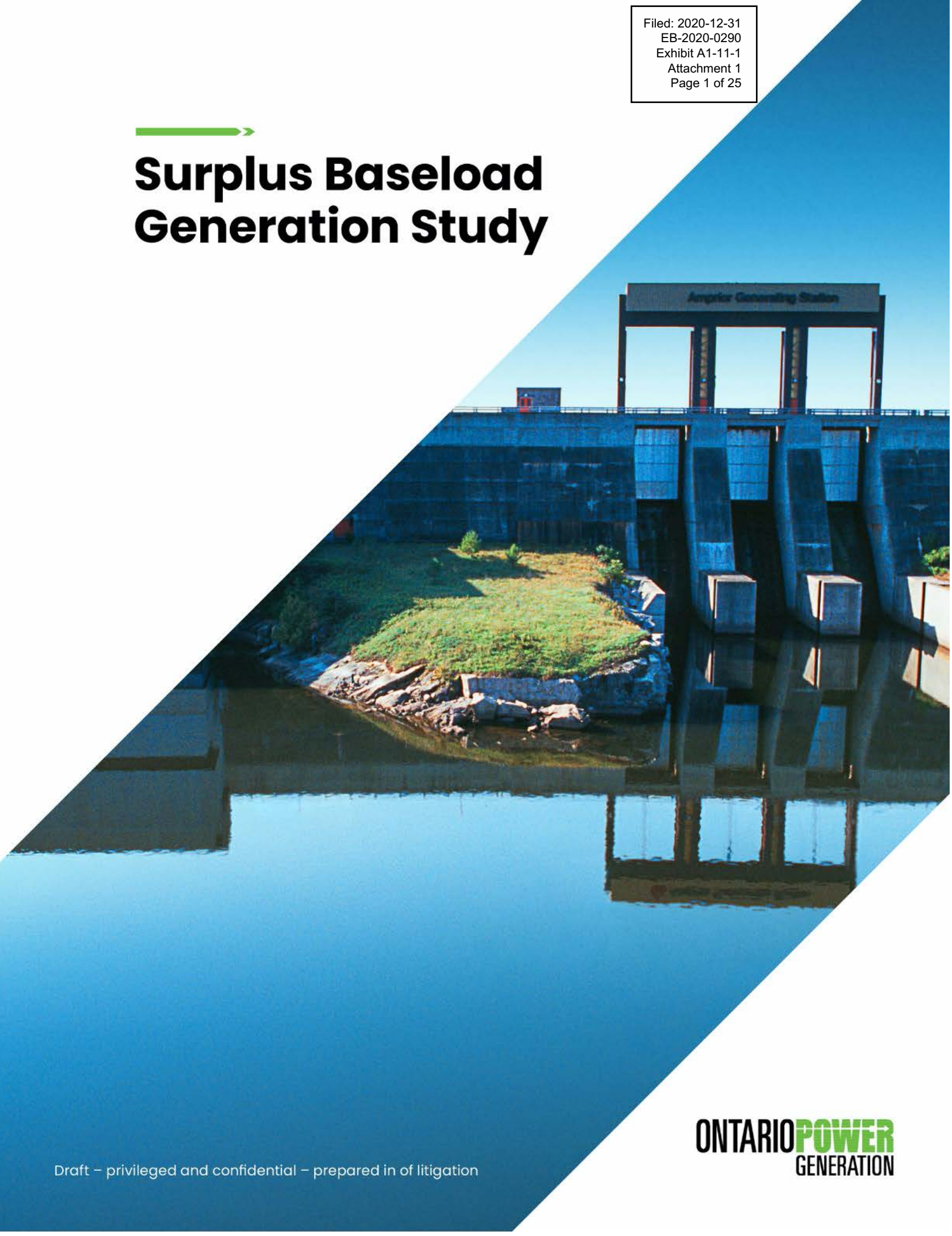
Surplus Baseload Generation Study



Draft – privileged and confidential – prepared in of litigation

ONTARIO POWER GENERATION

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1. Introduction and Purpose of Study

In EB-2018-0243, OPG applied to the Ontario Energy Board ("OEB") for approval to dispose of the balances in certain deferral and variance accounts, including the Surplus Baseload Generation Variance Account ("SBG Variance Account").

The parties reached a Settlement Proposal in respect of OPG's application. By Decision and Order dated February 21, 2019, the OEB approved the Proposal. As part of the Settlement, OPG agreed to prepare and file in the next rebasing application a forward-looking study to assess the management of its generating facilities in relation to SBG conditions ("Study"):

> OPG undertakes to prepare a forward looking study to assess OPG's management of its generating facilities in relation to surplus baseload generation conditions, including any opportunities OPG can take to help the system respond to surplus baseload generation conditions in order to mitigate the associated cost to customers. In preparing the study, OPG will consult with the IESO and take into consideration IESO forecasts. Such study will be filed as part of OPG's next rebasing application. [1]

This Study is in response to the OEB-approved Settlement Proposal. It addresses the following main questions:

- What constitutes SBG conditions and how are such conditions managed by the Independent Electricity System Operator ("IESO")?
- How much SBG is expected in the IESO planning horizon?

[1] EB-2018-0243, Settlement Proposal dated January 30, 2019, p. 15.

- How does OPG manage its generating facilities in response to SBG conditions?
- What other potential actions could OPG take in response to SBG conditions and are those actions any more appropriate than those being currently taken?

The IESO was consulted in the development of this Study and provided the following comments:

The IESO reviewed the draft report and did not have concerns with the following conclusions noted in the report:

a. SBG conditions are expected to decline, as illustrated by the Surplus Baseload Generation ("SBG") forecast in the IESO's Annual Planning Outlook – December 2020.

b. IESO will continue to use economic dispatch order to respond to SBG conditions that were established as a result of (SE-91) *A Discussion Paper for Stakeholder Engagement 91 (Renewable Integration)*[2] in 2013 and the Floor Price Review completed in 2015.

c. The current dispatch order continues to yield economic benefits, based on the principles and conclusions outlined in SE-91.

d. OPG's presented alternative consideration in scheduling hydroelectric outages is not preferred as it will reduce available supply and may create a need for replacement energy and higher system costs.

e. OPG's presented potential other actions in response to SBG conditions, under section 4, would be at odds with the approach the IESO has taken to establish an economic merit order for dispatch during periods of SBG.

[2] IESO, Dispatch Order for Baseload Generation, A Discussion Paper for Stakeholder Engagement 91 (Renewable Integration), dated November 2, 2011.

2. Surplus Baseload Generation Conditions

This section of the Study discusses system conditions that lead to SBG, outlines the role of the IESO in forecasting and managing SBG conditions through the use of a dispatch order, summarizes the economic and environmental benefits of the current dispatch order, and reviews the OEB's approach to SBG impacts in setting OPG's hydroelectric payment amounts.

2.1. Definition of SBG Conditions

According to the IESO, SBG is a system condition that occurs when electricity production that can be generated from baseload facilities exceeds demand.[3] Electricity from baseload facilities is made up of generation from nuclear facilitates, variable generators such as wind and solar, baseload hydroelectric energy, and other electricity generation sources that may contribute to baseload supply such as self-scheduling resources, gas plant minimums, and commissioning units. Surplus generation, in relation to demand net of economic exports to interconnected jurisdictions, can cause some of OPG's hydroelectric resources to forgo generation in the form of hydroelectric spill.

The frequency and duration of SBG conditions is largely driven by the magnitude of baseload generation online, economic intertie activity, and the various factors that impact the demand for electricity.

[3] EB-2010-0008 Ex. E1-1-1, p. 5, line 16.

2.2. IESO Forecasts of SBG Conditions

The IESO issues forecasts of demand and supply for the electricity market, including forecasts of SBG, over a variety of time frames ranging from balance of current day to decades into the future. Specifically, the current IESO forecast horizons are long term, near term and short term. The IESO describes the functions of these forecasts, including the Reliability Outlook and the Ontario Annual Planning Outlook ("APO"), as follows:

> The results of our reliability assessments drive decision making, whether short term – as in when to schedule outages – or, over the long term, which allows developers and investors to respond to the needs and price signals, invest accordingly.[4]

Long Term (up to 20 years) - Longer term forward studies such as the APO include SBG forecasts as part of an energy adequacy outlook. The purpose of the adequacy outlook is to assess Ontario's ability to meet its own electricity needs and better characterize the nature of future needs.[5]

Near-term (up to 18 months) – The IESO uses its near-term forecast to make market participants aware of potential SBG conditions, so they can assess and react to potential impact on their facilities.[6]

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[4] IESO Reliability Outlook, From January 2020 to December 2024, p. 1.

[5] Annual Planning Outlook, December 2020, Section 3.3, p 44

[6] Market Manual 7.2, Near Term Assessments and Reports, Section 4.2, p. 8.

Short-term (real time or current day to days ahead) – The IESO publishes short-term forecasts hourly, daily, and days ahead. The IESO describes the purpose of the short term SBG forecast as follows:

> The IESO endeavours to provide as much information in advance so that market participants are aware of potential SBG conditions and can plan their business and respond appropriately.[7]

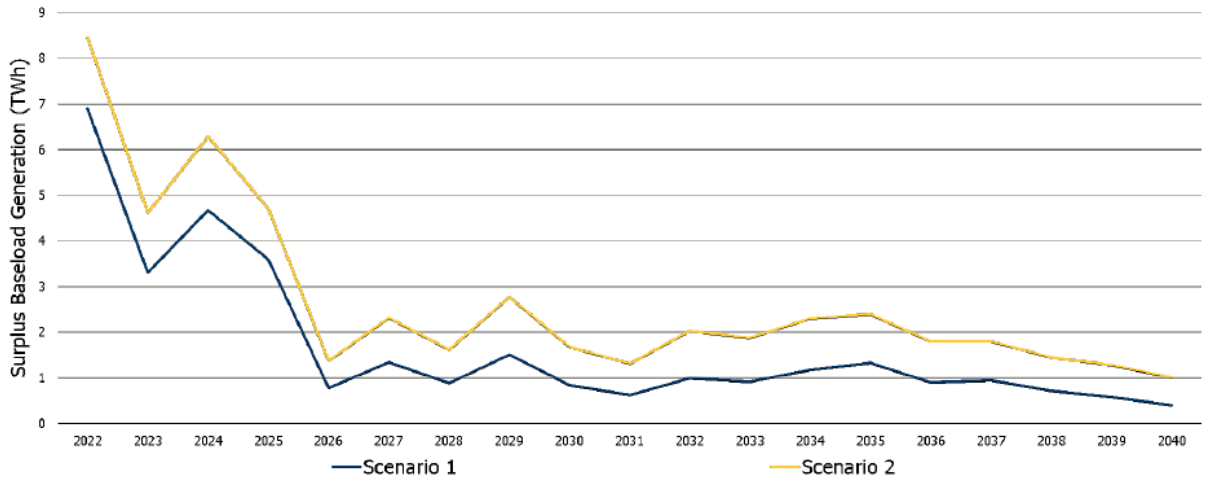
2.3. Current IESO Long Term Forecast of SBG

The most recent long term forecast of SBG available at the time of this Study was released as part of the IESO's Annual Planning Outlook issued in December 2020.[8] With the emergence of the COVID-19 global pandemic, the 2020 Annual Planning Outlook forecasts demand using two scenarios based on different assumptions for the pace of economic recovery. Scenario 1 assumes a shallow economic recession in 2020 and early 2021 followed by a rapid economic recovery in 2021 and 2022, with demand expected to reach pre-pandemic levels by the end of 2022. Scenario 2 assumes a deep economic recession until the end of 2021, followed by a slow multi-year economic recovery starting in 2022, with demand not expected to reach pre-pandemic levels until 2024.

[7] http://www.ieso.ca/en/Power-Data/Data-Directory, See SBG Forecast Report.

[8] IESO Annual Planning Outlook December 2020, p. 47.

Figure 1 – IESO Annual Planning Outlook-Dec 2020: SBG Forecast



The IESO's forecast extends to the year 2040 and shows SBG conditions declining through to 2026 and remaining at a much lower level than recently experienced going forward to 2040. The IESO attributes the decrease in SBG conditions to nuclear refurbishments and retirements, as well as rising demand, and explains that over the next 20 years, SBG is expected to be managed using existing market mechanisms, such as exports, variable generation curtailment, and nuclear manoeuvers/curtailment. The IESO has also noted that demand is expected to rebound past levels forecast in the previous APO due to growth in electric vehicles, and in the agricultural and residential sectors.[9]

[9] "2020 APO Addresses Impacts of COVID-19, and Shifting Energy Landscape", IESO News Release, December 17, 2020

2.4. The IESO and the Development of a Dispatch Order

The IESO is responsible for ensuring the reliability and efficiency of Ontario's power grid.[10] The IESO manages the power system in real-time, plans the province's future energy needs, enables conservation, and facilitates the efficient operation of the electricity market in order to support sector evolution.

IESO dispatches generators in a manner seeking to achieve an efficient and lowest cost dispatch to meet demand.[11] During periods of SBG, the IESO-administered market utilizes a "dispatch order for baseload generation which will produce real-time dispatch outcomes that promote market efficiency, achieve cost-effectiveness, [and] minimize environmental impacts".[12] The current concept of dispatch order and the relevant Market Rules and Market Manuals were developed as a result of IESO initiated consultation activities beginning in late 2010. At the time, SBG had recently emerged as a market condition. As the IESO explained:

> Since 2008, we have seen a significant increase in the frequency and duration of surplus baseload generation events. These events are typically associated with negative market and locational prices and the need to spill water at hydroelectric stations or to reduce the output of, or completely shut down, nuclear units. In anticipation of these events, we initiate

[10] IESO 2019-2021 Business Plan, p. 3.

[11] Renewable Integration Stakeholder Engagement SE-91, p. 8.

[12] Dispatch Order for Baseload Generation, A Discussion Paper for Stakeholder Engagement 91 (Renewable Integration) dated November 2, 2011, p. 3.

> communications with baseload generation operators in order to assess their dispatch flexibility should we encounter SBG. Through these conversations, and through operating experience under SBG conditions, we have come to better understand the technical, regulatory and public safety restrictions that place limits on how hydroelectric and nuclear generation operators manoeuvre the output of their units when the electricity system is faced with a generation oversupply.[13]

It was further anticipated by the IESO that the pending elimination of coal fired units and the increase in natural gas generation could increase the frequency of SBG conditions.

> With the retirement of the coal fleet, which typically has low minimum loading points and broad dispatch capability, and the building of a larger natural gas fleet, which typically has higher minimum loading points and less dispatchable range, bringing gas generation online to meet increasing demand and replace decreasing wind generation can lead to surplus generation conditions. In these instances, it may be necessary to reduce the output from wind generation a few hours in advance in order to avoid oversupply conditions, either globally or locally.[14]

In response, the IESO launched multiple electricity market stakeholder initiatives under the umbrella of *Stakeholder Engagement SE 91 – Renewable Integration*. The purpose of the initiative was to integrate new renewable generation (wind and solar) into system and

[13] IESO Dispatch Order for Baseload Generation, A Discussion Paper for Stakeholder Engagement 91 (Renewable Integration), November 2, 2011, p. 6.

[14] Ibid, p. 5.

market operations,[15] with the expectation that the integration of renewables into the economic dispatch model should help resolve issues like SBG.[16]

Through its stakeholder engagement process, the IESO established a list of principles that formed the basis for the development of new Market Rules and Market Manuals, resulting in changes to the operations of the power system and the Energy Market. Design Principle 10 was particularly significant:

> The IESO may establish various floor prices for offers from baseload generators (e.g. wind, must-run hydro, nuclear, etc.) to ensure efficient dispatches during periods of local and/or global surplus baseload generation (SBG) events.[17]

In the process of establishing floor prices, the IESO acknowledged that hydroelectric facilities may be required to generate in order to meet various safety and regulatory obligations. In addition, based on economic, regulatory, and environmental analysis, the IESO concluded that using coarse hydroelectric spill and/or nuclear manoeuvres results in over-curtailment and requires replacement energy that results in higher cost and carbon emissions.[18] Ultimately, the IESO established a dispatch order by setting floor prices for the various forms of generation beginning with -$15/MWh and -$10/MWh for

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[15] IESO letter, B. Campbell, "Re. Integrating Renewable Resources-Design Principles", December 9, 2010.

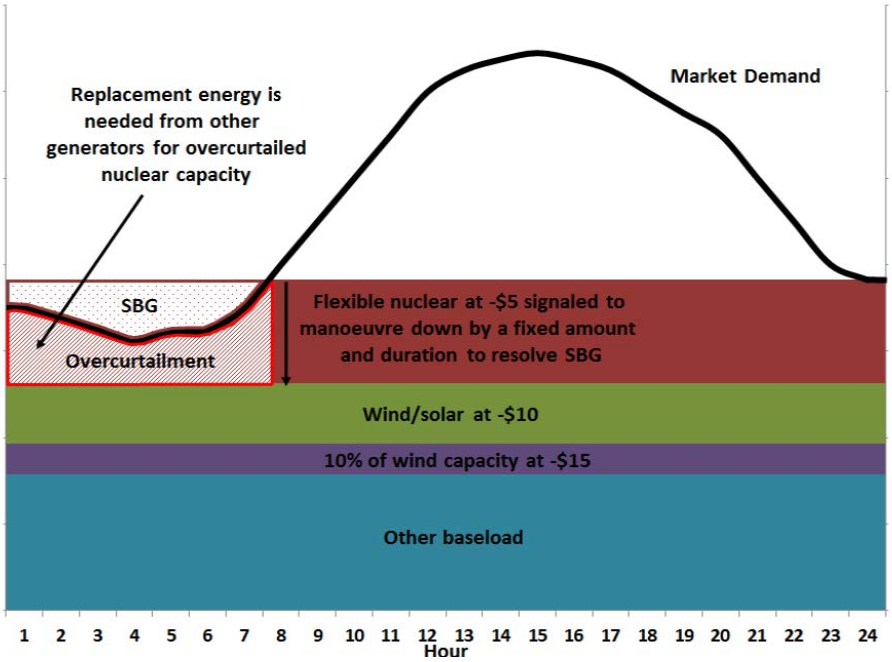
[16] Renewable Integration Stakeholder Engagement SE-91, p. 8.

[17] IESO, Renewable Integration SE 91.

[18] SE-91, Response to Stakeholder Feedback, April 26, 2012

10% and 90% of variable generation respectively, and -$5/MWh for flexible nuclear[19] generation as illustrated in Figure 2 below.

Figure 2 : IESO Dispatch Order – 2013 [20]



The IESO indicated that, "the implementation of floor prices will achieve an appropriate dispatch outcome, a more efficient market, while at the same time increasing the environmental benefit of Ontario's electricity system."[21] The above floor prices were implemented in September of 2013 and further revised in 2016[22], with the dispatch order

[19] Flexible nuclear is the maneuvering associated with Condenser Steam Discharge Valve (CSDV) reductions at the Bruce facilities.

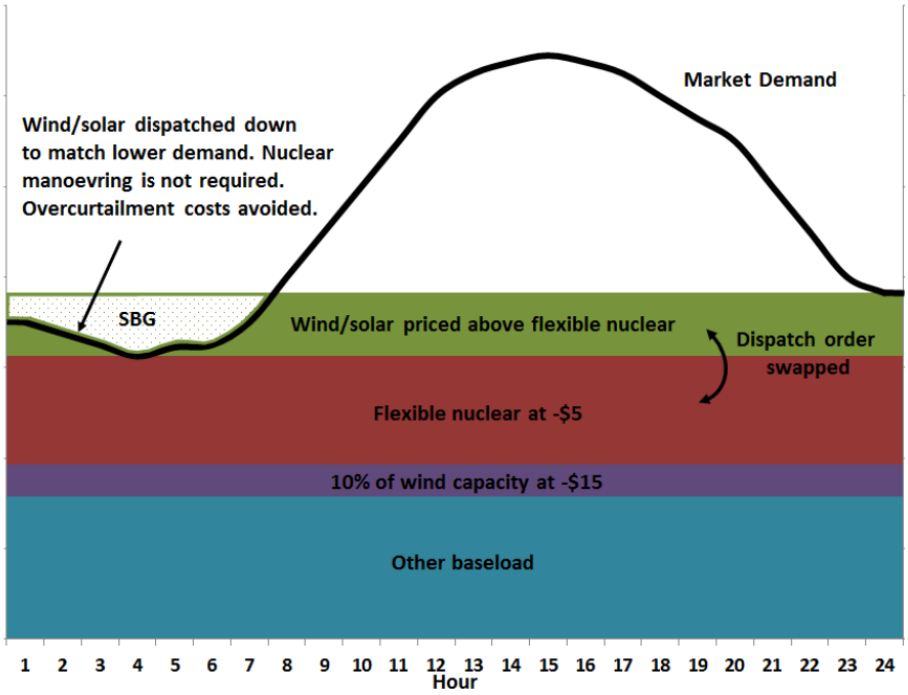
[20] IESO Floor Price Review Stakeholder Engagement, "Analyzing the Impact of Changing the Floor Price for Renewable Resources", July 2015.

[21] IESO Presentation SE-91 Aug 8, 2012.

[22] IESO Stakeholder Engagement Notification, "Floor Prices for Variable Generation – Update", December 2, 2015.

of flexible nuclear generation and 90% of variable generation reversed, as illustrated in Figure 3 below.

Figure 3: IESO Revised Dispatch Order - 2016



As highlighted previously, there is no mandated floor price for OPG's hydroelectric units. As OPG explained in previous OEB proceedings, its offer strategy for hydroelectric energy that is not must-run and where forebay[23] storage capability has been utilized based on

[23] Forebay is the area of upstream water that comes into contact with a dam.

market signals, is tied to its marginal cost of production. This cost is the Gross Revenue Charge ("GRC").[24]

OPG's GRC based offers range approximately between $5 and $14.40/MWh reflecting the applicable GRC rates. There are few, if any, generating assets in the market that are dispatchable at prices between $0/MWh and OPG's highest GRC offer of $14.40/MWh. As a result, during periods of SBG, OPG's regulated hydroelectric units are dispatched down first (i.e., instructed to spill water) at locations where spill does not violate safety, environmental or regulatory restrictions.

2.5 The Economic Benefits of the Current Dispatch Order

There are significant economic and other benefits to the current dispatch order. In SE-91, the IESO indicated that the "environmental and financial savings achieved by incorporating wind into the 5-minute dispatch are estimated to be $180 - $225 million and 1.6 - 2.0 Mt of avoided CO2 emissions in 2014".[25] These benefits were largely attributed to the implementation of the dispatch order that minimizes over-curtailment utilizing OPG's hydroelectric assets offered at GRC followed by the above noted floor prices for other forms of electricity generation.

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[24] GRC are payments made by OPG to the Province of Ontario and apply to hydroelectric facilities under section 92.1 of the *Electricity Act, 1998*. Further details are available in EB-2013-0321 Ex. F1-4-1

[25] SE-91 Presentation dated January 24, 2012, p. 9.

In 2015, in recommending that the relative order of flexible nuclear and solar/wind be switched to better reflect the marginal cost of renewable generation, the IESO indicated that this would result in further savings of $5 to $8 million for each year in the period 2016 to 2018, [26] in addition to the $180 - $225 million in savings estimated during SE-91.

2.6 The SBG Variance Account

At the time of OPG's EB-2010-0008 payment amounts proceeding, SBG had become a more prevalent market phenomenon due to reduced electricity demand, resulting from depressed economic conditions and an increase in available electricity supply, which had a material impact on the accuracy of OPG's hydroelectric production forecast absent an explicit adjustment for the impact of SBG conditions. In response, the OEB established the SBG Variance Account to record the financial impact of foregone production at OPG's regulated hydroelectric facilities due to SBG conditions.

In establishing the account, the OEB concluded that rather than reflecting the impact of SBG conditions in the forecast of regulated hydroelectric production as initially proposed by OPG, it was better to capture such impacts in a variance account, resulting in a production forecast being set on a pre-SBG basis.[27] The OEB also accepted that SBG was being addressed through market mechanisms implemented by the IESO, in addition to

[26] IESO Floor Price Review Stakeholder Engagement, "Analyzing the Impact of Changing the Floor Price for Renewable Resources", July 2015.

[27] EB-2010-0008 Decision with Reasons, p. 22.

acknowledging evidence that safety, environmental and other factors are taken into account by OPG when responding to SBG conditions.[28] OPG's evidence included an explanation that, from a safety and operational perspective, SBG is best managed at the Sir Adam Beck facilities where water associated with GRC offers at $14.40/MWh can generally be safely spilled over the Niagara Falls and that for other regulated hydroelectric facilities, spill may be subject to additional safety, environmental and regulatory considerations.[29]

Similarly, in EB-2013-0321, the OEB approved a regulated hydroelectric production forecast without a reduction for SBG conditions, and continued the SBG Variance Account, recognizing SBG forecast uncertainties.[30] The OEB also approved the SBG Variance Account balance.[31] Since EB-2013-0321, the account has been continued and the account balances have been approved in each subsequent OPG proceeding.

2.7 SBG Spill Forecast

As OPG explained in EB-2013-0321, SBG conditions impacting OPG's regulated hydroelectric facilities are deemed to be present when the prevailing market price is at, or falls below GRC at $14.40/MWh, which represents the minimum offer price that would allow OPG to cover its marginal production costs.[32]

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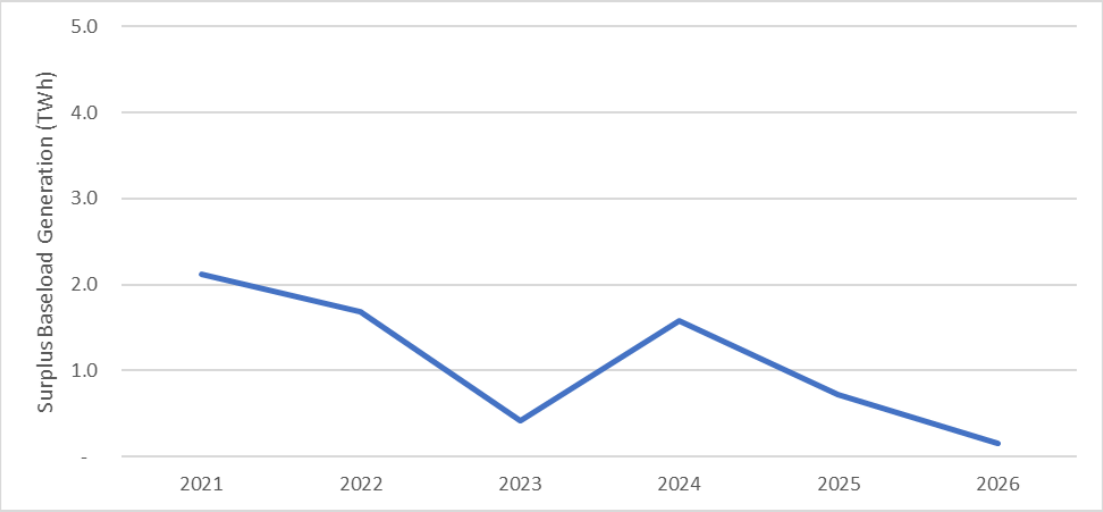
[28] EB-2010-0008 Decision with Reasons, p. 23.
[29] Ibid
[30] EB-2013-0321 Decision with Reasons, p. 9.
[31] EB-2013-0321 Decision with Reasons, p. 119.
[32] EB-2013-0321 Ex. E1-2-1, p. 3, lines 24-29.

Figure 4 - OPG Regulated Hydroelectric SBG Spill (TWh)



As illustrated in Figure 4 above, and in alignment with IESO's long term outlook, OPG's forecast[33] of the declining presence of SBG conditions points to a significantly lower expected SBG spill over the 2021 to 2026 period. As noted previously, the drivers for lower SBG conditions are nuclear refurbishments and retirements, as well as rising demand. The declining SBG conditions will continue to be managed by the IESO using existing market tools, as discussed in Section 2.3.

3. OPG's Management of Facilities in Response to SBG Conditions

The following section describes actions and considerations OPG takes in managing its facilities in response to SBG conditions.

[33] Based on OPG's forecast of SBG spill as stated in OPG's 2020-2026 Business Plan.

3.1 Long Term

OPG uses forward-looking generation models for the purposes of business planning and these models include a forecast of hydroelectric spill as a result of SBG conditions. OPG considers IESO's long term forecasts, including IESO's SBG conditions forecast, in the calibration of these models.[34]

3.2 Near Term

On a near term basis OPG considers SBG forecasts, including the IESO's forecast, as an input to its hydroelectric storage management plans and outage decisions.

Seasonally, OPG puts in place hydroelectric storage drawdown plans which create room in station forebays, where practicable, in advance of freshet.[35] Given the typical seasonal pattern of precipitation related to rain and snowmelt, water levels in river system reservoirs are managed over a period of months to adhere to the hydrological limits, flows and elevations as specified by the respective regulation or water management plan. For example, during winter months, water in reservoirs is drawn down by generating, which creates storage capacity to accommodate expected higher levels of water inflows expected later in the spring period. This volumetric storage management (i.e., drawdown

[34] OPG may make changes to inputs or algorithms in the models to better align with IESO's data to help improve the quality and accuracy of OPG's forecasts.

[35] Freshet is the higher inflow of water into a lake or river system typically occurring in the spring during snow melt and/or heavy rain.

strategy), is based on hydrological criteria found in water management plans designed to mitigate the effects of flooding during higher spring flows.

While the purpose of hydroelectric storage management is not strictly to respond to market conditions, their implementation affords an opportunity to take SBG into consideration. In this respect, when implementing its water management plans, OPG factors in market signals by withdrawing from storage during days or hours of expected stronger Hourly Ontario Energy Price ("HOEP"). From a seasonal perspective, the increased forebay room has a favourable affect on SBG conditions, which are typically more prevalent during higher spring flows.

OPG recognizes that outage planning at its baseload generating facilities can impact SBG conditions. In particular, many of OPG's Nuclear outages are scheduled in low demand and high SBG fall and spring periods of the year, such that nuclear units are available to a greater extent during the high demand summer and winter periods. Scheduling nuclear outages during high SBG periods directly contributes to a reduction in SBG conditions through the decrease of baseload generation.

OPG's hydroelectric outage planning methodology continues to focus on reliability-based maintenance while taking into consideration water availability. As OPG stated in EB-2013-0321, the objective of hydroelectric production planning is achieving total utilization of available water and, as a result, outages for hydroelectric units are primarily

taken during lower flow periods.[36] This approach carries broader system benefits as hydroelectric energy is made available to the system. As SBG conditions are typically only experienced during the lower demand hours in the day, hydroelectric energy is available to offset the need for incremental resources dispatched during peak hours.

3.3 Short Term

As described previously, expectations of SBG conditions in the real time and day ahead markets are conveyed through market prices. OPG's hydroelectric assets respond differently to price signals depending on their operational and market behaviour type: *baseload*, *run of the river, intermediate,* and *peaking*.

Baseload hydroelectric stations operate at nearly constant output and have limited storage ability. At these facilities, hydroelectric energy must either be generated or will typically result in spill.

Run of the River hydroelectric stations have minimal forebay storage and pass some or all inflow through one or more turbines on a continuous basis, with the remainder (if any) going over an existing spillway.

Intermediate and *Peaking* stations have higher ability to time shift production by storing water compared to *baseload* stations. Storage capabilities vary at each hydroelectric

[36] EB-2013-0321, Ex. E-2-1, p. 3, lines 1-2.

station and are also significantly affected by water flows, where high flows limit flexibility of time shifting.

In operating its *intermediate* and *peaking* facilities, OPG follows market price signals based on OEB approved Hydroelectric Incentive Mechanism ("HIM"), which is designed to reward pricing behaviour that shifts generation into higher priced periods. Time-shifting is achieved through OPG's pricing of hydroelectric energy based on opportunity cost which reflects the value of energy over a forward-looking storage horizon. Hydroelectric energy with no remaining forebay storage opportunity is priced at GRC consistent with the basis for the IESO's dispatch order described above.

The current HIM was initially established by the OEB in EB-2010-0008. In last reviewing the HIM in EB-2013-0321, the OEB noted that "shifting production of relatively low cost hydroelectric power from periods of low demand to periods of high demand will generally benefit all consumers by lowering the market price during high demand period" and found that the HIM has "encouraged appropriate use of the regulated hydroelectric facilities to supply energy in response to market prices."[37]

Additionally, by using the HIM to move hydroelectric production to higher price periods, and flexibly pricing hydroelectric energy subject to forebay storage limitations at GRC, OPG uses market price signals to support the IESO's response SBG conditions in accordance with the established dispatch order.

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[37] EB-2013-0321 Decision with Reasons, pp. 10, 12.

The Sir Adam Beck Pump Generation Station ("PGS") is OPG's largest hydroelectric storage facility and its operation is informed by the economic drivers associated with the HIM. As explained in EB-2010-0008, subject to operational constraints, the PGS is deployed based on a forecast of economic opportunities. While the IESO is responsible for responding to surplus conditions, when anticipating SBG, OPG establishes PGS offer prices so that output reductions are based on market economics and operational constraints.[38]

In addition to economic drivers and operational constraints, use of the PGS is also subject to the impact of water flows, with stronger water conditions, such as those experienced in recent years, reducing opportunities to time shift. OPG's current forecast of normalizing Great Lakes' hydrological conditions indicates that water flows will have a diminishing impact on PGS operations on a forward basis.

[38] EB-2018-0243, JT1.5.

4. Potential Other Actions that OPG could take in Response to SBG Conditions

This section discusses other potential actions OPG could take in response to SBG conditions, including an assessment as to whether such actions are any more appropriate than those currently being taken.

Two types of actions to respond to SBG conditions are considered: physical and market-based.

From a physical perspective, OPG could attempt to shift some hydroelectric unit outages to periods of high water flows, which historically have coincided with a presence of SBG conditions. OPG expects that such change will have an overall negative impact as it will remove hydroelectric energy from the system. As SBG conditions typically occur in hours with low demand, hydroelectric energy continues to contribute to a cost efficient dispatch of resources over the balance of the day. The removal of incremental hydroelectric energy as a result of additional outages during freshet would be expected to create a need for replacement energy, leading to additional system cost.

From a market-based perspective, there are two alternative offer strategies:

1. OPG could seek to minimize the SBG impact recorded in the SBG Variance Account by changing its GRC pricing strategy for hydroelectric resources to a price below flexible nuclear (given that hydroelectric resources are not subject to a floor price).

Under this scenario variable generation would be dispatched down first during SBG conditions, followed by flexible nuclear, with OPG hydroelectric facilities spilling last.

2. OPG could price its flexible hydroelectric resources between the minimum floor prices of variable generation and flexible nuclear. This would result in variable generation being curtailed before OPG hydroelectric but OPG hydroelectric would be dispatched down prior to flexible nuclear.

Both of these scenarios would be contrary to the existing dispatch order established by the IESO, which would erode the previously described economic benefits.[39] Therefore, while these strategies would reduce amounts recorded in the SBG Variance Account, they would have a significant negative impact on the system and increase the overall cost to consumers. OPG has not implemented these strategies.

In preparing this report, OPG reviewed and discussed its hydroelectric offer price strategy with the IESO, who has affirmed that it supports maintaining the current dispatch order established through the stakeholder engagement process and as part of SE-91.

5. Conclusion

OPG considers forecast of SBG conditions across all time horizons. The actions OPG currently takes in relation to such conditions are appropriate and consistent with the

[39] http://www.ieso.ca/-/media/Files/IESO/Document-Library/engage/fpr/FRP-20150717-Navigant.pdf?la=en

physical constraints associated with OPG's generation facilities, relevant water management plans, IESO's reliability requirements and market dispatch order, and economic signals in line with the approved HIM. Other potential strategies in relation to SBG conditions would have a significant, negative impact on the efficiency of the electricity market and erode the economic benefits associated with the current dispatch order to the disadvantage of consumers.