Reliability Outlook

An adequacy assessment of Ontario's electricity system

January 2022 to June 2023

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Executive Summary

Ontario is well positioned to meet Ontario's electricity needs for the next 18 months, with adequate supply to meet demand growth.

Electricity demand in Ontario increased throughout 2021 despite the ongoing challenges associated with the COVID-19 pandemic. Annual demand for the year is expected to top 133.5 terawatt-hours (TWh), an increase of 1.2% over 2020s.

Although the IESO had expected demand to return to pre-pandemic levels by year-end, supply chain disruptions and public health measures have been a drag on growth. As a result, that recovery has been pushed into 2022. Demand for electricity is expected to grow an additional 1.1% and hit 135.0 TWh by the end of 2022, mostly driven by pent-up demand for goods and services.

Two major factors are likely to increase demand later in the outlook period and beyond. In light of ongoing global supply change constraints, some Ontario manufacturers are looking to source or produce components locally to mitigate risk. This transition is already established in the greenhouse industry, where growers have shifted to domestic production as imports have become less reliable and more expensive. Secondly, efforts to decarbonize the economy – including transportation – will also result in increased demand, especially over the longer term.

To maintain grid reliability over the Outlook period, the IESO secured 1,286.7 MW of capacity for summer 2022 and 841.9 MW of capacity for winter 2022/2023 through the December 2021 capacity auction. However, this report uses the auction target amounts of 1000 MW for summer 2022 and 500 MW for winter 2022/2023 in its analysis as the auction was held after this report was completed. In addition, approximately 160 MW new grid-connected wind generation is scheduled to come into service over the next 18 months.

The province is expected to have sufficient supply resources for the winters of 2021/2022 and 2022/2023. There are four weeks in the spring and summer of 2022 when reserves may not meet requirements, should extreme weather conditions materialize. However, these potential shortfalls are expected to be mitigated through outage management.

Looking ahead, as the nuclear refurbishment and retirement programs proceed over the next few years, market participants should prepare for the risk of having their outages rescheduled. To ensure the reliable operation of the grid, close coordination among the IESO, transmitters and generators will be necessary for the next several years. In the meantime, the IESO will continue to work with generators to ensure outages are optimally scheduled.

In general, Ontario's transmission system is expected to continue reliably supplying province-wide demand for the next 18 months. However, there are a few region-specific items to note, especially in northern Ontario. For example, a one-and-a-half-month outage starting in early April, 2022 will reduce the transfer capability of the East-West Tie and require close coordination among affected participants.

Construction of the East-West Tie Expansion project, which will run roughly parallel to the existing line is proceeding, with a planned in-service date of Q1 2022. The new line will increase the

electricity transfer capability into Northwest Ontario and eventually improve the flexibility and efficiency of the Northwest electricity system. However, the full benefit of the new circuits will not be realized right away due to ongoing work in the northwest.

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1. Introduction

This Outlook covers the 18 months from January 2022 to June 2023, and supersedes the Outlook released on September 23, 2021.

The purpose of the 18-month horizon in the *Reliability Outlook* is to:

- Advise market participants of the resource and transmission reliability of the Ontario electricity system
- Assess potentially adverse conditions that might be avoided by adjusting or coordinating maintenance plans for generation and transmission equipment
- Report on initiatives being implemented to improve reliability within this time frame

This Outlook assesses resource and transmission adequacy based on the stated assumptions, following the Methodology to Perform the Reliability Outlook. Due to uncertainties associated with various assumptions, readers are encouraged to use their judgment in considering possible future scenarios.

Additional supporting documents are located on the IESO website.

Security and adequacy assessments are published on the IESO website on a daily basis and progressively supersede information presented in this report.

For questions or comments on this Outlook, please contact us at 905-403-6900 (toll-free 1-888-448-7777) or customer.relations@ieso.ca.

2. Updates to this Outlook

2.1 Updates to the Demand Forecast

The demand forecast used in this Outlook is informed by actual demand, weather and economic data through to the end of October 2021, and has been updated to reflect the most recent economic projections. Actual weather and demand data for November 2021 are included in the tables.

2.2 Updates to Resources

This *Reliability Outlook* considers planned generator outages over the 18-month period, submitted by market participants to the IESO's outage management system as of November 30, 2021. Market participants are required annually to submit information to enable the IESO to conduct reliability assessments. This information, provided to the IESO through Form 1230, was submitted by April 1, 2021.

The following resources cleared the Capacity Auction since the last Outlook:

- Capacity Auction (various resources)[1]
    - Summer 2022 obligation period – 1286.7 MW
    - Winter 2022/23 obligation period – 841.9 MW

2.3 Updates to the Transmission Outlook

This Outlook also considers transmission outage plans that were submitted to the IESO's outage management system by November 8, 2021.

2.4 Updates to the Operability Outlook

The outlook for surplus baseload generation (SBG) conditions over the next 18 months is based on generator outage plans submitted by market participants to the IESO's outage management system as of November 30, 2021.

[1] The IESO's December 2021 Capacity Auction was held after this assessment was completed; the target capacities for the December 2021 Capacity Auction, as announced in the IESO's Annual Acquisition Report have been included in the firm resource scenario for this forecast. More information about the Capacity Auction can be found on the IESO's website, including details on resources that cleared the auction, in the post-auction report

3. Demand Forecast

Electricity demand has been fairly robust through 2021 despite the ongoing pandemic. As the province emerges from the public health crisis and the economy reopens, electricity consumption is expected to increase. Pent-up demand for goods and services will buoy the economy and push electricity demand above the level seen in 2019. However, there is significant risk to the accuracy of this demand forecast as the outlook for the pandemic remains uncertain.

The IESO is responsible for forecasting electricity demand on the IESO-controlled grid. This demand forecast covers the period from January 2022 to June 2023 and supersedes the previous forecast released in September 2021. Tables of supporting information are contained in the 2021 Q4 Outlook Tables.

Electricity demand has strengthened throughout 2021 despite third and fourth waves of COVID. Annual demand is expected to top 133.5 TWh, an increase of 1.2% over 2020. In previous outlooks, the expectation was that 2021 would see the province exceed the pre-COVID demand level of 134.7 TWh, but subsequent waves of COVID and supply disruptions have pushed that recovery into 2022, with demand expected to grow an additional 1.1%, reaching 135.0 TWh. Pent-up demand for goods and services will be the main cause of this increase. However, towards the tail end of the forecast period, reflect two impactful trends. The first will see increased demand, as firms look to repatriate parts of the global supply chain in order to mitigate risk. This transition is already established in the greenhouse industry, where growers have moved production in-province as supplies from Mexico and California have become riskier and more expensive. Secondly, the province will see increased electrification resulting from efforts to decarbonize the economy. Those changes will come on many fronts, from the wider adoption of electric vehicles for both public and private use, and consumer and businesses pursuing fuel switching.

At this time, a large part of the workforce continues to work from home. This increases the weather sensitivity of the system, as both commercial and residential buildings are running both cooling and heating equipment. This will persist throughout the forecast period, as a certain amount of the workforce is expected to continue working from home either part-time or full-time on a permanent basis. Additionally, for the foreseeable future, commercial buildings will operate their HVAC and air-handling systems to mitigate the potential spread of COVID. This translates into higher weather-sensitive loads, particularly in the summer when air conditioning load drives peak demand. The Industrial Conservation Initiative (ICI) helps reduce peak demands, most notably in the summer. Going forward, the seasonal peaks will increase slightly over the forecast.

There remains a significant amount of uncertainty regarding the demand forecast. The pandemic and the global disruption that it has caused have resulted in economic, political and social upheaval. At the same time, the climate challenge, which will entail significantly greater disruption, is accelerating. The years ahead will bring about change that will affect a wide swath of our lives, and in turn, electricity demand.

Table 3-1 | Forecast Energy Demand Summary

Year	Normal Weather Energy (TWh)	% Growth in Energy
2021	133.5	1.20%
2022	135.0	1.13%

Table 3-2 | Forecast Seasonal Peaks

Season	Normal Weather Peak (MW)	Extreme Weather Peak (MW)
Winter 2021-22	20,984	22,271
Summer 2022	22,555	24,767
Winter 2022-23	21,283	22,467

Table 3-3 | Weekly Energy and Peak Demand Forecast

Week Ending	Normal Peak (MW)	Extreme Peak (MW)	Load Forecast Uncertainty (MW)	Normal Energy Demand (GWh)
02-Jan-22	19,345	20,514	528	2,632
09-Jan-22	20,261	22,032	528	2,758
16-Jan-22	20,619	22,255	570	2,861
23-Jan-22	20,965	22,271	547	2,879
30-Jan-22	20,984	22,021	483	2,887
06-Feb-22	20,446	21,636	404	2,834
13-Feb-22	20,205	21,475	734	2,822
20-Feb-22	20,002	21,399	635	2,805
27-Feb-22	19,960	21,405	581	2,759
06-Mar-22	19,401	20,977	501	2,719
13-Mar-22	18,908	20,493	531	2,668

Week Ending	Normal Peak (MW)	Extreme Peak (MW)	Load Forecast Uncertainty (MW)	Normal Energy Demand (GWh)
20-Mar-22	18,217	19,636	649	2,603
27-Mar-22	17,948	19,104	611	2,538
03-Apr-22	17,475	18,669	569	2,458
10-Apr-22	17,264	18,199	567	2,452
17-Apr-22	17,213	18,150	471	2,396
24-Apr-22	16,878	17,620	496	2,367
01-May-22	16,942	18,795	531	2,363
08-May-22	16,763	19,333	721	2,342
15-May-22	17,530	20,710	849	2,362
22-May-22	17,581	20,662	845	2,352
29-May-22	18,274	21,189	1,175	2,323
05-Jun-22	19,387	21,684	1,330	2,407
12-Jun-22	20,831	22,067	1,292	2,487
19-Jun-22	21,510	22,949	1,055	2,544
26-Jun-22	22,173	23,931	835	2,606
03-Jul-22	21,819	23,708	754	2,589
10-Jul-22	22,396	24,275	1,016	2,686
17-Jul-22	22,474	24,597	814	2,730
24-Jul-22	22,555	24,767	838	2,746
31-Jul-22	22,524	24,662	1,035	2,756
07-Aug-22	22,161	24,526	841	2,696
14-Aug-22	22,173	24,575	958	2,723
21-Aug-22	22,399	24,659	985	2,704
28-Aug-22	21,849	23,535	1,362	2,681

Week Ending	Normal Peak (MW)	Extreme Peak (MW)	Load Forecast Uncertainty (MW)	Normal Energy Demand (GWh)
04-Sep-22	21,446	23,323	1,413	2,604
11-Sep-22	21,341	22,481	1,370	2,485
18-Sep-22	20,035	21,323	680	2,433
25-Sep-22	19,086	20,454	781	2,406
02-Oct-22	17,755	19,154	420	2,377
09-Oct-22	16,906	18,195	554	2,366
16-Oct-22	17,045	17,589	786	2,333
23-Oct-22	17,231	18,660	507	2,407
30-Oct-22	17,430	18,896	392	2,432
06-Nov-22	17,595	19,155	318	2,463
13-Nov-22	18,694	19,032	416	2,517
20-Nov-22	19,014	19,664	601	2,597
27-Nov-22	19,368	20,276	342	2,652
04-Dec-22	19,610	20,753	607	2,699
11-Dec-22	20,083	21,344	409	2,737
18-Dec-22	20,087	21,488	555	2,775
25-Dec-22	19,972	21,584	690	2,796
01-Jan-23	19,873	21,127	362	2,645
08-Jan-23	20,306	21,321	528	2,756
15-Jan-23	20,796	21,938	570	2,864
22-Jan-23	20,959	22,051	547	2,889
29-Jan-23	21,283	22,467	483	2,909
05-Feb-23	21,015	21,976	404	2,884
12-Feb-23	20,891	21,770	734	2,857

Week Ending	Normal Peak (MW)	Extreme Peak (MW)	Load Forecast Uncertainty (MW)	Normal Energy Demand (GWh)
19-Feb-23	20,553	21,606	635	2,848
26-Feb-23	20,375	21,690	581	2,802
05-Mar-23	19,969	21,300	501	2,776
12-Mar-23	19,596	20,950	531	2,725
19-Mar-23	18,900	20,268	649	2,679
26-Mar-23	18,511	19,909	611	2,614
02-Apr-23	18,179	19,181	569	2,549
09-Apr-23	17,909	18,678	567	2,467
16-Apr-23	17,706	18,243	471	2,470
23-Apr-23	17,247	18,281	496	2,447
30-Apr-23	16,944	17,778	531	2,391
07-May-23	17,154	18,912	721	2,381
14-May-23	17,165	19,549	849	2,362
21-May-23	17,320	21,021	845	2,388
28-May-23	17,505	20,798	1,175	2,315
04-Jun-23	19,092	21,290	1,330	2,413
11-Jun-23	19,487	21,839	1,292	2,438
18-Jun-23	21,047	22,351	1,055	2,512
25-Jun-23	21,576	22,980	835	2,547
02-Jul-23	21,950	23,571	754	2,571

4. Resource Adequacy

The IESO expects to have sufficient generation supply for winters 2021/2022 and 2022/2023, accounting for zonal transmission constraints. Potential risks in spring and summer 2022 are expected to be mitigated through outage rescheduling. However, rescheduling outages could be difficult due to increased volume of outages and limited periods to avoid undesirable outage combinations.

This section assesses the adequacy of resources to meet the forecast demand. Resource adequacy is one of the reliability considerations used for approving generation and transmission outages. When reserves are below required levels, with potentially adverse effects on the reliability of the grid, the IESO will reject outage requests based on their order of precedence. Conversely, when reserves are above required levels, additional outages can be contemplated, provided other factors – such as local considerations, operability or transmission security – do not pose a reliability concern. In those cases, the IESO may place an outage at risk, signaling to the facility owner to consider rescheduling the outage.

Ontario's existing installed generation capacity is summarized in Table 4-1. This includes capacity from new facilities that have completed the IESO's market registration process since the previous Outlook. The forecast capability at the Outlook peak is based on the firm resource scenario, which includes resources currently in commercial operation, and takes into account deratings, planned outages and an allowance for capability levels below rated installed capacity.

Table 4-1 | Existing Grid-Connected Resource Capacity

Fuel Type	Total Installed Capacity (MW)	Forecast Capability at 2022 Summer Peak Normal Weather (MW)	Forecast Capability at 2022 Summer Peak Extreme Weather (MW)	Number of Stations	Change in Number of Stations	Change in Installed Capacity
Nuclear	13,089	10,447	10,447	5	0	0
Hydroelectric	8,918	5,072	4,514	76	0	0
Gas/Oil	10,515	9,211	8,800	33	0	0
Wind	4,783	727	727	40	0	0
Biofuel	296	254	254	7	0	0
Solar	478	66	66	10	0	0
Demand Measures	-	712	712	-	-	-
Firm Imports (+) / Exports (-) (MW)	-	0	0	-	-	-
Total	38,079	26,563	25,519	171	0	0

4.1 Assessment Assumptions

4.1.1 Generation Resources

All generation resources scheduled to come into service, be upgraded or be shut down within the Outlook period are summarized in Table 4-2. This includes generation projects in the IESO's connection assessment and approval (CAA) process, those under construction, and contracted resources. Details regarding the IESO's CAA process and the status of these projects can be found on the Application Status section of the IESO website.

The estimated effective date column in Table 4-2 indicates when the market registration process is expected to be complete for each generation resource, based on information available to the IESO as of November 30, 2021. Two scenarios are used to describe project risks:

- The **planned scenario** assumes that all resources scheduled to come into service are available over the assessment period.
- The **firm scenario** assumes only resources that have reached commercial operation status and completed commissioning at the time this assessment was completed are available.

Planned shutdowns or retirements of generators that have a high likelihood of occurring are considered for both scenarios.

Table 4-2 | Committed Generation Resources Status

Project Name	Zone	Fuel Type	Estimated Effective Date	Project Status	Firm (MW)	Planned (MW)
Romney Wind Energy Centre	West	Wind	2022-Q1	Commissioning		60
Nation Rise	Ottawa	Wind	2021-Q4	Commissioning		100
Calstock[2]	Northeast	Biofuel	2021-Q4	Expiring Contract	-38	-38
Iroquois Falls[3]	Northeast	Gas	2021-Q4	Expiring Contract	-131	-131
Lennox GS[4]	East	Gas/Oil	2022-Q4	Expiring Contract	-2,200	-2,200
Nipigon GS	Northwest	Gas/Oil	2022-Q4	Expiring Contract	-23	-23
Total					**-2,392**	**-2,232**

Notes on Table 4-2:

The total may not add up due to rounding and does not include in-service facilities. Project status provides an indication of the project progress, using the following terminology:

- Under Development – projects in approvals and permitting stages (e.g., environmental assessment, municipal approvals, IESO connection assessment approvals) and projects under construction
- Commissioning – projects undergoing commissioning tests with the IESO

[2] The Ministry of Energy has directed the IESO to execute a new, 5-year contract with Atlantic Power for Calstock GS. At the time of writing a contract has not been executed, so capacity from Calstock is not included in the firm and planned scenarios in this assessment; its retirement has been noted here for completeness.

[3] Iroquois Falls was recently successful in the IESO's December 2021 Capacity Auction. For more information about capacity secured in the auction, please see sections 2.2, 4.2.1, and the IESO's website.

[4] Lennox GS is critical to reliability due to its location, size and operating characteristics. As a transitional measure until there is greater competition in the area, the IESO and OPG are engaged in bilateral negotiations on a contract extension. Capacity from Lennox has been included in both the firm and planned scenarios in this assessment.

- Commercial Operation – projects that have achieved commercial operation status under the contract criteria, but have not met all of the IESO's market registration requirements
- Expiring Contract – contracts that will expire during the Outlook period are included in both scenarios only up to their contract expiry date. Generators (including non-utility generators) that continue to provide forecast output data are also included in the planned scenario for the rest of the 18-month period.

4.1.2 Generation Capability

Hydroelectric

A monthly forecast of hydroelectric generation output is calculated based on median historical values of hydroelectric production and contribution to operating reserve during weekday peak demand hours. Through this method, routine maintenance and actual forced outages of the generating units are implicitly accounted for in the historical data (see the first row in Table 4-3).

To reflect the impact of hydroelectric outages on the reserve above requirement (RAR) and allow the assessment of hydroelectric outages as per the outage approval criteria, the hydroelectric capability is also calculated, without accounting for historical outages (see the second row of Table 4-3). Table 4-3 uses data from May 2002 to March 2021, which are updated annually to coincide with the release of the Q2 Outlook.

Table 4-3 | Monthly Historical Hydroelectric Median Values for Normal Weather Conditions

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Historical Hydroelectric Median Contribution (MW)	6,207	6,128	5,948	5,898	5,981	5,798	5,667	5,326	5,103	5,478	5,733	6,200
Historical Hydroelectric Median Contribution without Outages (MW)	6,692	6,717	6,451	6,397	6,419	6,300	6,143	5,882	5,952	6,304	6,486	6,700

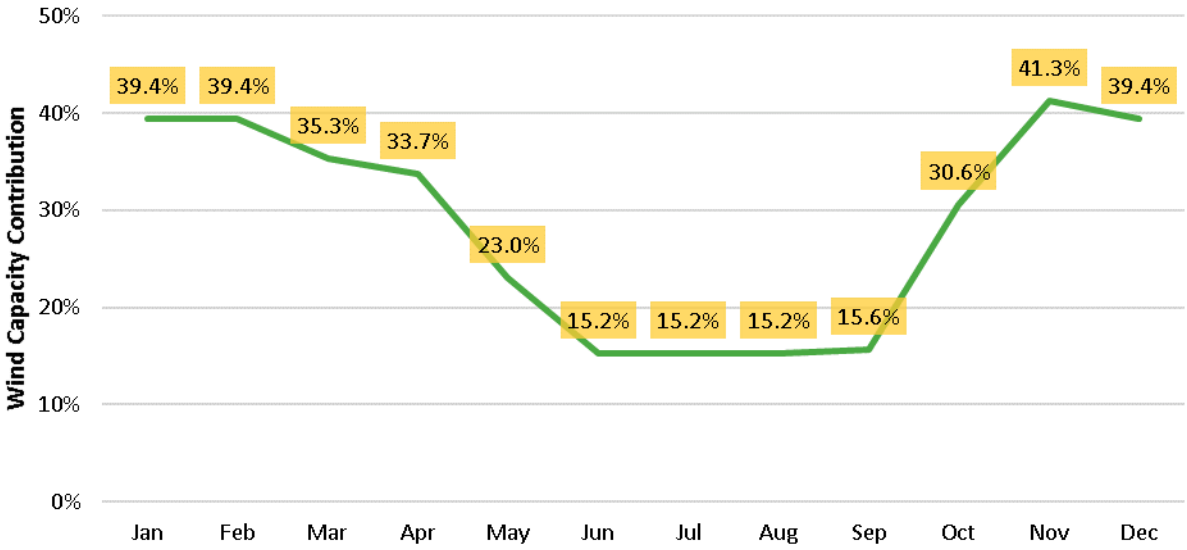
Thermal Generators

Thermal generators' capacity, planned outages and deratings are based on market participant submissions. Forced outage rates on demand are calculated by the IESO based on actual operational data. The IESO will continue to rely on market participant-submitted forced outage rates for comparison purposes.

Wind

For wind generation, monthly wind capacity contribution (WCC) values from the weekday peak hour are used. The process for determining wind contribution can be found in the Methodology to Perform the Reliability Outlook. Figure 4-1 shows the monthly WCC values, which are updated annually with the release of the Q2 Outlook.

Figure 4-1 | Monthly Wind Capacity Contribution Values

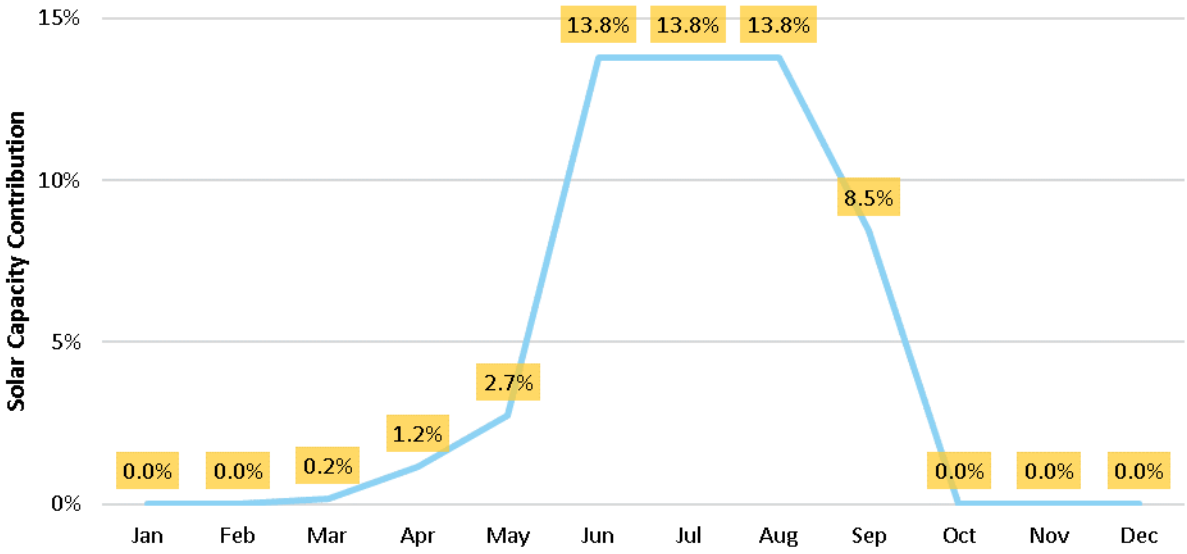


Solar

For solar generation, monthly solar capacity contribution (SCC) values are used from the weekday peak hour. Information on how the solar contribution is calculated can be found in the Methodology to Perform the Reliability Outlook. Figure 4-2 shows the monthly SCC values, which are updated annually for the release of the Q2 Outlook.

The grid demand profile has been changing, due in part to the penetration of embedded solar generation, which is pushing summer peaks to later in the day. As a result, the contribution from grid-connected solar resources has declined at the time of peak Ontario demand.

Figure 4-2 | Monthly Solar Capacity Contribution Values



4.1.3 Demand Measures

Both demand measures and load modifiers can impact demand, but differ in how they are treated within the Outlook. Demand measures[5], such as dispatchable loads and demand response procured through the IESO's capacity auction, are not incorporated into the demand forecast and are instead treated as resources. Load modifiers are incorporated into the demand forecast. The impacts of activated demand measures are added back into the demand history prior to forecasting demand for future periods.

4.1.4 Firm Transactions

Capacity-Backed Exports

The IESO allows Ontario resources to compete in the capacity auctions held by certain neighbouring jurisdictions, but only if Ontario has adequate supply. New York Independent System Operator (NYISO) will allow up to 42 MW of capacity-backed exports from Ontario for winter months, November 2021 to April 2022.

System-Backed Exports

As part of the electricity trade agreement between Ontario and Quebec, Ontario will supply 500 MW of capacity to Quebec each winter from December to March until 2023. In addition, Ontario will receive up to 2.3 TWh of clean energy annually, scheduled economically via Ontario's real-time markets. The economically imported energy will target peak hours to help reduce greenhouse gas emissions in Ontario. The agreement includes the opportunity to cycle energy.

[5] Note that 1.7 MW of storage capacity that cleared the 2020 Capacity Auction are included in the "demand measures" totals throughout this report, as well as in the accompanying data tables, given that it is an embedded resource that is a market participant.

As part of this capacity exchange agreement, Ontario can call on 500 MW of capacity during summer before September 2030, based on the province's needs. Ontario does not expect to call on this capacity during this 18-month period.

4.1.5 Summary of Scenario Assumptions

To assess future resource adequacy, the IESO must make assumptions about the amount of available resources. The Outlook considers two scenarios: a firm scenario and a planned scenario.

The starting point for both scenarios is the existing installed resources shown in Table 4-1. The planned scenario assumes that all resources scheduled to come into service are available over the assessment period. The firm scenario considers only those resources that have reached commercial operation status as of the time of this assessment. Generator-planned shutdowns or retirements that have a high likelihood of occurring are considered for both scenarios. They also both reflect planned outages submitted by generators. Table 4-4 shows the available resources that are forecast for the 18 months, under the two scenarios in normal weather conditions, at the time of the summer and winter peak demands during the Outlook.

Table 4-4 | Summary of Available Resources under Normal Weather

Notes	Description	Winter Peak 2021/2022 Firm Scenario	Winter Peak 2021/2022 Planned Scenario	Summer Peak 2022 Firm Scenario	Summer Peak 2022 Planned Scenario	Winter Peak 2022/2023 Firm Scenario	Winter Peak 2022/2023 Planned Scenario
1	Installed Resources (MW)	38,079	38,179	38,079	38,239	38,079	38,239
2	Total Reductions in Resources (MW)	11,570	11,654	12,228	12,364	13,317	13,437
3	Demand Measures (MW)	135	135	712	712	525	525
4	Firm Imports (+) / Exports (-) (MW)	-500	-500	0	0	-500	-500
5	Available Resources (MW)	26,144	26,160	26,563	26,587	24,787	24,827
6	Bottling (MW)	725	748	0	0	1,558	1,558
7	Available Resources without Bottling (MW)	26,869	26,908	26,563	26,587	26,345	26,385

Notes on Table 4-4:

1. Installed Resources: The total generation capacity assumed to be installed at the time of the summer and winter peaks.
2. Total Reductions in Resources: The sum of deratings, planned outages, limitations due to transmission constraints and allowances for capability levels below rated installed capacity.
3. Demand Measures: The amount of demand expected to be available for reduction at the time of peak.
4. Firm Imports/Exports: The amount of expected firm imports and exports at the time of summer and winter peaks.
5. Available Resources: Installed Resources (line 1) minus Total Reductions in Resources (line 2) plus Demand Measures (line 3) and Firm Imports/Exports (line 4). This differs from the Forecast Capability at System Peak shown in Table 4-1 due to the impacts of generation bottling (transmission limitations).
6. Available Resources without Bottling: Available resources after they are reduced due to bottling.

4.2 Capacity Adequacy Assessment

The capacity adequacy assessment accounts for zonal transmission constraints resulting from planned transmission outages assessed as of November 8, 2021. The generation planned outages occurring during this Outlook period have been assessed as of November 30, 2021.

As already noted, the outbreak of COVID-19 has added some uncertainty to our forecasts. The IESO will continue to provide timely updates to these assessments as information becomes available.

4.2.1 Firm Scenario with Normal and Extreme Weather

The firm scenario incorporates all capacity that had achieved commercial operation status as of November 30, 2021.

Figure 4-3 shows Reserve Above Requirement (RAR) levels, which represents the difference between available resources and required resources. The required resources equals demand plus the required reserve.

The target capacities for the December 2021 Capacity Auction, as announced in the IESO's Annual Acquisition Report, have been included in the firm resource scenario for this forecast.[6]

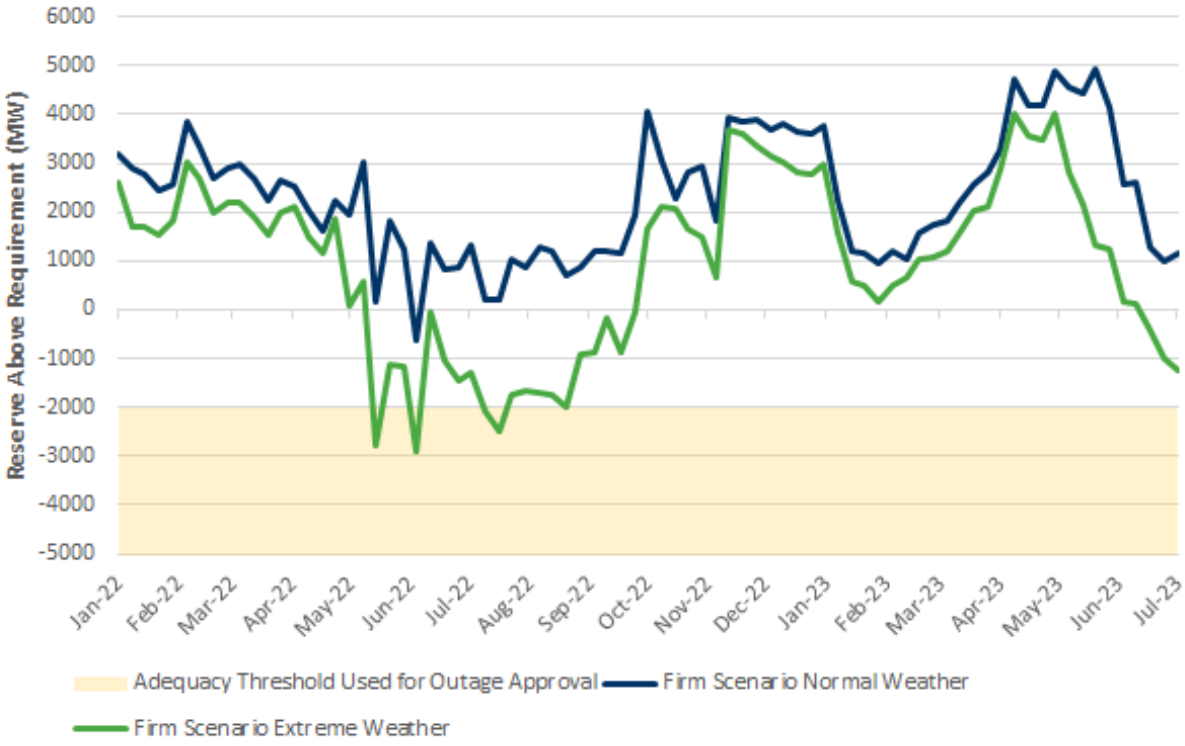
The reserve requirement in the firm scenario under normal weather conditions is met throughout the entire Outlook period. In the firm scenario under extreme weather conditions, the reserve is lower than the requirement for four weeks in the spring and summer of 2022. Under the current outage schedule, the RAR is below the -2,000 MW threshold for one week in May, one week in June, and two weeks in July of 2022.

This potential shortfall is partially attributed to planned generator outages scheduled during those weeks. Generators are advised not to schedule outages during this period, or any other period when reserves are forecast to be low.

If extreme weather conditions materialize, the IESO may reject some generator outage requests to ensure that Ontario demand is met. The IESO will continue to work with generators to ensure outages are optimally scheduled.

[6] Results of the December 2021 Capacity Auction were not available at the time this assessment was completed; actual results can be found in the post-auction report on the IESO's webpage, and will be included in the firm scenario in future outlooks.

Figure 4-3 | Comparison of Normal and Extreme Weather: Firm Scenario Reserve Above Requirement



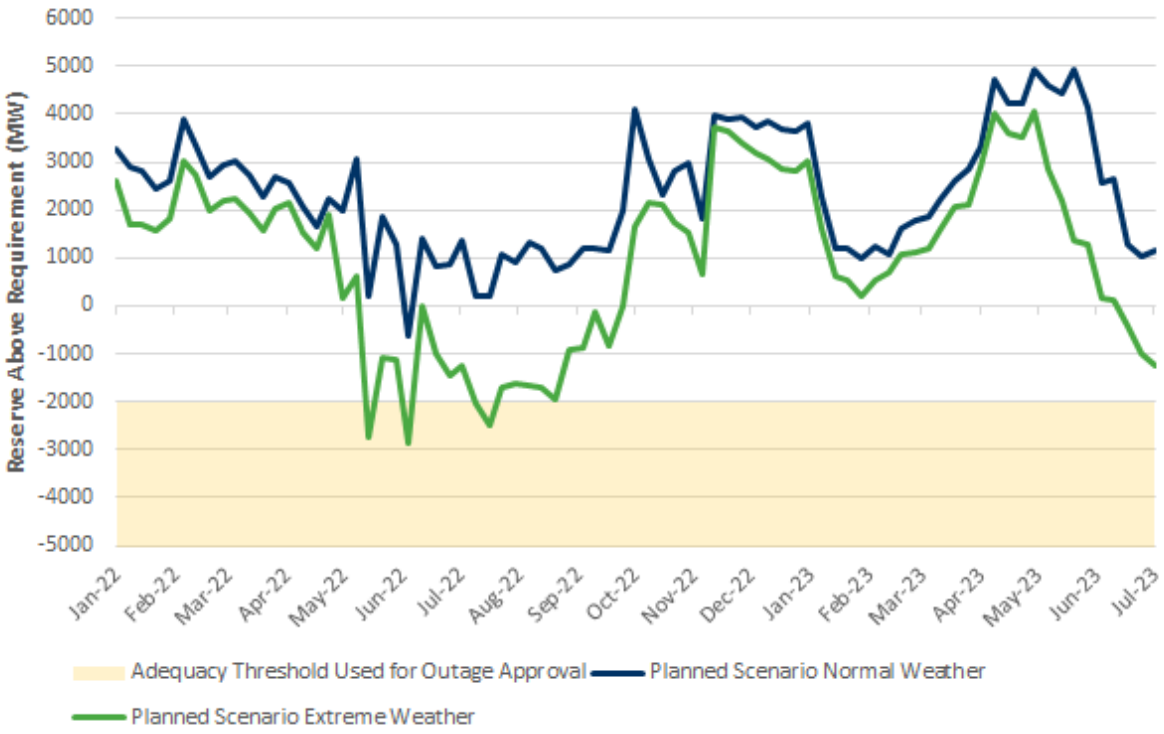
4.2.2 Planned Scenario with Normal and Extreme Weather

The planned scenario incorporates all existing capacity, as well as all capacity expected to come into service. Approximately 160 MW of new generation capacity is expected to connect to Ontario's grid over this Outlook period, while 2,392[7] MW of generation capacity contracts will expire. However, of this amount, 2,238 MW from Lennox GS and Calstock GS are expected to be re-acquired and, as such, this capacity has been included in both the firm and planned scenarios. For planning purposes, the remainder will not be considered to be available to meet demand for electricity.

Figure 4-4 shows RAR levels under the planned scenario. As observed, the reserve requirement will be met throughout the Outlook period under normal weather conditions. Under the extreme weather scenario, however, reserves fall short during the spring and summer of 2022.

[7] This figure includes the expiry of contracts at Calstock and Lennox GS. See notes to Table 4-2 for further details.

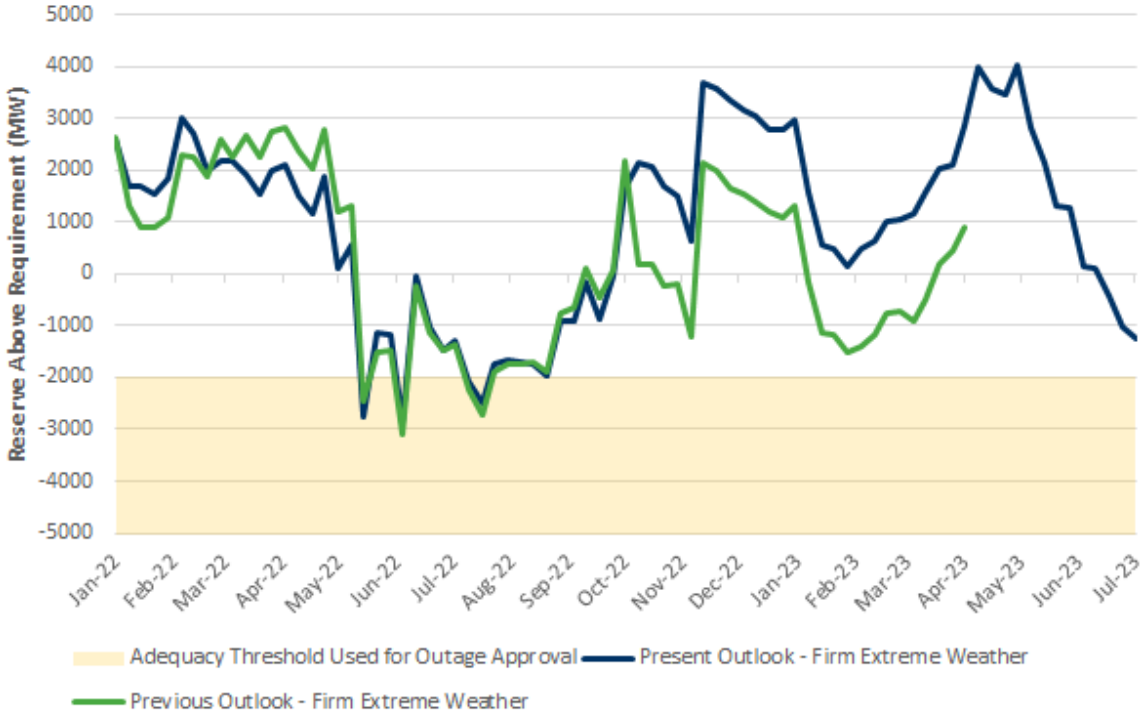
Figure 4-4 | Comparison of Normal and Extreme Weather: Planned Scenario Reserve Above Requirement



4.2.3 Comparison of the Current and Previous Weekly Adequacy Assessments for the Firm Extreme Weather Scenario

Figure 4-5 compares forecast RAR values in the current Outlook with those in the previous Outlook, which was published on September 23, 2021. The difference is primarily the result of changes in planned outages.

Figure 4-5 | Comparison of Current and Previous Outlook: Firm Scenario Extreme Weather Reserve Above Requirement



Resource adequacy assumptions and risks are discussed in detail in the Methodology to Perform the Reliability Outlook.

4.3 Energy Adequacy Assessment

This section assesses energy adequacy to determine whether Ontario has sufficient supply to meet its forecast energy demands, while highlighting potential adequacy concerns during the Outlook time frame. At the same time, the assessment estimates the aggregate production by resource category to meet the projected demand based on assumed resource availability.

4.3.1 Summary of Energy Adequacy Assumptions

The energy adequacy assessment (EAA) uses the same set of assumptions as the capacity assessment, as outlined in Table 4-1 and Table 4-2, which indicate the total capacity of committed resources and when they are expected to be available over the next 18 months. The monthly forecast of energy production capability, based on energy modelling results, is included in the 2021 Q4 Outlook Tables.

For the EAA, only the firm scenario in Table 4-5 with normal weather demand is assessed. The key assumptions specific to this assessment are described in the Methodology to Perform the Reliability Outlook.

4.3.2 Results – Firm Scenario with Normal Weather

Table 4-5 summarizes the energy simulation results over the next 18 months for the firm scenario with normal weather demand both for Ontario and for each transmission zone.

Table 4-5 | Summary of Zonal Energy for Firm Scenario Normal Weather

Zone	18-Month Energy Demand TWh	18-Month Energy Demand Average MW	18-Month Energy Production TWh	18-Month Energy Production Average MW	Net Inter-Zonal Energy Transfer TWh	Zonal Energy Demand on Peak Day of 18-Month Period GWh	Available Energy on Peak Day of 18-Month Period GWh
Bruce	1.1	87.0	59.2	4,517.0	58.1	1.7	134.6
East	11.9	906.0	19.6	1,496.0	7.7	25.1	90.9
Essa	13.0	995.0	4.7	358.0	-8.3	28.2	15.6
Niagara	6.1	469.0	21.3	1,628.0	15.2	15.0	52.0
Northeast	15.5	1,181.0	15.3	1,166.0	-0.2	25.1	31.9
Northwest	6.8	521.0	6.8	521.0	0.0	11.8	20.8
Ottawa	13.1	998.0	0.3	23.0	-12.8	30.1	1.0
Southwest	40.6	3,098.0	8.8	673.0	-31.8	93.2	22.8
Toronto	73.4	5,599.0	49.8	3,799.0	-23.6	173.8	145.3
West	21.1	1,609.0	16.8	1,280.0	-4.3	51.8	74.9
Ontario	**202.6**	**15,461.0**	**202.6**	**15,461.0**	**0.0**	**455.8**	**589.8**

4.3.3 Findings and Conclusions

As noted in section 4.2.1, Ontario is expected to have adequate reserves for the duration of the outlook in the firm resource, normal weather scenario. The EAA indicates that Ontario is also expected to have sufficient supply to meet its forecast energy needs throughout the outlook period for the firm scenario with normal weather demand, without having to rely on support from external jurisdictions.

The figures and tables in this section are based on a simulation of the province's power system, using the assumptions presented within the Outlook to confirm that Ontario will be energy adequate.

Figure 4-6 breaks down projected production by fuel type to meet Ontario's energy demand for the next 18 months, while Figure 4-7 shows the expected production by fuel type for each month. The province's energy exports and imports are not considered in this assessment. Table 4-6 summarizes these simulated production results by fuel type, for each year.

Figure 4-6 | Forecast Energy Production by Fuel Type

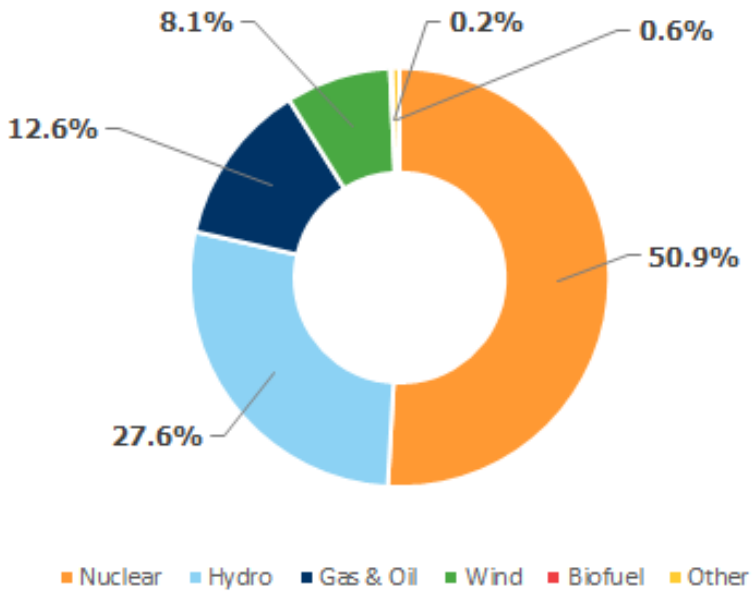


Figure 4-7 | Forecast Monthly Energy Production by Fuel Type

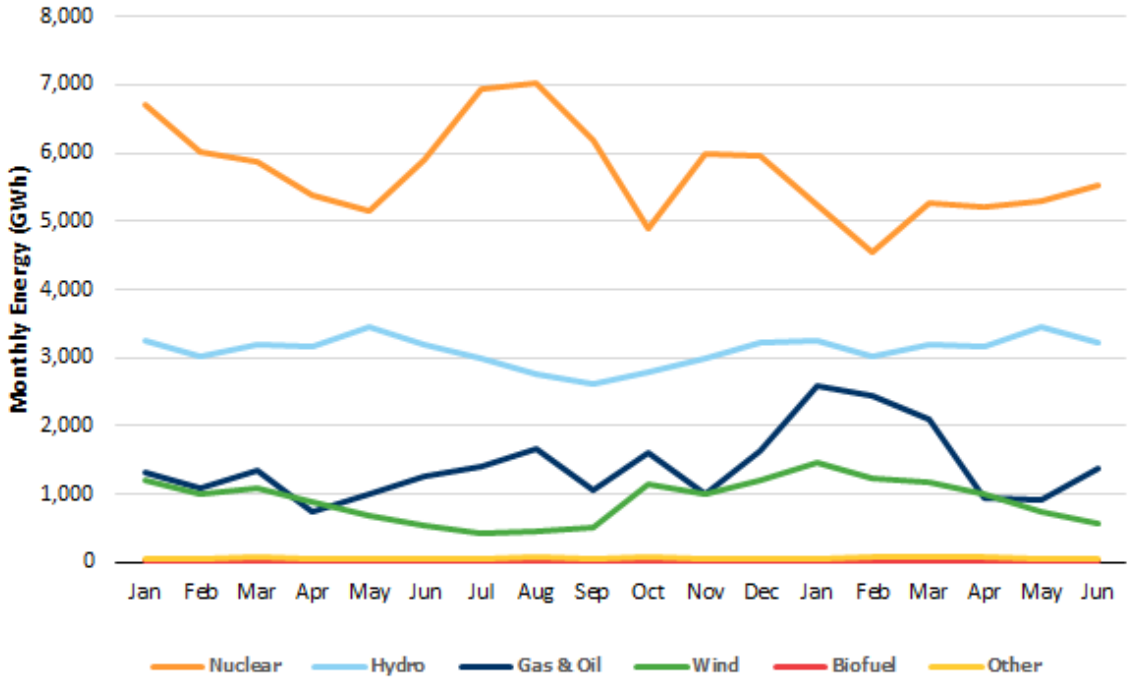


Table 4-6 | Energy Production by Fuel Type for the Firm Scenario Normal Weather

Fuel Type (Grid-Connected)	2022 (Jan 1 – Dec 31) (GWh)	2023 (Jan 1 – Jun 30) (GWh)	Total (GWh)
Nuclear	72,045	31,105	103,149
Hydro	36,649	19,308	55,957
Gas & Oil	15,167	10,403	25,570
Wind	10,198	6,237	16,435
Biofuel	222	108	330
Other (Solar & DR)	730	435	1,165
Total	**135,010**	**67,595**	**202,606**

5. Transmission Reliability Assessment

Ontario's transmission system is expected to continue to reliably supply province-wide demand, while experiencing normal contingencies defined by planning criteria for the next 18 months. However, some combinations of transmission and/or generation outages could create operating challenges. With this, it is increasingly difficult to schedule certain outages due to sheer volume and limited periods to avoid undesirable combinations.

The IESO assesses transmission adequacy using a methodology based on conformance to established criteria, including the Ontario Resource and Transmission Assessment Criteria (ORTAC), NERC transmission planning standard TPL 001-4 and NPCC Directory #1 as applicable. Planned system enhancements and projects, and known transmission outages are also considered in the studies.

Ontario's transmission system is expected to continue to reliably supply province-wide demand while experiencing normal contingencies defined by planning criteria for the next 18 months.

5.1 Transmission Projects

This section considers the information transmitters have provided with respect to transmission projects that are planned for completion within the next 18 months. The list of transmission projects can be found in Appendix B1. Note that the planned in-service dates in this table and throughout this document are as of September 2021. These dates are subject to change as the COVID-19 pandemic may impact project logistics. Any changes will be communicated through subsequent Reliability Outlooks.

5.2 Transmission Outages

The IESO's assessment of transmission outage plans is shown in Appendix C, Tables C1 to C11. The methodology used to assess the transmission outage plans is described in the Methodology to Perform the Reliability Outlook. This Outlook reflects transmission outage plans submitted to the IESO as of November 8, 2021.

5.3 Transmission Considerations

The purpose of this section of the report is to highlight projects and outages that may affect reliability and/or the scheduling of other outages, and to consolidate these considerations by zone. For more information about the IESO's transmission zones and interfaces, please see the Transfer Capability Assessment Methodology.

Bruce, Southwest, and West Zones

Significant growth in the greenhouse sector has led to a number of customer connection requests in the Windsor-Essex region that are expected to exceed the capacity of the existing transmission system in the area. A new switching station at the Leamington Junction is proceeding toward a Q2 2022 in-service date. Outages may be more challenging to accommodate as new load connections are made and required transmission reinforcements are being implemented.

A series of planned outages for one month starting May 9, 2022 on circuit B502M will impact the flow out of Bruce zone.

Toronto, East, and Ottawa Zones

Operational challenges due to high voltages in eastern Ontario and the Greater Toronto Area continue to occur during low-demand periods. High voltages are the result of lower minimum demand for electricity, which has been exacerbated by the impacts of COVID-19.

The IESO and Hydro One are currently managing this situation by removing from service certain 500 kV circuits mainly in eastern Ontario and occasionally in the Bruce area during those periods. Up to three 500 kV circuits have been removed from service during the lowest demand periods in Ontario. To address this issue on a longer-term basis, two 500 kV line-connected shunt reactors are being installed at Lennox TS. The first reactor has been installed and it is expected to be in-service in Q1 2022. The planned installation date of the second reactor is Q1 2022 and it is expected to placed in-service soon after.

There are upcoming nuclear refurbishments of multiple units at Darlington with overlapping timelines. As a result, it will be increasingly challenging for market participants to take outages related to the FETT interface. Future planned outages will necessitate enhanced coordination between transmitters and generators. Planned outages for certain windows may need to be rescheduled or rejected to ensure reliability.

The FETT Capacity Upgrade (i.e. Richview-Trafalgar Reinforcement) project to address needs in 2026 is expected to begin next year, with an expected in-service date of Q1 2026.

The Hawthorne-Merivale transmission path supplies load in western Ottawa and delivers eastern Ontario resources and imports from Quebec to southern Ontario load centres. The reinforcement consists of upgrading the two 230 kV circuits between Merivale TS and Hawthorne TS, a length of 12 km. Hydro One is expected to begin the project next year, with an expected in-service date of Q4 2023.

The capacity of Flow into Ottawa (FIO) interface will be reduced for extended periods due to the outages on X522A: a set involving two months starting April 6, 2022 and a one-month outage starting September 12, 2022.

Northwest, Northeast, and Essa Zones

A one-month outage on circuit X504E starting October 3, 2022 will reduce the transfer capability of the North-South Tie.

A one-and-a-half-month outage on circuit M24L starting April 4, 2022 will reduce the transfer capability of the East-West Tie.

A planned one-month D501P outage starting January 31, 2022 will result in operational challenges in managing local supply and demand balancing. Close coordination with various loads and generators in Kapuskasing, Pinard, and the surrounding area, will be required over this period.

The East-West Tie Expansion project consists of a new 230 kV transmission line roughly paralleling the existing East-West Tie Line between Wawa and Thunder Bay. The new line will increase the electricity transfer capability into Northwest Ontario and will improve the flexibility and efficiency of the Northwest electricity system. As part of this project, upgrades are being planned for the Lakehead, Marathon and Wawa transformer stations to accommodate the new line. The planned in-service date of the project is Q1 2022. However, the full benefit of the project will not be realized right away due to ongoing and upcoming outages as a result of work in the Northwest.

Studies in the Kirkland Lake area have indicated the need for transmission reinforcements due to potential load growth and limited transfer capabilities, as well as load security violations under planning scenarios. Until these reinforcements are finalized and put in service, the addition of new loads may be difficult and subject to requirements such as pre-contingency load curtailment and post-contingency load rejection.

Due to multiple equipment failures in the Northeast, there have been high-voltage operational concerns. This has resulted in challenges in accommodating outages that exacerbate these concerns.

Interconnections

The failure of the phase angle regulator (PAR) connected to the Ontario-New York 230 kV circuit L33P in early 2018 continues to hinder the province's ability to import electricity from New York through the New York-St. Lawrence interconnection and from Quebec through the Beauharnois interconnection. This has required enhanced coordination with affected parties and more focused management of St. Lawrence-area resources in real-time. Careful coordination of transmission and generation outages will continue to be required in the area.

PARs are unique pieces of equipment and replacements are not readily available. Replacement options were investigated by the IESO, in conjunction with Hydro One, the NYISO and the New York Power Authority. The proposed replacement will provide greater flexibility to control both current and future intertie flows with New York. The PAR on L34P will be upgraded to match L33P. The expected in-service date is Q2 2022 for the PAR on L33P and Q2 2023 for the PAR on L34P.

Several planned outages on circuits PA301 and BP76 during the second half of 2022 will reduce the import and export transfer capability between Ontario and New York.

6. Operability

During the Outlook period, Ontario will continue to experience potential surplus baseload generation conditions, much of which can be managed with existing market mechanisms, such as exports and curtailment of variable generation.

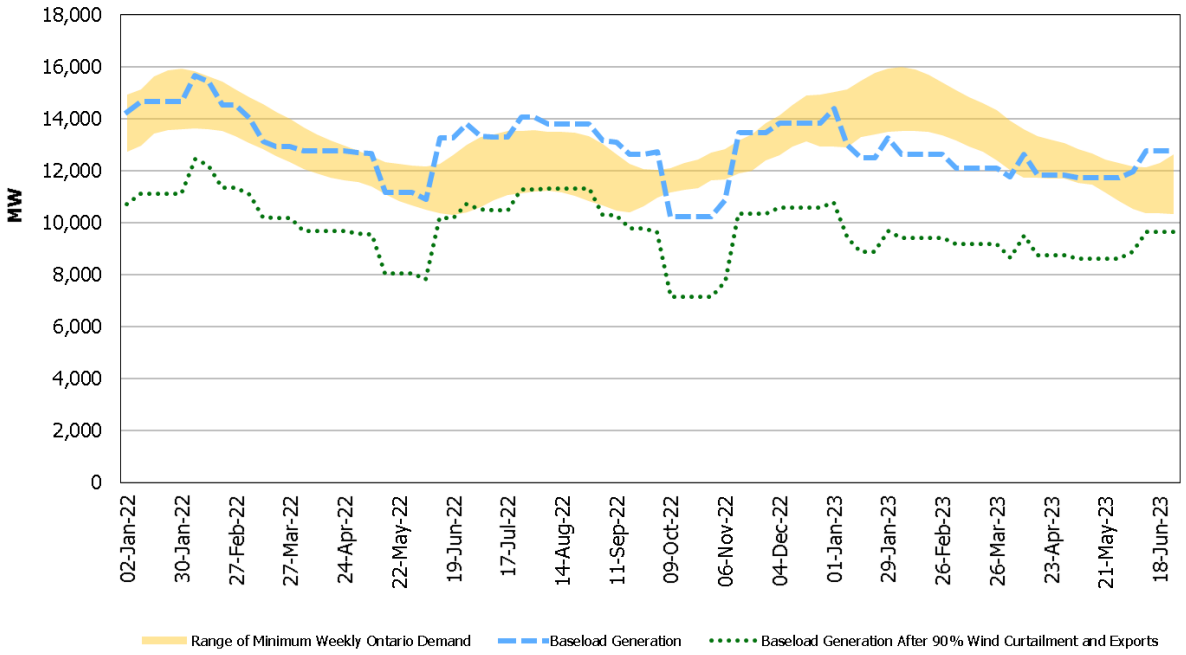
This section highlights existing or emerging operability issues that could impact the reliability of Ontario's power system.

6.1 Surplus Baseload Generation

Baseload generation comprises nuclear, run-of-the-river hydroelectric and variable generation, such as wind and solar. When baseload supply is expected to exceed Ontario demand, market signals reflect such conditions through lower prices, and resources in Ontario and at the interties respond accordingly. The resulting market outcomes may include higher export volumes, dispatching down of hydroelectric generation and grid-connected renewable resources, and nuclear manoeuvring or shutdowns. For severe surplus conditions that could affect the reliability of the system, the IESO may take out-of-market actions, such as manually curtailing resources and/or imports.

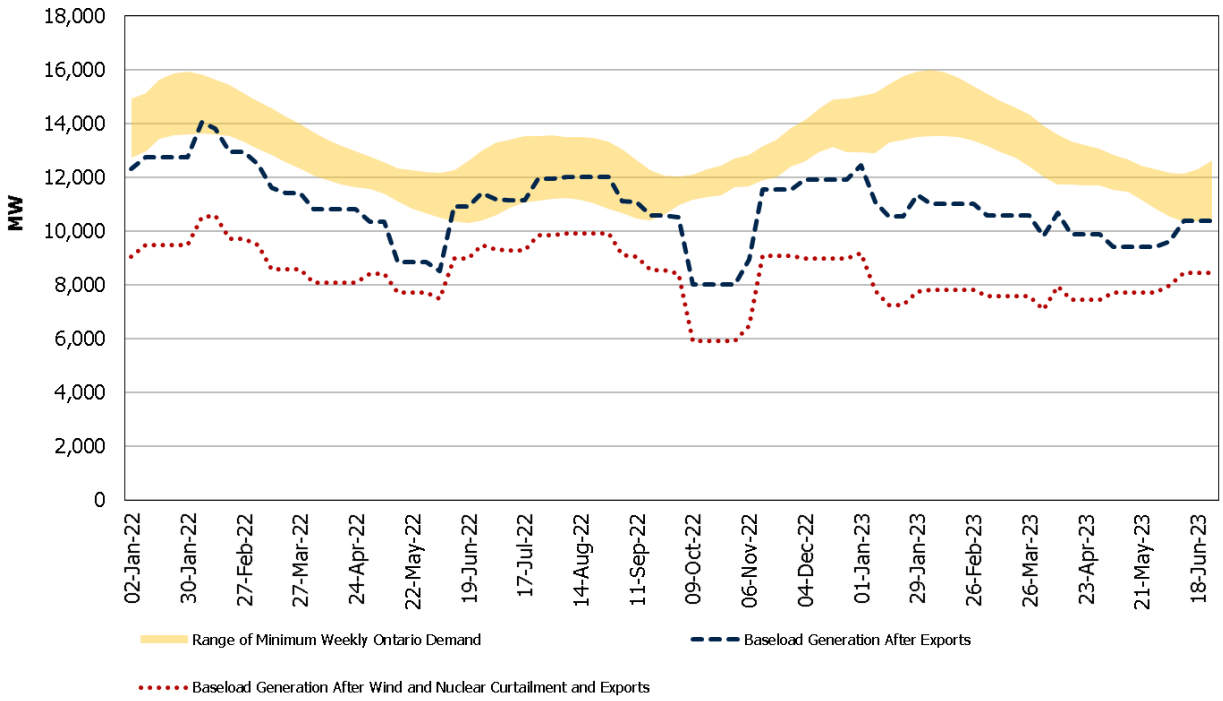
Ontario is expected to experience potential surplus baseload conditions at various times throughout the Outlook. Figure 6-1 highlights the periods during which expected baseload generation may exceed forecast demand.

Figure 6-1 | Minimum Ontario Demand and Baseload Generation



Surplus baseload conditions can be managed with existing market mechanisms signaling for exports, and by curtailing variable and nuclear generation. Going forward, as shown in Figure 6-2, existing mechanisms will be sufficient for managing SBG.

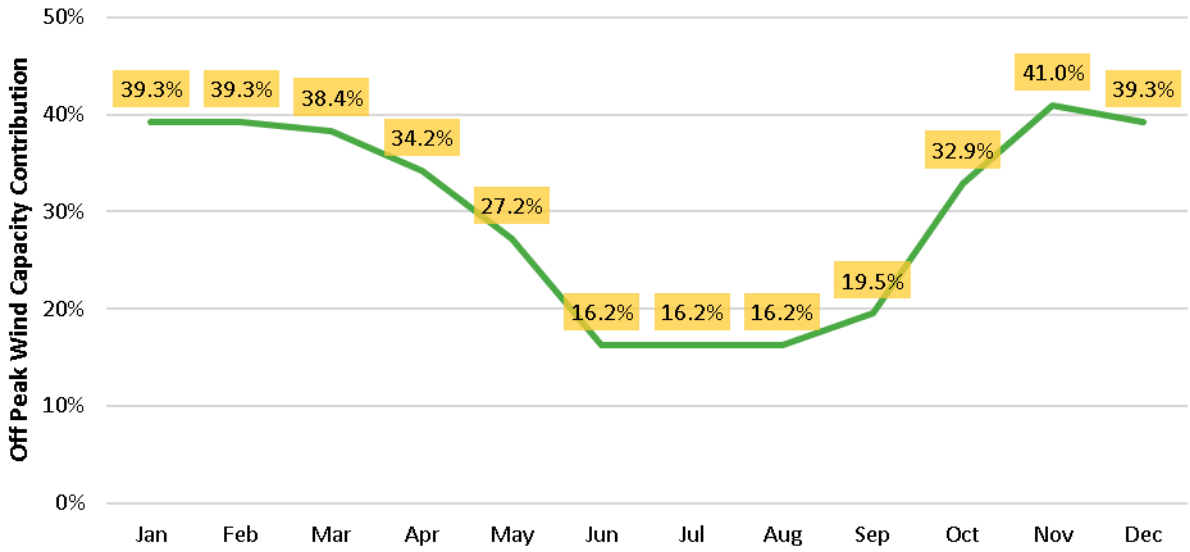
Figure 6-2 | Minimum Ontario Demand and Baseload Generation



The baseload generation assumptions include expected exports and run-of-the-river hydroelectric production, the latest planned outage information and in-service dates for new or refurbished generation. The expected contribution from self-scheduling and intermittent generation has been updated to reflect the latest data. Information on the dispatch order of wind, solar and flexible nuclear resources can be found in Market Manual 4 Part 4.2.

Output from commissioning units is explicitly excluded from this analysis due to uncertainty and the highly variable nature of commissioning schedules. Figure 6-3 shows the monthly off-peak wind capacity contribution values calculated from actual wind output up to March 31, 2021. These values are updated annually to coincide with the release of the Q2 Outlook.

Figure 6-3 | Monthly Off-Peak Wind Capacity Contribution Values



6.2 Ancillary Services

Ancillary Services are services that help ensure the reliable operation of the power system. The IESO contracts for four ancillary services: certified black start facilities, regulation service, reactive support and voltage control service, and reliability must-run. The IESO regularly studies the needs for these services. Salient details of recent studies are presented below.

6.2.1 Regulation Service

The IESO conducted a regulation service needs assessment in 2021 to determine if an incremental regulation need exists beyond today's minimum +/-100 MW requirement, for a period up to 2026. The assessment found that there is no incremental need for more than +/-100 MW of regulation to be scheduled in Ontario over the outlook period.

7. Resources Referenced in This Report

The table below lists additional resources in the order they appear in the report.

Table 7-1 | Additional Resources

Resource	URL	Location in This Report
Reliability Outlook Webpage	http://www.ieso.ca/en/Sector-Participants/Planning-and-Forecasting/Reliability-Outlook	Introduction
Security and Adequacy Assessments	http://www.ieso.ca/power-data/data-directory	Introduction
2021 Q4 Outlook Tables	http://www.ieso.ca/-/media/files/ieso/document-library/planning-forecasts/reliability-outlook/ReliabilityOutlookTables_2021Dec.xls	Throughout
Connection Assessments and Approval Process	http://www.ieso.ca/en/sector-participants/connection-assessments/application-status	Assessment Assumptions
Methodology to Perform the Reliability Outlook	http://www.ieso.ca/-/media/files/ieso/document-library/planning-forecasts/reliability-outlook/ReliabilityOutlookMethodology.pdf	Throughout
Capacity Auction	http://www.ieso.ca/en/Sector-Participants/Market-Operations/Markets-and-Related-Programs/Capacity-Auction	Demand Measures
Enabling Capacity Exports	http://www.ieso.ca/en/Sector-Participants/Market-Renewal/Capacity-Exports	Firm Transactions
Ontario Resource and Transmission Assessment Criteria	https://www.ieso.ca/-/media/Files/IESO/Document-Library/Market-Rules-and-Manuals-Library/market-manuals/connecting/IMO-REQ-0041-TransmissionAssessmentCriteria.ashx	Transmission Considerations
NERC Transmission Planning Standard TPL-001-4	http://www.nerc.com/pa/Stand/Reliability%20Standards/TPL-001-4.pdf	Transmission Considerations
NPCC Directory #1	https://www.npcc.org/Standards/Directories/Directory_1_TFCP_rev_20151001_GJD.pdf https://www.npcc.org/content/docs/public/program-areas/standards-and-criteria/regional-criteria/directories/directory-01-design-and-operation-of-the-bulk-power-system.pdf	Transmission Considerations
Market Manual 4 Part 4.2	http://www.ieso.ca/-/media/Files/IESO/Document-Library/Market-Rules-and-Manuals-Library/market-manuals/market-operations/mo-dispatchdatartm.pdf?la=en	Surplus Baseload Generation

8. List of Acronyms

Acronym	Definition
CAA	Connection Assessment and Approval
CROW	Control Room Operations Window
DER	Distributed Energy Resource
DR	Demand Response
EAA	Energy Adequacy Assessment
ESAG	Energy Storage Advisory Group
FETT	Flow East Toward Toronto
GS	Generating Station
GTA	Greater Toronto Area
ICI	Industrial Conservation Initiative
IESO	Independent Electricity System Operator
IRRP	Integrated Regional Resource Plan
kV	Kilovolt
LDC	Local Distribution Company
MW	Megawatt(s)
NERC	North American Electric Reliability Corporation
NPCC	Northeast Power Coordinating Council
NYISO	New York Independent System Operator
ORTAC	Ontario Resource and Transmission Criteria
PAR	Phase Angle Regulator
RAR	Reserve Above Requirement
RAS	Remedial Action Scheme
SBG	Surplus Baseload Generation
SCC	Solar Capacity Contribution
TS	Transmission/Transformer Station
TWh	Terawatt-hour(s)
WCC	Wind Capacity Contribution

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