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May 15, 2019

The Board of Commissioners of Public Utilities
Prince Charles Building
120 Torbay Road, P.O. Box 21040
St. John's, NL A1A 5B2

Attention: **Ms. Cheryl Blundon**
Director Corporate Services & Board Secretary

Dear Ms. Blundon:

Re: The Board of Commissioners of Public Utilities Investigation and Hearing into Supply Issues and Power Outages on the Island Interconnected System - Near-Term Generation Adequacy Report – May 2019

Further to the Board of Commissioners of Public Utilities correspondence of October 13, 2016, requesting semi-annual reports on May 15 and November 15 each year on generation adequacy for the Island Interconnected System, enclosed please find one original plus twelve copies of Newfoundland and Labrador Hydro's report entitled "Near-Term Generation Adequacy Report".

Should you have any questions, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

SWalsh

Shirley A. Walsh
Senior Counsel, Regulatory
SAW/las

Encl.

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey
Dennis Browne, Q.C. – Browne Fitzgerald Morgan & Avis
Danny Dumaresque

ecc: Denis Fleming – Cox & Palmer
Roberta Frampton Benefiel – Grand Riverkeeper® Labrador
Larry Bartlett – Teck Resources Ltd.

Near-Term Generation Adequacy Report

May 15, 2019

A Report to the Board of Commissioners of Public Utilities

Table of Contents

1 Introduction

Newfoundland and Labrador Hydro ("Hydro") recognizes that supply adequacy in advance of the availability of full production from the Muskrat Falls Generating Facility is top of mind for its stakeholders. The enclosed assessment of near-term resource adequacy takes an in-depth view of system risks and mitigating measures to ensure Hydro can reliably meet the needs of its customers through the full system transition.

This report discusses the near-term resource adequacy and reliability of the Newfoundland and Labrador Interconnected System ("NLIS") for a five-year period, 2019-2023, and provides the results of the probabilistic resource adequacy assessment for the NLIS through the near-term. The reliability indices in this near-term report include both annual and monthly Loss of Load Hours ("LOLH"), Expected Unserved Energy ("EUE"), and Normalized EUE[1] for a five-year period. The analysis considers the different types of generating units (i.e., thermal, hydro, and wind) in Hydro's fleet, firm capacity, contractual sales, transmission constraints, peak load, load variations, load forecast uncertainty, and demand side management programs. Similar to previous analyses, a range of projected availabilities was considered for the Holyrood Thermal Generating Station ("Holyrood").

The analysis was conducted consistent with the format proposed in the NERC "Probabilistic Assessment Technical Guideline Document" that provides modelling "*practices, requirements and recommendations needed to perform high-quality probabilistic resource adequacy assessments".*[2] As such, this edition of the near-term report is a hybrid of the methodology used in prior near-term generation filings, paired with the assessment guidelines as defined by NERC.

The *"Probabilistic Assessment Technical Guideline Document*" suggests a more granular view of resource adequacy, focusing on monthly and annual LOLH and EUE reporting. By conducting this type of analysis, the impact of system changes can more easily be observed than by using an annual analysis only. As LOLH and EUE do not currently have generally acceptable criterion, unlike the generally accepted LOLE

[1] Normalized EUE provides a measure relative to the size of the assessment area. It is defined as: [(Expected Unserved Energy)/(Net Energy for Load)] x 1,000,000 with the measure of per unit parts per million.
[2] "Probabilistic Assessment Technical Guideline Document," NERC, August 2016.
<https://www.nerc.com/comm/PC/PAITF/ProbA%20Technical%20Guideline%20Document%20-%20Final.pdf>

criterion of 0.1, the quantified results are presented to show how loss of load accrues through the year rather than for comparison against a threshold.

The granular near-term view provides insight into the impact of seasonal load and generation variations on supply events. This can be used to further inform decisions on the most appropriate resource options as system requirements evolve, resulting in more informed long-term planning.

Given the current evolving nature of the NLIS, an analysis was conducted for each of the next five years (2019 to 2023) to provide the Board of Commissioners of Public Utilities (the "Board") with insight into the evolution of system reliability as the Lower Churchill Project assets are integrated into the NLIS.

The analysis in this report has been completed using Hydro's reliability model. This is the same model that was used in the Reliability and Resource Adequacy Study, filed in November 2018 (the "November 2018 Filing"), with updates to reflect current system assumptions.[3] A detailed discussion of the modelling approach used can be found in Volumes I and II of the November 2018 Filing.

2 Modelling Approach

Detailed modelling of the near-term supply period was undertaken using the reliability model developed in 2018 and updated with the current system assumptions.[4] It is noted that transmission system adequacy is assessed separately in accordance with Transmission Planning Criteria; these are posted publically on the Newfoundland and Labrador System Operator ("NLSO") Open Access Same-Time Information System ("OASIS") website. [5]

3 Asset Reliability

On a quarterly basis, Hydro reports to the Board on the rolling 12-month performance of its generating units,[6] including actual forced outage rates and their relation to: (i) past historical rates, and (ii) the

[3] "Reliability and Resource Adequacy Study" filed with the Board on November 16, 2018.
[4] For a detailed description of the modelling parameters and assumptions, refer to Volume I, Section 4.2 of the November 2018 Filing.
[5] "NLSO Standard Transmission Planning Criteria Doc # TP-S-007," Newfoundland and Labrador Hydro, May 11, 2018 <http://www.oasis.oati.com/woa/docs/NLSO/NLSOdocs/TP-S-007_Transmission_Planning_Criteria_UPDATED_ 05112018.pdf>
[6] "Quarterly Report on Performance of Generating Units".

assumptions used in assessment of resource adequacy. The most recent report was filed with the Board on April 30, 2019, for the quarter ending March 31, 2019. These reports detail unit reliability issues experienced in the previous 12-month period and compare performance for the same period year-over-year.

Hydro continues to take actions to address repeat performance issues by conducting broader reviews which frequently involve external experts, addressing issues with urgency, and placing an increased focus on asset reliability.

These actions are intended to support reliable unit operation and increase the likelihood of improved reliability in near-term operating seasons.

3.1 Factors Affecting Recent Historical Generating Asset Reliability

Hydro has reviewed the factors affecting generating unit reliability since the November 2018 Filing. Updates on these items, as well as any additional items which may impact asset performance in the near-term, are provided in this report. The intention is to ensure issues affecting reliability have been appropriately addressed as recurring issues , if not managed properly, can have a significant impact on unit reliability. The information included in Sections 3.1.1 through 3.1.3 of this report provides an overview of repeat or broader issues. Isolated equipment issues (i.e., those that occur once on a particular unit) are also investigated, with the root cause identified and corrected. These types of issues are reflected in the calculation of Derated Adjusted Forced Outage Rates (“DAFOR”) and Derated Adjusted Utilization Forced Outage Probabilities (“DAUFOP”).

The following sections provide a description of issues, both asset and condition based, that have previously affected generating unit reliability, as well as the current status of those issues and the actions taken to mitigate against future reliability impacts. The scope is not limited to Hydro’s assets (e.g., penstock, boiler tubes), but also considers environmental challenges facing Hydro’s operations (e.g., lower than average inflows). As part of this exercise, Hydro has identified the following items, grouped by facility type:

- **Hydraulic Facilities**: Continued monitoring (Bay d'Espoir penstocks, Upper Salmon Rotor Key Cracking); ongoing (Hinds Lake rotor resistance and Granite Canal control system);

- **Thermal Facilities**: Ongoing (unit boiler tubes, air flow limitations due to normal boiler fouling during operating season, and Unit 1 and Unit 2 hydraulic fluid condition); and resolved (variable frequency drives); and

- **Gas Turbines**: Ongoing (Exciter Vibration at Hardwoods); and resolved (End A unavailability at Stephenville).

Risks not specifically noted above are embedded in the DAFOR and DAUFOP assumptions selected for each asset.

3.1.1 Hydraulic

3.1.1.1 Bay d'Espoir Penstocks

The November 2018 Filing noted that the condition assessments of Penstock 1, 2 and 3 in Bay d'Espoir, as well as the necessary refurbishments of Penstock 3, were completed in 2018. A report discussing the penstock condition assessments as well as the long-term Bay d'Espoir penstock inspection, maintenance, and investment plan is underway and will be filed with the Board in the third quarter of 2019. As per the present penstock inspection plan, similar inspections to those completed in 2018 are to be completed on Bay d'Espoir Penstocks 1, 2 and 3 on an annual basis. At present, an inspection has been completed on all of Penstock 2 and the upper portion of Penstock 3, which included inspection of both original welds and welds which were refurbished in 2018. These inspections revealed no material issues or concerns with Penstocks 2 and 3. The outstanding inspection on Penstock 1 is scheduled for the fall of 2019.

Additionally, as part of the Penstock Inspection Plan, and aligned with unit major outages, penstock inspections are planned for Granite Canal, Bay d'Espoir Penstock 4 and Hinds Lake in 2019.[7] The long-

[7] Hydro anticipates filing a supplemental capital budget application related to these inspections by end of May 2019.

term Bay d'Espoir penstock inspection, maintenance, and investment plan will be informed by the Condition Assessment report currently underway.

3.1.1.2 Hinds Lake Rotor Resistance

As noted in the November 2018 Filing, resistance readings from the Hinds Lake rotor, which are measured during annual maintenance inspections, have trended down over the past several years, approaching the critical level of 0.14 Mohms as established by the Original Equipment Manufacturer ("OEM").

Hydro installed a new relay during the fall 2018 maintenance outage that monitors the field resistance, which includes the rotor, while the unit is online. This allows Hydro to assess and monitor field resistance on an ongoing basis and trend the readings. At present the value is 0.25 Mohms, which is above the critical value.[8] The resistance readings have deteriorated since the November 2018 filing; however, this is expected as the unit has been in operation since that time. Should the online resistance readings continue to deteriorate to a point of concern, the unit protection will remove the unit from service, allowing Hydro time to inspect and perform maintenance.

Hydro completed maintenance in the fall of 2018 and again in the spring of 2019 to improve readings and expects that the rotor will remain in reliable service until fall 2019 when the rotor is scheduled for a planned refurbishment.

3.1.1.3 Granite Canal Control System

In the November 2018 Filing it was noted that the Granite Canal unit has experienced control system malfunctions that occur when remotely starting and/or stopping the unit. In 2018, an operational restriction to limit unnecessary starts/stops was implemented. Additionally, a short-term solution involving software changes was applied on October 13, 2018. Hydro is completing a thorough engineering assessment of the system. Following the conclusion of this assessment, any findings will be reviewed and implemented, or, if capital expenditures are required, Hydro will propose a capital project as per the established capital budget process.

[8] As of May 13, 2019

3.1.1.4 Upper Salmon Rotor Key Cracking

In 2018, Hydro replaced the rotor rims keys during the unit annual maintenance outage at Upper Salmon. As per consultation with the OEM, Hydro has continued to schedule and conduct regular inspections of the new rotor rim keys at Upper Salmon and will continue to monitor this situation throughout the anticipated wear-in period of the new keys and assess the effectiveness of the replacement keys.

3.1.2 Thermal

3.1.2.1 Unit Boiler Tubes

Each of the three thermal generating units at Holyrood has a boiler that contains tubes. Boiler tube failures are a common issue in thermal power plants due to the inherent design, which requires relatively thin walls for heat transfer that are subjected to high temperatures and stresses. Hydro inspects boiler tubes on an annual basis to verify the condition and to identify trends.

There were two boiler tube failures in 2018 at Holyrood. In May 2018 there was a boiler tube failure in the lower waterwall section of Unit 2 and the failed tube was replaced. A laboratory analysis of the failure determined it was due to a crack that had developed at an original butt weld between two pieces of tube, made during the time of boiler construction. Analysis showed that this weld was of poor quality when installed. The weld on the adjacent tube, that did not fail, was also removed from the boiler and examined by the lab. The quality of this weld was better than the one that failed, with no cracking observed.

In November 2018 there was a failure of a waterwall tube on Unit 3 at a location where, as part of the original boiler structural design, a portion of the combustion air duct known as the windbox is attached to the waterwall tubes by welding. This attachment results in additional stress on the adjacent tubes which led to stress cracking and failure of the tube. Similar failures were last observed on this unit in 2009. Mitigation efforts made by the boiler contractor at the time to reduce these failures were effective. With respect to the recent failure, Babcock and Wilcox (“B&W”)[9] has developed an action plan

[9] B&W is the current boiler contractor at Holyrood and the designer of the Unit 3 boiler

for execution during the 2019 annual boiler outage. The plan involves additional non-destructive evaluation at tube attachments.

Hydro conducts an annual tube inspection program to mitigate the possibility of tube failures and has determined that boiler tube sections, as a whole, are in good condition. Hydro continues to recognize that random tube failures pose a risk, particularly given the age of the Holyrood boilers. Hydro maintains a thorough selection of spare tube material and has an established contract with B&W for the provision of emergency repairs in the event of tube failures. As such, should a tube failure occur, return to service time is accounted for in the projected DAFOR targets.

3.1.2.2 Variable Frequency Drives

Forced draft fans provide combustion air required for boiler operation at Holyrood. The Variable Frequency Drives ("VFD") were installed to more efficiently vary the amount of air required based on generation need. This reduces auxiliary power requirements and results in fuel savings.

Hydro completed preventive maintenance work on the drives in 2018 and ensured appropriate spares were available. For the 2018-2019 operating season, Hydro also implemented operating strategies to reduce the likelihood of VFD failures, such as pre-energizing VFD equipment prior to unit start-ups. There was one VFD related failure during the 2018-2019 operating season when a power cell failed on Unit 2 in October of 2018, causing a forced derating to 70 MW for approximately eight hours. This issue is considered resolved.

3.1.2.3 Air Flow Limitations

Appropriate air flow is required to provide enough air for combustion to enable units to provide full output. Deratings had resulted from fouling of the air heaters and boiler sections including the economizer, and from air heater leakage due to normal wear and tear. For the 2018-2019 operating season, Hydro was successful in eliminating these deratings and was able to operate all three units at full load capability.

Two significant projects were implemented during the 2018 annual overhauls to achieve this result. A supplemental capital project was completed to replace air heater baskets in all three units. In addition, the Unit 1 and Unit 2 economizers were chemically washed by an experienced boiler cleaning contractor. The chemical wash was effective in removing fouling from approximately 70% of the economizer flow area in both units, resulting in a significant improvement in back pressure in the furnace.

Unit capabilities were maintained through effective sootblower operation, maintenance of the MgO fuel additive system and burner guns, air heater washes, and control of operational parameters. Unit capabilities were successfully tested and confirmed throughout the 2018-2019 winter operating season.

3.1.2.4 Unit 1 and Unit 2 Hydraulic Fluid Condition

In the first quarter of 2018, Hydro observed contamination in the hydraulic fluid that is used to operate the Unit 1 and Unit 2 turbine valves.[10] The level of fluid contamination observed required fluid and filter replacement.

As a mitigating measure, flushing was completed during the 2018 annual outages for both units to replace the fluid and clean the systems. However, continued hydraulic contamination issues caused a forced outage on Unit 1 in November of 2018. This prompted additional and extensive work on both Units 1 and 2 in November and December.

Hydro engaged a technical field representative from the OEM, GE, as well as local hydraulics contractor, Pennecon. Work included refurbishment of all hydraulic cylinders, replacement of servo valves, and replacement of the contaminated fluid. After completion of this work, there were no further operational issues related to the hydraulic fluid condition. Hydro continued to perform monthly fluid sample analyses during the 2018-2019 winter operating season and all results were acceptable. To support continued reliable operation, additional work will be completed during the 2019 annual outages for Unit 1 and Unit 2. This work will mainly consist of refurbishing the five hydraulic dump valves on each unit.

[10] Contamination has been observed through regular sampling. On March 22, 2018, the contamination resulted in a forced outage on Unit 2. On April 3, 2018, Unit 2 was taken off-line for repair of the hydraulic ram for the turbine control valves.

3.1.3 Gas Turbines

3.1.3.1 Exciter Bearing Vibration at Hardwoods

The Hardwoods Gas Turbine is currently derated to 25 MW following a unit trip on February 21, 2019, while placing End B in service. The trip occurred as a result of high exciter bearing vibration, which occurs only when End B is being placed online. Operation of End A continues to be normal with all bearing vibration within operational limits and comparable to historical levels. The alternator and exciter OEM, Brush, has been engaged to complete a non-intrusive inspection of the bearing to determine whether End B can be returned to service immediately or will require replacement of bearing components. This inspection is planned to be completed the week of May 20, 2019. Hydro intends to file a supplemental application to the 2019 Capital Budget Application for the bearing replacement project, if required.

3.1.3.2 End A Unavailability at Stephenville

On December 27, 2017, Stephenville End A tripped while attempting to switch from synchronous condenser operation to generate mode. The cause of the trip was determined to be an issue with the rear power turbine bearing which subsequently required the replacement of the bearing. However, it has also been determined that the vibration detection system was being affected by electrical noise resulting in false high vibration readings. Repairs to the vibration system were completed and the unit was fully released for service on November 28, 2018. This issue is considered resolved.

3.2 Near Term Assumptions for the Lower Churchill Project Assets

In correspondence titled *"Planned Outage for the Labrador-Island Link"*,[11] Hydro informed the Board that a maintenance outage to the Labrador-Island Link ("LIL") would be required form May 1 to November 1, 2019, to enable delivery of bipole capability in advance of winter 2019-2020.

The forced outage rate of the LIL is modelled conservatively in order to capture any testing activities and potential operational unknowns during the first years of operation. In 2019 and 2020 the monopole forced outage rate is assumed to be 10% for each pole. The forced outage rate assumption decreases to 2.5% in 2021, 1% in 2022 and finally to the long term forced outage rate of 0.556% per pole in 2023.

[11] Filed with the Board on April 11, 2019.

First generation from the Muskrat Falls Generating Station is expected in 2019. Following the in-service of the first unit, the subsequent three units will be placed in service through 2020. Delivery of the Nova Scotia Block will commence once the third unit has been successfully commissioned. High power commissioning of the LIL at 900 MW will commence once all four units at the Muskrat Falls Generating Station have been fully commissioned. Table 1 provides a summary of the expected in-service dates and associated LIL capabilities.

Table 1: Summarized Asset Reliability Metrics

Milestone	Anticipated In-service Date
LIL bipole (low power–225 MW)	November 1, 2019
Muskrat Falls Generating Station Unit 1	December 9, 2019
Muskrat Falls Generating Station Unit 2	February 21, 2020
Muskrat Falls Generating Station Unit 3	May 6, 2020
Muskrat Falls Generating Station Unit 4	July 20, 2020
Lower Churchill Project Full In-service	September 1, 2020

While the transfer capability of the LIL increases as generating units are placed in service at the Muskrat Falls Generating Station, for the purposes of the analysis conducted in this report, the LIL is assumed to be available at its low power rating of 225 MW through the winter of 2019-2020. This provides a conservative view of anticipated system reliability through the coming winter across all considered cases.

3.3 Selection of Appropriate Performance Ratings

3.3.1 Consideration of Asset Reliability in System Planning

As an input to the assessment of resource adequacy, unit forced outage rates ("FOR") provide a measure of the expected level of availability due to unforeseen circumstances.

The FOR used in this analysis were determined based on historical data. The historical data is based on a weighted average of DAFOR for Holyrood and hydroelectric units, and DAUFOP for gas turbine units. Analysis was performed for a range of Holyrood DAFOR assumptions to provide an indication of the sensitivity of supply adequacy to changes in Holyrood availability.

FOR assumptions are evaluated annually to incorporate the most recent data available. Table 2 summarizes the projected availability of Hydro's generating assets considered in the assessment of near-term supply adequacy. These projections of asset reliability include appropriate consideration of asset availability and deration.

Table 2: Summarized Asset Reliability Metrics

Asset	Reliability Metric
Hydraulic Units	DAFOR = 2.8%
Holyrood Thermal Units	DAFOR = 15%, 18%, 20%
Holyrood Gas Turbine	DAUFOP = 1.7%
Happy-Valley Gas Turbine	DAUFOP = 9.8%
Stephenville Gas Turbine	DAUFOP = 30%
Hardwoods Gas Turbine	DAUFOP = 30%

3.4 Asset Retirement Plans

3.4.1 Holyrood Thermal Generating Station

Holyrood Units 1 and 2 were commissioned in 1971 and Unit 3 was commissioned in 1979. The three units combined provide a total firm capacity of 490 MW. Following the in-service of the Muskrat Falls Generating Station, the Holyrood plant is planned to be retired from generation mode, with Unit 3 remaining operational in synchronous condenser mode.

3.4.2 Hardwoods and Stephenville Gas Turbines

The Stephenville Gas Turbine consists of two 25 MW gas generators that were commissioned in 1975. The Hardwoods Gas Turbine consists of two 25 MW gas generators that were commissioned in 1976. Each plant provides 50 MW of firm capacity to the system. These units were designed to operate in either generation mode to meet peak and emergency power requirements, or synchronous condense mode to provide voltage support to the IIS. While Hydro had intended to retire these assets later in the 2020s, requirements for dispatching the units materially changed in 2014, resulting in increased frequency and duration of operation. As such, there have been operational issues in recent years that have impacted the reliability of the plants and resulted in increased maintenance costs. Hydro plans to confirm retirement plans of these assets following stakeholder review of the November 2018 Filing.

4 Load Forecast

4.1 Load Forecasting

The purpose of load forecasting is to project electric power demand and energy requirements through future periods. This is a key input to the resource planning process, which ensures sufficient resources are available consistent with applied reliability standards. The load forecast is segmented by the IIS and Labrador Interconnected System ("LIS"), rural isolated systems, as well as by utility load (i.e., residential and general service loads of Newfoundland Power and Hydro) and industrial load (i.e., larger direct customers of Hydro such as Corner Brook Pulp & Paper Limited ("CBPP"), NARL Refining Limited Partnership, Vale Newfoundland and Labrador Limited ("Vale"), and Iron Ore Company of Canada). The load forecast process entails translating an economic and energy price forecast for the province into corresponding electric demand and energy requirements for the electric power systems. For the current analysis Hydro has updated its provincial load forecast outlook to reflect the latest available load forecast information from its industrial customers, Newfoundland Power, and Hydro's own rural service territories.[12]

4.2 Economic Setting[13]

Newfoundland and Labrador remains in a transitionary period, as major projects reach completion and new developments wait to be realized.

Construction of the Hebron oil project was completed in late 2017 and has transitioned from the development phase to production phase while the Muskrat Falls development is in the final development phase and will transition to the production phase in 2020. As a result, capital investment in the provincial economy declined in 2018 compared to 2017 and, combined with reduced mineral production as a result of a labour dispute at the Iron Ore Company of Canada, resulted in a decline in overall provincial economic output.

However, there were several positive developments in the Newfoundland and Labrador economy in 2018 associated with the resource sector. Work related to the multi-billion dollar expansion of the

[12] Consistent with Hydro's approach in the November 2018 Filing, the P50 load forecast has been modeled with weather driven load forecast uncertainty. This modelling of weather driven load forecast uncertainty includes the increase in demand associated with the P90 forecast at its appropriate likelihood of occurrence. For a detailed description, please refer to Section 4.2.1.2 of Volume I of the November 2018 Filing.

[13] Budget 2019, The Economy, Government of Newfoundland & Labrador

White Rose project continued and a framework agreement for the Bay du Nord project was announced with project sanction currently expected in 2020. In addition to these developments, Vale announced it will proceed with the underground mining development at Voisey's Bay in Labrador and Tacora Resources secured sufficient funding to restart the Wabush Mines iron ore facilities that were idled in early 2014.

The Provincial Government is forecasting positive growth in the provincial economy in 2019 as a result of higher exports and increased capital investment, however the medium term outlook remains muted as government fiscal restraint and declining construction activity on major projects negatively impacts economic growth. The seafood sector remains a significant contributor to the provincial economy with fish landings expected to remain on par with recent landings but with increased activity and expansion within the aquaculture industry. It can be expected that more optimistic growth futures for the provincial economy are likely to hinge on activity within the offshore oil sector which has significant upside growth potential.

With the Provincial Government's fiscal situation remaining relatively challenging and an overall muted economic environment, the underlying local market conditions for electric power operations suggest stable or modest decline for the near term followed by a return to increasing power requirements once economic conditions improve.

4.3 Forecast Load Requirements

The customer load requirement component of Hydro's five-year load forecast was developed using forecasted load requirements provided by Newfoundland Power, Hydro's industrial customers, and Hydro's load forecast for its rural service territories.[14] Hydro relied on these inputs to determine a five-year forecast of customer energy and coincident demand for the IIS, LIS and NLIS.

Changes in forecast load requirements since the completion of the November 2018 Filing study include forecast IIS industrial power and energy requirements across the medium term that are modestly higher (+2%) through the medium term and primarily result from increased power and energy requirements for

[14] Hydro's rural service territory includes independently completed load forecasts for the Island Interconnected rural service territory, the Labrador East rural service territory and the Labrador West rural service territory.

the oil refinery at Come by Chance and for Vale's nickel processing facilities at Long Harbour. Increased power requirements at both facilities are associated with planned production increases. Forecast IIS utility power and energy requirements remain largely unchanged from previously forecast and continue to reflect the mostly stagnant outlook for the provincial economy and increased consumer rates through the medium term.[15]

In Labrador, the re-start of mining at the former Wabush Mines site is set to significantly increase power requirements on the LIS. At this early stage Tacora Resources is expecting power requirements to be on par with the former operator's power requirements. Forecast LIS utility power and energy requirements reflect load forecast updates completed by Hydro during the spring of 2019 and includes Hydro's latest forecast of approved new customer loads. As with the IIS utility power and energy requirements, the LIS utility power and energy requirements remain largely unchanged from previously forecast.

The load forecasts by system are provided in Tables 3 through 5.

Table 3: Island Interconnected System Load Forecast (MW)

	P50				
	2019	**2020**	**2021**	**2022**	**2023**
Utility Requirements	1481	1476	1478	1482	1484
Industrial Customers	178	182	183	183	183
IIS Customer Coincident Demand	1659	1657	1662	1666	1668
IIS Transmission Losses and Station Service Requirements	81	76	58	58	58
Total IIS Requirements	**1740**	**1733**	**1720**	**1724**	**1726**

Table 4: Labrador Interconnected System Load Forecast (MW)

	P50				
	2019	**2020**	**2021**	**2022**	**2023**
Utility Requirements	149	144	145	145	146
Industrial Customers	290	290	290	290	290
LIS Customer Coincident Demand	438	434	435	435	435
LIS Transmission Losses and Station Service Requirements	47	47	45	46	46
Total LIS Requirements	**485**	**481**	**480**	**481**	**481**

[15] Recent statements in the media with respect to maintaining existing retail rates post Muskrat Falls have not been assessed by Hydro at this time.

Table 5: Newfoundland and Labrador Interconnected System Load Forecast (MW)

	P50				
	2019	**2020**	**2021**	**2022**	**2023**
NLIS Customer Coincident Demand	2063	2057	2063	2067	2069
NLIS Transmission Losses and Station Service Requirements	134	142	184	166	166
Total NLIS Requirements	**2197**	**2199**	**2247**	**2233**	**2235**

5 System Constraints and Future Supply Risk

To fully understand the potential supply risk posed to the IIS, both energy and capacity analysis was conducted.

5.1 System Energy Capability

Units 1, 2 and 3 at Holyrood were required to generate during winter 2018-2019 to provide capacity and the balance of energy to meet Hydro's customer and system reliability requirements. Thermal production above minimum was required through February and March 2019 at varying levels to support reservoir levels and to reliably meet Hydro's customer requirements. The required thermal generation was supplemented by deliveries over the LIL and purchases over the Maritime Link when available and economic.

System energy in storage remained above the minimum storage target throughout the winter of 2018-2019. However, the level at Long Pond declined significantly during February 2019 and the reservoir approached minimum level. This was due to unseasonably cold temperatures which resulted in decreased inflows, combined with historically high loads on the system and sustained high energy consumption. From February 23, 2019 to March 15, 2019, the decision was made to bypass water around Upper Salmon through the North Salmon Spillway to increase flows into Long Pond and ensure the continued ability to generate at maximum capability at the Bay d'Espoir Generating Station.

Imports on the Maritime Link through winter 2019 were primarily procured to offset thermal generation that would have otherwise been required. This enabled the economic shut down of the first unit at Holyrood on March 9, 2019; aiding in the reduction of overall system supply costs.

The second snow survey of 2019 was completed in mid-March. The snow water equivalent depth for the system at that time was approximately 79% of average for this time of year. On an equivalent energy basis it was 81% of average. The spring freshet is currently in progress over all reservoir basins, increasing the system energy in storage to 1,194 GWh at the end of April 2019.

LIL commissioning activities resumed on November 1, 2018, allowing Recapture Energy to be delivered to the IIS via the LIL.[16] On May 1, 2019 the LIL was taken off line to begin the first scheduled outage. Hydro's current assumptions for LIL availability when it is brought back online in bipole configuration on November 1, 2019, are 225 MW with a 10% FOR.

Hydro's energy in storage remains above its established minimum storage target. With the availability of thermal energy to provide the balance of load the availability of energy in Hydro's reservoir systems does not currently pose a risk to near-term resource adequacy.

6 Results

The following subsections provide the LOLH, EUE, and normalized EUE results for the cases considered. The two largest factors in determining system reliability in the near term are considered to be the capability and reliability of the LIL and the DAFOR of the Holyrood Thermal Generating Station. Therefore, the scenarios considered are focused on the potential for variability in these two factors.

6.1 Scenario Analysis

Several scenarios were analyzed to assess system reliability under a range of potential system conditions.

Scenario 1: The expected scenario, which includes the LIL operating in bipole mode when returned to service in November 2019, a 15% Holyrood FOR, and Hydro's existing capacity assistance agreement with CBPP.[17]

Scenario 2: Varies from Scenario 1 by assuming lower than anticipated unavailability of the LIL when placed in service for winter 2019-2020. The case assumes eight outage weeks during winter

[16] Under the terms of the Power Purchase Agreement between Hydro and Churchill Falls (Labrador) Corporation (CF(L)Co) (the NLH-CF(L)Co PPA), Hydro is able to, and does, purchase approximately 300 MW of Recapture Energy from CF(L)Co at a cost of 0.2¢ per kWh for use outside of the Province of Quebec.

[17] As approved in Board Order No. P.U. 40(2018).

2019-2020, in addition to the 10% FOR assumption.[18] The case also considers a 15% Holyrood Forced Outage Rate. For this scenario, it was assumed that the capacity assistance contracts with Vale would be renewed for winter 2019-2020 if this supply scenario were to occur.

Scenario 3: Varies from Scenario 2 by increasing the Holyrood DAFOR to 18%.

Scenario 4: Varies from Scenario 3 by increasing the Holyrood DAFOR to 20%.

Scenario 5: Varies from Scenario 2 by delaying the in-service of the LIL to June 1, 2020.

6.2 EUE and LOLH Analysis

Sections 6.2.1 and 6.2.2 provide the results of the annual and monthly analysis, respectively.

6.2.1 Annual Assessment Results

Table 6 provides the annual LOLH, EUE and normalized EUE results. Where cases are no longer relevant (i.e., the increase in DAFOR for Holyrood plant no longer varies the LOLH or EUE once it is retired), the results have been noted as not applicable ("N/A").

[18] This assumption is realized by modelling the LIL as out-of-service from February 1 to March 31, 2020.

Table 6: Annual LOLH, EUE, and Normalized EUE Results

Reliability Metric

LOLH (hours)	**2019[19]**	**2020**	**2021**	**2022**	**2023**
S1: Expected Case; Base Assumptions, Holyrood DAFOR = 15%	0.09	0.07	0.10	0.22	0.32
S2: Increased Capacity Assistance, +8 weeks unavailability of LIL, Holyrood DAFOR = 15%	0.09	1.35	0.10	N/A	N/A
S3: Increased Capacity Assistance, +8 weeks unavailability of LIL , Holyrood DAFOR = 18%	0.11	2.03	0.09	N/A	N/A
S4: Increased Capacity Assistance, +8 weeks unavailability of LIL , Holyrood DAFOR = 20%	0.13	2.59	0.09	N/A	N/A
S5: Increased Capacity Assistance, LIL Outage May 1, 2019–June 1, 2020, Holyrood DAFOR = 15%	0.78	2.64	N/A	N/A	N/A
EUE (MWh)	**2019[19]**	**2020**	**2021**	**2022**	**2023**
S1: Base Assumptions, Holyrood DAFOR = 15%	3	3	8	17	26
S2: Increased Capacity Assistance, +8 weeks unavailability of LIL , Holyrood DAFOR = 15%	3	70	7	N/A	N/A
S3: Increased Capacity Assistance, +8 weeks unavailability of LIL , Holyrood DAFOR = 18%	4	107	7	N/A	N/A
S4: Increased Capacity Assistance, +8 weeks unavailability of LIL , Holyrood DAFOR = 20%	5	141	8	N/A	N/A
S5: Increased Capacity Assistance, LIL Outage May 1, 2019–June 1, 2020, Holyrood DAFOR = 15%	42	135	N/A	N/A	N/A
Normalized EUE (ppm)	**2019[19]**	**2020**	**2021**	**2022**	**2023**
S1: Base Assumptions, Holyrood DAFOR = 15%	0.3	0.3	0.8	1.5	2.3
S2: Increased Capacity Assistance, +8 weeks unavailability of LIL , Holyrood DAFOR = 15%	0.3	6.3	0.7	N/A	N/A
S3: Increased Capacity Assistance, +8 weeks unavailability of LIL , Holyrood DAFOR = 18%	0.4	9.7	0.7	N/A	N/A
S4: Increased Capacity Assistance, +8 weeks unavailability of LIL , Holyrood DAFOR = 20%	0.4	12.8	0.7	N/A	N/A
S5: Increased Capacity Assistance, LIL Outage May 1, 2019–June 1, 2020, Holyrood DAFOR = 15%	3.9	12.3	N/A	N/A	N/A

The results for 2021 through 2023 are similar to those provided in the November 2018 Filing. Slight changes in the LOLH and EUE values can be attributed to the changes in load forecast, increase in available capacity assistance, decrease in hydraulic forced outage rates, and statistical variations.

The results indicate an increased LOLH and EUE in 2020 in every scenario with the exception of Scenario 1. As seen in the monthly results, this is primarily due to modelled increased unavailability of the LIL.

[19] 2019 results include the period from June 1, 2019 to December 31, 2019 only.

As seen in Scenario 1, if the LIL remains available through winter 2019-20 at the assumed 10% FOR with no requirement for additional outages during the winter operating season, LOLH and EUE results indicate a low expectation of loss of load in 2020.

The results for 2019 represent the remainder of the year, June to December 2019, giving lower values than would be expected on an annual basis, as only one winter month is included in this period.

Results of Scenario 5 indicate the highest exposure for LOLH and EUE in 2019 and 2020 and occurs if the LIL remains unavailable through the winter 2019-2020 operating season. Results of Scenario 2 also indicate exposure for LOLH and EUE if the LIL experiences higher than anticipated unavailability through the winter operating season. Results for Scenarios 3 and 4 highlight that this exposure increase as Holyrood unavailability increases.

6.2.2 Monthly Assessment Results

Tables 7 through 11 provide monthly analyses of LOLH and EUE, by year. The monthly analyses provide additional detail that assists in examining the complexity of the changing power system that would not necessarily be apparent from an analysis of the annual results only. Completing monthly analyses allows for easier identification of changes in system behaviour. For example, if a system had a change in forecast peak demand with no resultant change in annual LOLH or EUE, the monthly analysis would indicate where differences in LOLH and EUE were anticipated, allowing for better understanding of the drivers of the annual results. This type of analysis is used by NERC to complement its long-term reliability assessments.

For 2019, low values of LOLH and EUE are observed for the remainder of the year, with significant LOLH and EUE observed only in the instance that the LIL in service is delayed beyond the winter operating season (Scenario 5). The small values of LOLH and EUE observed across all cases in summer months are largely attributed to the current outage on the LIL from May 1, 2019 to November 1, 2019. Hydro will manage its maintenance activities to minimize the exposure for LOLH and EUE and ensure reliable service for its customers.

During the winter operating season in 2020, exposure for LOLH and EUE are higher than the expected scenario (Scenario 1) in Scenarios 2 through 5 primarily due to the unavailability of the LIL. Scenarios 3 and 4 highlight that the exposure for LOLH and EUE increases as unavailability at Holyrood increases. There is no quantifiable exposure for LOLH and EUE in the summer months as the LIL reaches its full capability, supported by generation at the Muskrat Falls Generating Station.

In 2021, LOLH and EUE are very low across all scenarios as both Muskrat Falls Generating Station and Holyrood are in service and available to reliably meet customer requirements.

Following the retirement of Holyrood, low values of LOLH and EUE are observed during the winter operating season. From 2022 onward it is expected that the NLIS will see modest year-over-year increases in LOLH and EUE due to load growth.

Table 7: Monthly LOLH and EUE for 2019

LOLH (hours)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
S1: Expected Scenario, Holyrood DAFOR = 15%	N/A	N/A	N/A	N/A	N/A	0.00	0.02	0.04	0.02	0.00	0.00	0.02
S2: Holyrood DAFOR = 15%, +8 weeks unavailability of LIL, Increased Capacity Assistance	N/A	N/A	N/A	N/A	N/A	0.00	0.02	0.03	0.03	0.00	0.00	0.01
S3: Holyrood DAFOR = 18%, +8 weeks unavailability of LIL, Increased Capacity Assistance	N/A	N/A	N/A	N/A	N/A	0.00	0.02	0.04	0.02	0.00	0.00	0.02
S4: Holyrood DAFOR = 20%, +8 weeks unavailability of LIL, Increased Capacity Assistance	N/A	N/A	N/A	N/A	N/A	0.00	0.03	0.05	0.03	0.00	0.00	0.03
S5: LIL Outage May 1, 2019–June 1, 2020, Holyrood DAFOR = 15%, Increased Capacity Assistance	N/A	N/A	N/A	N/A	N/A	0.00	0.02	0.05	0.02	0.00	0.00	0.68
EUE (MWh)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
S1: Expected Scenario, Holyrood DAFOR = 15%	N/A	N/A	N/A	N/A	N/A	0	0	1	1	0	0	1
S2: Holyrood DAFOR = 15%, +8 weeks unavailability of LIL, Increased Capacity Assistance	N/A	N/A	N/A	N/A	N/A	0	1	1	1	0	0	1
S3: Holyrood DAFOR = 18%, +8 weeks unavailability of LIL, Increased Capacity Assistance	N/A	N/A	N/A	N/A	N/A	0	1	1	1	0	0	1
S4: Holyrood DAFOR = 20%, +8 weeks unavailability of LIL, Increased Capacity Assistance	N/A	N/A	N/A	N/A	N/A	0	1	1	1	0	0	1
S5: LIL Outage May 1, 2019–June 1, 2020, Holyrood DAFOR = 15%, Increased Capacity Assistance	N/A	N/A	N/A	N/A	N/A	0	1	2	1	0	0	39

Table 8: Monthly LOLH and EUE for 2020

LOLH (hours)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
S1: Expected Scenario, Holyrood DAFOR = 15%	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
S2: Holyrood DAFOR = 15%, +8 weeks unavailability of LIL, Increased Capacity Assistance	0.02	0.78	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
S3: Holyrood DAFOR = 18%, +8 weeks unavailability of LIL, Increased Capacity Assistance	0.03	1.17	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
S4: Holyrood DAFOR = 20%, +8 weeks unavailability of LIL, Increased Capacity Assistance	0.04	1.50	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
S5: LIL Outage May 1, 2019–June 1, 2020, Holyrood DAFOR = 15%, Increased Capacity Assistance	1.22	0.77	0.53	0.02	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.01
EUE (MWh)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
S1: Expected Scenario, Holyrood DAFOR = 15%	1	1	0	0	0	0	0	0	0	0	0	0
S2: Holyrood DAFOR = 15%, +8 weeks unavailability of LIL, Increased Capacity Assistance	1	39	29	0	0	0	0	0	0	0	0	0
S3: Holyrood DAFOR = 18%, +8 weeks unavailability of LIL, Increased Capacity Assistance	2	60	44	0	0	0	0	0	0	0	0	1
S4: Holyrood DAFOR = 20%, +8 weeks unavailability of LIL, Increased Capacity Assistance	2	81	57	0	0	0	0	0	0	0	0	1
S5: LIL Outage May 1, 2019–June 1, 2020, Holyrood DAFOR = 15%, Increased Capacity Assistance	63	39	27	1	5	0	0	0	0	0	0	0

Table 9: Monthly LOLH and EUE for 2021

LOLH (hours)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
S1: Expected Scenario, Holyrood DAFOR = 15%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.09
S2: Holyrood DAFOR = 15%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.09
S3: Holyrood DAFOR = 18%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.08
S4: Holyrood DAFOR = 20%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.08
EUE (MWh)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
S1: Expected Scenario, Holyrood DAFOR = 15%	0	0	0	0	0	0	0	0	0	0	1	8
S2: Holyrood DAFOR = 15%	0	0	0	0	0	0	0	0	0	0	1	7
S3: Holyrood DAFOR = 18%	0	0	0	0	0	0	0	0	0	0	0	6
S4: Holyrood DAFOR = 20%	0	0	0	0	0	0	0	0	0	0	1	7

Table 10: Monthly LOLH and EUE for 2022

LOLH (hours)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
S1: Expected Scenario	0.07	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.07
EUE (MWh)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
S1: Expected Scenario	6	3	2	0	0	0	0	0	0	0	0	5

Table 11: Monthly LOLH and EUE for 2023

LOLH (hours)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
S1: Expected Scenario	0.09	0.11	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
EUE (MWh)	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
S1: Expected Scenario	8	9	3	0	0	0	0	0	0	0	0	5

7 Conclusion

Hydro closely monitors its supply-related assets to ensure its ability to provide reliable service to customers. As previously identified by both Hydro and the Board's Consultant, The Liberty Consulting Group, the availability of power over the LIL remains an important part of Hydro's supply adequacy in advance of the availability of generation from the Muskrat Falls Generating Station. Hydro is working closely with Nalcor Energy's power supply leadership to monitor and mitigate the risks associated with the timing of the in-service of the LIL to supply off-Island capacity and energy to the IIS. Following the full in-service of the Lower Churchill Project assets and the retirement of Holyrood, small values of LOLH and EUE continue to be observed in winter months (i.e., during time of system peak); however, values are materially reduced from those observed in 2020.