Approved by the RCC
December 6, 2016

NPCC 2016 Ontario Interim Review Of Resource Adequacy

FOR THE PERIOD FROM 2017 TO 2020 DECEMBER 2016

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Document Change History

Issue	Reason for Issue	Date
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1 EXECUTIVE SUMMARY

The Independent Electricity System Operator (IESO) submits this assessment of resource adequacy for the Ontario Area in accordance with the NPCC Regional Reliability Reference Directory #1, "Design and Operation of the Bulk Power System."

The 2016 Interim Review of Resource Adequacy covers the study period from 2017 through 2020 and identifies changes in assumptions from the 2015 Comprehensive Review, including changes to facilities and system conditions, generation resources' availability, demand forecast and the impact of these changes on the overall reliability of the Ontario electricity system.

The results presented in Table 1 conclude that Ontario will be able to meet the NPCC resource adequacy criterion that limits the loss of load expectation (LOLE) to no more than 0.1 days/year for all years within the study period (2017 to 2020).

For the Median Demand Growth scenario, the NPCC criterion is satisfied for 2018, 2019 and 2020 with existing and planned resources. For the 2017 forecast year, some planned maintenance outages were rescheduled in order to meet the LOLE criterion. However, there is no need to reschedule the planned maintenance outages to meet the LOLE criterion when limited use of Emergency Operating Procedures (EOPs) is assumed.

For the High Demand Growth scenario, the NPCC criterion is satisfied for 2017, 2018 and 2019 with existing and planned resources, after rescheduling some planned maintenance outages. For the 2020 forecast year, , EOPs is needed after rescheduling some planned maintenance outages in order to meet the LOLE criterion.

Table 1 Annual LOLE Values - Median and High Demand Forecast

Scenario	Outages Rescheduled	Tie Benefits (MW)	EOPs	LOLE [days/year]			
				2017	2018	2019	2020
Median	No	0	No	0.125	0.058	0.009	0.005
	Yes	0	No	0.062	-	-	-
	No	0	Yes	0.036	-	-	-
High	No	0	No	0.183	0.262	0.167	0.331
	Yes	0	No	0.089	0.099	0.096	0.260
	Yes	0	Yes	-	-	-	0.089

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2.1 List of Tables

2 INTRODUCTION

The 2016 Interim Review of Resource Adequacy for Ontario is submitted to the Northeast Power Coordinating Council (NPCC) to demonstrate compliance with the resource adequacy requirements of NPCC Regional Reliability Reference Directory #1, "*Design and Operation of the Bulk Power System*". This report was prepared by the Independent Electricity System Operator (IESO) in its role as the Planning Coordinator for Ontario.

The 2016 Interim Review of Resource Adequacy covers the study period from 2017 through 2020. This report describes changes in assumptions from the 2015 Comprehensive Review, including changes to facilities and system conditions, generation resources' availability, demand forecast and the impact of these changes on the overall reliability of the Ontario electricity system.

The assessment is based on information available to the IESO as of June 2016.

3 CHANGES IN ASSUMPTION FROM 2015 COMPREHENSIVE REVIEW

3.1 Demand Forecast

Table 2 compares the peak demand forecasts for the 2015 Comprehensive Review and the 2016 Interim Review under Median and High Demand Growth scenarios for the overlapping years. Although point forecasts are presented for both the Median and High Demand Growth scenarios, each scenario has an associated "uncertainty" distribution which recognizes the variability of demand due to weather volatility.

Table 2 Comparison of Demand Forecasts

Year	Normal Weather Summer Peak [MW]					
	Median Demand Growth			High Demand Growth		
	2015 Review	2016 Review	Difference	2015 Review	2016 Review	Difference
2017	22,819	22,680	-139	23,732	22,907	-825
2018	22,790	22,519	-271	24,431	23,420	-1,011
2019	22,669	22,357	-312	24,936	23,967	-969
2020	22,522	22,192	-330	24,886	24,412	-474
Average Growth Rate (2017-2020)	-0.44%	-0.72%		1.60%	2.14%	

Ontario grid demand is shaped by two opposing sets of drivers: those that increase grid demand and those that act to reduce it. Economic expansion, population growth and increased penetration of electrically powered devices act to increase the need for grid-supplied electricity. Conservation programs, increasing embedded generation output and prices act to reduce the amount of grid-supplied electricity needed. The interplay of these drivers will shape both peak and energy demand over the course of the forecast period.

When comparing the demand forecasts in the 2015 Comprehensive Review and the 2016 Interim Review, the differences are attributable to two items:

- The opposing sets of drivers described in the previous paragraph. These factors have been updated in the 2016 Interim Review to reflect the most recent information available. Though none of the drivers have changed significantly, the aggregation of the many small changes can lead to a shift in the total forecast demand.
- When 2015 actual historical demand data was included in the updated forecast for 2016 Interim Review, this resulted in resetting the starting point of the demand forecast thus having an impact on the ensuing demand levels.

Drivers that increase grid demand and those that act to reduce it

Over the forecast horizon, the summer peaks are expected to decline under the Median Growth scenario. This is because downward pressure from price impacts, increased conservation savings and the growth in embedded generation output is likely to outstrip the underlying growth in demand from economic expansion and population growth. There are two other factors that causes demand to decline, these are:

- As embedded solar output increases the net result is that demand is lowered and the peak is pushed later in the day.
- Also, pricing impacts further reduce peak demands as the Industrial Conservation Initiative (ICI) incents large users to reduce demand during peak conditions.

Despite all the changes incorporated into the updated forecast, the growth trajectories for the summer peaks remain very similar to those in the 2015 Comprehensive Review.

In the High Growth scenario, the summer peaks are expected to grow over the forecast horizon as strong economic growth combined with increased electrification due to carbon reduction strategies spur electricity demand. The factors offsetting growth–embedded generation, electricity prices and conservation are not strong enough to offset the underlying growth.

Inclusion of Actual Data

At the time of the 2015 Comprehensive Review, it was anticipated that the Ontario economy would be improving due to stronger U.S. growth and a lower Canadian dollar. These two factors are key to Ontario's export-oriented energy-intensive industries. While that has proven to be the case, there was a significant delay in realizing that increased output in the manufacturing sector. Only since January 2016 have we observed increases in industrial demand that had been flat since just after the recession. This delay was a contributing factor to the lower than expected demand levels experienced in 2015.

3.2 Resource Forecast

Table 3 compares the capacity of supply resources at the time of the summer peaks for the current 2016 Interim Review with the 2015 Comprehensive Review. This 2016 review assumes resource availability based on the latest available information regarding existing and planned resources. These values do not include generators that operate within local distribution company (LDC) service areas (embedded generation), except for those that participate in the IESO-administered markets.

Available resources are determined based on the following:

1) Historical median contribution of hydro resources during peak demand hours;
2) Total capacity available from thermal units (nuclear, gas, oil and biofuel) after discounting for seasonal derating;
3) Historical median contribution of wind and solar resources during the peak demand hours; and
4) Projected effective capacity of the following demand-side resources: Peaksaver, Demand Response (DR)/ Capacity-Based Demand Response (CBDR) and Dispatchable Loads.

Table 3 shows how the available capacity of supply resources has changed compared with the 2015 Comprehensive Review. Reductions due to planned outages are not accounted for in this table. However, the effects of nuclear refurbishments are reflected as reduction in available capacity.

Table 3 Comparison of Available Resource Forecasts (MW)

Year	Summer Peak		
	2015 Review	2016 Review	Difference
2017	27,745	28,177	432
2018	27,757	28,236	479
2019	27,687	29,023	1,336
2020	28,560	28,253	-307

The differences in available resources between the 2016 Interim Review and the 2015 Comprehensive Review are primarily due to:

- A nuclear refurbishment outage that was previously expected to take place commencing in 2017 has been deferred, leading to increased resource availability in 2017, 2018 and 2019.
- Additionally, in 2019, another nuclear refurbishment outage that was previously expected to take place has been deferred leading to even more resources available in 2019.

The remaining differences in resources are from small updates to hydroelectric, wind, solar and biofuel resource contributions. In addition, some attrition in new projects and changes to in-service dates of future wind and solar resources also contributed to the differences.

3.3 Transfer Capabilities

Northwestern Ontario is connected to the rest of the province by the 230 kV double-circuit East–West Tie. Local demand growth is forecasted as a result of an active mining sector in the region. To address demand growth, additional transmission capacity is required to maintain reliable supply to this area under the wide range of possible system conditions. The expansion of the East–West Tie with the addition of a 230 kV new double-circuit transmission line will provide reliable and cost-effective long-term supply to the Northwest. The line is anticipated to be in service in 2020.

3.4 Emergency Operating Procedures

Emergency Operating Procedures (EOPs) are used in the resource adequacy assessment if the existing and planned resources are not sufficient to meet the Loss of Load Expectation (LOLE) criterion. Table 4 summarizes the assumptions regarding the demand relief from EOPs used when required in this study. For this study, all EOPs are applied in one block.

This year Ontario incorporates the generators stretch capability into available resources and therefore it is no longer part of the EOPs listed below.

Table 4 Emergency Operating Procedure Assumptions

EOP Measure	EOP Impact % of Demand
Public Appeals	1.0
No 30-minute Operating Reserve OR (473 MW)	0*
No 10-minute OR (945 MW)	0*
Voltage Reductions	2.0
Aggregated Net Impact	**3.0**

* Although 30-minute and 10-minute OR are included in this list of EOPs, the analysis does not impose a requirement to provide for OR since only loss of load events are being considered. Therefore, the net benefit of applying EOPs in the analysis excludes relaxation of OR requirements.

3.5 Forced Outage Rates

The IESO made two updates regarding forced outage rates in the 2016 Interim Review relative to the 2015 Comprehensive Review. The first is the historical data has been updated as another year of unit outage data is available. The second is the IESO has changed its methodology of calculating forced outage rates for these assessments. Instead of Equivalent Forced Outage Rates (EFOR), the IESO now uses Equivalent Forced Outage Rates on Demand (EFORd). While these updates have changed the weighted average values for the Nuclear and Gas/Oil units, the net effect to the LOLE was not significant.

The resultant calculated EFORd based on historical 5 year generator performance record is shown in Table 5. For comparison reasons, Table 6 shows EFOR reported in the 2015 Comprehensive Review.

Table 5 Ontario's Projected EFORd

Fuel Type	Weighted Average EFORd	Range of EFORd
Nuclear	6.8%	2.1 – 14.9%
Gas/Oil	7.9%	1.4 – 44.8%
Biofuel	3.5%	3.3 – 3.9%

Table 6 EFOR from previous Review

Fuel Type	Weighted Average EFOR	Range of EFOR
Nuclear	8.4%	3 - 20%
Gas/Oil	5.0%	1 - 50%
Biofuel	4.4%	4.4%

3.6 Firm Transactions: Purchase and Sale of Capacity

In May 2015, the IESO signed a 500 MW seasonal firm capacity sharing agreement with Hydro-Quebec. Quebec can import up to 500 MW in winter months (December to March) and Ontario can import up to 500 MW in summer months (June to September). The energy associated with the capacity agreement will be scheduled through existing market mechanisms.

Ontario will provide 500 MW of capacity to Quebec in the winter of 2016/2017. Although the 500 MW of exports has yet to be confirmed for the winter of 2017/2018, it was modelled in the assessment.

Ontario has the option to call on up to 500 MW of capacity from Quebec for summer seasons until 2025. This summer capacity was not included in this assessment.

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4 RESOURCE ADEQUACY ASSESSMENT

The probabilistic resource adequacy assessment is performed using GE-MARS. The following inputs are used:

- Median and High Demand Growth forecast and load forecast uncertainty (LFU);
- Forecast of available resources and EOPs;
- Planned outage schedules submitted by market participants;
- Equivalent forced outage rates on demand (EFORd) for thermal units derived using historical generator performance data; and
- Transmission limits of major interfaces connecting different zones.

The above inputs are described in greater detail in the 2015 Comprehensive Review as well as in the Ontario's Methodology to Perform Long-Term Assessments. Sensitivity studies are performed for keeping planned maintenance outages 'as is' vs. moving them for situations where reliance on tie-benefits was needed.

4.1 Assessment Results

The results for the Median and High Demand Growth scenarios are presented in Table 7 and show that the NPCC LOLE criterion is satisfied for the forecasted scenarios.

For the Median Demand Growth scenario, the NPCC criterion is satisfied for 2018, 2019 and 2020 with existing and planned resources. For the 2017 forecast year, some planned maintenance outages were rescheduled in order to meet the LOLE criterion. However, there is no need to reschedule the planned maintenance outages to meet the LOLE criterion when limited use of Emergency Operating Procedures (EOPs) is assumed.

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Table 7 Annual LOLE Values, Median and High Demand Forecast

Scenario	Outages Rescheduled	Tie Benefits (MW)	EOPs	LOLE [days/year] 2017	2018	2019	2020
Median	No	0	No	0.125	0.058	0.009	0.005
	Yes	0	No	0.062	-	-	-
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