Reliability Outlook

An adequacy assessment of Ontario's electricity system

FROM OCTOBER 2019 TO MARCH 2021

Connecting Today.
Powering Tomorrow.

Executive Summary

The fall edition of the IESO's Reliability Outlook provides the sector with a big-picture energy overview for the 18-month period from October 2019 to March 2021. This analysis aims to help market participants schedule their outages, while drawing attention to considerations that could affect the reliability of Ontario's electricity system.

Energy demand remains stable

Not much has changed significantly in the three months since the summer Outlook was released. For 10 years, the demand for energy from the grid has remained fairly stable in Ontario, and 2019 is expected to wrap with a small decline in demand. In 2020, a strong U.S. economy, a low Canadian dollar and all the associated economic activity, are foreseen to spur increased demand.

Resources are ready and adequate

The Outlook determined that, under normal conditions, Ontario is well-positioned to meet the demand for electricity over the 18-month forecast period. Any risks arising during this time should be sufficiently managed through rescheduling outages.

Outage requests may face increasing pressure

Coordinating outages is increasingly challenging as significant capital upgrades often coincide with ongoing routine maintenance. Considering firm resources and extreme weather, Ontario's reserve above requirement (RAR) is projected to fall below the 2,000 MW threshold for several weeks in summer 2020. If these conditions materialize, the IESO may need to reject some outage requests during this period. The anticipated completion date for the Darlington Unit 2 refurbishment has been delayed until mid-2020. If the project is pushed back further into the summer, managing outages could become an even greater challenge.

The Independent Electricity System Operator (IESO) ensures the reliability of Ontario's power system on behalf of all Ontarians. Balancing electricity supply and demand depends on comprehensive short- and long-term planning that enables the IESO to continue to meet reliability requirements, while giving market participants the data and insights they need to make informed operational and investment decisions.

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1. Introduction

This Outlook covers the 18-month period from October 2019 to March 2021, which supersedes the Outlook released on June 20, 2019.

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

- Advise market participants of the resource and transmission reliability of Ontario's 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

Additional supporting documents are located on the IESO website.

This Outlook presents an assessment of resource and transmission adequacy based on the stated assumptions, using the methodology described in the accompanying methodology document. Due to uncertainties associated with the assumptions used in this analysis, readers must exercise judgment in applying this information to possible future scenarios.

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

For questions or comments on this Outlook, please contact us by:

- Telephone: 1-888-448-7777 or 905-403-6900
- E-mail: customer.relations@ieso.ca

2. Updates to This Outlook

2.1 Updates to Demand Forecast

The demand forecast used in this Outlook is informed by actual demand, weather and economic data through to the end of June 2019, and has been updated to reflect the most recent economic projections. Actual weather and demand data for July and August 2019 are included in the tables.

2.2 Updates to Resources

This *Reliability Outlook* considers planned generator outages submitted by market participants to the IESO's outage management system as of September 9, 2019.

2.3 Updates to Transmission Outlook

Transmission outage plans that were submitted to the IESO's outage management system by July 29, 2019, are considered in this Outlook.

2.4 Updates to 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 September 9, 2019.

3. Demand Forecast for 18-Month Period

Grid-supplied energy demand is expected to dip in 2019, as some of the weakness in the latter half of 2018 carried over into 2019. For 2020 and early 2021, demand is expected to see positive gains beyond the bump that comes with the additional day of a leap year. Continued economic and demographic growth will push demand higher.

The IESO is responsible for forecasting electricity demand on the IESO-controlled grid. This demand forecast covers the period from October 2019 to March 2021 and supersedes the previous forecast released in June 2019. Tables of supporting information are contained in the 2019 Q3 Outlook Tables spreadsheet.

Electricity demand is shaped by a number of factors. These can:

- Increase the demand for electricity, e.g., population growth, economic expansion and the increased penetration of end-uses
- Reduce the need for grid-supplied electricity, e.g., conservation and embedded generation
- Shift demand, e.g., time-of-use rates and the Industrial Conservation Initiative (ICI)

How each of these factors impacts electricity consumption varies by season and time of day – and is reflected in the demand forecast.

Grid-supplied energy demand has been fairly flat since the 2009 recession with small increases and decreases year-to-year. Based on the actuals to date, a small decline is expected in 2019. Going forward, a strong U.S. economy and low Canadian dollar will help boost demand in the industrial sector, while population growth and consumer activity should help increase electricity demand in the residential and commercial markets. These combined effects, along with the additional leap year day, will lead to positive growth in 2020. As well, embedded generation capacity has stopped growing and conservation savings are forecast until the end of 2020, eliminating downward pressure on electricity demand later in the forecast.

Peak demands are subject to the same forces as energy demand, though the impacts vary. This is true when comparing energy demand to peak demand, and summer to winter peaks. Recent history has seen lower summer peaks, thanks to growth in embedded-generation capacity and the ICI. The majority of embedded generation is provided by solar-powered facilities that generate high output during traditional summer peak-hour periods and no output during the winter peak-hour periods. In addition to reducing summer peaks, higher embedded solar output has also pushed the peak to later in the day. As before, with the amount of embedded solar capacity plateauing and no incremental conservation savings beyond 2020, the downward pressure on peaks is forecast to ease, allowing for an overall increase in the demand forecast.

The following tables show the seasonal peaks and annual energy demand over the forecast horizon of the Outlook.

Table 3-1 | Historical and Forecast Energy Summary

Year	Normal Weather Energy (TWh)	% Growth in Energy
2006	152.3	-1.9%
2007	151.6	-0.5%
2008	148.9	-1.8%
2009	140.4	-5.7%
2010	142.1	1.2%
2011	141.2	-0.6%
2012	141.3	0.1%
2013	140.5	-0.6%
2014	138.9	-1.1%
2015	136.2	-1.9%
2016	136.2	0.0%
2017	132.3	-2.8%
2018	135.2	2.2%
2019 (Forecast)	134.9	-0.2%
2020 (Forecast)	135.9	0.7%

Table 3-2 | Forecasted Seasonal Peaks

Season	Normal Weather Peak (MW)	Extreme Weather Peak (MW)
Winter 2019-20	21,115	22,288
Summer 2020	22,138	24,500
Winter 2020-21	21,160	22,456

3.1 Actual Weather and Demand

Since the last forecast, actual electricity demand and weather data for June, July and August have been recorded.

June

- In June, the weather was much colder than normal, with average temperatures putting it in the coldest quartile of the past 50 years. The peak temperature for the month was also in the coldest quartile.

- The monthly peak occurred on Thursday, June 27, the hottest day of the month. The afternoon high was 28.9°C (at Toronto), the coolest June peak since 2015, when the June peak (19,339 MW) was the lowest since market opening.
- The weather-corrected peak for the month was 21,043 MW. This is consistent with the past several years where the weather-corrected peak has averaged 21,200 MW since the 2009 recession.
- Energy demand for the month was 10.4 TWh (10.5 TWh weather-corrected), lower than the last several years which averaged roughly 11.0 TWh weather-corrected.
- The minimum demand for the month was 10,564 MW, in line with June values since the 2009 recession. The minimum occurred in the early hours of Sunday, June 9.
- Embedded generation for the month was 602 GWh, an increase of 0.1% compared to the previous June. Hydro (27.6%) and non-contracted (94.4%) output were up, but reductions in solar (-9.1%) and bio (-6.5%) output offset those increases.
- Wholesale customer consumption increased 0.9% year over year. Most of the growth came from petroleum refining (45.2%) and chemicals (2.6%). Other major sectors were flat.

July

- This year, the weather was warmer than normal for July. The warmer weather didn't occur during peak periods, but instead over the remainder of the month when the weather is usually cooler. The peak temperature was the 18th highest over the past 50 years, but the average temperature was the 7th highest.
- The peak occurred on July 29, the third warmest day of the month, during a modest heat wave. The peak-day high was 31.4°C, which was slightly warmer than normal. The actual peak was 21,791 MW (21,069 MW weather-corrected). The observed July peak was the fourth-lowest since market opening.
- Similar to last July, energy demand for the month was 12.7 TWh (12.3 TWh weather-corrected)
- Minimum demand was 11,565 MW – a high value by recent historical standards – and occurred in the early morning of the Canada Day holiday.
- Embedded generation for July topped 607 GWh, which represents a 20.1% increase over last July. Bio-gas output was down slightly (-1.3%) over the previous July, while all other types increased – solar (2.4%), wind (12.6%) and hydro (24.2%).
- Wholesale customer load fell 0.4% year over year. While iron and steel (4.5%) rebounded with the removal of U.S. tariffs, and petroleum refining (0.3%) and chemicals (4.3%) continued to perform strongly, declines in pulp and paper (-9.3%) and other sectors brought the numbers down for the month.

August

- This year, the weather for August was near normal. Although average temperatures were representative, peak temperatures were cooler than normal and minimum temperatures were higher than normal. This means that energy demand was typical but peak demand was low. The peak temperature was the 45th highest over the past 50 years, while the average temperature was the 26th highest.

- Peak demand occurred on August 21, which was the hottest day of the month and came at the end of a moderate heat wave. The peak-day high was 30.2°C, which was cooler than normal. The actual peak was 21,354 MW (22,100 MW weather-corrected).
- Without the high temperatures of last year, actual demand was 11.8 TWh, much lower than last year's 12.7 TWh. With near normal average temperatures, the weather-corrected value was also 11.8 TWh.
- Minimum demand of 11,280 MW and occurred in the early morning of the Sunday, August 11.
- Embedded generation for August topped 557 GWh, representing a 6.7% increase over last August. Increases in wind (28.5%) and hydro (39.0%) output more than offset the decline in solar (-4.9%) and bio-gas (-5.5%) output.
- Wholesale customer load fell slightly (-0.1%) in August. Pulp and paper (-9.3%) and iron and steel (-8.6%) showed declines that outweighed growth in mining (10.4%) and chemicals (3.1%). Wholesale customer load continues to bounce around without a clear and sustained pattern.

Overall, energy demand for the three summer months from June to August was down 3.6% compared with the previous summer. After adjusting for the weather, demand for the three months showed a decline of 2.0%.

Embedded generation for the three months increased by 8.5% over the same time a year ago. Most of the increase came from wind and hydro generation.

For the three months, wholesale customer consumption posted a 0.1% decrease over the same months a year prior. Pulp and paper and iron and steel showed declines where the other large sectors – mining, refining, chemicals and motor vehicle production showed an increase.

The 2019 Q3 Outlook Tables spreadsheet contains several tables with historical data. They are:

- Table 3.3.1 Weekly Weather and Demand History Since Market Opening
- Table 3.3.2 Monthly Weather and Demand History Since Market Opening
- Table 3.3.3 Monthly Demand Data by Market Participant Role

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)
06-Oct-19	17,091	17,334	786	2,398
13-Oct-19	16,936	16,952	507	2,422
20-Oct-19	17,186	17,593	392	2,377
27-Oct-19	17,365	17,843	318	2,460
03-Nov-19	17,559	18,193	416	2,477
10-Nov-19	18,521	18,946	601	2,573
17-Nov-19	18,717	19,533	342	2,591
24-Nov-19	19,318	20,022	607	2,678
01-Dec-19	19,597	20,619	409	2,708
08-Dec-19	19,924	21,033	555	2,754
15-Dec-19	20,307	21,173	690	2,791
22-Dec-19	20,086	21,165	362	2,782
29-Dec-19	18,512	19,560	528	2,626
05-Jan-20	19,859	20,856	570	2,755
12-Jan-20	21,115	22,288	547	2,913
19-Jan-20	20,694	21,320	483	2,889
26-Jan-20	20,548	21,502	404	2,889
02-Feb-20	20,573	21,658	734	2,905
09-Feb-20	19,853	21,449	635	2,841
16-Feb-20	19,490	20,841	581	2,773
23-Feb-20	19,245	20,903	501	2,740
01-Mar-20	19,764	20,956	531	2,784
08-Mar-20	19,318	20,091	649	2,716
15-Mar-20	18,214	18,867	611	2,628
22-Mar-20	17,543	18,448	569	2,532
29-Mar-20	17,526	18,494	567	2,529
05-Apr-20	17,257	17,811	471	2,487
12-Apr-20	16,616	17,485	496	2,375
19-Apr-20	15,985	16,142	531	2,358
26-Apr-20	16,179	16,715	721	2,353
03-May-20	17,207	19,509	849	2,335
10-May-20	16,497	19,247	845	2,340
17-May-20	18,002	21,097	1,175	2,361
24-May-20	17,648	21,341	1,330	2,313
31-May-20	18,482	20,800	1,292	2,376
07-Jun-20	19,209	23,331	1,055	2,550
14-Jun-20	20,278	23,723	835	2,567
21-Jun-20	21,347	23,789	754	2,630

Week Ending	Normal Peak (MW)	Extreme Peak (MW)	Load Forecast Uncertainty (MW)	Normal Energy Demand (GWh)
28-Jun-20	21,477	23,793	1,016	2,686
05-Jul-20	20,481	23,246	814	2,646
12-Jul-20	22,138	24,500	838	2,749
19-Jul-20	20,683	23,994	1,035	2,620
26-Jul-20	21,232	24,194	841	2,710
02-Aug-20	21,890	24,042	958	2,707
09-Aug-20	21,234	23,634	985	2,673
16-Aug-20	20,478	23,450	1,362	2,655
23-Aug-20	21,320	23,094	1,413	2,702
30-Aug-20	19,926	22,346	1,370	2,550
06-Sep-20	18,330	23,143	680	2,442
13-Sep-20	18,788	20,493	781	2,417
20-Sep-20	17,556	19,734	420	2,422
27-Sep-20	16,783	18,057	554	2,362
04-Oct-20	17,109	17,141	786	2,407
11-Oct-20	16,746	16,794	507	2,424
18-Oct-20	17,042	17,451	392	2,384
25-Oct-20	17,225	17,720	318	2,468
01-Nov-20	17,477	18,111	416	2,495
08-Nov-20	18,470	18,796	601	2,576
15-Nov-20	18,617	19,332	342	2,596
22-Nov-20	19,168	19,851	607	2,668
29-Nov-20	19,583	21,044	409	2,730
06-Dec-20	19,880	20,889	555	2,757
13-Dec-20	20,271	21,240	690	2,798
20-Dec-20	19,991	21,070	362	2,785
27-Dec-20	18,740	19,587	528	2,742
03-Jan-21	20,182	21,072	528	2,731
10-Jan-21	21,160	22,456	570	2,938
17-Jan-21	20,826	21,752	547	2,909
24-Jan-21	20,680	21,836	483	2,909
31-Jan-21	20,704	21,987	404	2,933
07-Feb-21	20,179	21,577	734	2,860
14-Feb-21	19,815	21,164	635	2,792
21-Feb-21	19,571	21,230	581	2,759
28-Feb-21	20,108	21,294	501	2,811
07-Mar-21	19,670	20,244	531	2,744
14-Mar-21	19,009	19,465	649	2,674
21-Mar-21	17,866	18,567	611	2,551

Week Ending	Normal Peak (MW)	Extreme Peak (MW)	Load Forecast Uncertainty (MW)	Normal Energy Demand (GWh)
28-Mar-21	17,850	18,614	569	2,548
04-Apr-21	17,877	18,207	567	2,474

3.2 Forecast Drivers

3.2.1 Economic Outlook

Economic fundamentals remain generally positive for the Ontario economy. Strong U.S. growth, a low Canadian dollar and low interest rates are conducive to growth in Ontario's export-oriented, energy-intensive manufacturing sector. The economy will continue to face significant downside risk during the forecast period due to trade tensions, climate impacts, and global political uncertainty. As long as these risks do not materialize, Ontario should experience increasing economic output over the forecast period. Table 3.3.4 of the 2019 Q3 Outlook Tables presents the economic assumptions for the demand forecast.

3.2.2 Weather Scenarios

The IESO uses weather scenarios to produce demand forecasts. These scenarios include normal and extreme weather, along with load forecast uncertainty, which is a measure of uncertainty in demand due to weather volatility. Table 3.3.5 of the 2019 Q3 Outlook Tables presents the weekly weather data for the forecast period.

3.2.3 Demand Measures and Load Modifiers

Both demand measures and load modifiers can impact demand but differ in how they are treated within the Outlook. Demand measures are not incorporated into the demand forecast and are instead treated as resources. Load modifiers are incorporated into the demand forecast.

As demand measures are dispatched like generation resources, they are included in the supply mix, and added back into the history when forecasting demand. Therefore, the impacts of demand measures are not included in the demand forecast.

Load modifiers include conservation (energy-efficiency programs, codes and standards and fuel switching), price impacts (time-of-use rates and the Industrial Conservation Initiative), and embedded generation. Each impacts demand differently in terms of level and timing, but together have the net effect of reducing the demand for grid-supplied electricity. Conservation affects both the height of peaks and the energy consumed, prices reduce demand during peak periods, and embedded generation impacts vary by fuel type.

4. Resource Adequacy for 18-Month Period

The IESO expects to have sufficient generation supply for winter 2019/2020 as well as winter 2020/2021. Potential risks in summer 2020 are expected to be mitigated by outage rescheduling and by the capacity that will be acquired in the IESO's upcoming capacity auction. Over the next 18 months, 1,500 MW of new generation are planned to come into service, while approximately 38 MW of generation will reach the end of its contract life.

This section provides an assessment of the adequacy of resources to meet the forecast demand. Resource adequacy is one of the key reliability considerations used for approving outages. When reserves are below required levels, and could adversely affect 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 considered, provided other factors, such as local considerations, operability, or transmission security do not pose a reliability concern. In those cases, the IESO may place a planned outage at risk, signaling to the facility owner to consider rescheduling the outage.

The existing installed generation capacity is summarized in Table 4-1. This includes capacity from new projects 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 under commercial operation, and takes into account deratings, planned outages, and 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 Outlook Peak (MW)	Number of Stations	Change in Number of Stations	Change in Installed Capacity
Nuclear	13,009	11,258	5	0	0
Hydroelectric	9,065[1]	4,995	76	0	0
Gas/Oil	10,277	8,439	31	0	0
Wind	4,486	611	39	0	0
Biofuel	295	254	7	0	0
Solar	424	58	9	0	0
Demand Measures	-	794	-	-	-
Firm Imports (+) / Exports (-) (MW)	-	0	-	-	-
Total	**37,555**	**26,411**	**167**	**0**	**0**

[1] Hydroelectric installed capacity has been revised upward since the previous outlook due to a change in calculation methodology; there has been no new hydro capacity installed since the last outlook. The effective MW contribution of hydro at peak remains unchanged.

4.1 Assessment Assumptions

4.1.1 Generation Resources

All generation projects that are scheduled to come into service, or to be upgraded or shut down within the Outlook period are summarized in Table 4-2. This includes generation projects in the IESO's connection assessment and approval process (CAA), 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 the best estimated date of the completion of market registration available to the IESO as of September 9, 2019.

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 resources are restricted to those that have achieved commercial operation status.

Planned shutdowns or retirements of generators that have a high certainty of occurring in the future are considered in both scenarios.

Table 4-2 | Committed Generation Resources Status

Project Name	Zone	Fuel Type	Estimated Effective Date	Project Status	Capacity Considered Firm (MW)	Capacity Considered Planned (MW)
Loyalist Solar	East	Solar	2019-Q4	Commissioning	0	54
Henvey Inlet Wind Farm	Essa	Wind	2020-Q1	Commissioning	0	300
Napanee Generating Station	East	Gas	2020-Q1	Under Development	0	985
Nation Rise	East	Wind	2020-Q1	Under Development	0	100
Romney Wind Energy Centre	West	Wind	2020-Q1	Under Development	0	60
Calstock	Northeast	Biofuel	2020-Q2	Expiring Contract	-38	-38
Total					**-38**	**1,461**

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 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.

• 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 – generators whose contracts 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 without accounting for historical outages is also calculated (see the second row of Table 4-3). Table 4-3 uses data from May 2002 to March 2019, 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)	6,338	6,276	6,102	6,035	6,139	5,958	5,876	5,522	5,273	5,643	5,882	6,336
Historical Hydroelectric Median Contribution without Outages (MW)	6,851	6,846	6,609	6,555	6,594	6,465	6,270	6,047	6,104	6,449	6,616	6,846

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 operations 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 are used at the time of weekday peak. The specifics on wind contribution methodology can be found in the Methodology to Perform the Reliability Outlook. Figure 4-1 shows the monthly WCC values, which are updated annually to coincide with the release of the Q2 Outlook.

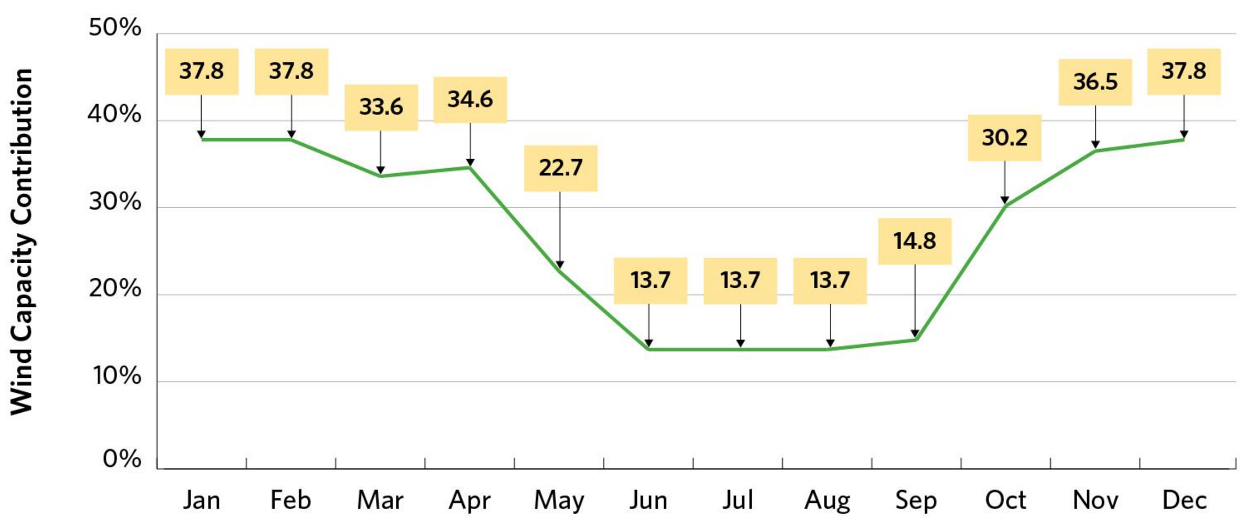

Figure 4-1 | Monthly Wind Capacity Contribution Values

Solar

For solar generation, monthly solar capacity contribution (SCC) values are used at the time of weekday peak. The specifics on solar contribution methodology can be found in the Methodology to Perform the Reliability Outlook. Figure 4-2 shows the monthly SCC values, which are updated annually to coincide with the release of the Q2 Outlook.

Due to the increasing penetration of embedded solar generation, the grid demand profile has been changing, with summer peaks being pushed to later in the day. As a consequence, the contribution of grid-connected solar resources at the time of peak Ontario demand has declined.

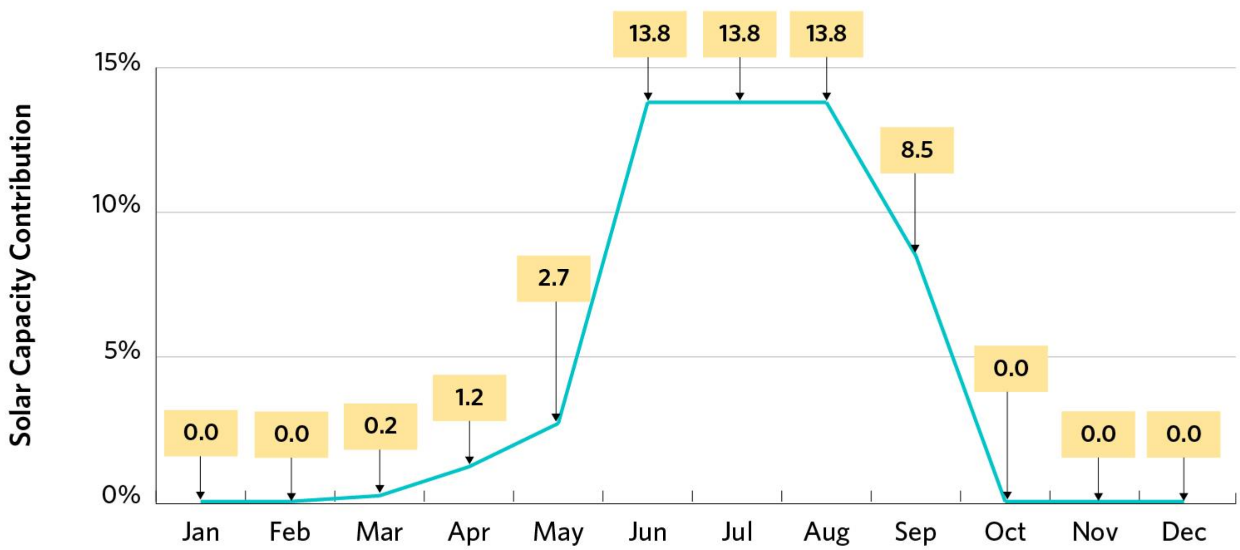

Figure 4-2 | Monthly Solar Capacity Contribution Values

4.1.3 Demand Measures

Both demand measures and load modifiers can have an impact on demand, but they differ in how they are treated within the Outlook. Demand measures, 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, as explained in 3.2.3 (Demand Measures and Load Modifiers). The impacts of actual activations of 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 of some neighbouring jurisdictions, provided Ontario is adequately supplied. Capacity-backed exports of up to 128 MW of installed capacity were successful in the New York Independent System Operator (NYISO) auctions for delivery between May and October 2019.

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 imported energy will target peak hours to help reduce greenhouse gas emissions in Ontario. The agreement includes the opportunity to cycle energy.

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.

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, as described in section 4.1.1.

The starting point for both scenarios is the existing installed resources shown in Table 4-1. Generator-planned shutdowns or retirements that have a high certainty of occurring in the future are considered in both scenarios, as are planned outages submitted by generators. Table 4-4 shows a snapshot of the forecast available resources, 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 2020 Firm Scenario	Winter Peak 2020 Planned Scenario	Summer Peak 2020 Firm Scenario	Summer Peak 2020 Planned Scenario	Winter Peak 2021 Firm Scenario	Winter Peak 2021 Planned Scenario
1	Installed Resources (MW)	37,555	37,609	37,555	39,054	37,555	39,054
2	Total Reductions in Resources (MW)	12,257	12,311	11,980	12,490	10,370	10,727
3	Demand Measures (MW)	924	924	794	794	924	924
4	Firm Imports (+) / Exports (-) (MW)	-500	-500	0	0	-500	-500
5	Available Resources (MW)	25,722	25,722	26,369	27,358	27,609	28,751
6	Bottling (MW)	1,996	1,996	42	42	426	426
7	Available Resources without Bottling (MW)	27,718	27,718	26,411	27,400	28,036	29,178

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 allowance 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 transmission constraints.

4.2 Capacity Adequacy Assessment

The capacity adequacy assessment accounts for zonal transmission constraints resulting from planned transmission outages assessed as of July 29, 2019. The planned generation outages occurring during this Outlook period have been assessed as of September 9, 2019. Note that the reserve above requirement (RAR) charts shown below reflect changes in the refurbishment schedule for Darlington G2. The return-to-service date has changed from February 2020 to June 2020.

4.2.1 Firm Scenario with Normal and Extreme Weather

The firm scenario incorporates all capacity that had achieved commercial operation status as of September 9, 2019.

Figure 4-3 shows RAR levels, which represent the difference between available resources and required resources. The latter equals the demand plus required reserve. The reserve requirement in the firm scenario under normal weather conditions is met throughout the entire Outlook period.

The IESO's revised outage approval methodology, using the extreme weather scenario with up to 2,000 MW of imports, has been in effect since May 1, 2019. In the extreme weather scenario, the reserve is lower than the requirement for a total of four weeks in 2020. Under the current outage schedule, the RAR is below the

- 2,000 MW threshold for three weeks in June 2020 and one week in September 2020. This potential shortfall is largely attributed to planned generator outages scheduled during those weeks. If extreme weather conditions materialize, the IESO may reject some generator maintenance outage requests to ensure that Ontario demand is met during the summer peak periods.

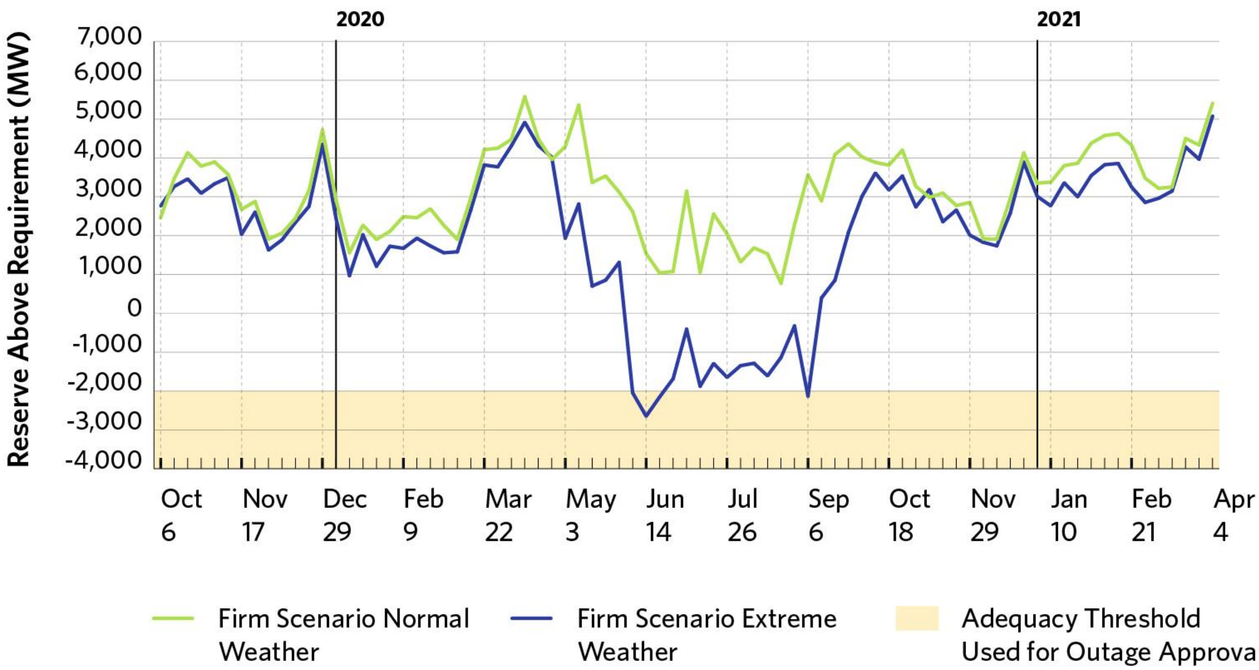

Figure 4-3 | Comparison of Normal and Extreme Weather: Firm Scenario Reserve Above Requirement

4.2.2 Planned Scenario with Normal and Extreme Weather

The planned scenario incorporates all existing capacity plus all capacity coming into service. Figure 4-4 shows RAR levels under the planned scenario, with the reserve requirement being met throughout the Outlook period under normal weather conditions.

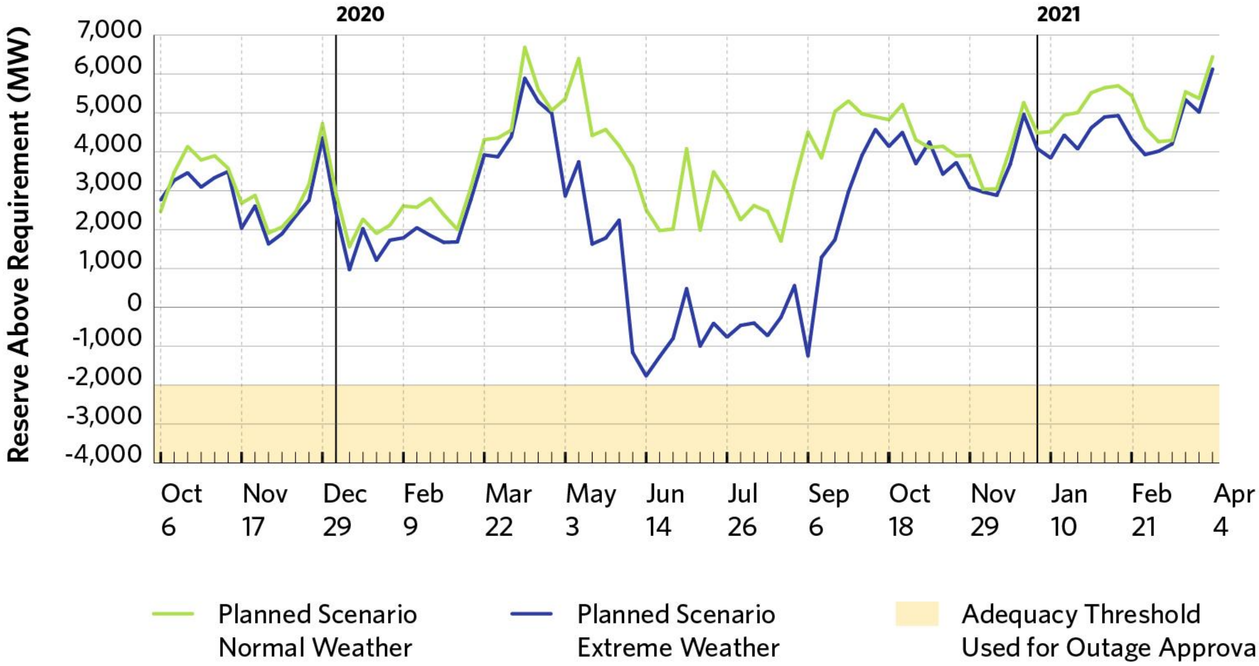

Figure 4-4 | Comparison of Normal and Extreme Weather: Planned Scenario Reserve Above Requirement[2]

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 published on June 20, 2019. The difference is primarily due to changes to planned outages and the expected in-service dates of new resources.

[2] Note that the "Planned" scenarios are not used for outage approval, and the adequacy threshold is shown in this chart for illustrative purposes only.

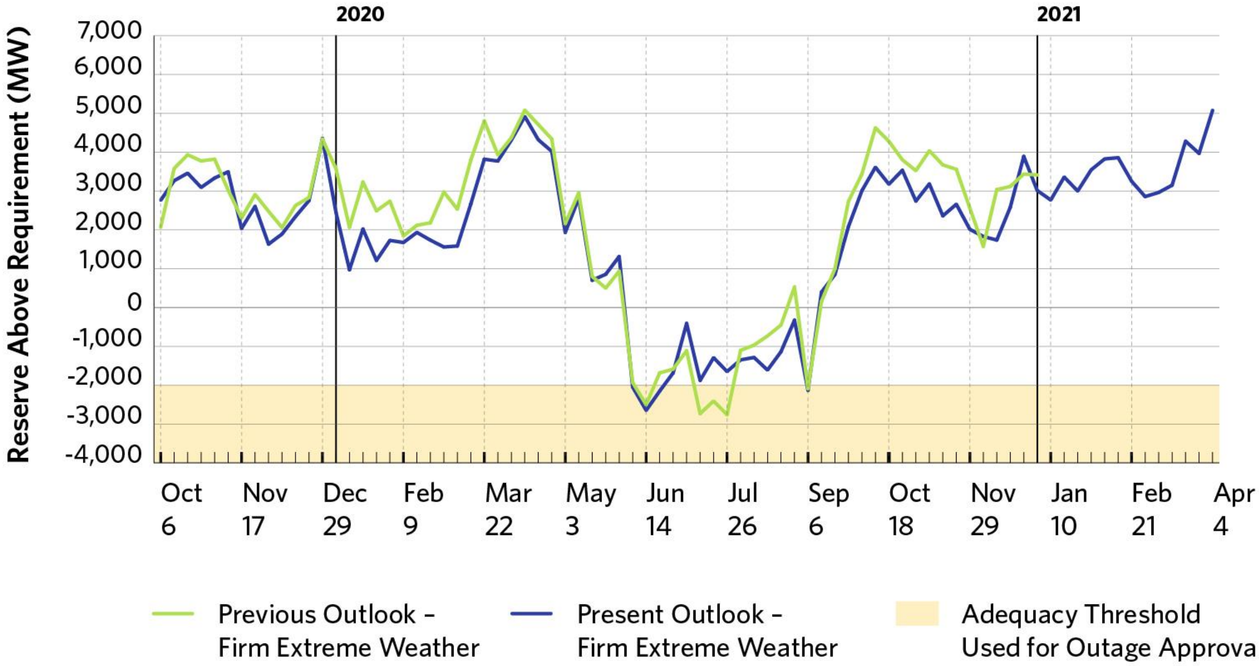

Figure 4-5 | Comparison of Current and Previous Outlook: Firm Scenario Extreme Weather Reserve Above Requirement

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

4.2.4 Capacity Auction

For this Outlook, the capacity adequacy assessment assumes that existing off-contract resources will continue to be available. The IESO's first capacity auction is expected to begin this December and will enable competition between dispatchable generators with expired contracts and demand response resources for delivery of auction capacity over two obligation periods: summer and winter (beginning May 1, 2020 and November 1, 2020, respectively). The pre-auction report will be published on September 26.

4.3 Energy Adequacy Assessment

This section provides an assessment of energy adequacy to determine whether Ontario has sufficient supply to meet its forecast energy demand and to highlight potential adequacy concerns during the Outlook time frame. The assessment also estimates aggregate production by resource category to meet the projected demand based on the assumed availability of resources.

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, pertaining to resources expected to be available over the next 18 months. The monthly forecast of energy production capability, based on the energy modelling results, is included in the 2019 Q3 Outlook Tables.

For the EAA, only the firm scenario in Table 4-5 with normal weather demand is considered. 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 for Ontario and each transmission zone.

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

	18-Month Energy Demand		18-Month Energy Production		Net Inter-Zonal Energy Transfer	Zonal Energy Demand on Peak Day of 18-Month Period	Available Energy on Peak Day of 18-Month Period
Zone	**TWh**	**Average MW**	**TWh**	**Average MW**	**TWh**	**GWh**	**GWh**
Bruce	1.0	79	65.4	4,970	64.4	1.4	129.6
East	14.0	1,065	13.6	1,032	-0.4	28.9	71.5
Essa	12.1	920	3.5	269	-8.6	24.8	13.6
Niagara	5.8	438	20.2	1,539	14.4	14.0	51.5
Northeast	16.5	1,252	16.1	1,224	-0.4	28.0	37.6
Northwest	6.2	473	7.1	539	0.9	10.1	22.1
Ottawa	15.0	1,144	0.3	20	-14.7	25.2	1.3
Southwest	42.2	3,208	8.8	672	-33.4	92.2	24.1
Toronto	74.6	5,673	57.0	4,337	-17.6	176.7	160.6
West	20.9	1,586	16.2	1,234	-4.7	48.8	74.6
Ontario	**208.3**	**15,837**	**208.3**	**15,837**	**0.0**	**450.1**	**586.5**

4.3.3 Findings and Conclusions

For the firm scenario with normal weather demand, the EAA results indicate that Ontario is expected to have sufficient supply to meet its energy forecast during the next 18 months without support from external jurisdictions. The figures and tables in this section are based on 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 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.

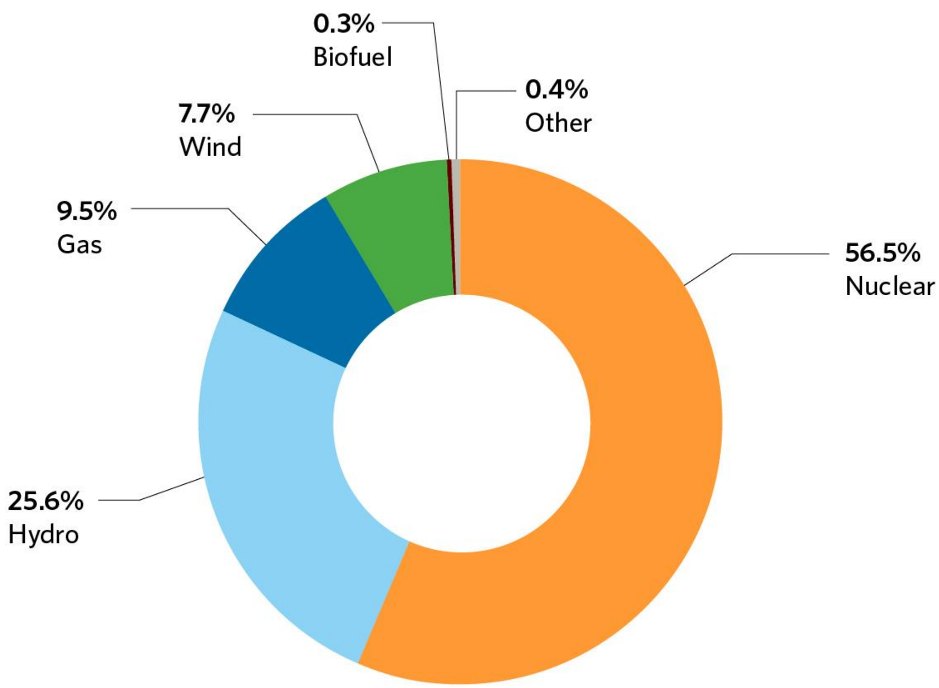

Figure 4-6 | Forecast Energy Production by Fuel Type

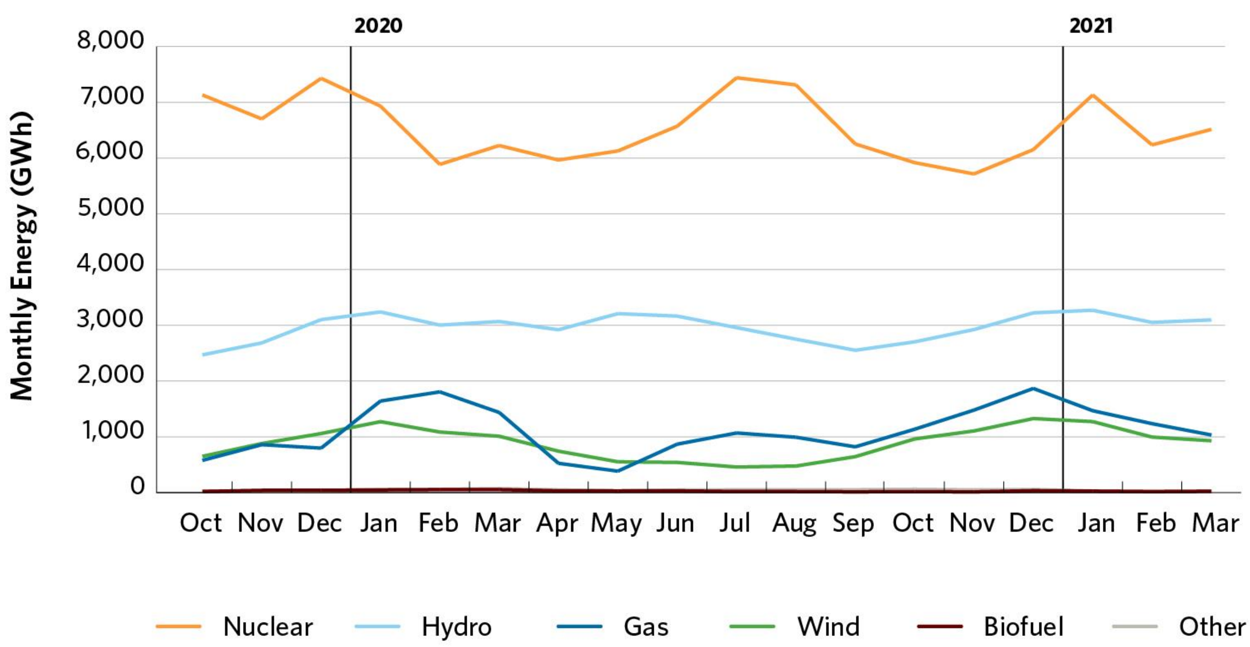

Figure 4-7 | Forecast Monthly Energy Production by Fuel Type

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

Fuel Type (Grid Connected)	2019 (Oct 1 - Dec 31) (GWh)	2020 (Jan 1 - Dec 31) (GWh)	2021 (Jan 1 - Mar 31) (GWh)	Total (GWh)
Nuclear	21,263	76,495	19,881	117,639
Hydro	8,256	35,720	9,419	53,396
Gas & Oil	2,234	14,029	3,737	20,000
Wind	2,588	10,177	3,198	15,964
Bio Fuel	101	355	66	523
Other (Solar & DR)	85	613	73	770
Total	**34,528**	**137,389**	**36,374**	**208,291**

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.

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 known transmission outages are also considered in the studies.

5.1 Transmission Projects

For the purpose of this section, the information that transmitters provide, with respect to transmission projects that are planned for completion within the next 18 months, is considered. The list of transmission projects is provided in Appendix B1.

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 contains transmission outage plans submitted to the IESO as of July 29, 2019.

5.3 Transmission Considerations

The purpose of this section is to highlight select projects and outages that may significantly affect the scheduling of other outages and/or may significantly affect reliability (i.e., in terms of limiting transfer capabilities in the system). These considerations are categorized by zone.

Bruce and Southwest Zones

Hydro One's replacement of aging infrastructure at the Bruce 230 kV switchyard is underway and requires careful coordination of transmission and generation outages. This project is scheduled to be completed by Q2 2021.

A planned three-week outage on circuit B560V starting November 4, 2019 will reduce the transfer capability out of the Bruce Zone.

Niagara Zone

On August 30, 2019 the Niagara Reinforcement Project was completed. This project increases the summertime transfer capability out of the Niagara area to the rest of Ontario by up to 800 MW.

A number of non-contiguous planned outages from September 4, 2019 until November 11, 2019 will impact circuits out of Beck #2 TS, reducing the transfer capability out of the Niagara area during this time.

West Zone

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 currently proceeding toward a planned Q4 2022 in-service date. Outages may become more challenging to facilitate starting in late 2019, when new loads are connected and required transmission reinforcements are being implemented.

A planned two-week outage on circuit B569B starting October 5, 2020 will reduce the transfer capability into the West Zone.

Toronto, East and Ottawa Zones

Operational challenges due to high voltages in Eastern Ontario and the Greater Toronto Area continue to occur during periods of low demand. The IESO and Hydro One are currently managing this situation by removing one of the 500 kV circuits in Eastern Ontario during those periods. To address this issue on a longer-term basis, two 500 kV line-connected shunt reactors will be installed at Lennox TS with a target in-service date of Q4 2020 for the first reactor and Q4 2021 for the second reactor.

A number of non-contiguous planned outages impacting circuits E510V and E511V from October to December 2019 will reduce transfer capability north from the Toronto Zone to the Essa Zone.

Northwest and Northeast Zones

Reinforcements to the system in the Kapuskasing area, including upgrades to circuit H9K and installing reactive compensation, are planned for Q1 2020 and Q1 2021 respectively. During the construction of these reinforcements, outages in the area may be restricted.

Multiple outages impacting circuit X504E between September and November 2019 will reduce transfer capability on the North-South Tie.

A planned two-week outage starting November 30, 2019 impacting circuit M23Lwill reduce transfer capability across the East-West Tie.

Interconnections

The early 2018 failure of the phase angle regulator (PAR) connected to the Ontario-New York 230 kV interconnection circuit L33P continues to hinder the province's ability to import 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 on St. Lawrence area resources in real-time. Careful coordination of transmission and generation outages will be required in the area. PARs are unique pieces of equipment and replacements are not readily available. Replacement options for the unit are currently being investigated jointly with the IESO, Hydro One, NYISO and the New York Power Authority. The preferred replacement option is a new PAR with a +/- 50-degree angle range, based on the recommendation by the joint NY/ON team to Hydro One for tendering. If all goes well, the return to service date for the L33P PAR would be November 2021.

Intermittent planned outages will impact interconnection circuit PA302 from September to November 2019 and will reduce the import and export transfer capacity between Ontario and New York at Niagara ties.

A planned three-week outage starting November 18, 2019 will impact circuit L51D, reducing import and export transfer capability between Ontario and Michigan.

6. Operability

During the Outlook period, Ontario will continue to experience potential surplus baseload conditions, much of which can be managed with existing market mechanisms, such as exports and curtailment of variable generation. Nuclear curtailments may be required in spring and early fall 2020.

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

6.1 Outage Management Concerns

Market participants are reminded that outage coordination is becoming more challenging as significant capital upgrades are underway such as refurbishment outages, station rebuilds, etc., at the same time as ongoing routine maintenance. The Reliability Outlook informs market participants about critical periods, allowing the market the opportunity to reschedule outages and minimize the risk of outages being revoked by the IESO in the operating timeframe.

6.2 Grid Voltage Control

During low demand periods, including the overnight period, it can be challenging to maintain system voltages within the prescribed limits in certain parts of the system. Increased supply from distribution connected resources results in the displacement of centralized generation facilities and, consequently, in reduced transfers across the transmission system. Lightly loaded lines are a source of reactive power and result in high system voltages. The IESO and Hydro One are currently managing this situation with day-to-day operating procedures and plan to address this issue on a longer-term basis (refer to section 5.3 – Toronto, East and Ottawa Zones).

6.3 Surplus Baseload Generation

Baseload generation is made up of 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 these conditions through lower prices. Resources and activity at the interties respond accordingly to the prices. The resulting outcomes from the market include higher export schedules, dispatching down of hydroelectric generation and grid-connected renewable resources, and nuclear maneuvering or shutdown. For severe surplus conditions, which may affect reliability of the system, the IESO may take out-of-market actions such as manual curtailments of resources and/or imports. Significant SBG conditions were observed last quarter as a result of lower demand due to cooler weather and minimal nuclear outages. A number of control actions, including nuclear generation manoeuvers and shutdowns were required to manage SBG.

Ontario will continue to experience potential surplus baseload conditions during the Outlook period. Figure 6-1 highlights the periods during which curtailment of nuclear generation may be expected.

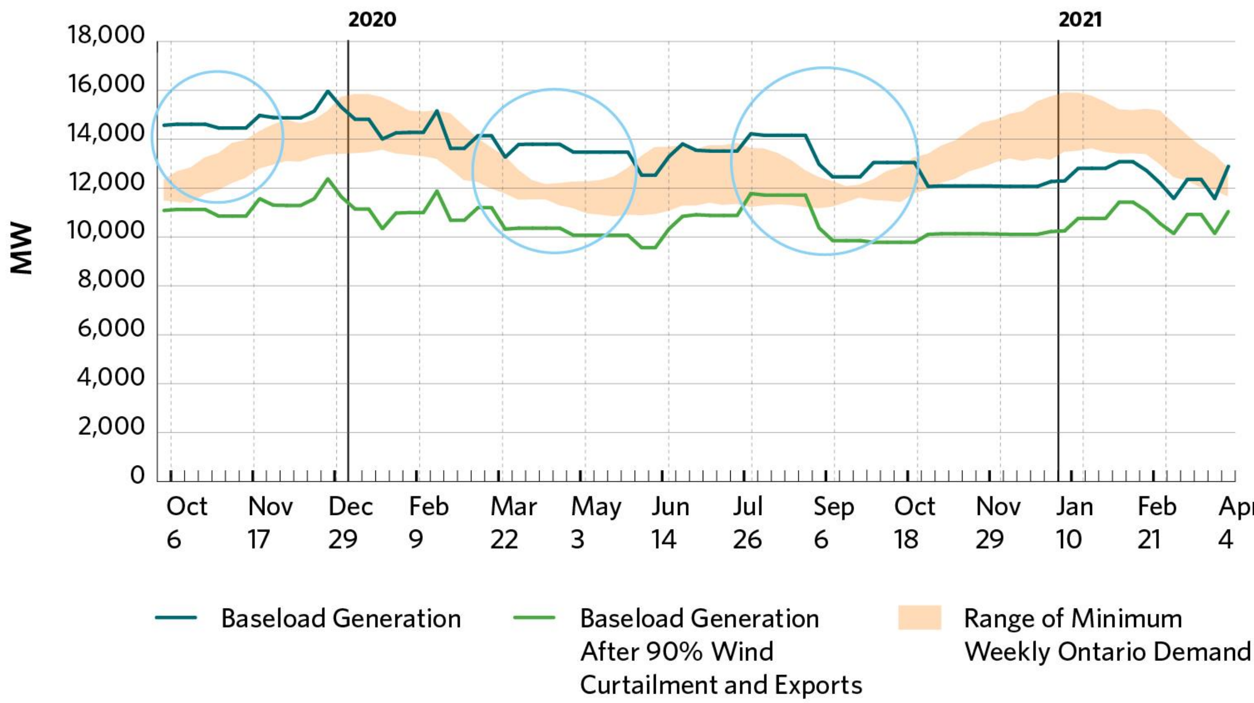

Figure 6-1 | Minimum Ontario Demand and Baseload Generation

Much of the surplus baseload conditions can be managed with existing market mechanisms signaling for exports, and curtailment of variable and nuclear generation. Going forward, as shown in Figure 6-2, existing mechanisms will be sufficient for managing SBG.

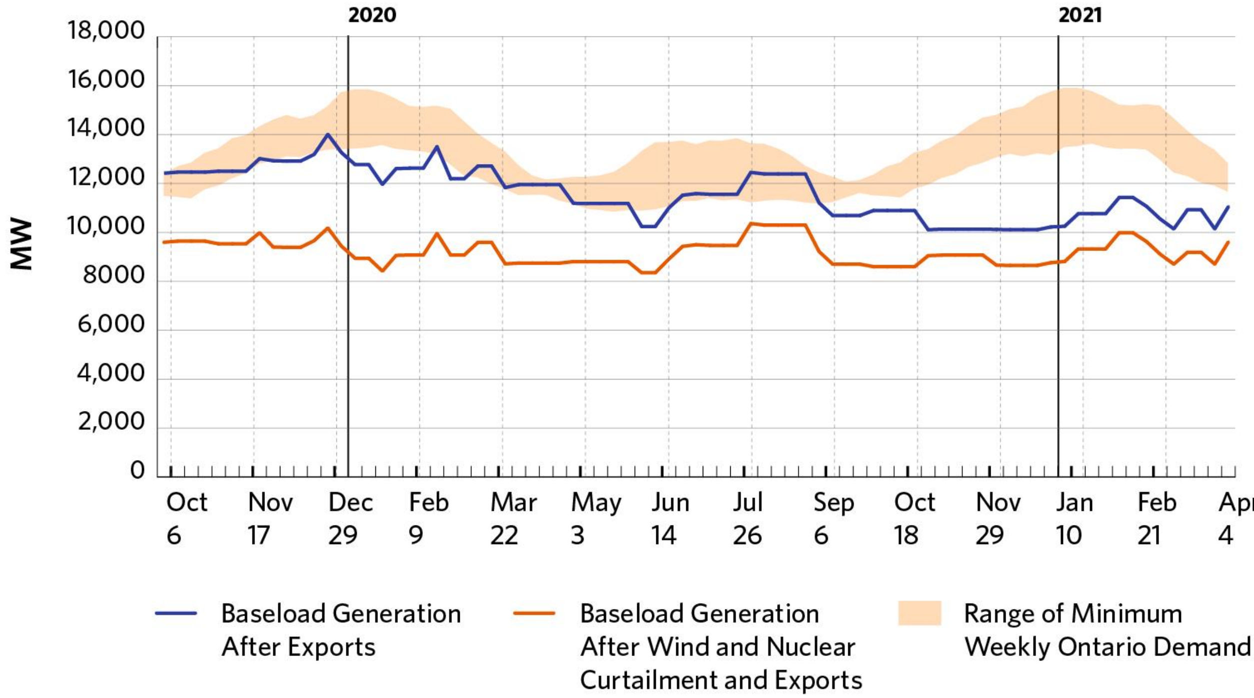

Figure 6-2 | Minimum Ontario Demand and Baseload Generation

The baseload generation assumptions include expected exports and run-of-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 reflects 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, 2019. These values are updated annually to coincide with the release of the summer Outlook.

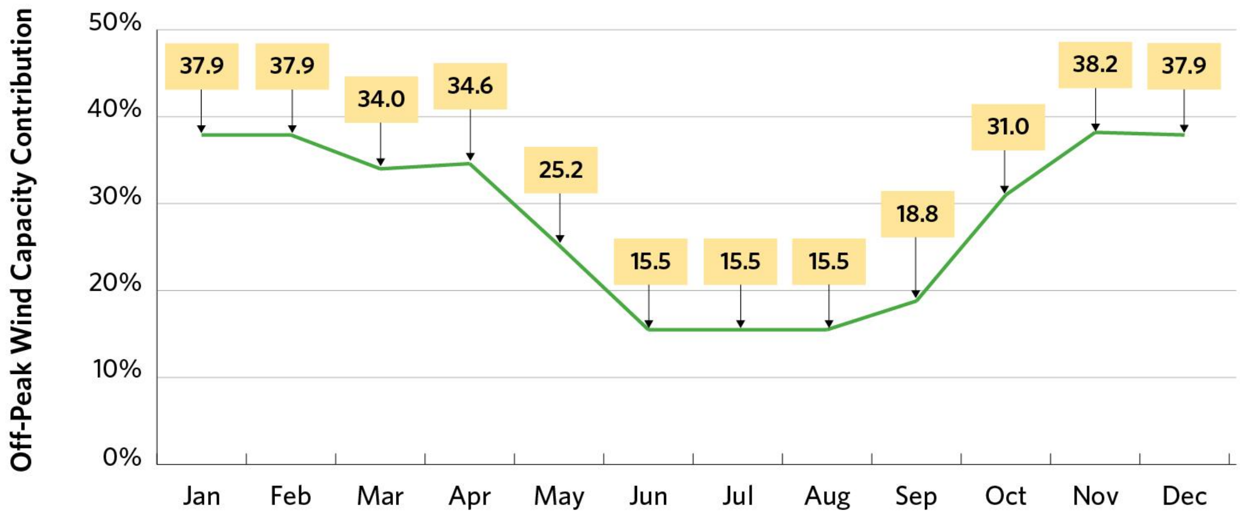

Figure 6-3 | Monthly Off-Peak Wind Capacity Contribution Values

7. Resources Referenced in Report

The table below lists 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
2019 Q3 Outlook Tables	http://www.ieso.ca/-/media/files/ieso/document-library/planning-forecasts/reliability-outlook/ReliabilityOutlookTables_2019Sep.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/ReliabilityOutlookMethodology2019Sep.pdf	Throughout
Capacity Auction	http://www.ieso.ca/Sector-Participants/Engagement-Initiatives/Engagements/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	http://www.ieso.ca/-/media/files/ieso/Document%20Library/Market-Rules-and-Manuals-Library/market-manuals/market-administration/IMO-REQ-0041-TransmissionAssessmentCriteria.pdf	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	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
Grid-LDC Interoperability Standing Committee	http://www.ieso.ca/Sector-Participants/Engagement-Initiatives/Standing-Committees/Grid-LDC-Interoperability-Standing-Committee	Distributed Energy Resources

8. List of Acronyms

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	Megawatts
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 Station
TWh	Terawatt-hours
WCC	Wind Capacity Contribution

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