchable. Resources that are highly flexible may also have a large operating range[8] and the capability to ramp up or down quickly. Currently, when system flexibility needs arise, the IESO uses an interim process for the real-time market operation whereby the IESO can increase the 30-minute operating reserve requirement to schedule additional resources.
- Ramping capability is the ability of a resource to change its active power output, expressed in MW/minute, to assist the system to follow changes in Ontario demand from hour to hour and during periods of large demand changes.
- Ancillary service capability is the ability of a resource to provide operating reserve, reactive support and voltage control, regulation or black start capability, as described in the section below.

[8] Operating range refers to the combined effect of size and range of dispatchable operation of each resource, defined by Minimum Loading Point (MLP), Minimum Generation Block Run Time (MGBRT), and Minimum Generation Block Down time (MGBDT). These terms are defined in the IESO's Market Rules.

Ancillary Services

Ancillary services are required to maintain the reliability of the IESO-controlled grid, and are procured through a combination of market-based and competitive RFPs and/or bilateral contracts. The IESO continues to monitor the need for additional ancillary service capability, with the potential for future identified needs to be incorporated into subsequent AARs.

Operating Reserve (OR) is stand-by power or demand reduction that can be called on with short notice to manage unexpected mismatches between supply and demand. Through the administration of operating reserve markets, the IESO ensures that additional supplies of capacity are available to ensure that energy needs are met when unanticipated events occur in real-time.

Operating reserve requirements must adhere to reliability standard requirements established by NERC and NPCC[9] and are set in the operating time frame, unlike other services which are acquired in advance. Although the IESO's acquisition activities are not specifically aiming to acquire operating reserve in the planning timeframe, resources with the ability to provide OR may be valued favourably due to the potential to increase competition in the IESO's OR markets.

Reactive Support and Voltage Control (RSVC) service is required to maintain acceptable reactive power and voltage levels on the power system in order to move active power through the transmission and distribution system from generators to end consumers. Due to the nature of the transmission system, reactive power needs are very localized and cannot be provided over long distances. All generating facilities injecting energy into the IESO-controlled grid are required to provide a certain level of reactive support and voltage control service in accordance with the market rules.

Regulation service, which is sometimes referred to as frequency regulation, acts on a second-to-second basis to match total system generation to total system load, and helps correct variations in power system frequency. This service corrects for short-term changes in electricity use that may affect the stability of the power system. As outlined in the 2021 APO Ancillary Services Module, the IESO conducted a regulation needs assessment in 2021 to determine if an incremental regulation need exists beyond today's minimum 100 MW requirement. The assessment determined that for the period up to 2026, there is no incremental need for scheduled regulation above the minimum requirement, and as such, the acquisitions discussed further in this report do not target regulation services.

Black start capability assists with restoring the power system in a timely manner following a power system blackout. This service is provided through certified black start facilities that have the ability to start without power from grid-supplied station service or other sources of generation, and support the energization of transmission elements, other generation units and load in a defined area of the IESO-controlled grid. The 2021 APO introduced a principle-based methodology to assess future black start capability needs, that takes into consideration both the need to meet system requirements as Ontario's supply mix evolves, and potential extreme weather events. The existing portfolio of black start facilities satisfies current black start needs, as defined in the Ontario Power System Restoration Plan.

[9] Reliability standards require an amount of operating reserve to be carried that is equal to the single largest contingency, plus half of the second largest contingency.

Power System Resilience Needs

Power System Resilience is defined by the National Infrastructure Advisory Council (and cited by NERC) as the ability to reduce the magnitude and/or duration of disruptive events, and includes the capability to anticipate, absorb, adapt to, and rapidly recover from a potentially disruptive event. An increase in the frequency and impact of extreme weather-related events, as well as cyber threats that are growing in number and complexity, require resilience to be an essential component of reliable power system design and operation.

Resilience is made up of the following key components:

- **Robustness**, the ability to maintain operations and functions during disruptive events;
- **Resourcefulness**, the ability to prepare for, respond to, and manage a disruptive event as it unfolds;
- **Rapid recovery**, the ability to restore services and return to normal operations as quickly and efficiently as possible after a disruptive event; and
- **Adaptability**, the ability to incorporate lessons learned from past events in order to improve resilience.

Similar to assessments for energy adequacy, assessments and common industry processes related to resilience are evolving. While the existing NERC Reliability Standards and NPCC Directories provide a degree of resilience in planning and operating the power system, more resilience-focused reliability standards may be required as the sector evolves and the frequency and impact of disruptive events increases. Understanding that resilience will play an increasingly significant role in Ontario's future power system, the IESO is continuously reviewing its planning and operating criteria to define and incorporate resiliency requirements. In the meantime, procurements or contracts that secure services for the future, especially those with long commitment periods, may value resources that can be utilized to reduce the magnitude or duration of disruptive events. Examples include:

- Acquiring services from energy limited resources such as batteries, that may not have the technical capability to provide energy for the entire duration of an expected energy shortfall, but can reduce the duration of a shortfall event; or
- Acquiring services and providing remuneration to resources that have the ability to provide operating reserve, black start capability or frequency response.

As extreme weather events increase in frequency, ensuring diversity of the supply mix will become more important to maintaining the reliability of the power system, and upcoming RFPs may value resources that can help enhance this diversity.

Developing Planned Actions

The planned actions in this report are informed by the needs identified in the APO, the planned actions underway from the 2021 AAR and consideration of various risks that can impact the magnitude of needs. Capacity needs identified in the 2021 APO for the years up to and including 2024 are expected to be met through the planned actions identified in the 2021 AAR. A portion of capacity needs identified in the 2021 APO for 2025 and 2026 are expected to be met through the 2021 AAR planned actions and recent policy decisions. Some additional actions are needed to address the totality of needs during this time frame and, recognizing that these needs continue in the long-term, can work alongside long-term commitments for new, incremental capacity to ensure reliability in the latter half of this decade and beyond.

The Resource Adequacy Framework sets out a competitive strategy to acquire services from resources, balancing ratepayer value and supplier risks, while recognizing the unique characteristics and contributions of different resource types. The framework is designed to facilitate the transition to a more transparent and competitive procurement environment that aligns resource acquisitions with evolving system needs. The framework consists of mostly competitive mechanisms. Some mechanisms can be adapted and executed in time to address short-term needs (i.e. those arising in the next one to four years), and include the capacity auction, programs supporting government policy, and bilateral negotiations. Other mechanisms target medium- or long-term commitments through RFPs or potentially enhanced capacity auctions, and require additional time to execute or longer forward periods. Although the IESO is committed to prioritizing the use of competitive mechanisms, the early stages of operationalizing the framework may require execution of other mechanisms to address reliability needs.

The IESO's decision making methodology, below, allows solutions to be determined to address the reliability needs identified in the previous year's APO in a manner that aligns with the principles of certainty, transparency, competition, efficiency and implementability. The methodology begins with the APO and other planning studies as the starting point for determining future acquisitions. The APO describes the reliability needs of the system without providing suggestions as to how these needs will be met, by including two scenarios: a supply scenario where existing assets are re-acquired and a supply scenario where existing assets are not re-acquired. New to this year's AAR, the IESO conducts an assessment to measure the impact of previous planned actions using the probabilistic methodology utilised for the APO, whereas the 2021 AAR depicted a deterministic accounting of the unforced capacities. This step improves alignment between the two reports and is a better evaluation of the impact of individual resources on reliability by including factors such as location, technological capability, and energy/fuel limitations.

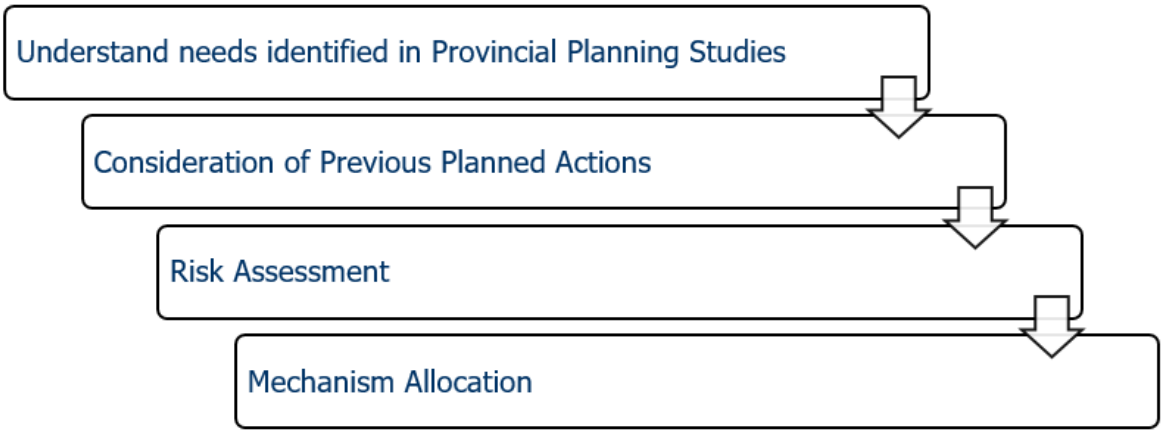


Figure 8 | Process to Allocate Mechanisms to Address Reliability Needs

Consideration of Previous Planned Actions

To determine planned actions, the IESO leverages the iterative nature of the APO and AAR to conduct an assessment of how previous decisions impact the needs. This assessment incorporates planned actions from previous years, government directives and outcomes from highly probable policy decisions. This provides the IESO the opportunity to leverage the outcomes of a procurement, or early indicators such as registration information, to determine resource-specific profiles and understand the synergistic effects of resources acquired/registered for an acquisition. Over time, the intent is that a cadenced approach to procurements will provide additional data that can be considered in the assessments, such as development times or the probability that each mechanism achieves the targets set out in the AAR.

In some cases, the needs identified in the APO may be fully alleviated by previous planned actions and no further action is required. In other cases, residual needs may remain. This analysis ensures that new planned actions will not duplicate efforts of previous planned actions.

Since the planned actions and government decisions from 2021 focused on capacity, the assessment for this report was used to confirm whether the capacity needs described in the 2021 APO have been satisfied, and if not, what residual needs remain. This assessment augments the APO by modifying the supply outlook presented in the 2021 APO and applying the Resource Adequacy and Energy Assessment Methodology. Further details are provided in Appendix 1 and the modifications to the supply outlook are as follows:

- The upper limit of the capacity auction forward guidance targets stipulated in the 2021 AAR was assumed to be met, for the five-year forward period of 2023 to 2027.
- The Medium-Term I RFP target of 475 MW was assumed to be met, with a common three-year core period of 2026 to 2029.
- The capacity from Brighton Beach GS and Lennox GS was assumed to be available up to April 30, 2029.
- The 500 MW of capacity under the Hydro Quebec Capacity Sharing Agreement was assumed to be available in summer 2026.

- Based on policy decisions, Calstock GS was considered to be available to March 31, 2027, the Oneida Energy Storage Project was assumed to be in-service in 2025, and OPG's SMR was assumed to be in-service as of January 2029.

Results of the assessments are summarized below, and illustrated in **Figure 9**.

- Capacity needs identified in the 2021 APO for the years up to and including 2024 are expected to be met through the planned actions identified in the 2021 AAR.
- A portion of capacity needs identified in the 2021 APO for 2025 and 2026 are expected to be met through the 2021 AAR planned actions, recent policy decisions, and use of options discussed in the 2021 AAR (e.g. outage management and the 500 MW import from the Hydro Quebec Capacity Sharing Agreement). Some additional actions are needed to address the totality of needs.
- Recognizing the potential for uncertainties to play out in the latter part of the decade, the 2021 AAR provided signals of potential planned actions, including the initiation of a long-term RFP of at least 1,000 MW, with a delivery period starting in 2027. The latest assessment confirms that actions to address needs in the long-term will require mechanisms that acquire capacity from existing resources and that substantially more capacity from new, incremental resources are required than described in the 2021 AAR.

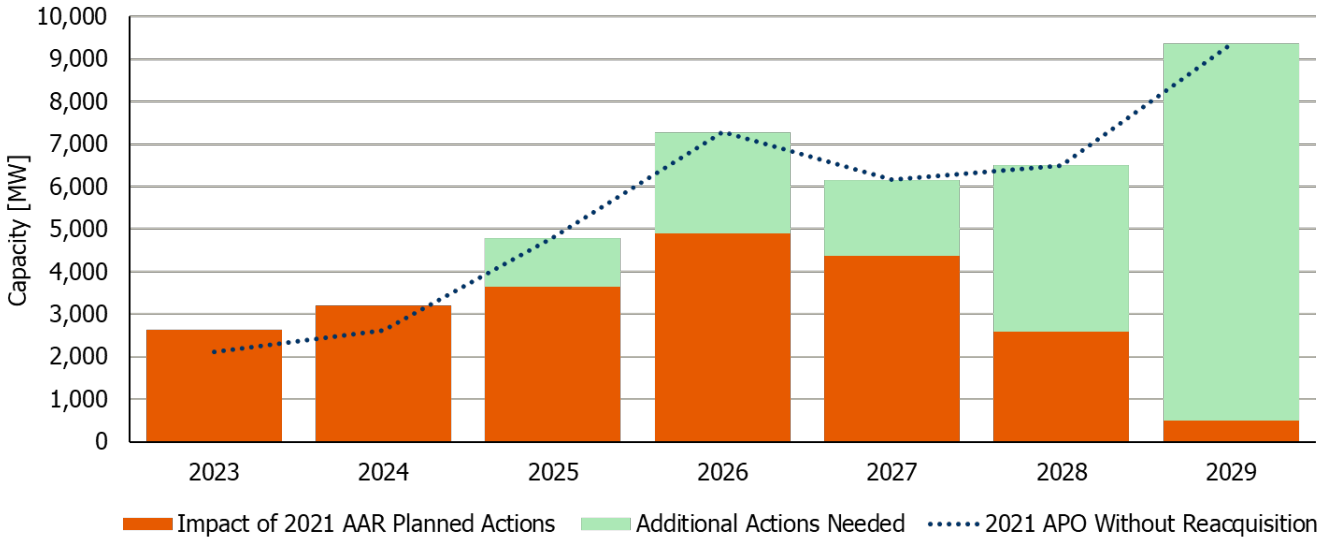


Figure 9 | Impact of 2021 Planned Actions on Resource Adequacy Needs

Risk Assessment

To develop prudent planned actions, the IESO takes into consideration the potential impacts of various uncertainties should they materialize. The risk assessment is used as an aid to ensure that reliability needs are addressed in a timely manner, while also balancing factors that could drive oversupply or inefficient outcomes.

Demand Side Uncertainties

The 2021 APO identified a wide range of uncertainties that could impact the demand forecast. While energy consumption is forecasted to increase in the future, there are many factors that could affect projected demand. The pace of economic recovery, demographic changes, changes in government policy, future energy management initiatives and increasing electrification could significantly change provincial demand profiles. With an emerging transformation of the economy driven by climate change, decarbonization and electrification, as well as potential economic development and policy stimulus, a high level of uncertainty is present in the 2021 APO demand forecast. The IESO manages this uncertainty by considering scenarios and by updating forecasts annually to account for the best available information.

Demand side uncertainties can act in two directions; on the one hand, a slower exodus from the current COVID-19 pandemic and/or supply chain uncertainties can cause delays in most demand drivers identified in the 2021 APO. While the 2021 APO's reference demand forecast shows the potential for year-over-year increases, the IESO evaluates its reference demand forecast annually to adapt to changing conditions and information on the exact timing of when increases might occur. On the other hand, recognizing that high demand creates complexities in planning for a reliable system, the 2021 APO includes a high demand forecast for the purpose of understanding the drivers that could stress Ontario's ability to serve load, that are discussed in the sections below. The high demand scenario in the 2021 APO was developed to reflect the impact of certain possible, yet highly uncertain elements, including accelerated uptake of electric vehicles, electrification of space and water heating, and a number of large industrial electrification projects.

Many of the drivers of higher demand impact not only the requirements of the system at peak, but also total energy requirements and demand patterns. A right-sizing of the system in a manner that minimizes ratepayer costs imposes new challenges. For example, planned actions must be able to adapt to changing requirements either as they emerge, or as they become more probable. Further, significant policy decisions impacting technology choice and consequently, demand forecasts, are anticipated over the next decade as Ontario and other parts of the world embark on deeper decarbonization approaches. As the impacts of these decisions will acutely impact the accuracy of today's demand forecasts, and recognizing the tendency of utilities to over-forecast demand as a means of reducing reliability risks, the IESO's Resource Adequacy Framework allows a range of commitment term lengths such that the sector and the IESO can adapt to changing conditions.

Energy Management

Existing energy and demand-side management programs such as the Industrial Conservation Initiative (ICI) and Save on Energy Programs help to lower capacity and energy needs. The IESO's most recent forecasts assume that the ICI program can provide 1,300 MW of demand reduction for the top five system peak days, and 650 MW of demand reduction for the second top five system peak days.[10] In the 2021 APO's high demand scenario, which assumes incremental demand growth in

[10]The forecasted hourly levels of ICI response included in the demand forecast are based on observed actual ICI participant response on system demand in the latest Base Period, and have been grouped into two categories: 1) the top five system peak days; and 2) the second top five system peak days. More details are provided in the Annual Planning Outlook: Demand Forecast Methodology.

the industrial sector, the response on a top five system peak hour grows to 1,800 MW by 2030 for the top five system peak days, and 900 MW for the second top five system peak days.

Similarly, the IESO assumed 2.7 TWh and 440 MW of cumulative annual energy and demand savings from the current 2021-2024 Conservation and Demand Management (CDM) Framework, with this level of annual savings expected to persist beyond the current framework, as reflected in the 2021 APO. Furthermore, the joint IESO and Ontario Energy Board 2019 Conservation Achievable Potential Study (APS) found that energy efficiency has more potential peak demand and energy savings in the near and longer term. Leveraging the findings of the 2019 APS, the IESO's Decarbonization and Ontario's Electricity System report, released on October 7, 2021, modelled an additional 1,600 MW of energy savings from energy efficiency as an important component for the future electricity system. In addition to addressing system needs over the next decade, energy efficiency can help to play a role in the implementation of any future decarbonization policies.

In accordance with the September 30, 2020 Ministerial Directive, the IESO will begin the 2021-2024 CDM Framework Mid-Term Review in 2022 and report the findings to the Ministry of Energy by December 31, 2022. The Mid-Term Review will provide an opportunity to evaluate the latest achievable potential opportunities, as well as to consider opportunities to change targets compared to those identified in the 2019 APS. These findings may inform changes to the programs and targets to address upcoming system needs, with any changes to targets expected to be reflected in future APOs and factored into the analysis for future AARs.

Supply Side Uncertainties

Potential Government Policy Decisions

Ontario's supply mix continues to be informed by, and adapt to, government policy. The IESO was asked by the Ministry of Energy to pursue discussions on the following projects, which could impact the supply of energy and capacity. Should the IESO receive government direction in relation to these projects, it is anticipated that they would be reflected in future planning outlooks and AARs. Where the IESO received a government directive to extend or enter into negotiations for a project, as in the case of Calstock GS and Oneida Energy Storage Project, these resources were incorporated into the assessment of needs described above.

- **Re-Contracting Biomass Generation Facilities**: The IESO has entered into a short-term extension (ending December 31, 2022) for the power purchase agreement for the 5 MW nameplate Chapleau Generating Station. The November 10, 2021 letter from the Ministry of Energy requested that the IESO report back by July 2022 on potential options for re-contracting this facility. In addition, the IESO was requested to engage sequentially with other biomass facilities based on the following contract expiry dates:
    - Thunder Bay Condensing Turbine Project – expires March 20, 2023
    - Hornepayne Power Inc. – expires Feb 14, 2024
    - Atikokan Generating Station – expires July 23, 2024

The IESO will continue to engage with these suppliers as the government considers policy decisions for these facilities. In total, these Northern Ontario facilities represent 285 MW (nameplate capacity).

- **Unsolicited Proposals**: Through the Ministry of Energy's Unsolicited Project Proposals framework, the Minister asked the IESO for the following assessments:
    - **Lake Erie Connector**: A proposed 1,000 MW high voltage bi-directional underwater transmission line that would provide the first direct link between Ontario and the PJM Interconnection.[11] Under the framework, the IESO provided the Ministry of Energy with the Gate 3 assessment report in December 2021. On January 26, 2022, the Ministry of Energy asked the IESO to provide an update by March 22, 2022 on the status of discussions with PJM on a Joint Operating Agreement and a draft transmission agreement. If completed, the Lake Erie Connector will expand Ontario's intertie capability, which could facilitate greater competition in the energy markets and capacity acquisition mechanisms.
    - **Pumped Storage Projects**: The Ministry of Energy asked the IESO to move the Marmora, Meaford and Schreiber Pumped Storage projects to the second stage of assessment (Gate 2), and acknowledged that the projects may be moved beyond the Gate 2 phase if the proponents are able to make significant improvements to the ratepayer value of their projects, including through improved financing. The IESO has been asked to report back to the Ministry of Energy on the Gate 2 analysis of the three projects by January 31, 2023.
- **Opportunities for New Hydroelectric Development**: On January 20, 2022 the Ministry of Energy asked OPG to provide a preliminary industry update on opportunities for new hydroelectric development in Northern Ontario by April 1, 2022. Part of this work includes updating previous evaluations of hydroelectric potential in Northern Ontario, and working with the IESO to assess the role new hydroelectric generation could play in servicing supply needs that are expected to emerge in response to Ontario's electrification efforts.
- **Opportunities for Existing Hydroelectric Facilities**: As part of the January 27, 2022 directive, the Ministry of Energy also directed the IESO to conduct an assessment of a program for existing hydroelectric facilities with an installed capacity greater than 10 MW and with an existing IESO or Ontario Electricity Financial Corporation (OEFC) contract expiring before December 31, 2030. The IESO is required to report back to the government by October 1, 2022 with analysis that considers a number of elements, including the ratepayer value of contracting larger hydroelectric facilities, either through a program or bilaterally, compared to other competitive mechanisms.

The Ministry of Energy also issued a directive to the IESO to design a program to provide new contracts to existing small hydroelectric facilities whose installed capacity is equal to or below 10 MW, and whose existing contract with the IESO or the OEFC has expired or will expire on or before December 31, 2030. The IESO is required to report back to the Ministry of Energy by July 1, 2022.

Availability of Nuclear Resources

While resources of all technology types have inherent uncertainties regarding availability, Ontario's large nuclear fleet has some unique considerations that could have a notable impact on Ontario's reliability outlook. The assessments in this report and in the 2021 APO make the following assumptions on the availability of nuclear resources:

[11] The PJM Interconnection coordinates the movement of electricity through all or parts of 13 states and the District of Columbia.

- **CNSC Approval for Pickering Extension**: As reported in the 2020 and 2021 APOs, the IESO's assessments assume that Pickering NGS will end operation in 2024 and 2025. To enable operations, OPG has submitted a letter to inform the Canadian Nuclear Safety Commission (CNSC) of their intent to pursue approval for extended operation of Pickering NGS into 2025. The assessments of nuclear risk in the 2021 APO and this AAR assume that the CNSC will approve this plan. Further details are available here.
- **Refurbishment Risk**: The nuclear refurbishment program, currently underway, has multiple nuclear units scheduled to be out of service for years at a time. Given the size of each unit, there is a significant risk to resource adequacy if the return of units is delayed. To account for these risks, the APO incorporates a Nuclear Refurbishment Reserve as part of the needs assessment, with this same amount of reserve incorporated in the assessments for this AAR. Further details are available in the 2021 APO Supply, Adequacy and Energy Outlook Module.
- **CNSC Orders**: On July 26, 2021, the CNSC issued an order to Bruce Power and OPG requiring that authorization be obtained from the Commission prior to the re-start of a number of nuclear units following any outage resulting in the cool down of the heat transport system. Assessments of nuclear risk in the 2021 APO and this AAR assumed that the order would not pose delays to refurbishment activities. Further details on the order are available here.

Aging Infrastructure

Ontario's existing resources consist of facilities of varying age, ranging from hydroelectric generation that has operated for a century to renewable generation that came into service in the past year. As facilities age, investments in the facility may increase in order to maintain the same level of reliability that existed before. As a result, aging infrastructure of supply assets can create upwards pressure on resource adequacy requirements in the future by increasing the frequency and duration of planned outages, result in higher forced outage rates in the absence of investments, or result in the asset exiting from the market.

Availability of Non-Firm Imports

In spring 2021, the IESO concluded the Reliability Standards Review engagement. As a result, the IESO now incorporates non-firm imports into assessments of resource adequacy.[12] In the 2021 APO and this AAR, non-firm imports of 251 MW for summer and 243 MW for winter were assumed to be available for all study years.

The amount of non-firm imports that the IESO expects to consider in future assessments is dependent on whether:

- Excess capacity is available in neighbouring areas (determined through planning studies);
- Excess supply is available in neighbouring areas in real-time;

[12] Non-firm imports are energy-only intertie transactions that may be curtailed in real-time by a neighbouring area experiencing shortage conditions. The IESO's resource adequacy assessments include an amount of non-firm imports that are anticipated to be relied upon in real-time.

- Sufficient intertie capability exists, including sufficient transmission in neighbouring systems to deliver energy to the point of interconnection with Ontario;
- Imports are likely to flow under tight supply conditions and higher prices;
- Imports are able to be delivered to, and within, Ontario's transmission system; and
- There is ability to manage non-discretionary outages on the interties and within Ontario.

The availability of non-firm imports can impact Ontario's adequacy in the future. For example, the Lake Erie Connector, if completed, would expand Ontario's intertie capability and potentially increase the amount of non-firm imports that can be relied upon for resource adequacy. Conversely, changes in supply outlooks in other jurisdictions can reduce the IESO's reliance on non-firm imports. For example, as reported in the 2021 NERC Long-Term Reliability Assessment, Midcontinent Independent System Operator (MISO) has reported potential reserve margin shortfalls as early as 2025. The next capacity auction will enable participation from generator-backed imports. The IESO will continue to monitor the capacity auction to determine whether adjustments to the estimate of non-firm imports are required, should a significant volume of imports clear the capacity auction or otherwise be made firm, consuming intertie capability and reducing the likelihood of non-firm imports arising in the real-time energy markets.

Reliance on Firm Imports

The IESO's acquisition activities allow participation of imports from neighbouring jurisdictions. However, decarbonization efforts in other jurisdictions and general trends towards carrying lower planning reserves may reduce the magnitude of firm imports available to compete in Ontario procurements. Firm imports are intended to be as reliable as domestic resources and qualification for firm imports takes into consideration tests of deliverability within the neighbouring jurisdiction and within Ontario, as well as the amount of energy that can be scheduled on the interties. The IESO's participation in NPCC and NERC working groups provides regular opportunities to review the ability of neighbouring jurisdictions to support acquisition targets set in the AAR.

Emerging Technologies

Many emerging technologies have the potential to play a role in future IESO acquisitions. The IESO's Enabling Resources Program is intended to facilitate the entry of these technologies into the IESO's energy and ancillary services markets and capacity acquisition mechanisms. As with all new technologies, it is difficult for forecasts of reliability to simulate and quantify their operational behavior. In the absence of operational experience, the IESO uses generalized assumptions to forecast expected capability. As these resources begin to operate in the IESO's market, the ability to more accurately assess their contribution to reliability is anticipated to improve.

Project Development and Financing

An implicit assumption in the AAR is that the combination of revenue sources available in the IESO-administered markets and through the acquisition mechanisms can provide sufficient revenue adequacy to investors, and that they incent enough participation to achieve the mechanism targets. In turn, new projects are expected to have sufficient financing to complete proposals on time. Project financing is subject to numerous uncertainties and risks, including uncertainty about how energy

market prices will change following implementation of the Market Renewal Program (MRP). Some of these uncertainties, if they materialize, can result in project delays or termination. To mitigate the impact on reliability of project delays or termination, the IESO's procurements may also include incentives for early deployment. In addition, the short forward period in the capacity auction allows the IESO to adjust targets in the event that project development risks materialize.

Mechanism Allocation and Target Setting

For each year in which a reliability need has been identified, the IESO conducts an implementability screen to determine which mechanisms from the Resource Adequacy Framework have a high probability of delivering on the needs. The screening takes into consideration: (1) whether there is sufficient time to run a competitive procurement in which there is a high degree of confidence that the desired outcome will be achieved, and (2) available market intelligence that indicates whether a sufficient pool of potential resources or projects exists to support competition. To allocate target capacities between the mechanisms that are chosen to meet reliability needs, the IESO considers the availability of existing resources to satisfy the need.

Medium-term commitments, such as medium-term RFPs or enhanced capacity auctions are designed to be a predictable, recurring process that allows existing resources that are no longer under contract to compete for new three- to five-year terms. The length of the forward period for medium-term commitments provides time for any necessary planning to take place for existing facilities, allows investments to be spread over multiple years, and provides more operational certainty. Over the past year, the IESO has worked with sector participants to develop an approach for medium-term RFPs whereby they can compete for five-year flexible terms. Going forward, the IESO intends to continue working with sector participants and communities to develop opportunities for an enhanced capacity auction with a term length of three years, to increase certainty in the availability of resources.

The annual **capacity auction** offers a competitive opportunity to help meet near-term resource adequacy needs.

When the reliability need exceeds the capability of the existing resource fleet, it creates a requirement for new-build facilities to satisfy the need. As these types of investments typically require longer forward periods to support project design and development, along with longer commitment terms to better amortize the costs of the facility, the IESO leverages **long-term commitments** to address the incremental reliability needs**.** Long-term RFPs are a well-established process to solicit proposals for new-build projects, with design parameters that are influenced by system needs, including resource adequacy, transmission security or operability needs that contribute to the reliability and resiliency of the power system. The design of contracts should aim to complement the existing and/or renewed energy market, while addressing known shortfalls such as revenue sufficiency, to account for new capacity costs.

In the event that the competitive mechanisms described above cannot be implemented, either due to urgency of need or specific requirements that greatly reduce the pool of competition, the IESO examines opportunities such as leveraging existing assets, potential import opportunities, or other means to best satisfy the needs for the time frame under consideration. When proposing a non-competitive or **bilateral solution**, the AAR helps to provide a signal to the marketplace that there is a need to be met, by clearly and transparently articulating the need and recognizing that a

competitive process could be used in the future to meet the need if sufficient resources are available to support competition.

Since Ontario's electricity fleet is comprised of many resources of varying ages and types, the acquisition mechanisms provide opportunities to secure services from existing assets and drive investment in new assets. The targets factor in both the reliability needs identified in the APO and allowances for decisions by existing asset owners on whether to continue operations, and development timelines for new assets. Through the annual planning cycle, the IESO will be able to conduct reliability assessments that consider the impact of resource-specific factors like location, technological capability, and energy/fuel limitations on reliability. All resource types have their own risk profiles that prevent any resource from providing the "perfect capacity" used for determining adequacy needs in the APO. A number of factors may prevent projects acquired by the IESO from completing development activities on time (or at all). Therefore, it is prudent to create procurement targets that in totality might exceed the reliability needs previously specified in order to cover this risk. In doing so, the IESO aims to develop a resilient supply mix that can not only adapt to unforeseen system events, but also has enough total capacity to support regular maintenance and other outages.

Planned Actions

The IESO is proposing the following set of planned actions:

- To address needs prior to 2027, the IESO will leverage short, medium and long-term commitments. The annual capacity auction will continue to grow by increasing its target capacity and through a number of enhancements to increase participation. The first medium-term RFP will acquire capacity from existing resources. To acquire additional capacity from other resources, the IESO intends to work with sector participants and Indigenous communities to develop other competitive procurements, such as an enhanced multi-year auction and an expedited competitive process for delivery by 2025.

- To address needs in the latter half of this decade and the early 2030s, the IESO intends to leverage a series of long-term RFPs to acquire incremental capacity, complemented by medium-term RFPs to acquire capacity from existing resources. These competitive processes may provide opportunities for expansions or upgrades for existing resources. The annual capacity auction will round out these mechanisms, as a balancing instrument that adjusts to year-to-year changes in needs.

The planned actions described in this section consider actions to address needs prior to 2027, and actions to address needs in 2027 and beyond. While the 2021 APO provides a 20-year outlook of reliability needs, the AAR considers planned actions to address only the first 10 years of the APO outlook period, recognizing that uncertainties increase over the longer term. With that in mind, some of the actions proposed in this AAR will result in commitments that extend beyond the 10-year look ahead period. The targets set out by the planned actions in this section are set in megawatts, with the expectation that resources are qualified on a UCAP basis. The qualification process is intended to approximate the effective capacity stipulated by the APO.

Addressing Needs Prior to 2027

In advance of 2027, emerging resource adequacy needs have been identified. The IESO will address these needs using many of the options contemplated in the Resource Adequacy Framework. Specifically, the IESO plans to:

- Employ the Medium-Term I RFP to acquire capacity from existing resources following the expiry of their current contracts. The IESO is introducing a bridging mechanism to allow for seamless transition from existing contracts into the medium-term RFP or capacity auction;
- Include an early operation incentive under the Long-Term I RFP to incent resources able to meet in-service dates in 2025 or 2026;
- Exercise the existing Hydro Quebec Capacity Sharing Agreement in 2026; and
- Acquire incremental capacity by growing the annual capacity auction.

To help address capacity needs identified prior to 2027, the IESO is exploring supplemental mechanisms to work alongside existing acquisition mechanisms. Informed by feedback from sector participants and communities throughout 2021 and 2022, as well as a questionnaire in early 2022,

additional options under consideration include (1) an enhanced capacity auction, (2) an expedited process for same-technology expansions at existing facilities and (3) an expedited procurement for new-build facilities able to enter service in 2025. The IESO will work with sector participants and communities on these proposed solutions.

Enhanced Capacity Auction

The option of an additional capacity auction in 2023 would secure capacity for a three-year period from 2024 to 2026. This auction could attract and commit incremental and existing resources including, but not limited to, imports. The IESO would continue to execute annual capacity auctions for the years of 2024 to 2026, that would acquire further incremental capacity based on the latest forecasts.

Same Technology Expansions

The IESO anticipates that some existing facilities may be interested in adding incremental new-build projects at the location of their existing facility. While this may be capital intensive and in many respects aligns with a long-term commitment, projects of this nature have the opportunity to leverage an existing site location, electrical connection point, supporting infrastructure, and experience with IESO Market Rule requirements. This sub-category of potential projects offers unique opportunities that will likely require significant engagement with the sector to ensure incentives can be properly aligned. Through engagement with sector participants and communities, the IESO aims to understand the level of interest from the sector in bringing forward new projects that would be able to deliver for 2025 with the intent to develop a separate process to acquire incremental capacity from existing facilities. This process would value capacity as its primary service, and target resources that are able to expand or uprate. It is also expected that this effort will inform opportunities to streamline procurement processes for existing facilities with expansion capability, while also considering the role that approving ministries and authorities have in ensuring that high quality projects are developed and can participate in the IESO's procurements.

Expedited Procurement

An expedited procurement for new-build resources in addition to the first Long-Term I RFP, could provide a viable option for resources, with the expectation that they enter service as early as 2025. The IESO will work with stakeholders to explore whether this these new resources would be deployed on greenfield sites or co-located at existing facilities.

In addition to the above planned actions, needs may also be reduced by nuclear operators adjusting outage schedules occurring during the 2025 to 2026 period, along with additional energy efficiency. Government policy decisions, such as the potential to re-contract biomass facilities reaching the end of their contract terms or potential contracts related to unsolicited proposals, can also help contribute to meeting the overall system reliability need during this time period.

Growing the Annual Capacity Auction

The IESO's annual capacity auction continues to demonstrate the capability of the marketplace to supply capacity, using a mechanism with a short forward period and two six-month obligation periods. As system needs continue to grow, the capacity auction will increasingly be relied upon to address needs during the transitional period, until other mechanisms begin their delivery periods. In addition, the auction will serve as one of the main mechanisms to meet needs prior to 2027. Once

the other mechanisms have been executed, the capacity auction is expected to continue to serve primarily as a balancing mechanism, adapting on a season-to-season or year-to-year basis to changes in reliability needs that may be driven by planned outages, greater than expected demand growth, or reductions in supply availability.

Similar to the 2021 AAR, the IESO is providing three levels of forward guidance for the capacity auction, each informed by the level of certainty about needs going forward and the importance of maintaining stability in the capacity auction. The first component is setting the capacity auction target for the upcoming auction. The second component is the prescription of a minimum target threshold for the capacity auction two years out, and the third component is to provide guidance on the range of potential target capacities for future capacity auctions further out.

The IESO continues to work with sector participants to enhance the auction mechanism for the next capacity auction and to enable more resources to participate. In addition, the IESO will continue to explore further enhancements beyond the next auction to continually support more competition and ensured cost-effectiveness.

Target Capacity for Upcoming Capacity Auction

The following section sets out actions to be taken for the next capacity auction for a commitment period beginning May 1, 2023. Over the past year, the IESO has worked with sector participants to evolve the capacity auction, and the targets described in this section reflect the expectation that future capacity auctions will qualify capacity on a UCAP basis.

The 2021 APO[13] identified a small capacity surplus of approximately 200 MW in summer 2023, which continues to decrease in 2024 and inverts to a significant capacity deficit beginning in 2025, primarily driven by the retirement of Pickering NGS and nuclear refurbishments. Consistent with the summer forward guidance provided in the 2021 AAR, the next capacity auction will have a target of 1,200 MW for the summer 2023 obligation period, while the target capacity for the winter 2023-2024 obligation period will increase to 750 MW. The assessment of the 2021 AAR's planned actions, described previously in this report, includes the expectation that the entire 1,200 MW target for the summer period would be achieved, suggesting that the small surplus in summer 2023 is dependent on the results of the next capacity auction. Increasing participation and competition in the capacity auction is intended to provide a flexible capacity acquisition mechanism capable of meeting Ontario's growing capacity needs. Consideration has been given to growing our winter capacity targets to enable increased participation from resources requiring year-round revenue. This has been reflected in the forward guidance and auction targets for years leading up to 2025/26. To support the increase in the target capacity, the IESO will continue to support competitive outcomes and learnings, by expanding the global import limit in the capacity auction to 500 MW in the 2022 auction.

[13] The 2021 APO assumed that the quantity of resources acquired in the December 2020 capacity auction for summer 2021 delivery continues for the duration of the APO period.

In determining the target capacity, the IESO considered the following principles:

- **Competition/Liquidity**: The enrolled capacity14 in the 2021 auction, for both the summer and winter obligation periods, exceeded 1,800 MW. The capacity auction has continued to play an effective role in attracting an expanded resource pool with competitive and cost-effective results to ratepayers. The next capacity auction intends to broaden participation to new resource types such as generator-backed imports, increasing the pool of competition and the ability to meet the higher target capacity.
- **Implementability**: The increase in target capacity is aligned with the forward guidance projections outlined in the 2021 AAR, and is a modest increase from the December 2021 capacity auction targets. The ability of suppliers to meet or exceed targets15 was demonstrated through the December 2021 capacity auction, with the amount of capacity that cleared being higher than both the summer and winter targets.

Forward Guidance for Future Capacity Auctions

Building off of the introduction of forward guidance in the 2021 AAR, the IESO has extended the capacity auction forward guidance to 2027. The IESO intends to continue to set the target capacity for each obligation period at a quantity no less than 500 MW. Minimum target capacity helps ensure predictability, which provides a stable marketplace for capacity suppliers, building confidence and leading to lower costs. The minimum target capacity also provides assurance to the IESO that resources will be available to maintain reliability.

Looking ahead, the capacity auction forward guidance illustrated in **Figure 10** shows the expected continued growth of both the summer and winter target capacities. The continued growth is reflective of the emerging summer and winter capacity needs beginning in 2025, and the use of the capacity auction as a tool to address these needs. To cushion the market from large year-to-year step changes, gradual increases in the summer and winter target capacities are expected. After mid-decade, the IESO anticipates minimal growth from the capacity auction, at which point the auction is expected to behave primarily as a balancing mechanism whose targets fluctuate year-to-year. A gradual decline to the winter 2027 target is indicative of the slight decrease in forecasted winter needs, as well as the expectation that projects from Long-Term I RFP will reach commercial operation.

[14] Enrolled capacity is the maximum capacity auction offer a resource is willing to provide into an auction and is determined by individual capacity auction participants.
[15] The downward sloping demand curve can result in the capacity auction securing more capacity than its target, when cost-effective.

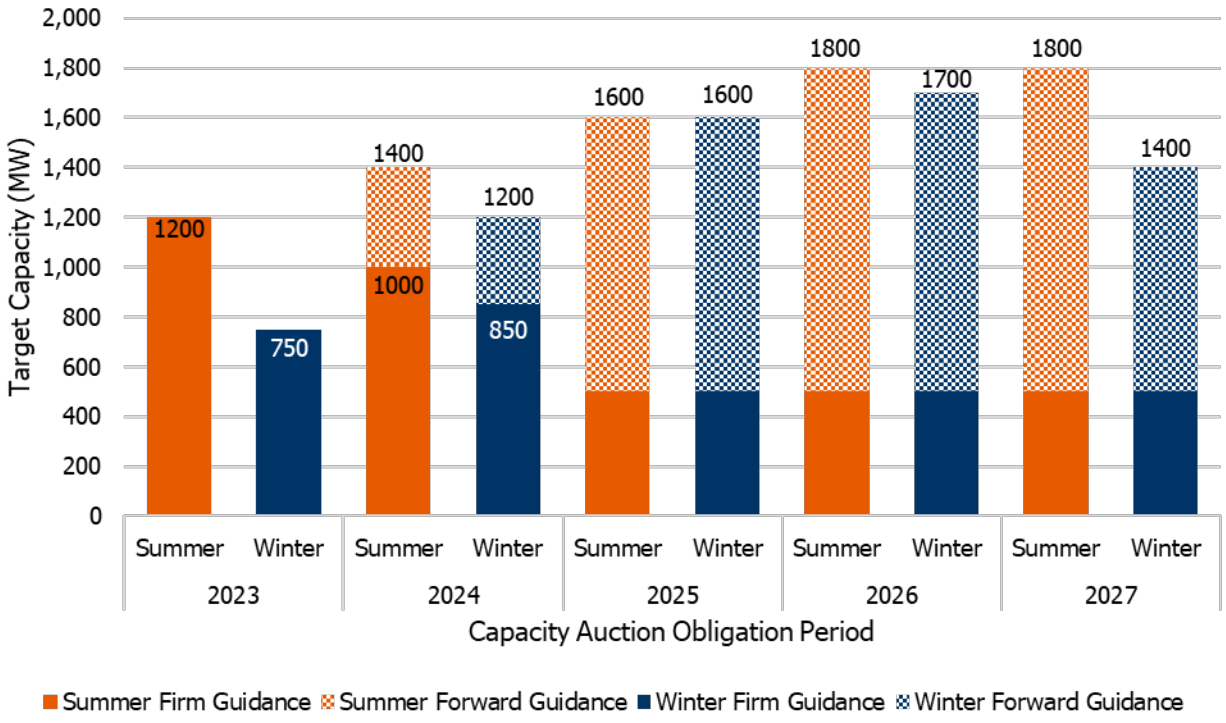


Figure 10 | Capacity Auction Forward Guidance

Enhancements to the Annual Capacity Auction

In order to achieve greater competition and improve the performance of participating resources, several enhancements to the existing capacity auction have been proposed and developed through discussions with sector participants throughout 2021. These enhancements include:

- Expanding participation to generator-backed imports to increase competition and drive cost-effective results;
- Introducing capacity qualification methodologies to derive the UCAP value of resources. These methodologies account for resource characteristics while providing transparency and fairness to assess how much a resource can reliably be expected to provide towards meeting capacity needs; and
- Modifying the performance assessment framework to enhance performance metrics for participating capacity resources while accounting for unique resource requirements, and to create alignment and integration between performance assessment and capacity qualification. The IESO will monitor the impact of this enhancement on participation in the capacity auction.

To ensure continued success of the capacity auction, the IESO is considering future enhancements beyond those that will be implemented for the next capacity auction. These enhancements will be driven by key objectives to expand participation and competition and ensure that the auction mechanism and framework continues to attract a reliable supply of capacity resources to meet system needs. The IESO will continue to engage with sector participants on future enhancements in a transparent manner.

Medium-Term Commitments

The IESO aims to facilitate a range of competition for medium-term RFPs, allowing participation from existing resources as well as opportunities for expansions and upgrades.

A significant number of generation resources are expected to reach the end of their contract terms between 2029 and 2032, representing a potential pool of competition exceeding 7,000 MW (on a UCAP basis) of existing resources, including those that may be contracted in Medium-Term I RFP. For resource adequacy, this amounts to securing known existing assets and their associated capacity and energy contributions, but does not contribute to satisfying incremental capacity or energy needs that are identified in the APO.

Participation in the medium-term RFP is anticipated to be expanded starting with Medium-Term II RFP, as more resources expire and by allowing participation from additional resource types compared to the first medium-term RFP. This is expected to increase competition and to more predictably facilitate market exit by aging facilities once they reach end-of-life and are no longer competitive for subsequent commitment terms.

The quantity of resources eligible to participate is expected to vary from cycle to cycle, until such time that existing legacy contracts pre-dating the Resource Adequacy Framework have expired. As a result, the target for the second medium-term RFP is dependent on the completion of the first long-term RFP. Given the number of contracts expiring, the IESO anticipates a larger target capacity for the second medium-term RFP, while leveraging learnings from Medium-Term I RFP and Long-Term I RFP. Figure 11 shows the nameplate capacity from resources whose contracts expire over the next decade. A large amount of capacity is expected to expire in 2029, making facilities with expiring contracts eligible to participate in subsequent medium-term RFPs. The majority of these facilities are transmission-connected facilities that will continue to play a vital role in ensuring Ontario's resource adequacy.

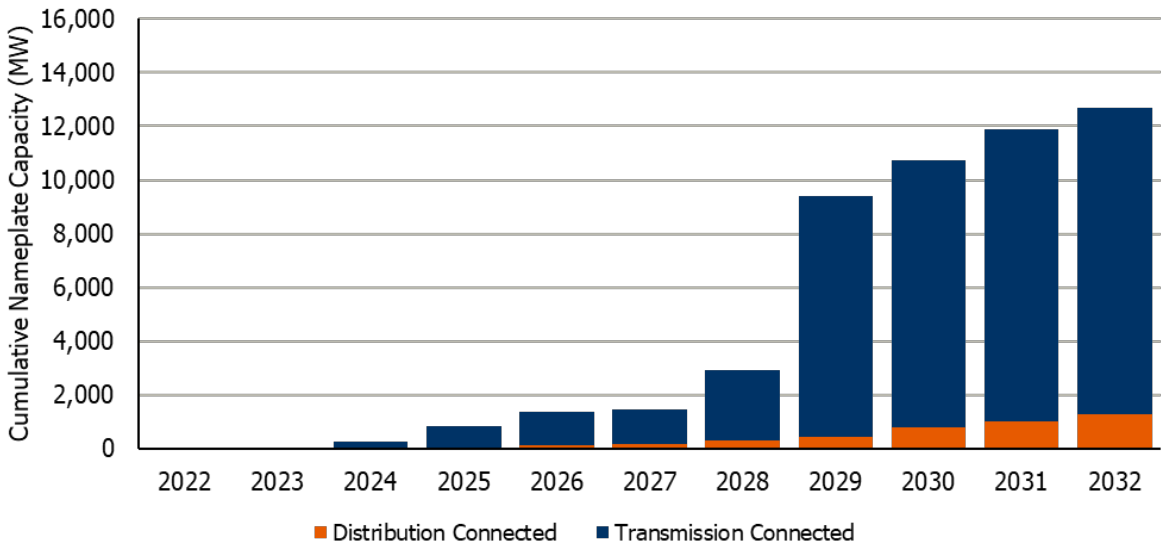


Figure 11 | Nameplate Capacity of Expiring Resources, by Connection Type

Long-Term Commitments

The purpose of the long-term RFP is to mitigate the resource adequacy risks that were identified in the 2021 APO and discussed in the Resource Adequacy Needs section of this report, where needs were demonstrated to occur for sustained duration across many hours of the day. To address these needs, the IESO intends to seek capacity from resources that are able to deliver energy continuously for at least four consecutive hours, and can be available during business days between 7:00 to 23:00 EST. Recognizing the importance of operability in ensuring power system reliability, resources that are (at minimum) able to be dispatched in the wholesale energy market would provide significant benefit. The long-term RFP targets are intended to address the majority of the needs identified in the APO Capacity Adequacy Outlook for the period 2027-2034, with continued availability of existing resources.

Size of the Need

The resource adequacy need (with continued availability of existing resources) indicated in the 2021 APO starts at 2,500 MW in 2027 and grows within four years to almost 3,900 MW in 2030, after which the need is sustained through the 2030s. This provides a strong signal that new, incremental resources will be vital to maintaining the reliability of the power system in the late 2020s and into the 2030s, with the long-term RFP as the primary mechanism to acquire new resources to address these needs.

A number of uncertainties could drive this need higher, such as the potential for increased demand growth to be higher than the amounts stated in the 2021 APO reference demand forecast, or retirement of older resources. This target also provides a small cushion for supply side uncertainties, such as exact timing of individual facilities reaching commercial operation or interactive effects of individual resources to contribute to resource adequacy needs.

Although there is the potential for demand to grow more slowly than forecast in the 2021 APO, the IESO expects long-term demand to grow.

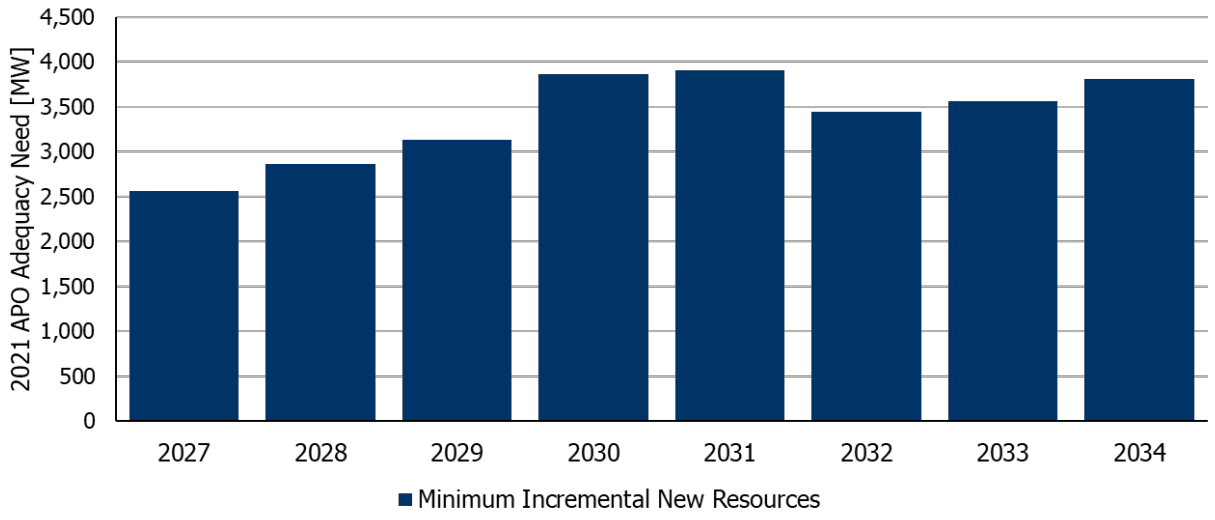


Figure 12 | Minimum Incremental New Resources Required (from 2021 APO)

Allocating the Target to Secure New-build Resources

With resource adequacy needs over the 2027 to 2034 period ranging from approximately 2,500 to 3,900 MW, a possible solution to address these needs is for Long-Term I RFP to acquire 2,500 MW of qualified capacity for delivery by 2027 (or earlier) and a subsequent target in Long-Term II RFP to acquire an anticipated 1,500 MW by 2030 (or earlier). The two long-term RFPs would total 4,000 MW of new incremental capacity by 2030, which is prudent, given the potential for uncertainties to materialize. These target capacities would be set recognizing that if various uncertainties were to materialize, the adequacy need for this period would likely increase. Targeting the upper end of the range of needs as opposed to the lower end would help to ensure that resource adequacy is maintained. In addition, a cumulative 4,000 MW target capacity is sufficiently high that it is anticipated to drive investment in new projects.

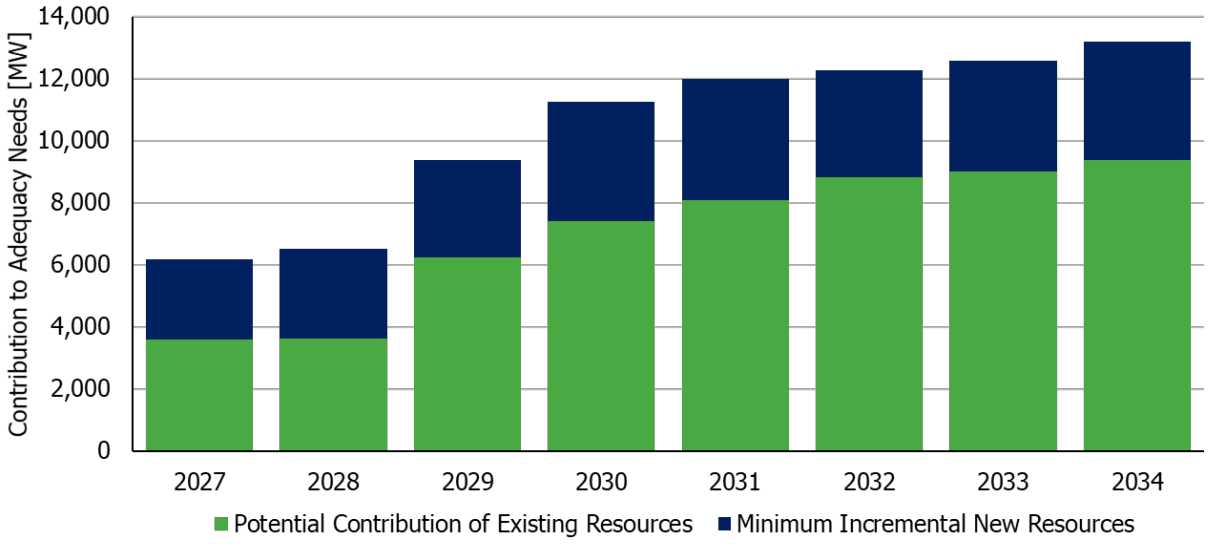


Figure 13 | Size of Need Between 2027 and 2034 (from 2021 APO)

From a resource adequacy perspective, incremental capacity can be provided by new-build facilities, or through uprates and expansions at existing facilities. The IESO will work with sector participants and communities to identify approaches for resources that are successful in the Medium-Term I RFP and wish to participate in the Long-Term I RFP by investing in upgrades or installing new energy storage resources.

Long-Term I RFP Design Considerations

To ensure high quality resources that can satisfy emerging reliability needs, the Long-Term I RFP should aim to acquire capacity from facilities that meet the following criteria:

- **Ability to Reach Commercial Operation by May 1, 2027**: Successful projects should be ready to deliver services for a core period beginning in 2027. Since the APO projects capacity needs enduring beyond 10 years, and to provide greater certainty to investors, it may be prudent to consider a term length exceeding 10 years. Due to the immediacy of resource adequacy needs and the importance of ensuring reliability, the RFP should take into consideration whether there is a high degree of confidence in the project being delivered in advance of when needs arise. This could be demonstrated by resources that have met all permitting, regulatory and engagement requirements prior to commercial operation.

With the need for new incremental capacity beginning as early as 2025, the IESO expects to engage sector participants and communities to explore the possibility of incenting early term starts for Long-Term I RFP, or allowing for additional term-length beyond the core period identified above.

- **Ability to Participate in the IESO-Administered Energy Market**: All resources should be able to participate in the IESO-Administered Market, be at least 1 MW in size, and meet the requirements stipulated in Chapter 4 of the Market Rules.
- **Ability to Inject Energy/Reduce Load for Continuous Period of Time**: As demonstrated in IESO's assessment of resource adequacy, periods of risk range in length from several hours to several days. Given these ranges, it is not practical nor cost-effective to require all facilities to be able to inject or reduce load for the same duration of time. By designing the RFP to consider technologies that can provide for various durations, a more diverse set of resources may be procured. The Long-Term I RFP should value resources that can provide continuous energy for extended periods of time, with consideration of the following three tranches:
  - Ability to deliver for a period greater than 16 hours;
  - Ability to deliver for a period between eight hours and 16 hours; and
  - Ability to deliver for a period between four hours and eight hours.
- **Location**: Capacity located in specific areas of the province where transmission security or resource adequacy needs have been identified, described in the Defining Locational Needs – Responding to Transmission Security Needs section of this report, should be valued in the procurement. In particular, capacity in West of London area and East of the FETT interface, including Ottawa, may provide the most value.
- **Deliverability**: Resources supplying capacity should be located such that they avoid areas with limited connection availability due to transmission and/or distribution system limitations. As part of the Long-Term I RFP process, resources should be screened for deliverability.
- **Ability to Improve Operability of the Grid**: Recognizing emerging needs for enhanced operability of the grid, the most operable resources are, at minimum, dispatchable. In addition, the procurement design should value those that have one or more of the following technical characteristics:
  - The ability to ramp up or down quickly;
  - The ability to register as a quick start facility as per the IESO's Market Rules;
  - The ability to provide a wide operating range16, especially resources with low minimum loading points; and
  - The ability or technical capability to provide one or more ancillary services.

[16] Operating range is a combination of the size and range of dispatchable operation of a resource.

Subsequent Long-Term RFPs

The 2021 APO anticipates that resource adequacy needs will grow in the early 2030s, with a range of reliability services (including capacity, energy, ramping, frequency response and regulation) that may be required as Ontario's electricity system transforms. The magnitude of these needs and the solutions to address them are impacted by refinements to demand forecasts, changing policy objectives and technological advances, which can create significant changes in long-term forecasts.

Recognizing that development of new electricity projects has been on pause for several years, and that for investors in Ontario this may mean that additional time is required to prepare for delivery, the IESO intends to launch subsequent long-term RFPs.

Subsequent long-term RFPs may be suitable for resource types that are not yet fully enabled in the IESO Administered Markets, or for projects that require longer development timelines. The target size and timing of future long-term RFPs, including the estimated 1500 MW target capacity for Long-Term II RFP, will be highly dependent on the ability of previous procurements to successfully acquire their target capacities, and the specific details of the resources acquired. In executing subsequent long-term commitments, the IESO anticipates the benefits listed below.

- **Longer lead times**: Some sector participants and communities have indicated that there are challenges to completing development of projects, in which case a longer lead time could serve to accommodate development activities.
- **Ability to respond to changes in needs, policy or resource mix**: Given the level of uncertainty with demand growth, system needs may change over time. For example, decarbonization efforts may not only increase electricity demand on peak, but can also change daily and seasonal demand shapes. Further, the types of facilities and their design may vary depending on policy choices. Leveraging subsequent long-term RFPs provide the ability to better adapt to these potential changes.
- **Opportunity for new technologies to participate**: The pace of technological change is increasing rapidly, with many technologies in the pilot stage. Examples include grid-forming technologies for inverter-based resources, SMRs, resources employing carbon capture or sequestration technologies, and hydrogen capabilities. As these technologies mature, subsequent long-term RFPs may be designed to allow the participation of these technologies.
- **Benefit from learnings from the previous RFPs**: Previous RFPs may provide learnings on procurement and contract design that can be applied to subsequent RFPs.
- **Leverage post market renewal energy prices**: Sector participants, communities and the IESO all acknowledge that there are uncertainties about energy market prices following the implementation of the market renewal program, which may be addressed for subsequent long-term RFPs.

Consideration of Government Policy in All Planned Actions

In September 2021, the IESO released its report 'Decarbonization and Ontario's Electricity System: Assessing the Impacts of Phasing Out Natural Gas Generation by 2030'. In response, on October 7, 2021, the Ministry of Energy asked the IESO to evaluate a moratorium on the procurement of new natural gas generating stations and develop an achievable pathway to decarbonization in the electricity sector and report back by November 2022. The findings of these studies will be available for consideration in future planning activities.

Recognizing that the results of these assessments may have significant impacts on future procurements, the IESO intends to leverage a series of long-term RFPs to allow the markets/procurements to respond accordingly. In addition, the framework will continue to have varied term lengths to allow the IESO and the sector to adapt to the latest information, policies and innovations as they arise and evolve.

Considerations to Enable Competition

There are additional opportunities to increase competition through the Enabling Resources Program (ERP), transmission infrastructure, the Market Renewal Program and if implemented, the Lake Erie Connector with PJM. In addition, the IESO is working to expand resource eligibility in the capacity auction.

Enabling Resources Program

The IESO's ERP facilitates the integration of emerging technologies into the post-Market Renewal electricity market, and ensures that resources acquired through the Resource Adequacy Framework mechanisms will be successfully integrated in market in time to meet forecasted system needs. In December 2021, the IESO presented the Enabling Resources Work Plan to sector participants and communities, to outline the sequencing, timing and scope of activities to be undertaken by the IESO to enable emerging resources to provide electricity system services in the renewed Ontario wholesale market. The work plan was designed to facilitate greater competition in future acquisitions and proactively provide resource owners and developers with the information necessary to identify opportunities for participation in these acquisitions. Informed by feedback received from sector participants and communities, the work plan outlined the IESO's priority enablement opportunity as enabling hybrid-storage resources and further enabling storage resources and Distributed Energy Resources (DER).

The Enabling Resources Program is complementary to the Resource Adequacy Framework, supporting achievement of its objective of attaining cost-effective reliability by increasing competition in the Resource Adequacy mechanisms and ensuring full value is realized from ratepayer investments in existing resources capable of providing required services.

Storage Enablement

The IESO's Energy Storage Design Project Long-Term Vision identified two operational enhancements for storage resources, including automatic approval of state of charge changes and supporting changes for storage in the IESO's Automatic Generation Control (AGC) tool.

The automatic approval of state of charge changes project will allow storage resources to revise their capability due to state of charge limitations within the mandatory window, without requiring manual approval by the IESO. In addition, the project will enable dispatchable loads to communicate outages to the IESO using the Control Room Operations Window (CROW) tool. Both initiatives are anticipated to be implemented in 2025 following completion of the Market Renewal Program, and are expected to enhance participation of resources in the energy market.

The supporting changes for storage in the AGC tool project will enable storage resources to provide regulation service using the same mechanism as other resources, however, additional work will be required to complete this enablement. While the IESO has taken steps to enable storage resources to provide regulation service as a foundational step towards enabling competition in the future, the IESO's recent regulation needs assessment determined that there is no additional need for regulation service. As such, the IESO has deferred implementation of the supporting changes for storage in the AGC tool project until 2027, to allow other projects that will support meeting more urgent capacity needs to proceed.

Existing storage resources are eligible to participate in the IESO's capacity auction and Medium-Term I RFP, and new storage resources are anticipated to be eligible to participate in the Long-Term I RFP as standalone facilities or as part of a hybrid resource.

Hybrid Enablement

Under the Hybrid Integration Project, the IESO worked with sector participants and communities to develop two foundational models for hybrid resources to enable robust competition in time to facilitate participation in the long-term RFP. These models are based on existing IESO resource types, and are the co-located hybrid model and the integrated hybrid model.

The co-located hybrid model is the combination of two independent facilities operating from the same connection point, as a method of adding incremental capacity and flexibility value to existing generation resources. Under the co-located hybrid model, each hybrid facility would be registered with the IESO as three separate resources - a dispatchable generator and an energy storage resource under the interim storage design, which models a storage facility as two resources (a dispatchable load and a dispatchable generator) at the same site.

The integrated hybrid model provides the opportunity for participants to manage optimization of the resource's capabilities and output, while providing fast and predictable output to the system, helping to address energy, flexibility and capacity needs. Under the integrated hybrid model, each hybrid facility would be registered as two separate resources – a quick-start, dispatchable generator (representing the combination of a generator resource registered with a storage resource), and a dispatchable load resource used to allow charging from the grid.

The IESO has proposed that the two hybrid foundational models apply to procurements in the following manner:

- Co-located hybrid: This foundational model may be preferred for existing resources with active contracts during the long-term RFP commitment period that are eligible to participate as hybrids. This type of participation would allow contracting with a new storage resource through the long-term RFP, while maintaining the existing resource's active contract.
- Integrated hybrid: This foundational model may be preferred for existing off-contract resources and new-build resources that are eligible to participate in the long-term RFP. This type of participation would allow for a single contract for the entire hybrid resource.

As the IESO continues to engage with sector participants and Indigenous communities to develop the design elements for the long-term RFQ and RFP, input from the Hybrid Integration Project will help to inform the procurement criteria and contracting requirements. The draft design model for the Hybrid Integration Project was presented to sector participants in Q1 2022 to provide potential long-term RFP proponents with information prior to the procurement's final RFQ and qualification submission period.

Distributed Energy Resource Enablement

DERs that are 1 MW or greater in size are currently eligible to participate in the IESO-administered markets, by registering under their applicable resource participation model. In addition, dispatchable DERs using existing participation models, or DERs participating as hourly demand response resources, are eligible to participate in the IESO's capacity auction.

A limited quantity of existing DERs that are not currently enabled in the market are expected to be off-contract for the start of the first medium-term RFP and long-term RFP commitment periods. Under the Enabling Resources Program, the IESO is working to further enable DER participation by establishing new or enhanced participation models that are suitable for these smaller resources. The IESO's DER integration activities will also be informed by projects supported through the Grid Innovation Fund. DERs that participate in the IESO's acquisitions using the existing or planned new participation models will be required to meet the technical requirements specified by each mechanism.

Transmission Infrastructure

Transmission infrastructure brings power from sources of supply to where it is needed in the province. The IESO is responsible for ensuring sufficient transmission infrastructure is planned to address forecasted electricity growth. Based on the bulk and regional planning processes, the IESO makes transmission recommendations to be implemented by transmitters, which are responsible for seeking approvals, such as leave to construct from the Ontario Energy Board.

The IESO's bulk and regional planning processes ensure that both local and province-wide system needs are addressed, creating a more reliable, robust and cost-effective power system. Transmission system solutions identified through the bulk planning process enable the reliable transportation of power across the province, increasing competition by relieving congestion and allowing more economic resources to be dispatched to meet load, and allowing new customers to connect by ensuring that the system can deliver the power required.

To cost-effectively address power system reliability needs, the IESO conducts analyses on a range of alternatives, and ensures that sector participants, municipalities and Indigenous communities are engaged through the process. The analysis includes performing economic and market efficiency assessments to compare alternatives, such as implementing transmission or supply solutions to address system issues, and recognizing that while transmission solutions allow for more efficient electricity delivery, longer development times are required compared to supply solutions.

Lake Erie Connector

The proposed 1,000 MW Lake Erie Connector transmission line has the potential to provide direct and indirect value to Ontario ratepayers by providing a number of economic and operational benefits through the trading of energy, capacity and other reliability services between Ontario and the electricity markets operated by PJM. If implemented, it would increase Ontario's overall transfer capability with other jurisdictions and facilitate more competition in the IESO's energy and capacity markets.

From an operational and reliability perspective, trading electricity provides a significant amount of flexibility to address needs that emerge close to real-time and without much notice. Real-time trading also provides a significant economic benefit to the province, as importing cost-effective energy

means that ratepayers avoid the cost of operating a more expensive asset in Ontario. The Lake Erie Connector would allow resources from PJM to compete in the IESO's acquisition mechanisms to provide capacity directly to Ontario. This would contribute to additional liquidity and competition for Ontario's capacity mechanisms, potentially displacing higher cost options and reducing total costs paid by ratepayers, or would reduce Ontario's resource adequacy needs, potentially removing or deferring the need to build a new asset.

Market Renewal Program

The IESO's Market Renewal Program will improve the current market design by delivering more efficient markets, more operational certainty to participants, and ensuring a cost-effective and reliable supply of electricity to consumers. Changes introduced by the new energy market design will provide a robust platform to support the evolution of the power system, with new resource types helping to address emerging power system needs. As the IESO does not produce forecasts of pricing, participants can refer to historical shadow prices for modelling considerations. Locational prices in the new energy market design are expected to provide improved signals for locating resource and transmission infrastructure investments in areas where they can provide the most value to potential suppliers, and to increase reliability of the power system. As a result, these signals could help to alleviate energy or capacity market constraints, and enable lower prices for consumers.

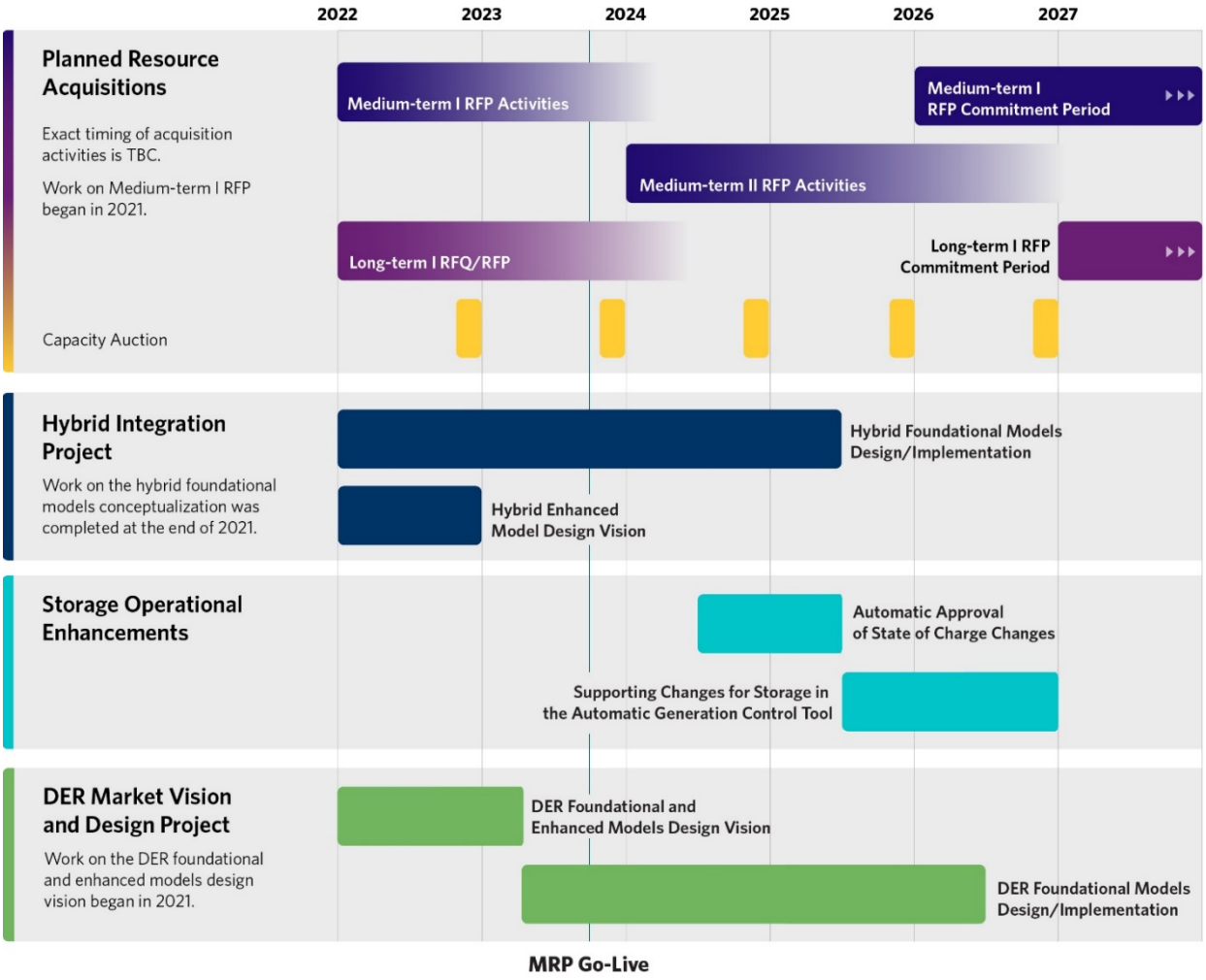


Figure 14 | Activities to Enable Greater Competition

Conclusions and Next Steps

A growing post-pandemic economy and decarbonization efforts are accelerating electricity demand across the province, helping to drive growth in a number of regions and resulting in a significant degree of change within Ontario's electricity system. The Resource Adequacy Framework is part of the IESO's iterative planning process, and is designed to respond to this influence by providing a flexible approach to ensuring reliability through a variety of mechanisms and commitment periods.

The 2021 AAR described a number of planned actions to acquire services from resources. This year's AAR builds on those actions, considering the latest information shared in the 2021 APO and other planning reports. It also uses the most up to date demand and supply forecasts, and identifies needs emerging mid-decade that will require additional actions beyond what was projected last year.

The annual capacity auction continues to demonstrate the capability of the marketplace to adapt and supply capacity, and will increasingly be relied upon to address needs prior to 2027. The 2022 Capacity Auction will have a target capacity of 1,200 MW for the summer 2023 obligation period and 750 MW for the winter 2023-2024 obligation period. Target capacities for future auctions are expected to grow. The IESO continues to work with sector participants and communities to enhance the capacity auction and increase participation, supporting reliability, competition and ensuring cost-effectiveness. Following execution of other acquisition mechanisms in the middle of this decade, the capacity auction is expected to serve as a balancing mechanism, adapting to changes in reliability needs on a year-to-year basis.

The final Medium-Term I RFP was posted in early 2022, the first in a cadenced approach to securing existing resources and offering flexible five-year commitment periods. With a substantial number of existing contracts expiring by 2029, the IESO anticipates a larger pool of participation for subsequent medium-term RFPs, which may also facilitate opportunities for expansions, upgrades and the construction of new facilities capable of competing with existing resources for three- to five-year contracts.

A variety of options are under consideration to meet anticipated resource adequacy needs in 2025/26 that will not likely be met by planned actions already underway. For example, the IESO anticipates making use of the existing Hydro Quebec Capacity Sharing Agreement in 2026. Government policy decisions, such as the potential to re-contract biomass facilities reaching the end of their contract terms, can also contribute to meeting the overall system reliability need during this period. The IESO will be engaging with the sector on potential solutions and mechanisms, such as an enhanced multi-year auction for a three-year commitment, and two new long-term competitive processes for delivery by 2025.

Long-term RFPs remain the primary procurement tool for acquiring reliability services from new resources for the late 2020s and into the 2030s. The IESO intends to launch two long-term RFPs to address the majority of needs identified in the 2021 APO for the period of 2027-2034. The first long-term RFP, with a target of 2,500 MW, is anticipated to drive investment in new projects that can contribute to meeting Ontario's reliability needs.

In conjunction with sector participants and communities, the IESO will explore additional measures this year to meet resource adequacy needs, both in the near-term and into the next decade.

Appendix 1 – Methodology to Assess Resource Adequacy Needs

Introduction

This appendix outlines the methodology and assumptions that were used to refine system needs outlined in the 2021 APO in order to inform planned actions specified in this report.

Consideration of Previous Planned Actions

Leveraging the Annual Planning Outlook

Capacity adequacy needs are determined by the IESO on an annual basis using a probabilistic assessment, and are published in the APO.

The probabilistic assessment uses a sequential Monte Carlo simulation that runs a series of simulations and outputs the expected loss of load expectation (LOLE). The model iteratively adds (or removes) different amounts of "perfect capacity" to achieve data points such that the simulation results in 0.1 days/year LOLE. The capacity is added into the model in each of the 10 electrical zones in Ontario, the magnitude of which is proportional to the need in that zone. The capacity added, modelled as a load modifier, reduces demand in the zone consistently throughout every hour of the year. A best-fit LOLE-MW curve is created and the capacity requirement is the amount of capacity that must be added to the system to satisfy the LOLE criterion. Details on the methodology for how the IESO conducts resource adequacy assessments are available in the Resource Adequacy and Energy Assessment Methodology.

Building on the APO's Probabilistic Assessment

Leveraging the latest APO resource adequacy assessment as a starting point, the IESO updates inputs to the probabilistic assessment to confirm whether previous planned actions and policy decisions can resolve the reliability needs identified in the APO. For this assessment, a representative supply mix is developed, whose sum is equal to the targets of all planned actions or policy decisions that have been confirmed prior to report publication.

Inputs

The 2022 AAR used the 2021 APO reference demand forecast and supply outlook (without the continued availability of existing resources after contract expiry), with the latter updated to reflect the impact of the planned actions and policy decisions as indicated in **Tables 1 and 2** below.

Table 1 | 2021 AAR Planned Actions

Planned Action	Assumption
Capacity Auction	• The upper limit of the forward guidance targets was assumed to be met. • Forward guidance targets are specified for the five-year forward period, 2023-2027.
Medium-Term I RFP	• The Medium-Term I RFP target capacity of 475 MW was assumed to be met. • A representative supply mix was modelled to reflect the target capacity available for a five-year commitment period, with a common three-year core period of 2026-2029.
Bilateral Negotiations – Brighton Beach GS	• For the purpose of this assessment, the capacity from Brighton Beach GS was assumed to be available up to April 30, 2029. • The IESO published the West of London Bulk Report in September 2021, detailing system needs in the area (driven by strong indoor agricultural growth in vegetable greenhouses and cannabis) and the necessary actions to ensure the adequacy and reliability of electricity supply up to the year 2035. One of the actions identified in the 2021 AAR and the West of London Bulk Report was the continued operation of the Brighton Beach Generating Station, a 588 MW natural gas-fuelled generator. The continued operation of this facility is required to address supply gaps that are projected until 2028, when the necessary transmission reinforcements are expected to be in-service. Discussions are currently underway between the IESO and Atura Power regarding the continued operation of the Brighton Beach Generating Station, with the contract term anticipated to extend to 2029.
Bilateral Negotiations – Lennox GS	• For the purpose of this assessment, the capacity from Lennox GS was considered to be available up to April 30, 2029. • The Richview x Trafalgar Upgrade Assessment, posted in July 2021, specifies necessary upgrades to the transmission line between north Oakville (Trafalgar TS) and Pearson Airport (Richview TS) and is anticipated to be in-service in 2026. While these upgrades will increase the FETT transfer capability and reduce the need to acquire capacity east of FETT, prior to their completion, significant generation will be required in Eastern Ontario due to nuclear retirements and refurbishments. As outlined in the 2021 AAR, the dual-fuel natural gas and oil Lennox Generating Station, with its 2,100 MW of installed capacity, flexibility to respond to system needs and location in Eastern Ontario, is the only supplier in place to address the immediate need. Negotiations between the IESO and Ontario Power Generation for the re-contracting of Lennox Generating Station concluded in December 2021, extending the contract term to 2029.

Planned Action	Assumption
Hydro Quebec Capacity Sharing Agreement	• For the purpose of this assessment, 500 MW of capacity was assumed to be available in summer 2026 (to align with capacity needs) under the Hydro Quebec Capacity Sharing Agreement. • The agreement allows 500 MW of summer capacity to be delivered by Quebec to Ontario in any one summer before 2030. Although not an explicit planned action outlined in the 2021 AAR, this was identified as an additional option to address changes to resource adequacy needs over time.

Table 2 | Policy Decisions

Planned Action	Assumption
Extension of Calstock GS	• For this assessment, Calstock GS was considered to be available up to March 31, 2027. • In December 2021, the Government of Ontario granted a short-term extension (ending March 31, 2022) to the power purchase agreement for Calstock Generating Station, a 35 MW biomass facility in Northern Ontario. As directed by the Government on January 27, 2022, the IESO entered into a new contract with a commitment period ending March 31, 2027.
Oneida Energy Storage Project	• As part of the government's unsolicited project assessment framework, the IESO was directed on January 27, 2022 to enter into a contract with a 10-year term for the 250 MW/1,000 MWh battery storage project, for the provision of capacity and regulation services, proposed through a partnership between NRStor and the Six Nations of the Grand River Development Corporation and expected to be in-service mid-decade.
OPG's Small Modular Reactor (SMR)	• For this assessment, the SMR facility was assumed to be in-service as of January 2029. • Ontario Power Generation, with the Government of Ontario's support, is working with GE Hitachi Nuclear Energy to deploy a SMR at OPG's Darlington nuclear site. The approximately 300 MW SMR is projected to be completed as early as 2028.

Assessment Outcomes

The outcome of this assessment is a determination of capacity needs for the period 2023 - 2029, factoring in the expected contribution of planned actions identified in the previous year's AAR and recent policy decisions. This process is expected to be repeated annually to reflect the latest planning outlook, planned actions and policy decisions. The IESO uses this assessment to identify any years with potential capacity shortfalls and conduct a risk assessment, informed by the uncertainties noted in the AAR, on the likelihood and magnitude of the shortfalls. This informs decisions on whether to plan additional actions from the mechanisms described in the Resource Adequacy Framework to address the identified shortfalls.

Appendix 2 - Resource Adequacy Framework Evolution

The Resource Adequacy Framework was developed in 2020 through a series of engagements between the IESO and sector participants and communities. It sets out how to acquire the services of resources through a variety of time frames leveraging competitive processes where possible. At its core, the Resource Adequacy Framework is a fundamental commitment to pursue competitive solutions wherever practicable, ensuring that system needs and the solutions to meet those needs are closely aligned.

The framework uses a multi-pronged approach to secure resources with varying commitment lengths. It allows the IESO to use multiple approaches to address system needs and initiate each mechanism when there is an appropriate level of clarity about system requirements. As a result, these mechanisms will often run in parallel.

The 2021 AAR was the IESO's first step in operationalizing the framework and in doing so, over the course of 2021 and early 2022, the marketplace uncovered opportunities to improve aspects of the Resource Adequacy Framework. These improvements, described in the following section, will increase certainty and competition in future procurement activities.

Bridging Mechanism

Through the development of the medium-term RFP, and in response to sector participant feedback received in the ongoing Resource Adequacy Engagement, the IESO has refined the Resource Adequacy Framework's bridging mechanism in accordance with the Minister's directive. In addition to the option to use the capacity auction as a bridging mechanism between contracts, as previously proposed in the 2021 AAR, the following options (shown in **Figure 15**) now exist for bridging:

- Contract Extension: To provide greater certainty for existing contracts whose term lengths do not align with the start of a capacity auction obligation period or the Medium-Term I RFP commitment period, the IESO, as directed by Government on January 27, 2022, will work with contract holders to extend contracts to the next April 30 date (e.g. a contract that expires July 1, 2023 would be extended to November 1, 2023, the start of the next capacity auction obligation period). The intent is that suppliers will be on the same cycle and align with the start of the capacity auction commitment period or the Medium-Term I RFP contract dates.
- Flexible Commitment Terms: Medium-Term I RFP will have a flexible five-year commitment period where suppliers can choose to take any five-year term between 2024 and 2031. This concept would ensure that all resources are committed for the three-year period identified in the 2021 AAR (2026 to 2029), while providing additional flexibility and certainty for each resource's individual needs.

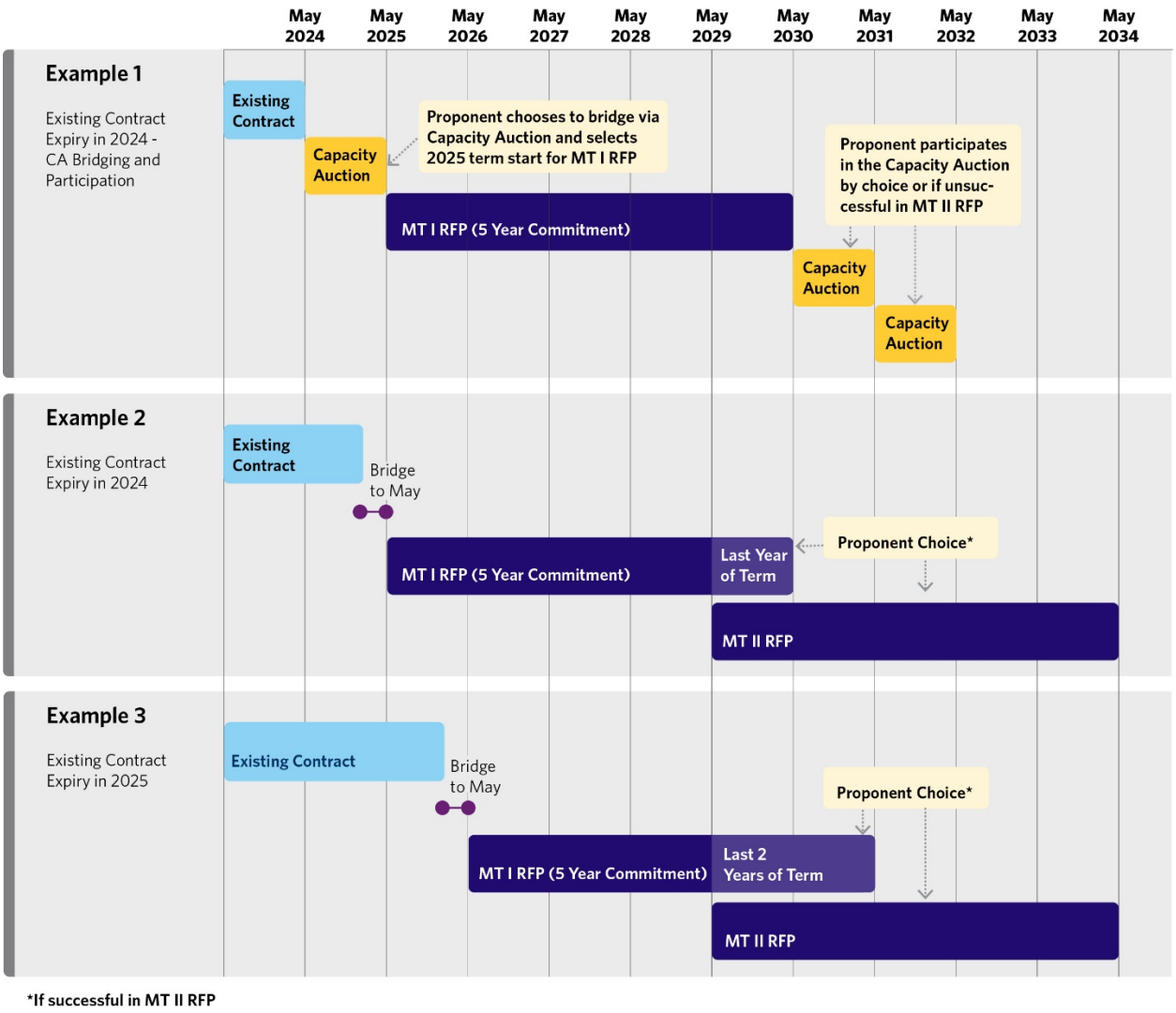


Figure 15 | Contract Term Options, Considering Contract Extensions and Flexible Commitment Terms

Cadence Approach

The IESO has proposed an approach to sector participants and communities for subsequent medium-term commitments, to assist with providing greater certainty around an enduring cadenced process. The IESO intends that each subsequent procurement will be focused around a five-year contract with a common three-year core period, with the procurements being run at the intervals indicated in **Table 3** below. This schedule would provide a forward period of at least two years for proponents selecting the earliest term commencement date, and four years for those selecting the latest commencement date. Examples are illustrated in Figure 16 below.

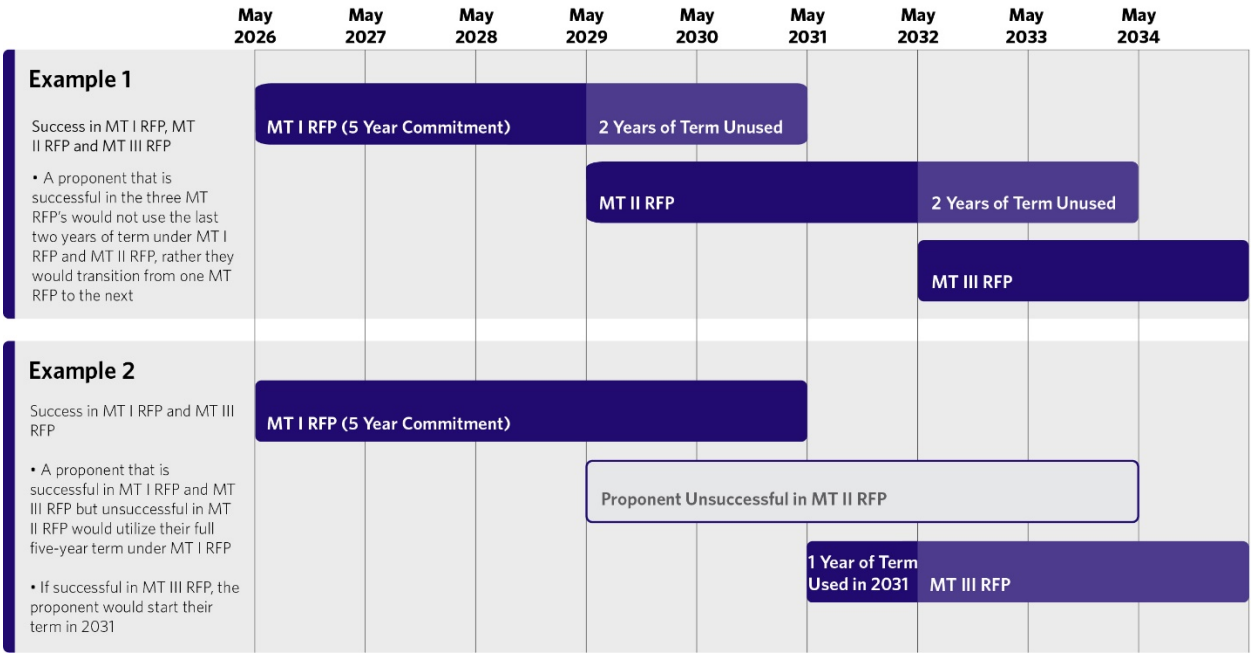


Figure 16 | Cadence Approach for Subsequent RFPs

Table 3 | Anticipated RFP Timelines

RFP	Core Years	Optional Start Dates	Procurement Period
Medium-Term I RFP	• 2026-2029	• May 1 in 2024, 2025 or 2026	• 2021-2022
Medium-Term II RFP	• 2029-2032	• May 1 in 2027, 2028 or 2029	• 2024-2025
Medium-Term III RFP	• 2032-2035	• May 1 in 2030, 2031 or 2032	• 2027-2028

Appendix 3 – Resources Referenced in this Report

Reference	URL
Annual Acquisition Report – July 2021	Annual Acquisition Report
Summary of Capacity Sharing Agreement between Ontario and Quebec	Quebec Capacity Sharing Agreement
Annual Planning Outlook – December 2021	Annual Planning Outlook
Ontario Resource and Transmission Assessment Criteria	Ontario Resource and Transmission Assessment Criteria
NERC ERO Reliability Risk Priorities Report	2021 ERO Reliability Risk Priorities Report
Need for Bulk System Reinforcements West of London	West of London Bulk Report
2021 Annual Planning Outlook: Ontario's Transmission Interfaces and Interties	Ontario Transmission Interfaces and Interties Overview
Richview x Trafalgar Upgrade Assessment	Richview x Trafalgar Upgrade Assessment
2021 Annual Planning Outlook: Ancillary Services Module	Ancillary Services Module
2021 Annual Planning Outlook: Resource Adequacy and Energy Assessment Methodology	Resource Adequacy and Energy Assessment Methodology
2019 Integrated Ontario Electricity and Natural Gas Achievable Potential Study	Achievable Potential Study
Decarbonization and Ontario's Electricity System	Decarbonization and Ontario's Electricity System
2021 Annual Planning Outlook: Demand Forecast Methodology	Demand Forecast Methodology
CNSC Approval for Pickering Extension	Letter from OPG to CNSC - December 16, 2021
2021 Long-Term Reliability Assessment – December 2021	2021 NERC Long-Term Reliability Assessment
Energy Storage Design Project Long-Term Design Vision Document	Energy Storage Design Project Long-Term Vision

Appendix 4 – List of Acronyms

Acronym	Definition	Acronym	Definition
AAR	Annual Acquisition Report	MRP	Market Renewal Program
AGC	Automatic Generation Control	MW	Megawatt(s)
APO	Annual Planning Outlook	MWh	Megawatt-hour(s)
CDM	Conservation and Demand Management	NERC	North American Electric Reliability Corporation
CNSC	Canadian Nuclear Safety Commission	NPCC	Northeast Power Coordinating Council
CROW	Control Room Operations Window	OEFC	Ontario Electricity Financial Corporation
DER	Distributed Energy Resources	OPG	Ontario Power Generation
ERP	Enabling Resources Program	OR	Operating Reserve
FETT	Flow East Toward Toronto	RFP	Request for Proposal
FN	Flow North	RFQ	Request for Qualification
GS	Generating Station	RSVC	Reactive Support and Voltage Control
ICAP	Installed Capacity	SS	Switching Station
ICI	Industrial Conservation Initiative	TS	Transformer Station
IESO	Independent Electricity System Operator	TWh	Terawatt-hour(s)
MISO	Midcontinent Independent System Operator	UCAP	Unforced Capacity
MISSW	Mississagi Flow West		

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