

**REPORT**

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**IESO Operability  
Review of OPA's  
Integrated Power  
System Plan**

**Issue 2.0**

## **Advice to Reader**

The study results in this report are based on information made available to the IESO at the time the assessment was carried out and the assumptions set out in the report. The IESO assumes no responsibility for the accuracy or completeness of such information or the conformity of actual events to the assumptions. Furthermore, the results and conclusions are subject to further consideration due to changes to this information or assumptions, or to additional information that may become available in the future.

The performance expectations of power system facilities were determined based on typical assumptions used in power system planning studies. The actual performance of these facilities during real-time operations will depend on actual system conditions, including ambient temperature, wind speed and facilities loading, and may be higher or lower than those stated in this study.

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# Table of Changes

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<b>Reference (Paragraph and Section)</b>	<b>Description of Change</b>
Section 3	Clarified assumptions in response to questions received from market participants.



# Executive Summary

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The electricity infrastructure of the future as envisioned by the Integrated Power System Plan represents the most significant transformation of Ontario's electricity sector since the incorporation of nuclear generation. Many of the proposed supply options have significantly different operating characteristics from the current generation fleet – and some of the proposed projects, such as intermittent and embedded generation are outside the IESO's traditional dispatch authority and monitoring. Also, increased conservation and demand management programs will create new daily, weekly and annual load patterns. These much needed initiatives must be incorporated into the routine operation of the system such that reliability is maintained throughout their implementation.

The IESO is accountable for managing the operation of the electricity system so that supply is reliably and efficiently delivered to the people of Ontario, and has carried out this task since its inception. Drawing on its experience and expertise, the IESO is well positioned to assess any operability issues and to develop any new or evolved operational and market processes needed to support the changing infrastructure going forward.

Operability is a measure of whether the proposed supply mix from the IPSP can be reasonably coordinated through unit commitment decisions and real-time dispatch to follow the ever-varying load profile through both high and low demand conditions, while constantly meeting all operating standards, such as operating with sufficient operating reserves.

The IESO has assessed the operability of the IPSP and concluded that it provides sufficient flexibility to meet future system needs. Current market mechanisms and control actions will allow the IESO to reliably operate the system described in the IPSP.

This report represents just the first step in addressing future operability. Assessments will be ongoing for two reasons:

- System operability is directly related to the infrastructure of the day. This operability assessment involved many assumptions about in-service dates for new generators, implementation timetables and results for conservation and demand response programs. The IESO will update this assessment for material changes to any assumptions, particularly in-service milestones, which can have an impact on operability.
- The currently available information provides a reasonable representation of hourly outcomes in the future. However, like other system operators, to date Ontario has limited actual experience with the combined impacts of significant amounts of wind generation, embedded generation and demand management. As the future is realized greater detail will be incorporated to examine intra-hour operability, local area impacts, and to achieve minute-to-minute coordination. The IESO expects that these more detailed operational requirements will be addressed through mechanisms such as the connection assessment process as each

project moves from the proposal stage to reality, and with the benefit of actual experience. As their penetration increases, future operations planning will capture their impact.

The IESO's operability assessment also reinforced a number of opportunities to improve transparency and efficiency in the operation of the power system and electricity market as the province moves forward with the IPSP. The IESO and its stakeholders should continue to evolve current operating processes and market incentives to capture these benefits, and the IESO has started initiatives to address these opportunities on several fronts. These efforts include a stakeholder initiative to address market design issues related to operability, and a new industry-wide examination of smart grid technologies and other non-traditional solutions to facilitate greater consumer involvement in solving future operational challenges.

**– End of Section –**

# 1. Introduction and Purpose

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The IESO directs the operation of Ontario's bulk electricity system, balancing demand and supply of electricity on a second-to second basis to meet the electricity needs of over 12 million Ontarians. It does this by administering the competitive wholesale electricity market, which involves, among other things, collecting offers from suppliers and bids from purchasers to determine the market price of electricity that reflects current conditions across the province. This price, in turn, helps to drive market efficiencies and participant behaviour to assist in solving reliability issues.

The IESO is also involved in planning and assessment of future conditions of the electricity system. Through various assessments, the IESO ensures that sufficient generation and transmission resources are available to satisfy the needs of Ontario's consumers and respond to unforeseen contingencies, both now and in the future. These assessments include:

- Near-term and mid-term adequacy assessments of generating resources and transmission system status
- Contingency planning for major outages or disruptions to power supply;
- The need for market evolution initiatives to enhance the efficiency of the market and encourage market-based solutions to managing reliability.

Given the IESO's role in overseeing the reliable operation of Ontario's electricity market and power system, it assisted the OPA in several areas of IPSP study. Support was given in the form of several system impact assessments, preliminary assessments, and planning study reports based on the forecast transmission and resource expansions contained in the IPSP.

This report is an independent assessment of the IPSP's operability. Operability is a measure of whether the proposed supply mix from the IPSP can be reasonably coordinated through unit commitment decisions and real-time dispatch to follow the ever-varying load profile through both high and low demand conditions, while meeting all operating standards.

The analysis is based on preliminary IPSP hourly data submitted to the IESO by the OPA, which includes Ontario demand, conservation<sup>1</sup>, scheduled intertie imports and exports, generator availability, and generation schedules. The simulated data was compiled by the OPA using cost-based dispatch as an approximation of market outcomes to determine generation output, costs and economic transactions between interconnected areas for each hour in the simulation period (2010 - 2026).

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<sup>1</sup> OPA conservation programs include demand management, demand response, customer generation, fuel switching and efficiency programs.

The criteria used to determine the operability of the IPSP includes the ability of the future supply mix to:

- Provide sufficient load following capability
- Manage surplus baseload generation conditions
- Serve Ontario demand during high demand conditions
- Meet operating reserve requirements

The IESO will continuously monitor IPSP implementation and update the assessment for material changes to any assumptions, particularly in-service milestones, which can have an impact on operability.

**– End of Section –**

## 2. Generation and Supply Mix Summary

This section provides a summary of Ontario's forecasted generating capacity, its evolving composition, based on fuel type, and an overview of the proposed supply mix changes. The generation summary is based on simulated schedules provided by OPA for every year between 2010 and 2014, and every second year between 2016 and 2026.

The OPA simulations produced an hourly available capacity value for each major generating station/resource in Ontario. The highest hourly value for the year for each resource was summed to produce the annual totals. Results are lower than could be achieved by summing the nameplate capacity of the affected resources as the capacity maximums used by the simulations reflect operational capacity limits.

### 2.1 Generation

Table 1 shows the simulated hourly maximum capability of each resource in each year, grouped by fuel type. These values do not represent either coincident peak-hour production quantities or installed capacity values, as they are simulations of actual hourly outputs which are subject to normal outages and de-ratings. As such, they provide practical maximum production levels for the various sources in any year.

	2010	2011	2012	2013	2014	2016	2018	2020	2022	2024	2026
Nuclear	11,379	11,379	12,919	12,403	12,403	10,242	10,572	10,941	12,923	13,804	13,804
Gas/Oil	9,338	9,690	10,696	11,576	12,112	11,986	11,540	11,012	10,350	10,352	10,349
Renewables	8,689	9,307	9,347	9,713	10,181	10,868	11,369	12,922	13,473	13,477	13,683
Conservation	2,911	3,342	3,762	4,170	4,570	5,153	5,658	6,040	6,453	6,849	7,329
Coal	6,343	4,893	3,928	3,443	3,232	-	-	-	-	-	-
Interconnections	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250	1,250
Other	88	88	149	189	229	457	483	525	525	525	525
<b>TOTAL</b>	<b>39,999</b>	<b>39,949</b>	<b>42,051</b>	<b>42,744</b>	<b>43,977</b>	<b>39,955</b>	<b>40,872</b>	<b>42,690</b>	<b>44,973</b>	<b>46,255</b>	<b>46,940</b>

**Table 1: Annual Generation Capacity Based on Preliminary IPSP Data Provided by OPA**

## 2.2 Supply Mix Changes

The changes in the proposed supply mix from 2010 through to 2026 are:

- Phase-out of all coal-fired generation by the end of 2014
- A significant increase in reliance on conservation and demand management with the implementation of the OPA's conservation programs
- Growth of wind generation in Ontario's generation portfolio
- Increase in biomass and gas-fuelled generation
- Refurbishment of 16 nuclear units as well as addition of two new units
- Production from contracted non-utility generation (NUG) units that is consistent with the IPSP assumptions
- General reduction in the proportion of manoeuvrable generation in Ontario's generating fleet

– End of Section –

## 3. Assumptions

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The IESO's analysis was performed using production data provided by the OPA. As such, the data reflects the many assumptions used in the IPSP. The IESO did not modify any IPSP assumptions. Hence, the analysis is based on the following:

- New resources and the transmission capability necessary to support the OPA's simulated hourly schedules were assumed in service, as indicated in the IPSP.
- Non-utility generator (NUG) outputs were consistent with IPSP assumptions and were provided to the IESO in the OPA's simulated hourly schedules.
- The energy and capacity schedules provided by the OPA respected normal operational limitations on the associated resources. These limitations include forced and planned outages, daily energy limits, and the need for hydroelectric units to run during periods of freshet.

The IESO was required to make certain assumptions to accurately interpret the simulated data and produce meaningful operating conditions:

- Existing generation resources were assumed to have ramping and operating characteristics similar to those they currently exhibit in the IESO-administered markets.
- Generation resources not yet in service were assumed to have ramping and operating characteristics similar to existing resources of the same technology type. Some operating parameters such as minimum load point were adjusted in proportion to nameplate capacity.
- It was assumed that ramping and operating characteristics did not appreciably degrade over the life of the plant and were held constant for the entire study period.
- Ontario's operating reserve requirement was assumed to be constant throughout the entire study period as no new generating unit in the OPA simulated schedules exceeded the size of today's largest resource. Any future increase in operating reserve requirements will be addressed within the IESO's Connection Assessment and Approval processes.
- Using voluntary regional reserve sharing programs, which can reduce operating reserve requirements, was not considered for this analysis.
- The operability benefits of currently registered dispatchable loads or NUGs that have elected to operate as dispatchable generation in today's IESO-administered markets were not considered in the simulated schedules. However, they were used in the analysis as a viable control action.

**– End of Section –**

## 4. Hourly Load Following

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Load following capability is a measure of the dispatchable resources' ability to be effectively dispatched to follow the fluctuations of consumer demand and overall system needs. The OPA submitted hourly data to the IESO for its analysis. The study of inter-hour load following capability used these hourly schedules by employing a methodology developed through the IESO's Stakeholder Engagement Program<sup>2</sup> that analyzed historical load following requirements. The hourly schedules include generation, Ontario demand, imports and exports, and the results of conservation programs.

The IESO assessment focused on the most critical days - the days with the highest hourly peak demand and highest hourly positive load following requirement (LFR)<sup>3</sup> of each season for each year of study. Where shortfalls were observed during these critical days, the analysis evaluated existing market mechanisms and control actions to determine whether a more optimized dispatch than provided by the OPA schedules could have resolved the shortfall. The assessment revealed that all the identified load following shortfalls could be successfully addressed through the current dispatch methodology. Table 2 summarizes the results of this analysis.

### 4.1 Hourly Load Following Analysis (2010-2016)

The first five years of the analysis, from 2010-2016, are the critical period, during which there is a profound transformation of the resource mix. During this period all of the coal-fired plants will be replaced with gas-fired units, hydroelectric, wind and conservation programs. In addition, a number of nuclear units are expected to be removed from operation for refurbishment. Over the 2010-2014 period, five of 40 days studied (12.5%) showed load following shortfalls, though all were successfully resolved by applying the unit commitment, curtailing exports and constraining-off dispatchable loads.

### 4.2 Hourly Load Following Analysis (2017-2026)

The second interval of the analysis was limited to every second year. This period saw the completion of all planned nuclear refurbishments, as well as the commissioning of two new nuclear units. Additionally there was continued growth in conservation programs, wind generation and several new hydroelectric units. The only reduction in the resource capacity over the period was due to an assumed further retirement of NUGs.

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<sup>2</sup> "Stakeholder Engagement #38 – Load Following Standard", [http://www.ieso.ca/imoweb/consult/consult\\_se38.asp](http://www.ieso.ca/imoweb/consult/consult_se38.asp)

<sup>3</sup> The hourly load following requirement is the calculated change in demand requirement between one hour and the next.

As shown in Table 2, during the later interval of study, the frequency of critical days with seemingly insufficient load following increased to 10 of 48 days (20.8%). With the increase, several days required more actions than were needed in the previous period to overcome shortfalls.

In addition to such actions as unit commitment, curtailment of exports, and constraining off of dispatchable loads, further imports and outage management were needed to resolve shortfalls.

Year	2010	2011	2012	2013	2014	2016	2018	2020	2022	2024	2026
Winter Max LFR	●	●	●	●	●	●	●	●	●	●	●
Spring Max LFR	●	●	●	●	●	●	●	●	●	●	●
Summer Max LFR	● <sup>1,2</sup>	● <sup>1,2</sup>	●	● <sup>1,2</sup>	●	● <sup>1,2,3</sup>	● <sup>1,2,3</sup>	● <sup>1,2</sup>	● <sup>1,2,3</sup>	●	●
Fall Max LFR	●	●	●	●	●	●	● <sup>1,2,3</sup>	●	●	●	●
Winter Peak Demand	●	●	●	●	●	●	●	●	●	●	●
Spring Peak Demand	●	●	●	●	●	●	●	●	●	●	●
Summer Peak Demand	●	● <sup>1</sup>	●	●	●	● <sup>1,2</sup>	● <sup>1,2</sup>	● <sup>1,2</sup>	●	●	● <sup>1,2,3</sup>
Fall Peak Demand	● <sup>1</sup>	●	●	●	●	● <sup>1,2</sup>	●	●	●	●	●

1 - Resolved through market scheduling and commitment of fossil units  
2 - Resolved through market not scheduling exports and/or dispatchable load  
3 - Requires additional measures to satisfy reserve requirement (i.e. additional imports, management of scheduled outages)

● - Sufficient Load Following Capability (73 of 88)

● - Insufficient Load Following Capability that would be managed through dispatch of the market (15 of 88)

**Table 2: Results of Critical Days (2010-2026)**

### 4.3 Unit Commitment

In today's operation, the market utilizes two programs to commit generation units:

- The Day-Ahead Commitment Process (DACP) provides a generator with day-ahead certainty in covering their start up costs, including the incremental operating and maintenance costs associated with the start up.
- The Spare Generation On Line (SGOL) program allows generators to commit to a start three hours out of real-time operation and covers the fuel costs associated with the start up.

Both programs schedule units to their minimum load points and allow them to meet the technical characteristics of the unit through a minimum runtime. This positions the units so they will be able to ramp to meet market dispatch.

In the OPA simulated schedules, hourly load following capability shortfalls often occurred when internal generation resources were scheduled at low energy output so they would be available to

provide operating reserve. This positioning of the units at low output, left them operating in a range of poor ramping capability. In these cases, the future potential of a load following shortfall is not a concern, as it will be mitigated by using of one of the unit commitment processes discussed above.

## **4.4 Dispatchable Load**

In today's IESO-administered markets, dispatchable loads provide ramping services on the same basis as generators. In the analysis, shortfalls in hourly load following capability were significantly mitigated by dispatching these resources, particularly during summer periods. This is consistent with experience in the summer of 2005, when the dispatch of dispatchable load allowed for more effective use of energy-limited hydroelectric resources during challenging operating conditions. The analysis shows the continued value of dispatchable demand in the market.

## **4.5 Other Market Actions**

Where unit commitment and dispatch of dispatchable loads was unlikely to resolve hourly shortfalls in load following capability, other actions were evaluated for effectiveness. Generally these events occurred in the summer, during periods of high demand and challenging operating conditions which typically included periods of operating reserve shortfalls. These types of conditions send market price signals that cause market participants to reschedule planned outages and elect not to export.

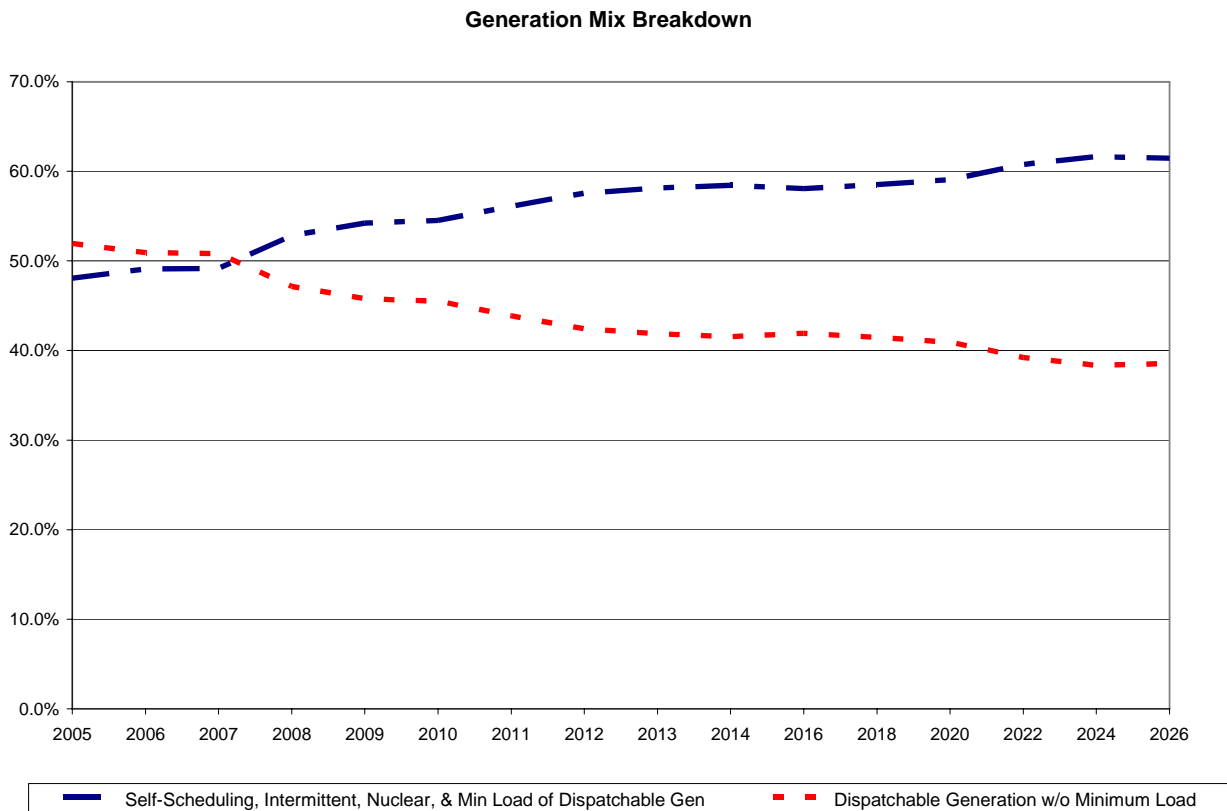
All shortfalls in hourly load following that remained after using the unit commitment process and the dispatch of dispatchable loads could be resolved through a combination of outage management (provided to the IESO through the OPA's hourly availability schedules) and curtailment of exports (provided through the hourly export schedules). It is expected that should such shortfalls actually develop, normal market price signals would be sufficient to drive these outcomes without intervention by the IESO.

**– End of Section –**

# 5. Intra-Hour Load Following and Dispatch Issues

The IESO balances supply and demand through its direction of dispatchable resources, which will continue throughout the on-going evolution of Ontario’s generating fleet. Although this report indicates, at least on an hourly basis, that there is sufficient flexibility to successfully operate using the proposed resources mix, challenges remain. Load following capability on a more granular level than hourly blocks of time is required if the proposed resource mix is to achieve true operability.

Figure 1 shows the gradual increase in the proportion of generation outside the dispatch control of the IESO or normally unavailable for dispatch and a corresponding decrease in dispatchable generation able to respond to 5-minute dispatch.



**Figure 1: Generation Availability for Dispatch**

## 5.1 Wind Generation

In 2006 the IESO participated in a study of the impact of wind power penetration on the operation of the IESO- controlled grid and the IESO-administered markets. This GE Truwind study<sup>(16)</sup> was sponsored by CANWEA, the Ontario Power Authority and the IESO. The study indicated that there is a 16% probability that the output of wind generation will change over the next ten-minute interval by more than 10%. The probability of a 20% change over 10 minutes was predicted to be negligible. The IESO has been monitoring wind production since the fall of 2006 and has found that this study value is consistent with operational experience. There is approximately 500 MW of currently installed wind capacity. As the size of the wind fleet increases as shown by the data in the IPSP, the IESO will have to consider its impact on flexible generation and the need for additional intra-hour load following services.

## 5.2 Dispatch Issues

The hourly data provided by the OPA did not allow an explicit analysis of the 5-minute dispatch effect on the future flexible generation pool. It is reasonable to assume that dispatch volatility is unlikely to reduce from current levels, in the absence of any further mitigation. For example, throughout the study period, in 20% of the hours, hydroelectric generation volumes changed by more than 500 MW. As slower moving thermal and gas units try to respond to these changes, other fast-moving resources must ramp to make up the difference, exposing them to significant dispatch volatility.

The IESO recognizes stakeholder concerns in this area and has implemented various programs to mitigate the dispatch volatility of load following units, but concerns remain. In order to maintain the availability rate of the dispatchable resources presented in the IPSP, the IESO and its stakeholders must continue to address the impact of dispatch issues on flexible generation. These efforts will ensure that the market maintains sufficient drivers to guarantee reliable and efficient load following and dispatch capability.

– End of Section –

## 6. Surplus Baseload Generation

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Surplus baseload generation (SBG) is an over-generation condition that occurs when Ontario's electricity production from baseload facilities such as nuclear and must-run hydroelectric units is greater than market demand.

Surplus baseload generation periods are typically the result of low demand and can be exacerbated by:

- Spring freshet, when hydroelectric stations cannot lower generation output
- The inability of neighbouring jurisdictions to absorb surplus energy in the form of exports
- High production from intermittent resources such as wind generation

Often these events can be foreseen in the planning timeframe. However, sometimes events such as unexpectedly high production of intermittent resources (i.e. under-forecasting from participants) or low export levels to adjacent areas can lead to surplus generation conditions in real-time.

Currently, surplus baseload generation occurs only a few times a year. In the planning timeframe, the IESO's reliability publications send signals to the market to take actions such as rescheduling outages to take advantage of these conditions. Closer to real-time operation, participants may respond to forecast surplus baseload generation by increasing the Ontario demand for electricity or scheduling additional exports during times of very low price signals.

The IPSP includes increases in conservation, which will have a lowering affect on the demand for electricity across the day, and increases in intermittent and embedded generation, both of which can increase the supply even at low demand periods. For these reasons, the frequency, magnitude, and duration of surplus baseload conditions is likely to increase in the future.

Analysis of the OPA data indicated that management of surplus baseload generation in the simulated schedules relied on significant amounts of exports. If these exports failed to materialize in real-time, the IESO would have to take other control actions to maintain reliability. In order to mimic operational conditions, a number of assumptions were made with respect to the schedules provided by the OPA:

- The maximum export schedule considered was capped at 1000 MW. This is based on the historical export volumes seen during overnight operation, and during the infrequent surplus baseload generation conditions seen over the last few years. This is consistent with current IESO practice (limited reliance on intertie transactions for reliability planning).

- All thermal generation, gas fired generation, and dispatchable hydroelectric resources were dispatched-off to mitigate surplus conditions, which reflects current practice
- An allowance of 100 MW of surplus baseload generation was considered acceptable in the analysis, as this amount can realistically be managed by generation under contract to provide Automatic Generation Control

## 6.1 Results of Surplus Baseload Generation Analysis

Surplus baseload generation can be managed through actual operation of the market and its attendant price signals. For example, recent experiences with surplus baseload generation due to export failures resulted in negative Ontario energy market prices, with a significant increase in exports in response. Such prices can be expected during the surplus events seen in the study period. This should encourage domestic consumer response and attract exports beyond the level assumed in the study.

Under existing market rules, the IESO only considers the curtailment of wind resources when all market mechanisms are exhausted, including the reduction in output of nuclear units. The significant amount of surplus baseload generation hours left after dispatching down all thermal, gas and dispatchable hydroelectric units during the periods from 2012-2014 and 2022-2026, led the IESO to analyze the effectiveness of curtailing wind resources. Curtailment of wind and other intermittent resources can be an effective approach when the dispatch down (or complete shut down) of a nuclear unit can lead to reliability concerns in future hours. The effectiveness of wind generation curtailment can be seen by comparing the number of hours of surplus baseload generation under the two columns of Table 3.

Year	Number of hours of Surplus Baseload Generation (no gas, thermal or dispatchable hydroelectric generation in service)	Hours remaining after further action of curtailing wind resources
2010	59 of 8760 Hours	25 of 8760 Hours
2011	115 of 8760 Hours	64 of 8760 Hours
2012	781 of 8784 Hours	435 of 8784 Hours
2013	754 of 8760 Hours	343 of 8760 Hours
2014	788 of 8760 Hours	282 of 8760 Hours
2016	88 of 8784 Hours	3 of 8784 Hours
2018	116 of 8760 Hours	14 of 8760 Hours
2020	140 of 8784 Hours	6 of 8784 Hours
2022	580 of 8760 Hours	114 of 8760 Hours
2024	891 of 8784 Hours	193 of 8784 Hours
2026	857 of 8760 Hours	236 of 8760 Hours

**Table 3: Surplus Baseload Generation Results**

Reducing a nuclear unit’s output can lead to it being unavailable to generate for up to three days. The analysis assumed the worst case for a reduction of a nuclear unit, i.e. the reduction resulted

in the unit poisoning out<sup>4</sup>, leaving it entirely unavailable for 72 hours. Therefore, before a unit was shut down in the analysis to resolve surplus baseload generation concerns, a verification step was taken to ensure that the remaining available generation could meet Ontario’s peak demand over the period required to return the nuclear generator to service.

Given the flexibility of thermal and gas units, any resulting generation shortfalls during the peak hours were resolved by increasing these generators’ schedules. Recognizing the possibility of thermal and gas units being on maintenance outage during the extended periods of low demand expected with surplus baseload conditions, a limitation was imposed on the increase to thermal and gas schedules. This limit was set to the larger of the maximum amount scheduled in the previous 24-hour period or 2,000 MW (conservative value based on estimates of fossil and gas availability). Where replacement energy was not available, Table 4 reported these as unresolved hours of surplus baseload generation.

Year	# of Nuclear Unit Shutdowns	# of SBG periods resolved by nuclear shutdown	Remaining SBG Hours
2010	5	4	0
2011	9	7	6
2012	77	36	47
2013	52	31	1
2014	39	25	6
2016	2	1	0
2018	4	4	3
2020	2	1	4
2022	23	16	2
2024	36	26	16
2026	42	25	28

**Table 4: Nuclear Unit Shutdowns to Resolve SBG Events**

Table 4 lists the results of the analysis that used nuclear generation to reduce unresolved hours of surplus baseload generation. The table includes:

- The number of unit-shutdowns that were required over the entire year,
- The number of surplus periods, lasting 3 days or more, where nuclear unit shutdowns were used to resolve the condition
- The remaining number of surplus condition hours, which could not be resolved through nuclear shutdown, due to insufficient replacement generation for upcoming demand.

Although not considered, the number of surplus baseload generation hours could be further reduced through the use of shallow manoeuvres of nuclear units. Shallow manoeuvres allow

<sup>4</sup> Term “poisoning out” refers to the situation where a nuclear unit reduces reactor power to a level where it can no longer sustain the chain reaction and must shutdown. This occurs when its normal reactor regulating devices cannot overcome the build-up of neutron absorbing isotopes that takes place after a significant power reduction.

nuclear units to partially reduce, without poisoning out and result in a limited restriction on their total subsequent output. Such manoeuvres could limit the impacts to the market by reducing the need for complete shutdown of a nuclear unit and the associated cost of replacement energy.

## 6.2 Other SBG Management Requirements

With a shrinking proportion of dispatchable generation for load following purposes, fossil and gas generation will be called on to provide energy as a result of peaking demand and fluctuations created by intermittent generators. Non-quick start units will need to be efficiently committed to address load following and operating reserve requirements, and must also be able to shut down during anticipated surplus baseload generation conditions. Committed generators need to respect the technical requirements of units such as minimum load, minimum run-time, maximum number of starts per day, and minimum turnaround time, which could require some generators to continue to operate through the night, potentially adding to the SBG likelihood. The IESO and stakeholders will have to continue their efforts to improve unit commitment processes and to create the market signals and incentives to encourage flexibility in these generators.

The IPSP indicates a forecasted growth of embedded/distributed generation. Embedded generators are generators that are connected to a distribution system or are connected “behind the meter” of an industrial facility. When located close to distribution load centres, these resources can provide benefits to the electricity system by reducing losses, and can often contribute to reduced load on transmission facilities. These generators are not currently monitored by IESO, nor under its dispatch control. This could result in less than optimal management of surplus baseload generation conditions. With the appropriate procedural and technological changes, embedded generation has the potential to enhance operability during periods of surplus baseload generation as well during normal conditions. These changes could include real-time monitoring, availability for dispatch (under specific conditions), appropriate communication protocols, and exposure to effective market signals.

– End of Section –

## 7. Adequacy Overview

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The OPA data was also analyzed for adequacy to assess periods where energy was not served or there were operating reserve shortfalls.

### 7.1 Periods of Energy Not Served

Energy not served refers to an under-generation condition that occurs when there is insufficient generation to meet Ontario demand. In determining whether an energy not served condition existed for the analysis, a shortfall of 100 MW was considered acceptable, as this amount can realistically be managed by generation under contract to provide Automatic Generation Control. There were no instances of insufficient energy to meet Ontario demand over the entire study period of 2008 to 2026.

### 7.2 Shortfalls in Operating Reserve

The IESO's operating reserve requirement is based on Northeast Power Coordinating Council Operating Reserve criteria and is roughly equal to one and one-half times the largest single contingency loss. This amount would increase if larger capacity generation units or single-element based contingencies than those presently in service were to materialize. The IPSP preliminary data provided to the IESO does not currently include larger generators or single contingencies than currently exist.

The OPA simulation results did not specifically model all options available to the IESO in meeting operating reserve requirements, and hence at times generated more exports than would actually occur. As a result, when analysing the ability of the Plan to provide sufficient operating reserve, the simulation data resulted in occasional periods of operating reserve shortfalls. During actual operation of the IESO-administered markets, such exports would not be scheduled in the pre-dispatch timeframe, or would be made recallable if the shortfall developed in real-time. In addition, the IESO-administered markets currently have over 600 MW of dispatchable load, which provides a significant amount of operating reserve to the market.

The incidence of operating reserve shortfalls becomes negligible when the market-driven export behaviour and the availability of dispatchable load to provide operating reserve is considered, as shown in Table 5.

<b>Year</b>	<b>IPSP Simulated Schedule After considering Non-Scheduled Exports &amp; Dispatchable Loads</b>
<b>2010</b>	0 of 8760 Hours
<b>2011</b>	0 of 8760 Hours
<b>2012</b>	0 of 8784 Hours
<b>2013</b>	0 of 8760 Hours
<b>2014</b>	0 of 8760 Hours
<b>2016</b>	2 of 8784 Hours
<b>2018</b>	3 of 8760 Hours
<b>2020</b>	1 of 8784 Hours
<b>2022</b>	0 of 8760 Hours
<b>2024</b>	0 of 8784 Hours
<b>2026</b>	1 of 8760 Hours

**Table 5: Frequency of Insufficient Operating Reserve**

**– End of Section –**

## 8. Conclusions and Recommendations for Future Action

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The IESO has assessed the operability of the IPSP and concluded that it provides sufficient flexibility to meet future system needs. Current market mechanisms and control actions will allow the IESO to reliably operate the system described in the IPSP.

### 8.1 Recommendations for Future Action

The assessment identified several opportunities, and in many instances reinforced current IESO initiatives to improve transparency and efficiency in the operation of the power system and electricity market. The IESO and its stakeholders should continue to evolve current operating processes and market incentives to capture these benefits. The IESO has begun initiatives to address these opportunities on several fronts, and will ensure the following are addressed:

**Reliability Starts and Unit Commitment** – Efficient scheduling of thermal units has been shown to facilitate optimal load following capability. With future reductions in fleet load following capability and the likelihood of increased surplus baseload generation conditions, current commitment programs should be maintained and evolved to meet the needs of the proposed supply mix.

**Dispatch Volatility and Load Following** - In order to maintain the availability rate of the dispatchable resources presented in the IPSP, the IESO and its stakeholders must continue to address the impact of dispatch volatility on flexible generation. These efforts will ensure that the market maintains sufficient drivers to guarantee reliable and efficient load following and dispatch capability.

**Load Following Service (incentives for capability)** – Given the shrinking portion of manoeuvrable generation in Ontario's fleet of generators, load following capability will be a generating commodity that will increase in value to the market. Market incentives should be investigated to determine if additional drivers are needed for new generators and loads to provide load following services.

**Mid-Hour Intertie Scheduling** – In order to implement the growing magnitude of intertie activity seen in the IPSP simulation data, the IESO should develop an intertie protocol that allows for more frequent scheduling than the current hourly practice. This would serve two purposes: to limit the load following required to accommodate changing intertie schedules, and to allow intertie scheduling to be used as a source of load following in a manner more granular than currently available.

**Conservation and Demand Management Measures** – The continuation and expansion of dispatchable load programs and smart grid technologies should be encouraged as these measures improve operability under all conditions.

**Visibility and Control of Embedded Generation** – The IESO should work with stakeholders to investigate incorporating increased visibility and control of embedded generation to enhance operability during periods of surplus baseload generation and assist in load following.

**Generation Curtailment Options to Manage Surplus Baseload Generation** – The future holds an increased likelihood of surplus baseload generation. The current practice of shutting down nuclear units to manage extreme surpluses carries significant risk. As a result, the IESO should perform a review of the prioritization and impact of current generation manoeuvring/shutdowns to manage surplus baseload generation conditions.

**Regional Reserve Sharing** – The IESO should continue to participate in reserve sharing programs that allow for portions of operating reserve to be shared between neighbouring jurisdictions. These programs reduce the associated costs and effectively free-up manoeuvrable generation for other services such as load following.

– End of Section –

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