2021 Capital Budget Application

August 2, 2020

An Application to the Board of Commissioners of Public Utilities

newfoundland labrador
hydro
a nalcor energy company

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August 4, 2020

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 of Corporate Services & Board Secretary

Dear Ms. Blundon:

Re: 2021 Capital Budget Application

Please find enclosed eight copies of Newfoundland and Labrador Hydro's ("Hydro") 2021 Capital Budget Application ("Application"), filed in accordance with the guidelines and conditions for capital budget proposals as outlined by the Board in Order No. P.U. 7(2002–2003), as well as the Provisional Capital Budget Application Guidelines issued by the Board of Commissioners of Public Utilities ("Board") in October 2007, along with the guideline modifications detailed in the Board's correspondence dated February 27, 2020 and March 9, 2020. Through this Application, Hydro is seeking approval of $107.5 million in capital expenditures. Hydro is also seeking approval of its 2017, 2018, and 2019 average rate base in the amounts of $1,979,748,000; $2,265,683,000; and $2,306,047,000, respectively.

The financial schedules included in Section A of the 2021 Capital Budget Application include planned total expenditures of $112.7 million; however, the Application seeks approval of $107.5 million as further analysis related to the solution to address the Charlottetown plant fire is ongoing, and Hydro is not yet ready to make a submission. As such, the 2021 anticipated expenditures associated with the Diesel Plant Replacement - Charlottetown project and the Install Fire Protection in Diesel Plants - Port Hope Simpson project that are reflected in the financial schedules are not included in the request for approval in this Application.

The discussion of deferral of projects from the 2021 Capital Budget Application is found in Volume I, 2021 Capital Projects Overview report; additionally, the specific project proposals document the reason(s) for deferral not being the preferred option. The information related to the revenue requirement impact of the 2021 Capital Budget Application is found in Volume I, 2021 Capital Projects Overview report.

The Application will be posted on Hydro's website at www.nlhydro.com in the coming days.

Hydro trusts that you will find the enclosed to be in order and satisfactory. Should you have any questions or comments about any of the enclosed, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

SWalsh

Shirley A. Walsh
Senior Legal Counsel, Regulatory
SAW/sk.kd

Encl.

cc: **Newfoundland Power**
Gerard M. Hayes

Consumer Advocate
Dennis M. Browne, Q.C., Browne Fitzgerald Morgan & Avis

ecc: **Board of Commissioners of Public Utilities**
Jacqui Glynn
PUB Official Email

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Julia Brown, Olthuis Kleer Townshend LLP

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Sheryl E. Nisenbaum

Teck Resources Limited
Shawn Kinsella

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Volume I

Application

IN THE MATTER OF the *Public Utilities Act*, (“*Act*”); and

IN THE MATTER OF an application by Newfoundland and Labrador Hydro (“Hydro”) for an order approving: (i) its 2021 Capital Budget pursuant to s.41(1) of the *Act*; (ii) its 2021 capital purchases and construction projects in excess of $50,000 pursuant to s.41(3)(a) of the *Act*; and (iii) for an order pursuant to s.78 of the *Act* fixing and determining its average rate base for 2017, 2018, and 2019.

To: The Board of Commissioners of Public Utilities (“Board”)

THE APPLICATION OF HYDRO STATES THAT:

A. Background

1. Hydro is a corporation continued and existing under the *Hydro Corporation Act, 2007*, is a public utility within the meaning of the *Act* and is subject to the provisions of the *Electrical Power Control Act, 1994.*

B. Application

2. All information in this application is prepared in accordance with the guidelines and conditions outlined in Order No. P.U. 7(2002–2003) and the Capital Budget Application Guidelines issued October 29, 2007, along with the guideline modifications detailed in the Board’s correspondence dated February 27, 2020 and March 9, 2020.

3. Volume I of this application provides an overview of the 2021 Capital Budget, Five-Year Capital Plan (2021–2025), Holyrood Thermal Generating Station Future Operating and Capital Requirements and Ten-Year Operating and Maintenance Plan. It also includes Sections A – I which provide specific details on the current proposed capital budget, historical capital expenditures, and proposed rate base.

4. Section A to this application includes Hydro’s proposed 2021 Capital Budget. The financial schedules provided in Section A include planned total capital expenditures of $112,691,400;

however, this application seeks approval of $107,452,400, as further analysis related to the solution to address the Charlottetown plant fire is ongoing and Hydro is not yet ready to make a submission. As such, the 2021 anticipated expenditures associated with the Diesel Plant Replacement - Charlottetown project and the Install Fire Protection in Diesel Plants - Port Hope Simpson project that are reflected in the financial schedules are not included in the request for approval in this application.

5. Section B to this application is Hydro's proposed 2021 Capital Budget with single- and multi-year projects listed separately.

6. Section C to this application is a list of the proposed 2021 construction projects and capital purchases for $500,000 and over.

7. Section D to this Application is a list of the proposed 2021 construction projects and capital purchases for $200,000 and over, but less than $500,000.

8. Section E to this application is a list of the proposed 2021 construction projects and capital purchases in excess of $50,000 but less than $200,000.

9. Section F indicates no new leases in excess of $5,000 per year are proposed for 2021.

10. Section G to this application is a schedule of Hydro's actual and projected capital expenditures, for the period 2016–2025.

11. Section H to this application is a report on the 2020 capital expenditures year-to-date June 30, 2020 and any associated variances between the approved budget and the forecasted total budget.

12. Section I sets out the proposed 2017–2019 rate base for Hydro.

13. Volume II to this application contains supplementary information on the construction projects and capital purchases greater than $500,000.

14. The proposed capital expenditures for 2021 as set out in this application are required to allow Hydro to continue to provide to its customers service and facilities which are reasonably safe, adequate and reliable as required by Section 37 of the *Act*.

15. Hydro has estimated the total of contributions in aid of construction for 2021 to be approximately \$290,000 for distribution upgrades and service extensions. The information contained in Section A of the 2021 Capital Budget Application takes into account this estimate of the contributions in aid of construction to be received from customers. All contributions to be recovered from customers shall be calculated in accordance with the relevant policies as approved by the Board.

C. Newfoundland and Labrador Hydro's Request

16. Hydro requests that the Board make an Order as follows:

    (i) Approving \$107,452,400 of Hydro's 2021 capital budget as set out in Section A hereto, pursuant to Section 41(1) of the *Act;*

    (ii) Approving Hydro's 2021 capital purchases and construction projects in excess of \$50,000 as set out in Sections C, D, and E hereto pursuant to Section 41(3) of the *Act*; and

    (iii) Fixing and determining Hydro's average rate base for 2017, 2018, and 2019 in the amounts of \$1,979,748,000; \$2,265,683,000; and \$2,306,047,000, respectively, pursuant to Section 78 of the *Act*.

D. Communications

17. Communications with respect to this Application should be forwarded to Shirley A. Walsh, Senior Legal Counsel, Regulatory for Hydro.

DATED at St. John's in the Province of Newfoundland and Labrador this 2nd day of August, 2020.

NEWFOUNDLAND AND LABRADOR HYDRO

Shirley A. Walsh
Counsel for the Applicant
Newfoundland and Labrador Hydro,
500 Columbus Drive, P.O. Box 12400
St. John's, Newfoundland, A1B 4K7
Telephone: (709) 685-4973

IN THE MATTER OF the *Public Utilities Act*, ("*Act*"); and

IN THE MATTER OF an application by Newfoundland and Labrador Hydro ("Hydro") for an order approving: (i) its 2021 Capital Budget pursuant to s.41(1) of the *Act*; (ii) its 2021 capital purchases and construction projects in excess of $50,000 pursuant to s.41(3)(a) of the *Act*; and (iii) for an order pursuant to s.78 of the *Act* fixing and determining its average rate base for 2017, 2018, and 2019.

AFFIDAVIT

I, Terry Gardiner, Professional Engineer, of Torbay in the Province of Newfoundland and Labrador, make oath and say as follows:

1. I am the Vice President, Engineering and Technology of Newfoundland and Labrador Hydro, the Applicant named in the attached Application.
2. I have read and understand the foregoing Application.
3. To the best of my knowledge, information, and belief all of the matters, facts, and things set out in this Application are true.

SWORN at St. John's in the)
Province of Newfoundland and)
Labrador this 2 day of ~~July~~ August)
2020, before me:)

Barrister – Newfoundland and Labrador

Terry Gardiner

Terry Gardiner, P. Eng.

2021 Capital Projects Overview

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A report to the Board of Commissioners of Public Utilities

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Appendix A: 2021 Project Prioritization

1.0 Introduction

Newfoundland and Labrador Hydro's ("Hydro") capital investment philosophy is founded in its obligation to responsibly steward the management of its electrical system and investments therein on behalf of customers. Hydro is committed to investing in capital in a manner which meets its obligation to provide reliable service at the lowest possible cost.[1] To balance the provision of reliable service with cost management, Hydro focuses on sound utility asset management practices, condition based investments (versus age based) where appropriate, and the use of operational and system requirements to inform the necessary level of capital investment required.

Hydro has applied these practices, particularly in recent years, to work toward reduced investment to the minimum capital level prudent so as to not compromise customer reliability, safety, or the environment. Hydro also continues to refine its budgeting and integrated planning processes to support the efficient execution of its capital plans.

Hydro's 2021 Capital Budget Application ("CBA") requests approval for $107.5 million[2] of capital investment, of which approximately 30% relates to continuation of projects that were previously approved to commence prior to 2021 and approximately 70% relates to new projects. This 2021 Capital Projects Overview report generally discusses the Capital Plan proposed for 2021, which are primarily driven by the following:

- Refurbishment required to support the reliable operation of aging assets;[3]
- Accommodation of load growth in Labrador West;
- Extension of the service life of the Holyrood Thermal Generating Station ("Holyrood TGS");[4] and Legislative compliance (i.e., safety and environmental).

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[1] In accordance with the Hydro Corporation Act, 2008, the Electrical Power Control Act, 1994, and the Public Utilities Act, 1990.

[2] 2021 financial schedules include planned total capital expenditures of $112,691,400; however, the 2021 CBA seeks approval of $107,452,400 as further analysis related to the solution to address the Charlottetown plant fire is ongoing and Hydro is not yet ready to make a submission. As such, the 2021–2024 Diesel Plant Replacement - Charlottetown ($5,194,700 in 2021) and Install Fire Protection in Diesel Plants – Port Hope Simpson ($44,300 in 2021) projects reflected in the financial schedules are not included in Hydro's request for approval. Hydro anticipates proposing an application related to this work once the analysis is complete.

[3] The majority of Hydro's installed assets, including the hydroelectric installation at Bay d'Espoir, the Holyrood TGS, the Stephenville Gas Turbine, the Hardwoods Gas Turbine, and much of Hydro's transmission and distribution systems, are more than 40–50 years old.

[4] Extension of the Holyrood Thermal Generation Station as a Generating Facility, Correspondence to the Board of Commissioners of Public Utilities ("Board") dated February 14, 2020.

2.0 2020 Capital Plan Execution

2.1 Impact of COVID-19 Pandemic

During the first quarter of 2020, Hydro enacted its Pandemic Plan[5] in response to the COVID-19 pandemic. To ensure reliable supply of energy to Hydro's customers as the COVID-19 pandemic evolved, protocols were established and Business Continuity Plans were revisited and enacted. Hydro's Business Continuity Plans focused on the prioritization of critical work necessary for the delivery of safe and reliable service to customers.

Hydro is working to mitigate the impacts of the COVID-19 pandemic on Hydro's 2020 capital plan and has focused its efforts on completing the highest priority capital projects in 2020. At the time of the filing of this Capital Budget Application, Hydro is confident the majority of its highest priority capital projects will be completed prior to year-end and is developing mitigation and/or contingency plans should a select portion of work not be completed. Consistent with prior years, capital projects approved in Hydro's 2020 CBA but not completed in 2020 will be carried over into 2021. Such projects will be reflected in Hydro's 2020 Capital Expenditures and Carryover Report.[6] At this time, Hydro does not foresee any concerns with execution of anticipated 2020 work carried into 2021 in addition to the 2021 capital plan.

2.2 Execution of 2020 Capital Projects

Section H of the 2021 CBA contains the 2020 Capital Expenditures Overview Report as of June 30, 2020, which details forecast expenditures and variances. Given the dynamic nature of the in-service failures projects, this report also contains a summary of work completed to-date or in-progress for each of the in-service failures projects related to 2020 thermal generation, hydraulic generation, and terminal stations.

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[5] Hydro advised the Board of its COVID-19 response activities in correspondence dated March 16, 2020.

[6] Due to be filed with the Board on March 1, 2021.

3.0 2021 Plan Considerations

3.1 Project Evaluation

3.1.1 Project Deferral

Prior to proposing capital projects for inclusion in the CBA, consideration is given to whether the investment can be deferred in light of the condition of the asset and its criticality to the system. Where deferral of projects is determined to be low risk, deferral is selected in an effort to balance the cost impact to customers with level of reliability required.

A portion of the capital projects proposed are required to address safety concerns or to comply with regulatory and legislative requirements; therefore, deferral is not appropriate. For example, federal legislation requires polychlorinated biphenyls ("PCBs") within Hydro's transformers to be removed by 2025.[7] To defer such projects to future years would place Hydro behind schedule and at risk of not meeting legislative requirements. Additionally, deferral is not appropriate for projects which are required due to load growth as it would compromise Hydro's ability to meet its peak load requirements and ensure reliable service (e.g., upgrades to the Wabush substation and Happy Valley distribution system included in the 2021 CBA).

As part of its assessment of alternatives, Hydro considered deferral for all projects contained in the 2021 CBA and has documented in the specific project proposals the reason(s) for deferral not being the preferred option.

3.1.2 Project Proposals

Maintaining Hydro's systems in reliable operating condition requires planned maintenance, rehabilitation of existing assets, and replacement of assets that have reached the end of their useful lives. Replacement of assets may also occur to reduce life cycle costs, improve operational characteristics, increase capacity for load growth, address violations of reliability criteria, improve productivity, and/or increase efficiency.

In determining whether a capital proposal is appropriate, Hydro gives consideration to: system performance and reliability criteria; Hydro's long-term asset management strategy; regulatory and legislative compliance; load growth and system planning criteria; Hydro's experience with the assets,

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[7] Environment Canada PCB regulations (SOR/2008-273) prohibit the release of PCBs in the environment.

including the condition and performance of the assets; ongoing operating and maintenance costs; opportunities for cost efficiencies; and, changes to operating conditions.

For those projects that relate to replacement of assets, Hydro bases such decisions on three broad categories of replacement criteria, as follows:

1) Time and condition based: hours of operation and condition, for example, diesel generators (100,000 hours of operation for 1,800 rpm units) and vehicles (combination of years and operating hours for some classes);
2) Condition based: in-situ condition of the assets, for example, decay in transmission line wood poles; and
3) Technical assessment based: an evaluation of reliability, performance, condition, costs, and other factors, such as the inspection of fuel tanks and subsequent upgrade where required.

3.2 Reassessment of Planned Capital Expenditures

Prior to filing the 2020 CBA in 2019, Hydro reestablished its commitment to invest prudently and manage costs within the capital budgeting process. Hydro realigned projects based on the condition of the assets, enabling adjustment to the time frames associated with project execution such that, in some instances, projects are proposed to be completed at later times than previously assessed. The result is a better balancing of capital investment with customer expectations for cost management and reliability. This investment philosophy continues to be reflected in the 2021 CBA.

4.0 2021 Capital Budget

The 2021 capital budget contains 78 projects, 65 of which are new projects,[8] as outlined in Section A, Capital Budget. The total planned capital expenditure for 2021, including new and previously-approved projects, is $107.5 million.[9,10]

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[8] Including projects less than $50,000.

[9] 2021 financial schedules include planned total capital expenditures of $112,691,400; however, the 2021 CBA seeks approval of $107,452,400 as further analysis related to the solution to address the Charlottetown plant fire is ongoing and Hydro is not yet ready to make a submission. As such, the 2021–2024 Diesel Plant Replacement - Charlottetown ($5,194,700 in 2021) and Install Fire Protection in Diesel Plants – Port Hope Simpson ($44,300 in 2021) projects reflected in the financial schedules are not included in Hydro's request for approval. Hydro anticipates proposing an application related to this work once the analysis is complete.

Figure 1 shows the 2021 Capital Budget Summary by major area.

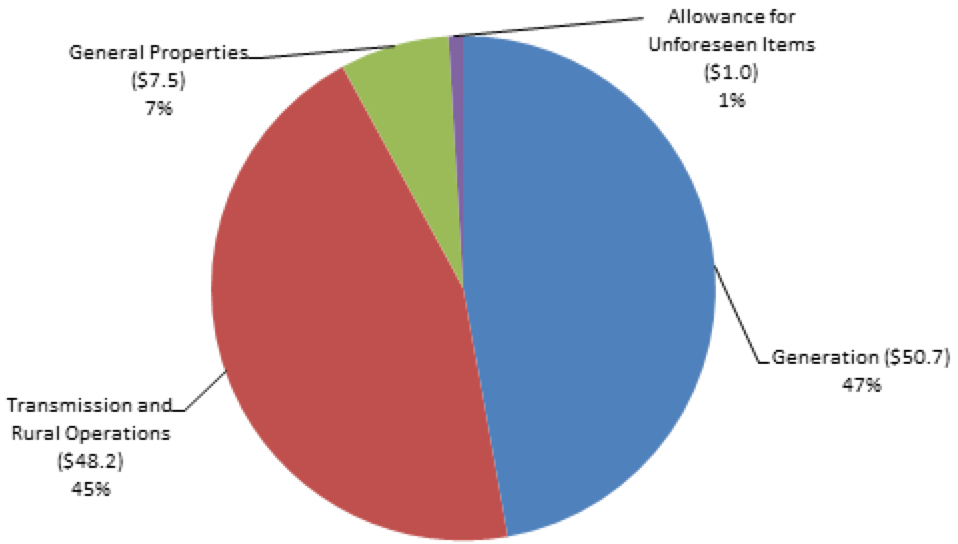

Figure 1: 2021 Capital Budget Summary ($ millions)[11]

4.1 Generation

Throughout the province, electricity is provided by Hydro through a mix of hydroelectric, thermal generation, gas turbines, and power purchases. The planned generation expenditures of $50.7 million account for 47% of the overall 2021 CBA. Further detail on the generation expenditures breakdown is shown in Figure 2 and the five-year[12] historical average capital expenditures for generation are shown in Figure 3.

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[10] The 2021 CBA also includes 2021 front end engineering and design expenditures, which is necessary to support the development of proposals, on a number of projects. Hydro will not capitalize Phase 1 costs related to a project if it does not receive Board approval.

[11] Excludes the planned 2021–2024 Diesel Plant Replacement - Charlottetown project ($5,194,700 in 2021) and the Install Fire Protection in Diesel Plants – Port Hope Simpson ($44,300 in 2021).

[12] 2015–2019.

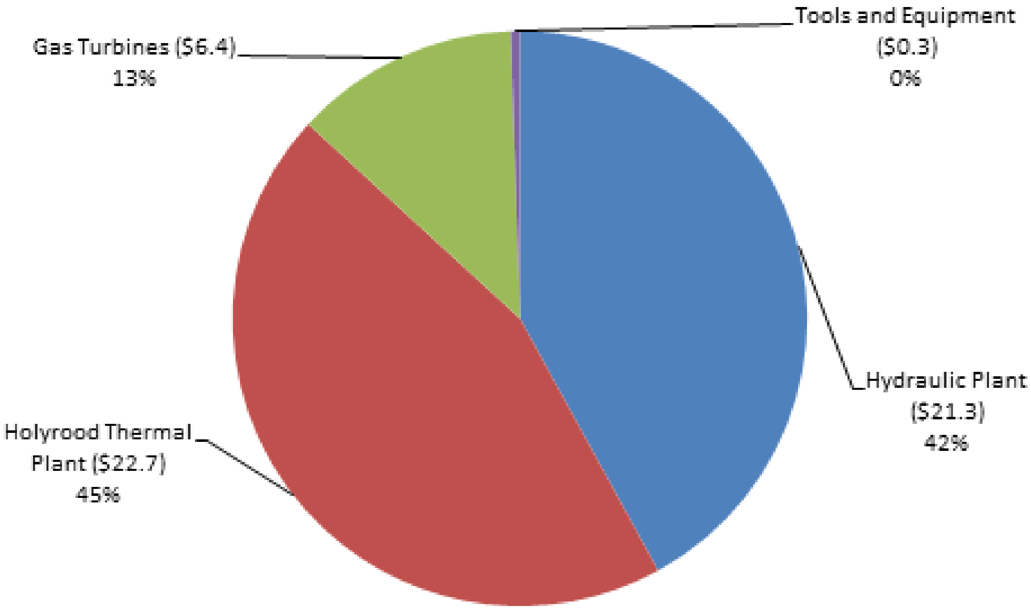

Figure 2: 2021 Capital Budget for Generation ($ millions)

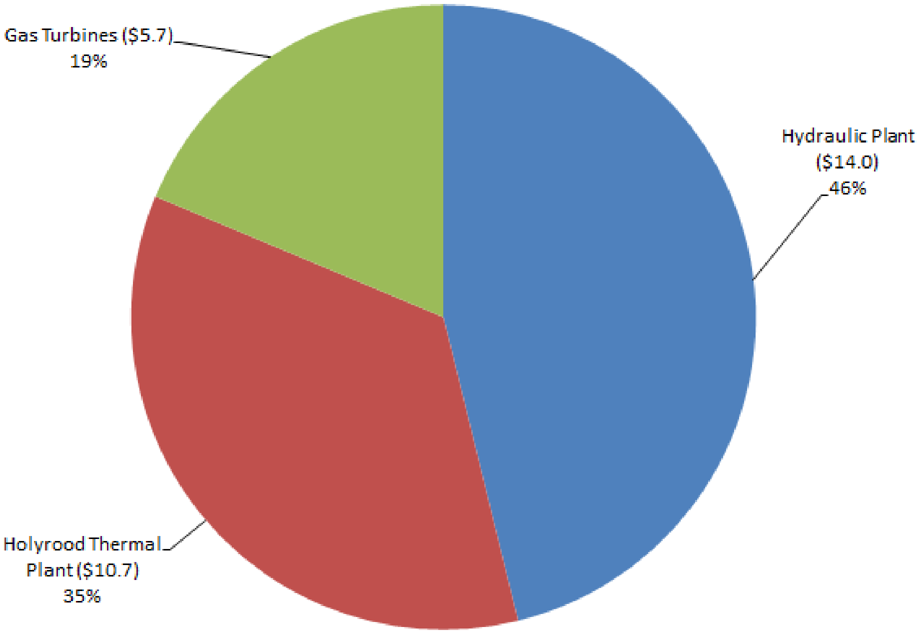

Figure 3: Five-Year Historical Average Capital Expenditures for Generation (2015–2019) ($ millions)

4.1.1 Hydraulic Plant

The planned capital expenditures for hydraulic plant ($21.3 million) has increased compared to the average over the past five years ($14.0 million); however, is consistent with that which was reflected in the 2020 CBA five-year capital plan for 2020–2024 ($19.9 million).

The increase in hydraulic plant expenditures from the 2015–2019 five-year average is primarily related to a planned increase in work required to support the refurbishment of aging assets. Hydro's major hydraulic generating plants range in age from 16 to 52 years; therefore, capital expenditures are required to ensure their continued reliability and to maximize the useful operating lives of these assets. Many components of the hydraulic generating stations are nearing, or have reached, the end of their expected service lives in the older plants.

Included in the 2021 CBA is $10.2 million related to year two of the 2020–2021 Hydraulic Generation Refurbishment and Modernization project originally approved in the 2020 CBA, and $6.6 million related to year one of the new 2021–2022 Hydraulic Generation Refurbishment and Modernization project. The 2021 CBA also includes $1.3 million for Hydraulic Generation In-Service Failures. In addition to projects to sustain its hydraulic generation assets, Hydro is proposing a four-year program to refurbish the Ebbegunbaeg Control Structure, of which $3.2 million is planned for 2021.[13]

Hydro is currently assessing the life extension requirements of the Bay d'Espoir Penstocks.[14] Following completion of Hydro's analysis and front end engineering design work, Hydro will confirm timing and magnitude of work required and present an application outlining the proposed project strategy and cost to the Board for review and approval. For transparency and completeness, in its five-year capital plan, Hydro has included a four-year project[15] beginning in 2022 related to refurbishment activity for the Bay d'Espoir Penstocks; however, there are no capital expenditures proposed for 2021 related to the Bay d'Espoir penstocks.

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[13] Hydro cancelled the previously approved Ebbegunbaeg capital refurbishment project as outlined in its correspondence of April 17, 2020, Cancellation of Capital Project – Ebbegunbaeg Control Structure Refurbishment.

[14] As communicated to the Board in correspondence dated June 3, 2020.

[15] Including preliminary budget.

4.1.2 Holyrood Thermal Plant

Planned capital expenditures for the Holyrood thermal plant ($22.7 million) in 2021 has increased materially compared to the five-year[16] historical average ($10.7 million) and that which was reflected for 2021 in the prior year five-year[17] capital plan ($11.1 million).

The increase in proposed expenditure for 2021 is primarily related to the inclusion of projects required to support the readiness to operate the Holyrood TGS as a generating facility until March 31, 2022.[18] As Hydro had previously planned to retire the Holyrood TGS as a generating facility on March 31, 2021 and lower levels of production were anticipated during 2019 and 2020, this work was not reflected in the 2020 CBA. Hydro committed to the extension to support the provision of safe, reliable service for customers while the Muskrat Falls assets are brought online and proven reliable. As such, in its 2021 CBA, Hydro is proposing $11.4 million in steam generation related projects which include (i) an overhaul of Holyrood TGS Unit 1 turbine and valves ($8.0 million), (ii) a boiler condition assessment and miscellaneous upgrades program ($3.0 million), and (iii) an overhaul of the Holyrood TGS Unit 3 boiler feed pump east ($0.4 million). In addition, there is $11.3 million in expenditures associated with post-steam generation related projects and thermal in-service failures. Based on the age and condition of the Holyrood TGS assets, as well as Hydro's historical experience with these assets, the proposed projects are required to support the extension of the Holyrood TGS as a reliable generating facility.

Further information related to the current operational outlook and schedule for the Holyrood TGS, Hydro's maintenance strategy for this facility, 2021 projects proposed related to the Holyrood TGS, and the 2021–2025 capital expenditure outlook is provided in the Holyrood Overview, which is provided in Volume I of the 2021 CBA.

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[16] 2014–2019.

[17] 2020–2024.

[18] Extension of Holyrood Thermal Generation Station as a Generating Facility, Correspondence to the Board dated February 14, 2020.

4.1.3 Gas Turbines

2021 planned capital expenditures for gas turbines ($6.4 million) has increased compared to the five-year[19] historical average ($5.7 million) and shows a decrease when compared to the 2021 amount reflected in the prior year five-year[20] capital plan ($9.2 million).

The decrease in expenditures relative to the prior year five-year capital plan is primarily driven by the timing of work related to the execution of the two-year Holyrood Gas Turbine combustor inspection. Expenditures were shifted to 2021 and 2022, with $2.5 million projected for 2021 versus the $4.9 million originally anticipated. Additional work related to the Holyrood Gas Turbine planned for 2021 includes completion of the project to install partial discharge monitoring, which was approved in the 2020 CBA ($0.6 million expenditure in 2021), and a new project to construct a lube oil cooler hood and containment system ($0.3 million).

Planned expenditures in 2021 include four projects for the Happy Valley Gas Turbine: (i) replacement of the fire suppression system, which was approved in the 2020 CBA ($2.4 million expenditure in 2021), (ii) replacement of fuel oil, lube oil, and glycol pumps ($0.2 million), (iii) replacement of the voltage regulator ($0.1 million), and (iv) upgrading the compressed air system ($0.1 million).

Additionally, Hydro is proposing a project to purchase capital spares for its gas turbines ($0.2 million). There are no proposed capital projects for either the Hardwoods or Stephenville Gas Turbines[21] in the 2021 CBA or in the five-year capital plan.

4.2 Transmission and Rural Operations

Hydro owns and operates 24 diesel generating stations[22] throughout Newfoundland and Labrador, 19 of which are isolated rural diesel generation plants. Hydro owns and operates approximately 4,400 kilometres of transmission lines and more than 50 high voltage terminal stations at voltages of 230, 138, and 69/66 kV. In addition, Hydro owns and operates approximately 3,400 kilometres of distribution lines, principally in rural Newfoundland and Labrador.

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[19] 2014–2019.

[20] 2020–2024.

[21] Hydro has included a project to complete terminal station upgrades required at the Bottom Brook and Stephenville terminal stations to support reliable service to customers in Stephenville following the retirement of the Stephenville Gas Turbine, currently scheduled for 2023. This is further discussed in Section 4.2.2.

[22] Including Natuashish, which Hydro operates but does not own.

Expenditures related to Transmission and Rural Operations account for 45% of overall planned capital expenditures for 2021, totaling $48.2 million.[23] Figure 4 shows the division of the 2021 Capital Budget for Transmission and Rural Operations and Figure 5 provides the five-year[24] historical average expenditures for this area.

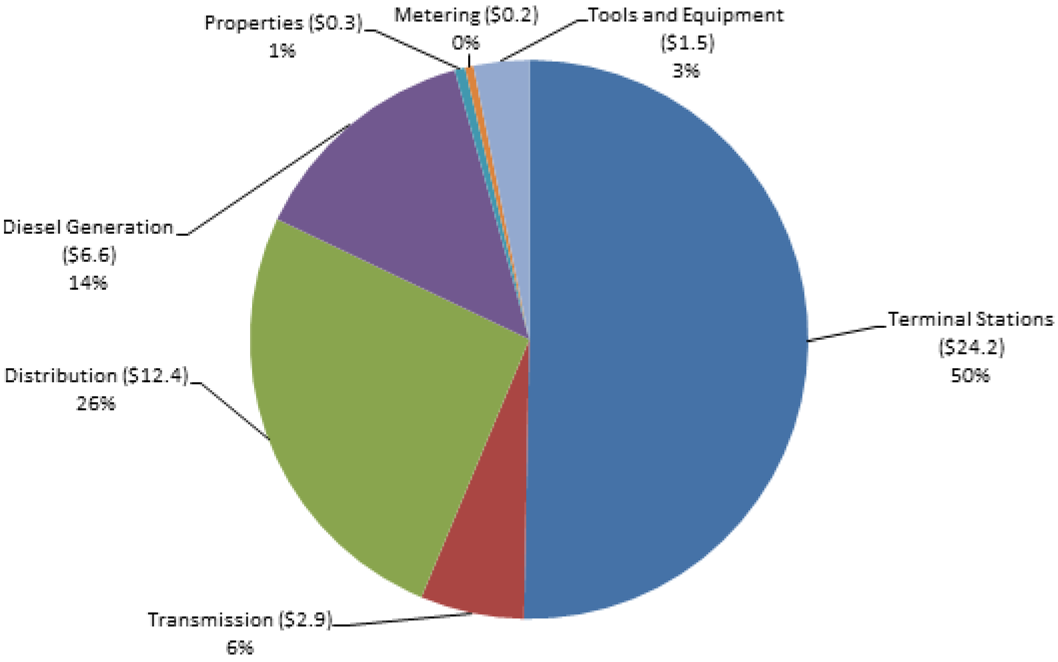

Figure 4: Capital Budget for Transmission and Rural Operations ($ millions)

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[23] Excludes the Diesel Plant Replacement – Charlottetown project ($5,194,700 in 2021).
[24] 2014–2019.

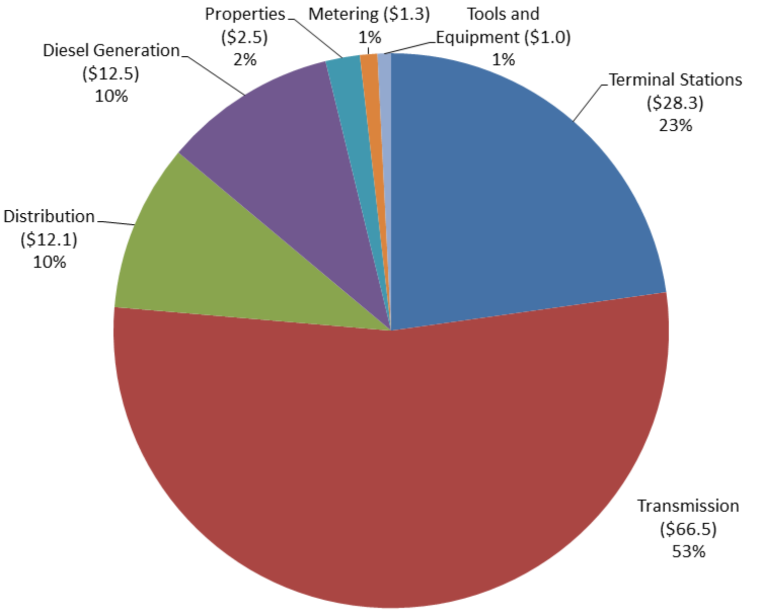

Figure 5: Five-Year Historical Average Capital Expenditures for Transmission and Rural Operations (2015–2019)

4.2.1 Transmission

Planned transmission expenditures for 2021 ($2.9 million) are materially lower than the five-year[25] historical average ($66.5 million). The average was elevated in recent years due to the construction of the TL 267 and TL 266 transmission lines. 2021 expenditures are related to the Wood Pole Line Management Program.

4.2.2 Terminal Stations

The planned capital expenditures for terminal stations ($24.2 million) is below the five-year historical average[26] ($28.3 million) and that which was reflected for 2021 in the prior year five-year[27] capital plan ($33.8 million).

The 2020 CBA five-year[28] capital plan included $13.6 million in 2021 related to a multi-year project for additions that were required to accommodate load growth in Labrador West. At the time, Hydro advised that the technical analysis was not complete and, as such, the 2020 CBA did not request approval of the

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[25] 2014–2019.
[26] Ibid.
[27] 2020–2024.
[28] Ibid.

funding for a specific project; rather, it was included in the five-year capital plan for transparency and completeness. Since then, the required technical analysis has been completed and Hydro is proposing specific projects to address load growth in Labrador West in its 2021 CBA. The two multi-year projects, Wabush Terminal Station Upgrades and Wabush Substation Upgrades, have an estimated 2021 expenditure of $2.3 million and $1.2 million, respectively. The reduction of approximately $10.1 million related to the timing of these projects is the primary driver of the reduction in planned 2021 capital expenditure related to terminal stations from what was reflected in the 2020 CBA five-year capital plan.

Many of Hydro's terminal stations were constructed in the 1960s with expected useful lives at that time in the range of 40–50 years. Refurbishment and general upgrades are necessary to support Hydro’s ability to provide reliable service. Within the 2021 CBA, projects are proposed for the continued upgrade of power transformers and circuit breakers ($5.4 million), terminal station refurbishment and modernization ($11.9 million),[29] terminal station in-service failures ($1.8 million), and the purchase of SF_6[30]gas recovery systems ($0.1 million). Hydro is also proposing a project for upgrades to the Bottom Brook and Stephenville Terminal Stations which are required to support continued provision of reliable service to customers in Stephenville following the planned retirement of the Stephenville Gas Turbine[31] ($1.5 million in 2021, $9.9 million total).

4.2.3 Rural Generation

Hydro has 24 diesel generating stations, 19 of which are remote electrical systems along the coasts of Labrador and on the island of Newfoundland. Providing service to customers in these communities requires that the fuel storage, diesel generating units, facilities, and distribution systems all be kept in safe, reliable, and environmentally responsible working order.

The planned capital expenditure for rural generation ($6.6 million) is below the historical five-year average ($12.5 million) and that reflected in the prior year five-year[32] capital plan ($8.5 million). Hydro’s 2021 CBA does not include a request for approval of the project to replace the Charlottetown Diesel Plant as an analysis related to this project is ongoing. Hydro anticipates filing an application related to

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[29] Including $5.7 million related to the 2021 portion of the two-year project approved in Hydro’s 2020 CBA.

[30] Sulfur hexafluoride (“SF_6”).

[31] As communicated in Hydro’s Near-Term Reliability Report, filed on May 15, 2020, retirement of the Stephenville Gas Turbine will occur following the completion of the upgrades to the Bottom Brook and Stephenville terminal stations in 2023.

[32] 2020–2024.

this work once the analysis is complete. Forecast expenses associated with this multi-year project are included in the five-year capital plan for 2021–2025 for transparency and completeness.

Planned expenditures for 2021 include continuation of the multi-year projects to replace the powerhouse roofing system at the L'Anse au Loup and St. Anthony diesel plant ($1.2 million) and upgrade the Nain diesel plant ventilation ($0.7 million). New projects in 2021 include the replacement of one of the diesel generator units in Nain ($2.6 million), overhaul of diesel units in Grey River, Black Tickle, Mary's Harbour, Cartwright, Rigolet, and Hopedale ($1.2 million), inspection of the fuel storage tanks in Postville ($0.5 million), and replacement of the fuel storage tank in Paradise River ($0.4 million).

4.2.4 Distribution

The planned capital expenditure for rural distribution ($12.4 million) is relatively consistent with the historical five-year[33] historical average ($12.1 million) and that reflected in the prior year five-year capital plan[34] ($12.7 million).

Hydro provides service to residential and general service customers on the Island and Labrador Interconnected Systems. Projects have been included in the 2021 CBA that are intended to ensure that distribution lines and equipment that require replacement due to asset condition are replaced prior to failure, thereby reducing the probability of service interruptions to customers.

The 2021 distribution related expenditures include the in-service failures, miscellaneous upgrades and street light modernization project ($3.8 million). A portion of this project includes the replacement of existing mercury vapour ("MV") and high pressure sodium ("HPS") street lights with light emitting diode ("LED") street lights. Hydro's experience with LED street lights in Ramea, Nain and Cartwright has yielded positive results (e.g., lower maintenance, increased energy efficiency, increased reliability, and better quality lighting). That experience, together with the decrease in the cost of LED street lights in recent years, supports this systematic retirement of existing MV and HPS street lights.[35] Hydro's proposal to modernize its street lights is consistent with Newfoundland Power's plan to transition to LED street lights and will result in reduced street and area light rates to Hydro's customers.

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[33] 2014–2019.

[34] 2020–2024.

[35] Hydro's distribution system includes approximately 7,700 street lights.

The 2021 CBA also includes a project for provisions of service extensions ($3.7 million) to resolve day-to-day issues and requests throughout the service area, as well as projects to addresses Hydro's worst performing feeders ($3.5 million total for year two of the 2020–2021 project and year one of the 2021–2022 project), with two additional feeders planned for replacement in the 2021–2022 project.

Planned expenditures also include the continuation of the project to install a recloser remote control at Hampden and Upper Salmon, which was approved in the 2020 CBA. The 2021 CBA also proposes a project to convert the voltage of line L22 in Labrador City to 25 kV to reduce the risk of a loss of supply in the event of a failure of Cooper Hill Transformer ($0.6 million), and modifications to Happy Valley line L7 ($0.6 million) which are required to support load growth in Labrador West.

4.3 General Properties

Expenditures related to General Properties account for 7% of the overall expenditures for 2021, with $7.5 million in proposed capital projects, including projects related to Hydro's information systems, where technology is strategically deployed in a wide variety of business applications. This section of the 2021 CBA also includes proposals for vehicle replacements and telecommunications system replacements. Figure 6 and Figure 7 show the breakdown of the General Properties Capital Budget for 2020 and the previous five-year average, respectively.

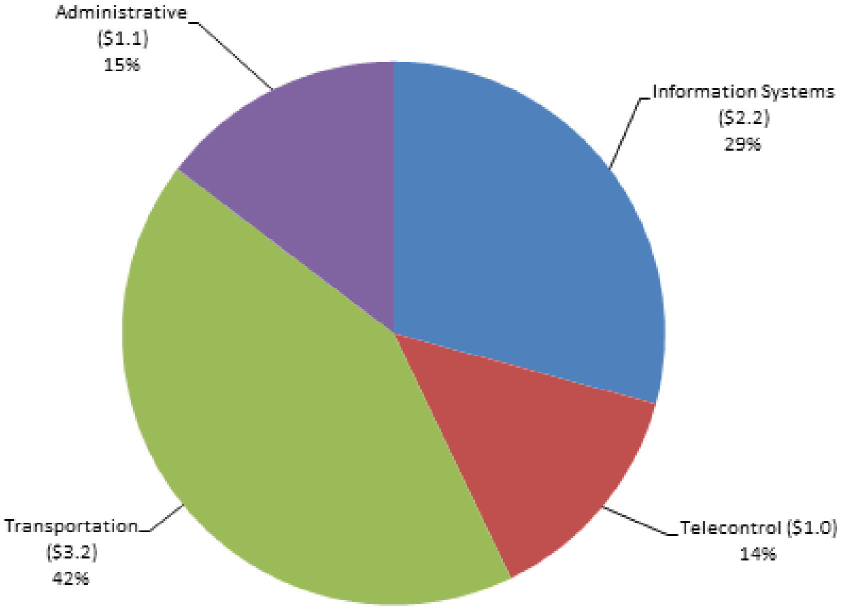

Figure 6: 2021 Capital Budget for General Properties

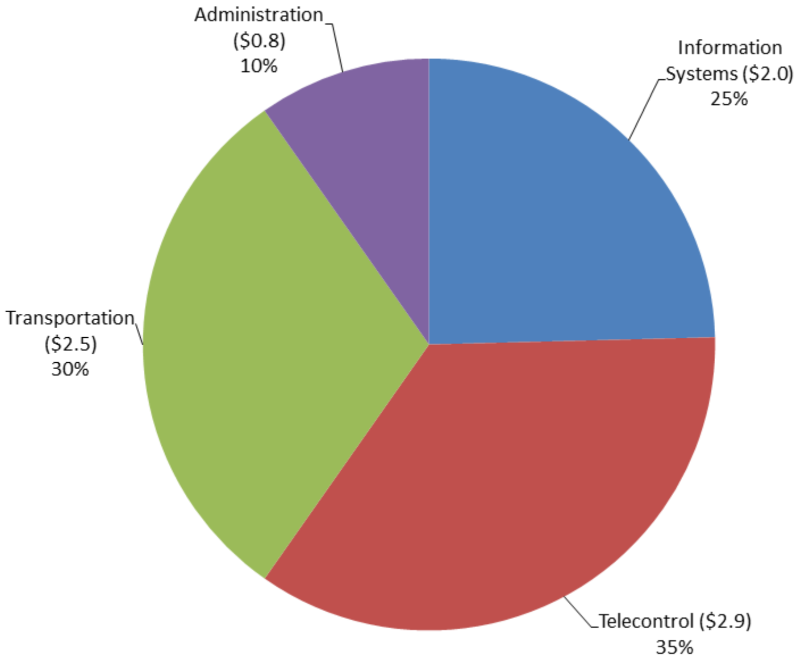

Figure 7: Five-Year Historical Average Capital Expenditures for General Properties (2015–2019)

4.3.1 Transportation

Hydro operates a fleet of approximately 335 pieces of light- and heavy-duty equipment distributed across its service areas. Using established replacement criteria that consider the operations and criticality of each asset, Hydro replaces vehicles within the fleet to ensure availability as and when required. In addition to expenditures related to the second year of the project to replace light and heavy-duty vehicles which was approved in the 2020 CBA ($1.6 million in 2021), the 2021 CBA includes a two-year project to replace 26 light-duty vehicles[36] and six heavy-duty vehicles ($1.3 million in 2021). The light duty vehicles meet age and condition replacement requirements that are in place to ensure the reliable operation of Hydro's fleet. The heavy duty replacements reflect both age and condition requirements, with a number of the units presenting with high cost maintenance requirements supporting their replacement.

Hydro is also proposing to install 18 level 2 chargers for electric vehicles at nine Hydro-owned sites across the province as part of its 2021 expenditures ($0.3 million). This investment supports the further integration of electric vehicles within Hydro's fleet, expected to commence in late 2021 and continue

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[36] Includes cars, pickup trucks, and vans.

throughout the five-year capital plan. Electric vehicles offer the opportunity for operating and maintenance savings relative to gasoline powered alternatives, while continuing to provide customers with the same level of reliable service on a least-cost basis. Hydro has made an application for government funding, which if approved, will offset approximately 30% of the capital cost of this project and will be required to be expended in 2021.

The planned 2021 capital expenditures for transportation are consistent with that reflected in the 2020 CBA five-year capital plan for 2021 with the exception of the inclusion of the proposal to install level 2 chargers for electric vehicles.

4.3.2 Information Systems

The Information Systems proposals are directed towards maintaining Hydro's computing capacity and associated infrastructure, ensuring that it remains current and reliable. Projects include upgrades to the software applications used throughout Hydro ($0.4 million), refresh of cybersecurity software ($0.2 million), the replacement of personal computers ($0.9 million) and peripheral infrastructure ($0.3 million), and upgrades to critical IT/OT and Energy Control centre infrastructure ($0.3 million and $0.2 million, respectively). Expenditures have trended down primarily due to completion of a few material projects over the past several years, including upgrading Microsoft Office, storage capacity, and server technology. Hydro's cost management efforts have also resulted in the reduced frequency of computer replacements by extending the life cycle duration.

4.3.3 Telecontrol

Operating an integrated electrical system requires reliable communication systems across Hydro's province-wide facilities, both to control equipment and to support employee communications, many of whom work in remote locations. The 2021 CBA proposals in this area include replacement of battery banks and chargers ($0.3 million), upgrade of remote terminal units ($0.2 million), and ongoing replacement or refurbishment programs for such items as microwave antenna radomes ($0.2 million), network communications equipment ($0.2 million), and other tools and equipment that are part of the communications infrastructure ($0.1 million). Hydro has deferred the $2.0 million project to replace various VHF mobile radio systems to 2022 as the current contract is near expiration and Hydro is reviewing current and future functionality required; there are no reliability impacts anticipated as a result of this deferral as a month by month option for extension of the contract is available.

4.3.4 Administration

The 2021 CBA proposes several projects which are required for the administration of Hydro's business, including elevator maintenance work ($0.6 million) and replacement of the backup power system transfer switches and associated hardware ($0.2 million) at Hydro Place, as well as the removal of various safety hazards ($0.2 million) and the purchase of office equipment ($0.1 million).

4.4 Specifically Assigned Assets for Industrial Customers

A portion of Hydro's asset base is specifically assigned to industrial customers on the Island and in Labrador.

Within the five-year plan, Hydro has a planned project in 2024 to replace the neutral bushings on Transformers T1 and T2 in the Come By Chance Terminal Station, which are specifically assigned assets for North Atlantic Refining Limited Partnership. It is suspected that these bushings are contaminated with polychlorinated biphenyls ("PCB") and are required to be removed by 2025.[37] Specific details will be developed as the project gets closer to execution.

There are no other specifically assigned capital projects for the Island Industrial Customer Group currently in the five-year capital plan. Additionally, there are no new specifically assigned capital projects for Labrador Industrial Customers; however, Hydro anticipates such projects in the future and will provide details in either a supplemental capital application or a future CBA.

4.5 Revenue Requirement Impact

On a *pro forma* basis, Hydro's 2021 and 2022 revenue requirement is estimated to increase by approximately $3 million and $10 million,[38] respectively, as a result of the capital projects proposed for 2021. Such a revenue requirement increase would represent an increase of 0.5% and 1.6% in 2021 and 2022, respectively, relative to Hydro's 2019 Test Year.

This *pro forma* estimate is comprised of return on rate base and depreciation. It does not reflect potential reductions in operating and maintenance charges (e.g., changes related to technology such as the conversion to LED streetlights where savings are expected to be realized).

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[37] Environment Canada PCB Regulations (SOR/2008-273) prohibits the release of PCBs in the environment.

[38] These amounts do not reflect any reduction which may occur as a result of asset retirements

5.0 General

5.1 Project Prioritization and Ranking

An overall ranking of 2021 projects is included in this Overview as Appendix A.

5.2 Projects by Definition and Classification

Table 1 and Table 2 list the 2021 capital expenditures related to projects proposed both within the 2020 CBA as well as previously approved multi-year projects with expenditures in 2021 by definition and classification, respectively. The projected expenditure of $106,245.5 reflects projects over $50,000.[39]

Table 1: Projects by Definition

Type	Number	($000)
Clustered	2	4,767.1
Pooled	29	48,523.9
Other	42	52,963.5
Total	**73**	**106,254.5**

Table 2: Projects by Classification

Type	Number	($000)
Normal	66	104,141.2
Justifiable	2	479.1
Mandatory	5	1,634.2
Total	**73**	**106,254.5**

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[39]

$106,254.5	Projects in excess of $50,000
$197.9	Five separate projects under $50,000
$1,000.0	Allowance for Unforeseen Items
$107,452.4	Proposed 2021 Capital Budget

Appendix A

2021 Project Prioritization

Prioritization Explanations

Table A-1 shows the ranking of Hydro's 2021 capital projects. Rank 1 indicates the projects of the highest importance. Projects that received the same score through the prioritization process have the same ranking. The eight projects that are classified as Rank 1 are considered high-priority projects that are mandatory or are required to address safety or system load issues. Please note that the non-prioritized projects ranked "*" in the table are the continuation of multi-year projects.

Table A-1: 2021 Project Prioritization

Project Description	Cost ($000)	Rank	Cumulative Project Cost ($000)
Multi-Year Projects (2021 is 2nd or 3rd Year)	34,802.1	*	34,802.1
TRO Service Extensions and Upgrades	7,544.1	*	42,346.2
Transportation	1,620.7	*	43,966.9
Tools & Equipment	2,099.8	*	46,066.7
Allowance for Unforeseen Items	1,000.0	1	47,066.7
Wabush Terminal Station Upgrades	2,301.7	1	49,368.4
Additions for Load - Wabush Substation Upgrades	1,186.7	1	50,555.1
Additions for Load Growth - Happy Valley Line 7	617.6	1	51,172.7
Remove Safety Hazards	199.1	1	51,371.8
Replace Fuel Storage Tanks - Paradise River	350.3	1	51,722.1
Inspect Fuel Storage Tanks - Postville	532.6	1	52,254.7
Construct Lube Oil Cooler Hood and Containment System - Holyrood Gas Turbine	318.8	1	52,573.5
Hydraulic Generation Refurbishment and Modernization (2021–2022)	6,569.6	2	59,143.1
Terminal Station Refurbishment and Modernization	6,171.6	3	65,314.7
Upgrade Waste Water Equalization System - Holyrood	1,813.4	4	67,128.1
Overhaul Unit 3 Generator - Holyrood	572.7	5	67,700.8
Overhaul Unit 1 Turbine and Valves - Holyrood	8,026.6	6	75,727.4
Boiler Condition Assessment and Miscellaneous Upgrades - Holyrood	3,000.0	6	78,727.4

Project Description	**Cost ($000)**	**Rank**	**Cumulative Project Cost ($000)**
Overhaul Unit 3 Boiler Feed Pump East - Holyrood	373.0	7	79,100.4
Inspect Chemical Tanks - Holyrood	919.8	8	80,020.2
Upgrade of Worst Performing Distribution Feeders (2021–2022)	318.9	9	80,339.1
Thermal In-Service Failures	2,000.0	10	82,339.1
Terminal Station In-Service Failures	1,800.0	10	84,139.1
Hydraulic Generation In-Service Failures	1,250.0	10	85,389.1
Overhaul Diesel Units	1,232.9	11	86,622.0
Upgrades for Future Retirement of Stephenville Gas Turbine	1,530.3	12	88,152.3
Replace Voltage Regulator - Happy Valley Gas Turbine	131.3	13	88,283.6
Replace Fuel Oil, Lube Oil, and Glycol Pumps - Happy Valley Gas Turbine	234.7	14	88,518.3
Wood Pole Line Management Program	2,896.9	15	91,415.2
Upgrade Circuit Breakers	5,418.8	16	96,834.0
Purchase SF6 Gas Recovery Systems	142.7	17	96,976.7
Replace Transfer Switches and Associated Hardware - Hydro Place	197.3	18	97,174.0
Refurbish Ebbegunbaeg Control Structure	3,236.8	19	100,410.8
Labrador City L22 Voltage Conversion	593.6	20	101,004.4
Upgrade Distributed Control System Hardware - Holyrood	360.4	21	101,364.8
Diesel Genset Replacements (2021–2022)	2,560.6	22	103,925.4
Upgrade Compressed Air System - Happy Valley Gas Turbine	76.6	23	104,002.0
Purchase Capital Spares - Gas Turbines	213.8	24	104,215.8
Computer Technology System Support	2,202.7	25	106,418.5
Network Services Infrastructure System Support	1,033.9	26	107,452.4

Table A-2 presents the prioritization criteria and the assigned weights used for the 2021 CBA.

Table A-2: Prioritization Criteria and Weight Factors

Criteria		Factors	Factor Weights
1	Work Classification	Normal	5
	(maximum weight = 85)	Justifiable: Payback (70)	15
		Justifiable: Payback (40)	45
		Justifiable: Payback (10)	85
2	Net Present Value[40]	NPV ($0)	0
	(maximum weight = 85)	NPV (<$100,000)	5
		NPV (<$500,000)	15
		NPV (<$1,000,000)	45
		NPV (>$1,000,000)	85
3	Goal 1: Safety	Minor	10
	(maximum weight = 100)	Treatment	50
		Lost Time	80
		Disability	100
4	Goal 2: Environment	None	10
	(maximum weight = 100)	Minor	50
		Moderate	80
		Significant	100
5	Goals 3-5: Alignment	None	15
	(maximum weight = 65)	Maps but no documentation	40
		Maps but with documentation	65
6	Schedule Risk	External and internal conflicts	10
	(maximum weight = 65)	Externals affecting completion	20
		No external but internal conflicts	40
		No conflicts	65
7	Continue service to customers	Can	20
	(maximum weight = 70)	Can but with high costs	50
		Cannot	70
8	Number of customers impacted	<100	10
	(maximum weight = 70)	<1000	30
		<10,000	50
		>10,000	70

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[40] Net Present Value ("NPV").

Criteria		Factors	Factor Weights
9	System Impact: Critical to …	None specific	5
	(maximum weight = 90)	System with standby unit	50
		Plant or station	70
		Entire system	90
10	Impact intensity	Minor	4
	(maximum weight = 90)	Moderate	40
		Significant	70
		High	90
11	Loss Type: Loss of …	No type	5
	(maximum weight = 90)	Equipment	40
		Facility	50
		Production	70
		Customer delivery	90
12	Loss mitigation	Redundant unit	30
	(maximum weight = 90)	Backup option	60
		Nothing	90
13	Percent Improvement in Five-Year	% SAIDI or SAIFI (0)	0
	Average SAIDI[41] or SAIFI[42]	% SAIDI or SAIFI (<1)	10
	(maximum weight = 50)	% SAIDI or SAIFI (<2)	15
		% SAIDI or SAIFI (<3)	30
		% SAIDI or SAIFI (>3)	50
14	Estimated Project Cost Range	N.R.P.[43]	0
	(maximum weight = 50)	Cost (>$1,000,000)	5
		Cost ($500,000 to $1,000,000)	15
		Cost ($200,000 to $500,000)	30
		Cost (<$200,000)	50

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[41] System Average Interruption Duration Index (“SAIDI”).
[42] System Average Interruption Frequency Index (“SAIFI”).
[43] Non-Reliability Project (“N.R.P”)

Level 1

Immediate HIGH Priority Projects

Extreme Safety

The project is required to prevent an incident that could cause a fatality, or correct a condition that otherwise left unattended may lead to a fatality.

Mandatory

A capital expenditure that Hydro is obliged to carry out as a result of Legislation, Board Order, Environmental or Safety risk.

Load Driven

The project is needed to meet load requirements determined by Hydro’s latest load forecasts. Without the project, Hydro’s firm load and/or reliability criteria will be compromised.

Level 2

Work Classification

Normal

A capital expenditure which is required based on an identified need or historical patterns of repair and replacement.

Justifiable

A capital expenditure which is justified based on a positive cost savings for Hydro. A cost-benefit analysis is required for the project.

Payback (70)

A cost-benefit analysis indicates that the payback period for the project is within 70% of the anticipated life of the project.

Payback (40)

A cost-benefit analysis indicates that the payback period for the project is within 40% of the anticipated life of the project.

Payback (10)

A cost-benefit analysis indicates that the payback period for the project is within 10% of the anticipated life of the project.

Net Present Value

NPV ($0)

The capital proposal generates $0 cost savings to Hydro.

NPV (<$100,000)

A cost-benefit analysis indicates that the capital proposal generates a positive cost savings of less than $100,000 for Hydro.

NPV (<$500,000)

A cost-benefit analysis indicates that the capital proposal generates a positive cost savings of less than $500,000 for Hydro.

NPV (<$1,000,000)

A cost-benefit analysis indicates that the capital proposal generates a positive cost savings of less than $1,000,000 for Hydro.

NPV (>$1,000,000)

A cost-benefit analysis indicates that the capital proposal generates a positive cost savings of more than $1,000,000 for Hydro.

Goal 1: Safety

Minor

The project has no or minor safety issues that are insignificant in impact.

Treatment

The project is required to prevent an incident or correct a condition that otherwise left unattended may result in the need for medical treatment.

Lost Time

The project is required to prevent an incident or correct a condition that otherwise left unattended may result in worker(s) incurring lost time for a short duration.

Disability

The project is required to prevent an incident or correct a condition that otherwise left unattended may result in worker(s) incurring long time leave due to inability to continue working on the job.

Goal 2: Environment

None

The project has no environmental issues.

Minor

The project is required to prevent an incident or correct a condition that otherwise left unattended may result in an environmental impact that:

- Is irreversible within 2 years; and/or
- Will cost more than $10,000 to mitigate; and/or
- Has aspects observed on Hydro’s property (at point of impact); and/or
- Is perceived as in conflict with specific individuals in the local community.

Moderate

The project is required to prevent an incident or correct a condition that otherwise left unattended may result in an environmental impact that:

- Is irreversible within 4 years; and/or
- Will cost more than $25,000 to mitigate; and/or
- Has aspects observed within a 1 kilometre radius of Hydro’s property (from point of impact); and/or
- Is perceived as in conflict with the local community or other industries.

Significant

The project is required to prevent an incident or correct a condition that otherwise left unattended may result in an environmental impact that:

- Is irreversible within the foreseeable future; and/or
- Will cost more than $50,000 to mitigate and/or
- Has aspects observed at more than 5 kilometre radius of Hydro's property (from point of impact); and/or
- Is perceived as in conflict with the local community and the general public and other industries.

Goals 3-5 Alignment

None

This project does not align with or support any department or corporate goals or objectives.

Maps but no Documentation

This project does align with or support a department or corporate goal or objective but no documentation exists to describe how it maps to the goal or objective.

Maps but with Documentation

This project does align with or support a department or corporate goal or objective and there is documentation that clearly describes how.

Schedule Risk

Externals and Internal Conflicts

The project has external (to Hydro) dependencies that affect the completion of the project on time and on budget and has major interfaces with other internal initiatives. Examples of external dependencies are: non-Hydro projects that interfere with Hydro proceeding with its project; unavailability of external contractors.

Externals Affecting Completion

The project has only external dependencies that affect the completion of the project on time and on budget.

No Externals but Internal Conflicts

The project conflicts with other internal initiatives that affect the completion of the project on time and on budget.

No Conflicts

The project will not encounter any external or internal conflicts that affect its completion.

Continue Service to Customers

Can

Service to customers can continue whether or not this project proceeds. Customers can be defined as either internal or external to Hydro.

Can but with High Costs

Service to customers can continue whether or not this project proceeds but a delay in the project will result in Hydro incurring costs. Customers can be defined as either internal or external to Hydro.

Cannot

Service to customers cannot continue without this project. Customers can be defined as either internal or external to Hydro.

Customers Impacted

<100

The project will impact up to 100 customers.

<1000

The project will impact up to 1,000 customers.

<10000

The project will impact up to 10,000 customers.

>10000

The project will impact more than 10,000 customers.

System Impact: Critical to...

None Specific

The project is not critical to any particular system.

System with Standby Unit

The project is critical to a system that has a standby unit which could be used to maintain operation or support continued service in the event of failure.

Plant or Station

The project is critical to the proper operation of a generating plant or a terminal station.

Entire System

The project is critical to ensure the reliable operation of the Hydro system.

Impact Intensity

Minor

If this project does not proceed, the repair time is ***less than half*** the Maximum Acceptable Downtime ("MAD") of 830 MWh of unsupplied energy or 2 days (whichever comes first).

Moderate

If this project does not proceed, the repair time is ***greater than the half but less than 90%*** of the MAD of 830 MWh of unsupplied energy or 2 days (whichever is comes first).

Significant

If this project does not proceed, the repair time is ***within plus or minus 10%*** of the MAD of 830 MWh of unsupplied energy or 2 days (whichever is comes first).

High

If this project does not proceed, the repair time ***exceeds by more than 10%*** the MAD of 830 MWh of unsupplied energy or 2 days (whichever is comes first).

Loss Type: Loss of...

No Type

If the project does not proceed, no loss is expected.

Equipment

If the project does not proceed, there exists a risk of the loss of some equipment.

Facility

If the project does not proceed, there exists a risk of the loss of a facility.

Production

If the project does not proceed, there exists a risk of the loss of production at a Hydro generating plant.

Customer Delivery

If the project does not proceed, there exists a risk of being unable to deliver power to Hydro customer(s).

Loss Mitigation

Redundant Unit

If the project does not proceed the expected loss will be mitigated by a redundant unit present on the system.

Back-up Option

If the project does not proceed the expected loss will be mitigated by a back-up option which ensures that service continues.

Nothing

This project is required because there is no available means to mitigate the expected loss.

Percent Improvement in Five-Year Average SAIDI or SAIFI

% SAIDI or SAIFI (0)

This project will have no effect on SAIDI or SAIFI. All non-reliability projects will receive this rating.

% SAIDI or SAIFI (<1)

This project is expected to improve the SAIDI or SAIFI factor by less than 1%.

% SAIDI or SAIFI (<2)

This project is expected to improve the SAIDI or SAIFI factor by less than 2% but greater than 5% is implied.

% SAIDI or SAIFI (<3)

This project is expected to improve the SAIDI or SAIFI factor by less than 3% but greater than 10%is implied.

% SAIDI or SAIFI (>3)

This project is expected to improve the SAIDI or SAIFI factor by at least 3%.

Estimated Project Cost Range

Non-Reliability Project

This project is a N.R.P.

Cost (>$1,000,000)

The cost of the project is estimated to be more than $1,000,000.

Cost ($500,000–$1,000,000)

The cost of the project is estimated to be between $500,000–$1,000,000.

Cost ($200,000–$500,000)

The cost of the project is estimated to be between $200,000–$500,000.

Cost (<$200,000)

The cost of the project is estimated to be less than $200,000.

Probability

Not Likely

The risk of the impact is very low if the project does not proceed. It would be surprising that there is an impact.

Low Likelihood

The risk of the impact is low if the project does not proceed. There is about 30% chance of the impact in the proposal year. It's less likely to happen than not.

Likely

The risk of the impact is possible if the project does not proceed. There is about 50% chance of the impact in the proposal year. It's as likely to happen as not.

Highly Likely

The risk of the impact is considerable if the project does not proceed. There is about 75% chance of the impact in the proposal year. It's more likely to happen than not.

Near Certain

The risk of the impact is almost certain if the project does not proceed. There is more than 90% chance of the impact in the proposal year. It would be surprising if the impact did not occur.

Confidence Level

Low

The confidence in the assessment of the impact is low. There are some uncertainties that could significantly change the assessment. The projects risks are not well defined.

Medium

The confidence in the assessment of the impact is uncertain but most likely correct. There are some uncertainties that might moderately change the assessment. The project risks are defined but with some uncertainty.

High

The confidence in the assessment of the impact is very high. The uncertainties will not measurably change the assessment. The project risks are well defined and well controlled.

2021 Capital Budget Application

2021–2025 Capital Plan

A report to the Board of Commissioners of Public Utilities

newfoundland labrador
hydro
a nalcor energy company

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Appendix A: Five-Year Capital Plan

1.0 Introduction

In Board Order No. P.U. 30(2007), Newfoundland and Labrador Hydro (“Hydro”) was directed to file a five-year capital expenditure plan. The Board of Commissioners of Public Utilities (“Board”) indicated the plan should focus on strategic spending priorities and identify shifts in spending priorities over the five-year period, the circumstances contributing to these shifts, and alternative approaches under consideration.

Hydro’s five-year capital plan includes details on the costs and timing of forecast asset replacements and refurbishments. The five-year plan is revised as asset management practices evolve, additional information pertaining to asset condition becomes available, and operational and system requirements dictate. As such, Hydro’s 2021–2025 Capital Plan reflects the capital investments necessary to maintain infrastructure and provide safe, reliable, least-cost electricity for customers.

2.0 Five-Year Plan Overview

Hydro plans to invest approximately $625 million in plant and equipment over the 2021–2025 period, resulting in an average annual capital expenditure of approximately $125 million.

Over the period 2015–2019, the average annual capital expenditure was $191 million, primarily due to the construction of transmission lines TL 267 and TL 266. Excluding these, the average annual spend was approximately $128 million. While the projects identified for the 2021–2025 period are primarily required for sustaining capital, the 2021–2025 Capital Plan also reflects expenditure related to capital additions for upgrades required to accommodate growth in Labrador West ($22 million), the solution to address the Charlottetown plant fire ($64 million), and refurbishment work at the Bay d’Espoir penstocks ($47 million).

3.0 Strategic Spending Priorities

Overall, capital expenditures in the five-year plan primarily reflect: (i) sustaining capital required for the reliable operation of aging assets,[1] (ii) the accommodation of load growth in Labrador West, and (iii) legislative compliance (i.e., safety and environmental). Hydro has assessed all proposed projects with

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[1] The majority of Hydro’s installed assets, including the hydroelectric installation at Bay d'Espoir, the Holyrood TGS, the Stephenville Gas Turbine, the Hardwoods Gas Turbine, and much of Hydro’s transmission and distribution systems, are more than 40–50 years old.

respect to the criticality and condition of the assets and has determined that, based on current operating conditions, deferring the work beyond this time frame would present an unacceptable level of risk to the system. Hydro has planned the identified projects with a view to balancing capital expenditures with customer reliability, safety, and/or the environment.

4.0 Generation

The requirement to invest sustaining capital in generation facilities increased several years ago as parts of Hydro's generating plants approached or surpassed their normal expected service lives. Primary drivers for these projects are the end of service lives for equipment, deterioration causing reductions in reliability or performance, the availability of more efficient technology, and considerations for safety. Hydro's 2021–2025 Capital Plan includes $203.7 million for work related to Hydro's generation assets.

4.1 Hydraulic

The condition of some key components of Hydro's hydraulic facilities, including auxiliary systems and equipment as well as the water control structures, have deteriorated and some have reached the end of their service lives. Capital investment is required in these areas to ensure the safe, reliable operation of the system. The 2021–2025 Capital Plan includes the continuation of the Hydraulic Generation Refurbishment and Modernization project, which consolidates program-based projects into a single project, ensuring that equipment is replaced or refurbished in a planned approach. It also includes the in-service failures program, which is an allotment of funds to be used in the event that immediate refurbishment or replacement must be completed due to the occurrence of an actual failure, the identification of an incipient failure, or determination of faster than anticipated equipment deterioration.[2]

4.1.1 Bay d'Espoir Penstock Refurbishment

On September 22, 2019, Penstock 1 experienced a failure along a previously refurbished longitudinal weld, approximately 30 metres downstream from previous failures[3] Repairs were completed and the penstock was returned to service. Following the most recent failure, Hydro commissioned SNC Lavalin to complete an investigation into the cause of the failure of Penstock 1, including a review of previous

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[2] Work will not be completed under this program if it is more appropriate for it to be executed as unforeseen or through a capital budget supplemental project.

[3] "Bay d'Espoir Penstock Failure and Analysis," Newfoundland and Labrador Hydro, November 12, 2019.

reports[4] on the Bay d'Espoir penstocks and validation of the engineering content of the previous reports. Hatch was also engaged to provide the opportunity for incorporation, where appropriate, of SNC Lavalin's findings into its previously issued report.[5]

Following receipt of the consultants' reports, Hydro completed a review of the findings and developed a process to assess the life extension of the penstock, which it communicated to the Board in correspondence dated June 3, 2020. The plans reflected in that correspondence remain unchanged.

As Hydro's analysis is ongoing, it has not included a project related to the refurbishment of Bay d'Espoir Penstock in its 2021 Capital Budget Application ("CBA"). However, for transparency and completeness, Hydro has included a four-year project beginning in 2022 related to refurbishment activity for the Bay d'Espoir penstocks. Once Hydro's analysis and front-end engineering design work is complete, Hydro will confirm the timing and magnitude of work required and submit an application outlining the proposed project strategy and cost to the Board for review and approval.

4.1.2 Refurbishment of Ebbegunbaeg Control Structure

In correspondence to the Board on April 17, 2020,[6] Hydro advised that it was cancelling the Ebbegunbaeg Control Structure Refurbishment project previously approved in Hydro's 2019 CBA (contained under the Hydraulic Generation Refurbishment and Modernization project) as additional unplanned work was required related to the structure's monorail hoist system and the original estimated project cost did not reflect the full project scope.

A new, four-year refurbishment project for the Ebbegunbaeg Control Structure is proposed in the 2021 CBA and is reflective of the work required for the monorail hoist system and the additional scope of work previously omitted.

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[4] "Bay d'Espoir Penstock 1 Refurbishment," Newfoundland and Labrador Hydro, January 9, 2017; "Bay d'Espoir Penstock 1 Emergency Refurbishment," Newfoundland and Labrador Hydro, January 19, 2018; "Bay d'Espoir Penstock 3 Emergency Refurbishment," Newfoundland and Labrador Hydro, August 2, 2018; "Bay d'Espoir Level II Condition Assessment of Penstocks No. 1, 2, and 3," Hatch, December 17, 2018; "Condition Assessment and Refurbishment Options for Penstocks No. 1, 2 and 3," Hatch, March 29, 2019; and "Penstock No.'s 1, 2 and 3 Life Extension Options," Hatch, July 30, 2019.

[5] "Penstock No.'s 1, 2 and 3 Life Extension Options," Hatch, July 30, 2019.

[6] "Cancellation of Capital Project – Ebbegunbaeg Control Structure Refurbishment," Newfoundland and Labrador Hydro, April 17, 2020.

4.2 Thermal

On February 14, 2020, Hydro advised the Board of its decision to extend the readiness to operate the Holyrood TGS to March 31, 2022.[7] Due to the age of the Holyrood TGS assets[8] as well as the commitment to have the assets fully available for generation until March 2022, the 2021–2025 Capital Plan reflects capital work required both for steam and post-steam operations. Further detail on the operational outlook and 2021–2025 capital expenditure requirements for the Holyrood TGS is found in the Holyrood Overview report.

4.3 Gas Turbines

Hydro's gas turbine assets are relied upon to provide stand-by and spinning reserve power and to function as synchronous condensers (with the exception of the Holyrood Gas Turbine) to help support voltage control on the Island and Labrador Interconnected Systems. These facilities accumulate fewer operating hours than other generation sources; however, they are critical to system reliability as they are crucial sources of electricity during system peaks or for other system component planned and unplanned outages. Capital investment planned for 2021–2025 related to the gas turbines is primarily related to inspections at the Holyrood Gas Turbine which are scheduled to occur in 2022 and 2025.

The combustor inspection was originally scheduled to take place in 2021; however, it is now deferred to 2022[9] as, based on current operational forecasts, it is not expected to reach the number of equivalent starts or equivalent base hours to necessitate the inspection in 2021. A major inspection at the Holyrood Gas Turbine is slated for execution in 2025. Similar to the combustor inspection, the timing of the major inspection may shift depending on the number of equivalent starts or equivalent base hours.

In addition to the inspection projects, there are planned expenditures related to replacement of the fire suppression system at the Happy Valley Gas Turbine and a number of smaller planned expenditures related to sustaining capital.

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[7] "Extension of Holyrood Thermal Generation Station as a Generating Facility," Newfoundland and Labrador Hydro, February 14, 2020.

[8] Holyrood TGS Units 1 and 2 were commissioned in 1970 and 1971, respectively. Unit 3 was commissioned in 1979.

[9] Procurement related expenses are expected to be incurred in 2021.

There are no capital proposals in either the 2021 CBA or the five-year plan for the Hardwoods and Stephenville Gas Turbines. As noted in Hydro's Near-Term Reliability Report, these assets are anticipated to be retired in 2023.[10]

5.0 Transmission and Rural Operations

Hydro's 2021–2025 Capital Plan includes $375.8 million for work related to Hydro's transmission and rural operations assets. Primary drivers for these projects are the end of service lives for equipment, deterioration causing reductions in reliability or performance, and additions required to accommodate load growth in Labrador West.

5.1 Terminal Stations

Capital investment is required in Hydro's terminal stations to ensure the safe, reliable operation of the system. The 2021–2025 Capital Plan includes the continuation of the Terminal Station Refurbishment and Modernization project and the Upgrade Circuit Breakers project in all years of the plan. It also includes the in-service failures program in all years, which is an allotment of funds to be used in the event that immediate refurbishment or replacement must be completed due to the occurrence of an actual failure, the identification of an incipient failure, or determination of faster than anticipated equipment deterioration.[11]

The 2021–2025 Capital Plan also includes plans for replacement of the Wabush Terminal Station Transformer T3 inspections of synchronous condensers at Wabush Terminal Station installation of fire barriers at Bay d'Espoir, Happy Valley Gas Turbine, and Massey Drive, and projects to replace capacitor banks, power transformers, and switchgear.

5.1.1 Projects to Accommodate Load Growth in Labrador West

The 2020 CBA five-year capital plan for 2020–2024 included $26.6 million related to a multi-year project for additions that were required to accommodate load growth in Labrador West. At the time, Hydro noted that the technical analysis was not complete and that the project was included in the five-year capital plan for transparency and completeness. Since then, the required technical analysis has been completed and Hydro is proposing specific projects to address load growth in Labrador West in its 2021

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[10] "Near-Term Reliability Report," Newfoundland and Labrador Hydro, May 15, 2020.

[11] Work will not be completed under this program if it is more appropriate for it to be executed as unforeseen or through a capital budget supplemental project.

CBA; the Wabush Terminal Station Upgrades and Wabush Substation Upgrades are both multi-year (2021–2023) projects. The Wabush Terminal Station Upgrades cost estimate is $11.6 million and the Wabush Substation Upgrades cost estimate is $10.5 million.

5.2 Transmission

The five-year transmission capital plan reflects $18.7 million in expenditures primarily related to the Wood Pole Line Management ("WPLM") Program. The WPLM Program is a critical component of Hydro's asset management strategy for its wooden transmission poles. The WPLM Program is based on a structured, periodic assessment of the wood transmission poles and facilitates replacement in advance of failure while extracting the maximum possible reliable life from each pole and component.

5.3 Distribution

The majority of the $68.9 million in distribution system expenditures for the next five years consist of service extensions, upgrades to distribution systems, and distribution line replacement focused on worst performing feeders.

Hydro's 2021–2025 Capital Plan includes expenditures related to the retirement of the remaining mercury vapour and high pressure sodium street lights in Hydro's system, beginning in 2021. These street lights will be replaced with light emitting diode ("LED") street lights. LED street lights require less maintenance, are more energy efficient, and provide more reliable and better quality lighting for customers, thus supporting the provision of least-cost reliable service to customers. Over the plan's five-year period, Hydro plans to invest approximately $2.5 million related to this work.

5.4 Rural Generation

The five-year capital spend of $112.7 million related to rural generation is largely impacted by the inclusion of projected expenditures for the Charlottetown diesel plant replacement solution. The remaining proposed expenditures is primarily focused on the overhaul and replacement of infrastructure required to ensure reliability for Hydro's isolated electrical systems, which are primarily supplied with electricity by diesel generating units. At each isolated system, Hydro has a typical installation of between 3 and 5 individual generating units. Hydro's diesel generating units have the shortest lives of all its generating assets, requiring overhaul after 20,000 hours for 1,800 rpm units and 30,000 hours for 1,200 rpm units. Replacement of the diesel generating units occurs after approximately 100,000 hours of operation for 1,800 rpm units and 120,000 hours for 1,200 rpm units.

Many of Hydro's diesel plants will require refurbishment or replacement in the near- to medium-term. Hydro is continuing with annual proposals to install diesel plant fire protection, where appropriate. Projects for the inspection, replacement, and upgrade of diesel plant infrastructure and auxiliary systems are included over the coming five years.

5.4.1 Charlottetown Diesel Plant Replacement

Preliminary forecast expenditures associated with this multi-year project are included in the five-year capital plan for 2021–2025 for transparency and completeness. Hydro's 2021 CBA does not include a request for approval of the project to replace the Charlottetown Diesel Plant as analysis related to this project is ongoing. Hydro anticipates proposing an application related to this work once the analysis is complete.

6.0 General Property

General properties include items such as vehicles, facilities, and information systems infrastructure. These assets typically require replacement or refurbishment due to deterioration, age, and obsolescence. Hydro's 2021–2025 Capital Plan includes $40.1 million related to general property.

6.1 Information Systems

Obsolete technology and aging hardware are the strategic drivers that most significantly contribute to the five-year plan of $9.7 million for Information Systems. Hydro's information systems provide the data required to effectively manage and control the activities of the business. Projects in this category include personal computer and software replacements, as well as upgrades to Hydro's cybersecurity software. These types of replacements, similar to previous years, are planned to continue over the next five years.

6.2 Telecontrol

Obsolete technology and aging hardware are the most significant contributors to the five-year plan of $9.6 million for telecontrol assets. Hydro's communications network is vital to the operation and control of the power systems. Communications must be reliable and rapid to protect and control the generation, transmission, and distribution equipment. The five-year plan contains expenditures in the form of several programs to replace battery banks and chargers, refurbish microwave sites, replace radomes, and replace obsolete radio equipment. The plan also includes site-specific projects to replace backup generation at microwave sites.

6.3 Transportation

The five-year plan includes $13.5 million of investment related to light and heavy duty vehicles and electric vehicle charging stations for fleet purposes. Hydro's vehicles and mobile equipment must continue to be both safe and reliable. Hydro operates a diversified and dispersed fleet of mobile equipment throughout the province that is required to operate and maintain our facilities in sometimes challenging and harsh physical environments. Hydro selects, operates, and maintains this equipment in a manner designed to achieve the least life cycle cost and replacements are scheduled in accordance with criteria previously submitted to the Board.

In order to expand Hydro's ability to integrate electric vehicles into its fleet, Hydro's 2021–2025 Capital Plan reflects a project to install 18, Level 2 electric vehicle chargers at nine Hydro-owned sites across the province.[12] This project is eligible for federal funding which, if approved, will provide for approximately 30% of the $0.3 million total project cost.

6.4 Administration

The five-year plan includes $7.4 million of investment related to building infrastructure and auxiliary systems, office equipment, and safety-related expenditures. 2021 includes the completion of the multi-year elevator controls project approved in the prior year CBA and the commencement of the proposed multi-year project to replace transfer switches in the power backup system located at Hydro Place.

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[12] This investment supports the further integration of electric vehicles within Hydro's fleet, expected to commence in late 2021 and continue throughout the five-year capital plan. Electric vehicles offer the opportunity for operating and maintenance savings relative to gasoline powered alternatives, while continuing to provide customers with the same level of reliable service on a least-cost basis.

Appendix A

Five-Year Capital Plan

Newfoundland and Labrador Hydro
2021 Capital Budget
Five-Year Capital Plan
($000)

	Expended to 2020	2021	2022	2023	2024	2025	Total
Generation	8,710.1	50,723.1	28,147.2	34,219.1	48,872.1	41,715.6	**212,387.2**
Transmission and Rural Operations	4,265.6	53,421.2	73,568.4	102,457.6	78,901.5	67,459.7	**380,073.9**
General Properties	1,714.6	7,547.1	9,708.6	7,052.7	7,159.6	8,619.2	**41,801.8**
Allowance for Unforeseen Items	-	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	**5,000.0**
Total Capital Budget	**14,690.3**	**112,691.4**	**112,424.2**	**144,729.4**	**135,933.2**	**118,794.5**	**639,263.0**

Newfoundland and Labrador Hydro
2021 Capital Budget
Five-Year Capital Plan
($000)

	Expended to 2020	2021	2022	2023	2024	2025	Total
Generation							
Hydraulic Plant	6,580.2	21,306.2	19,349.4	22,735.5	44,112.7	33,468.9	**147,552.9**
Thermal Plant	1,281.4	22,730.1	5,467.5	10,975.0	3,400.0	586.5	**44,440.5**
Gas Turbines	848.5	6,428.1	3,272.7	450.0	1,300.0	7,600.0	**19,899.3**
Tools and Equipment	-	258.7	57.6	58.6	59.4	60.2	**494.5**
Total Generation	**8,710.1**	**50,723.1**	**28,147.2**	**34,219.1**	**48,872.1**	**41,715.6**	**212,387.2**
Transmission and Rural Operations							
Terminal Stations	3,712.0	24,236.7	42,639.4	40,838.5	24,263.7	26,933.7	**162,624.0**
Transmission	-	2,896.9	2,745.5	2,289.1	2,884.4	7,841.0	**18,656.9**
Distribution	174.0	12,414.6	10,511.1	14,768.6	14,675.1	16,521.3	**69,064.6**
Rural Generation	288.0	11,801.6	14,727.2	39,716.5	34,855.1	11,566.6	**112,955.0**
Properties	91.6	292.6	869.3	2,240.8	1,078.6	1,706.0	**6,278.9**
Metering	-	233.4	194.8	193.9	195.0	196.8	**1,013.9**
Tools and Equipment	-	1,545.4	1,881.1	2,410.2	949.6	2,694.3	**9,480.6**
Total Transmission and Rural Operations	**4,265.6**	**53,421.2**	**73,568.4**	**102,457.6**	**78,901.5**	**67,459.7**	**380,073.9**
General Properties							
Information Systems	-	2,202.7	1,982.0	1,685.0	1,730.0	2,100.0	**9,699.7**
Telecontrol	-	1,033.9	3,344.4	1,991.0	2,027.9	1,156.9	**9,554.1**
Transportation	1,625.5	3,204.2	2,660.1	2,091.9	2,115.5	3,400.0	**15,097.2**
Administrative	89.1	1,106.3	1,722.1	1,284.8	1,286.2	1,962.3	**7,450.8**
Total General Properties	**1,714.6**	**7,547.1**	**9,708.6**	**7,052.7**	**7,159.6**	**8,619.2**	**41,801.8**
Allowance for Unforeseen Items	-	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	**5,000.0**
Total Capital Budget	**14,690.3**	**112,691.4**	**112,424.2**	**144,729.4**	**135,933.2**	**118,794.5**	**639,263.0**

Newfoundland and Labrador Hydro
2021 Capital Budget
Five-Year Capital Plan
($000)

Project Description	**Expended to 2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Total**
Hydraulic Plant							
Hydraulic Generation Refurbishment and Modernization (2020-2021)	6,580.2	10,249.8	-	-	-	-	**16,830.0**
Refurbish Ebbegunbaeg Control Structure	-	3,236.8	3,238.3	3,470.1	3,674.7	-	**13,619.9**
Hydraulic Generation Refurbishment and Modernization (2021-2022)	-	6,569.6	6,505.5	-	-	-	**13,075.1**
Hydraulic Generation In-Service Failures (2021)	-	1,250.0	-	-	-	-	**1,250.0**
Penstock Refurbishment Program (2022-2025)			4,120.0	4,390.0	22,730.0	16,080.0	**47,320.0**
Hydraulic Generation Refurbishment and Modernization (2022-2023)	-	-	4,235.6	3,124.3	-	-	**7,359.9**
Hydraulic Generation In-Service Failures (2022)	-	-	1,250.0	-	-	-	**1,250.0**
Hydraulic Generation Refurbishment and Modernization (2023-2024)	-	-	-	10,001.1	7,400.0	4,000.0	**21,401.1**
Hydraulic Generation In-Service Failures (2023)	-	-	-	1,250.0	-	-	**1,250.0**
Refurbish CD4 Rip Rap - Cat Arm	-	-	-	500.0	-	-	**500.0**
Hydraulic Generation Refurbishment and Modernization (2024-2025)	-	-	-	-	9,058.0	200.0	**9,258.0**
Hydraulic Generation In-Service Failures (2024)	-	-	-	-	1,250.0	-	**1,250.0**
Hydraulic Generation Refurbishment and Modernization (2025-2026)	-	-	-	-	-	11,938.9	**11,938.9**
Hydraulic Generation In-Service Failures (2025)	-	-	-	-	-	1,250.0	**1,250.0**
Total Hydraulic Plant	**6,580.2**	**21,306.2**	**19,349.4**	**22,735.5**	**44,112.7**	**33,468.9**	**147,552.9**

Newfoundland and Labrador Hydro
2021 Capital Budget
Five-Year Capital Plan
($000)

Project Description	Expended to 2020	2021	2022	2023	2024	2025	Total
Thermal Plant							
Rewind Unit 3 Stator - Holyrood	1,281.4	5,664.2	-	-	-	-	**6,945.6**
Overhaul Unit 1 Turbine and Valves - Holyrood	-	8,026.6	-	-	-	-	**8,026.6**
Boiler Condition Assessment and Miscellaneous Upgrades - Holyrood	-	3,000.0	-	-	-	-	**3,000.0**
Upgrade Waste Water Equalization System - Holyrood	-	1,813.4	547.7	-	-	-	**2,361.1**
Thermal In-Service Failures (2021)	-	2,000.0	-	-	-	-	**2,000.0**
Inspect Chemical Tanks - Holyrood	-	919.8	-	-	-	-	**919.8**
Upgrade Distributed Control System Hardware - Holyrood	-	360.4	368.2	-	-	-	**728.6**
Overhaul Unit 3 Generator - Holyrood	-	572.7	-	-	-	-	**572.7**
Overhaul Unit 3 Boiler Feed Pump East - Holyrood	-	373.0	-	-	-	-	**373.0**
Replace Stage II Electrical Distribution Equipment - Holyrood	-	-	298.9	4,966.8	-	-	**5,265.7**
Replace Unit 3 Generator - Holyrood	-	-	1,000.0	1,000.0	1,000.0	-	**3,000.0**
Replace Fire Water Distribution System - Holyrood	-	-	220.8	1,109.0	-	-	**1,329.8**
Install New Oil Systems Unit 3 - Holyrood	-	-	260.0	770.0	-	-	**1,030.0**
Inspect and Upgrade Light Oil System - Holyrood	-	-	100.0	900.0	-	-	**1,000.0**
Replace Stage 1 4160V AC Breakers - Holyrood	-	-	750.0	-	-	-	**750.0**
Thermal In-Service Failures (2022)	-	-	750.0	-	-	-	**750.0**
Replace High Bay Lighting with LED - Holyrood	-	-	15.9	609.2	-	-	**625.1**
Replace Unit 3 Protective Relaying - Holyrood	-	-	500.0	-	-	-	**500.0**
Replace One of North or South Service Air Receivers Unit 3	-	-	306.0	-	-	-	**306.0**
Upgrade WWTP 600V Variable Frequency Drives - Holyrood	-	-	250.0	-	-	-	**250.0**
Upgrade Bio-Green Treatment System - Holyrood	-	-	100.0	-	-	-	**100.0**
Thermal In-Service Failures (2023)	-	-	-	750.0	-	-	**750.0**
Refurbish Stage 2 Cooling Water Pumphouse - Holyrood	-	-	-	350.0	400.0	-	**750.0**
Upgrade Cooling Water System Unit 3 - Holyrood	-	-	-	320.0	-	-	**320.0**
Upgrade Holyrood Training Centre - Holyrood	-	-	-	200.0	-	-	**200.0**
Upgrade Water Treatment Plant - Holyrood	-	-	-	-	1,000.0	-	**1,000.0**
Thermal In-Service Failures (2024)	-	-	-	-	750.0	-	**750.0**
Upgrade Ambient Monitoring Stations - Holyrood	-	-	-	-	250.0	-	**250.0**
Upgrade Vibration Monitoring Equipment Unit 3 Generator - Holyrood	-	-	-	-	-	336.5	**336.5**
Main Warehouse Upgrades - Holyrood	-	-	-	-	-	250.0	**250.0**
Total Thermal Plant	**1,281.4**	**22,730.1**	**5,467.5**	**10,975.0**	**3,400.0**	**586.5**	**44,440.5**

Newfoundland and Labrador Hydro
2021 Capital Budget
Five-Year Capital Plan
($000)

Project Description	Expended to 2020	2021	2022	2023	2024	2025	Total
Gas Turbines							
Perform Combustor Inspection - Holyrood Gas Turbine	546.1	2,500.0	2,400.0	-	-	-	**5,446.1**
Replace Fire Suppression System - Happy Valley Gas Turbine	264.6	2,377.9	-	-	-	-	**2,642.5**
Install Partial Discharge Monitoring - Holyrood Gas Turbine	37.8	575.0	-	-	-	-	**612.8**
Replace Voltage Regulator - Happy Valley Gas Turbine	-	131.3	211.0	-	-	-	**342.3**
Replace Fuel Oil, Lube Oil, and Glycol Pumps - Happy Valley Gas Turbine	-	234.7	170.5	-	-	-	**405.2**
Construct Lube Oil Cooler Hood and Containment System - Holyrood Gas Turbine	-	318.8	-	-	-	-	**318.8**
Purchase Capital Spares - Gas Turbines (2021)	-	213.8	-	-	-	-	**213.8**
Upgrade Compressed Air System - Happy Valley Gas Turbine	-	76.6	69.2	-	-	-	**145.8**
Purchase Capital Spares - Gas Turbines (2022)	-	-	300.0	-	-	-	**300.0**
Replace Lube Oil / Glycol Cooler Radiator Coil - Happy Valley Gas Turbine	-	-	50.0	150.0	-	-	**200.0**
Install Infrared Scanning Ports - Happy Valley Gas Turbine	-	-	72.0	-	-	-	**72.0**
Purchase Capital Spares - Gas Turbines (2023)	-	-	-	300.0	-	-	**300.0**
Inspect Gas Turbine - Holyrood Gas Turbine	-	-	-	-	1,000.0	-	**1,000.0**
Purchase Capital Spares - Gas Turbines (2024)	-	-	-	-	300.0	-	**300.0**
Gas Turbine Major Inspection - Holyrood Gas Turbine	-	-	-	-	-	7,500.0	**7,500.0**
Inspect Fuel Tanks - Happy Valley Gas Turbine	-	-	-	-	-	100.0	**100.0**
Total Gas Turbines	**848.5**	**6,428.1**	**3,272.7**	**450.0**	**1,300.0**	**7,600.0**	**19,899.3**

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Project Description	Expended to 2020	2021	2022	2023	2024	2025	Total
Tools and Equipment							
Purchase Tools and Equipment Less than $50,000 (2021) - Hydraulic Plants	-	194.3	-	-	-	-	**194.3**
Purchase Tools and Equipment Less than $50,000 (2021) - Thermal Plants	-	18.8	-	-	-	-	**18.8**
Purchase Tools and Equipment Less than $50,000 (2021) - Gas Turbine	-	45.6	-	-	-	-	**45.6**
Purchase Tools and Equipment Less than $50,000 (2022) - Hydraulic Plants	-	-	22.4	-	-	-	**22.4**
Purchase Tools and Equipment Less than $50,000 (2022) - Thermal Plants	-	-	16.8	-	-	-	**16.8**
Purchase Tools and Equipment Less than $50,000 (2022) - Gas Turbine	-	-	18.4	-	-	-	**18.4**
Purchase Tools and Equipment Less than $50,000 (2023) - Hydraulic Plants	-	-	-	22.8	-	-	**22.8**
Purchase Tools and Equipment Less than $50,000 (2023) - Thermal Plants	-	-	-	17.0	-	-	**17.0**
Purchase Tools and Equipment Less than $50,000 (2023) - Gas Turbine	-	-	-	18.8	-	-	**18.8**
Purchase Tools and Equipment Less than $50,000 (2024) - Hydraulic Plants	-	-	-	-	23.0	-	**23.0**
Purchase Tools and Equipment Less than $50,000 (2024) - Thermal Plants	-	-	-	-	17.2	-	**17.2**
Purchase Tools and Equipment Less than $50,000 (2024) - Gas Turbine	-	-	-	-	19.2	-	**19.2**
Purchase Tools and Equipment Less than $50,000 (2025) - Hydraulic Plants	-	-	-	-	-	23.2	**23.2**
Purchase Tools and Equipment Less than $50,000 (2025) - Thermal Plants	-	-	-	-	-	17.4	**17.4**
Purchase Tools and Equipment Less than $50,000 (2025) - Gas Turbine	-	-	-	-	-	19.6	**19.6**
Total Tools and Equipment	**-**	**258.7**	**57.6**	**58.6**	**59.4**	**60.2**	**494.5**
Total Generation	**8,710.1**	**50,723.1**	**28,147.2**	**34,219.1**	**48,872.1**	**41,715.6**	**212,387.2**

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Project Description	Expended to 2020	2021	2022	2023	2024	2025	Total
Terminal Stations							
Terminal Station Refurbishment and Modernization (2020-2021)	3,712.0	5,684.9	-	-	-	-	**9,396.9**
Terminal Station Refurbishment and Modernization (2021-2022)	-	6,171.6	7,182.0	-	-	-	**13,353.6**
Wabush Terminal Station Upgrades	-	2,301.7	4,935.5	4,335.7	-	-	**11,572.9**
Upgrade Circuit Breakers - Various (2021-2022)	-	5,418.8	6,113.9	-	-	-	**11,532.7**
Additions for Load - Wabush Substation Upgrades	-	1,186.7	6,365.1	2,941.6	-	-	**10,493.4**
Upgrades for Future Retirement of Stephenville Gas Turbine	-	1,530.3	8,389.5	-	-	-	**9,919.8**
Terminal Station In-Service Failures (2021)	-	1,800.0	-	-	-	-	**1,800.0**
Purchase SF6 Gas Recovery Systems	-	142.7	-	-	-	-	**142.7**
Terminal Station Refurbishment and Modernization (2022-2023)	-	-	4,493.7	12,760.6	-	-	**17,254.3**
Upgrade Circuit Breakers - Various (2022-2023)	-	-	1,724.0	7,796.0	-	-	**9,520.0**
Replace Transformers - WABTS T3	-	-	1,254.1	4,959.0	-	-	**6,213.1**
Terminal Station In-Service Failures (2022)	-	-	1,500.0	-	-	-	**1,500.0**
Install Fire Barriers - Bay d'Espoir	-	-	208.6	1,049.5	-	-	**1,258.1**
Upgrade Drainage to Stop Frost Heaving - Various	-	-	200.0	450.0	400.0	-	**1,050.0**
Inspect Synchronous Condenser 2 Majorly - WABTS (2022)	-	-	273.0	-	-	-	**273.0**
Terminal Station Refurbishment and Modernization (2023-2024)	-	-	-	4,333.6	11,727.2	-	**16,060.8**
Upgrade Circuit Breakers - Various (2023-2024)	-	-	-	674.0	3,779.0	-	**4,453.0**
Terminal Station In-Service Failures (2023)	-	-	-	1,500.0	-	-	**1,500.0**
Construct Fire Separation Wall between Transformers - Happy Valley Gas Turbine	-	-	-	38.5	491.7	-	**530.2**
Terminal Station Refurbishment and Modernization (2024-2025)	-	-	-	-	3,876.9	9,218.3	**13,095.2**
Upgrade Circuit Breakers - Various (2024-2025)	-	-	-	-	1,810.1	8,205.9	**10,016.0**
Terminal Station In-Service Failures (2024)	-	-	-	-	1,500.0	-	**1,500.0**
Replace Capacitor Bank C1 - OPD (2024)	-	-	-	-	378.8	385.5	**764.3**
Install Fire Barriers between T1, T2 and T3 & the Substation - Massey Drive	-	-	-	-	100.0	400.0	**500.0**
Replace Switchgear	-	-	-	-	200.0	-	**200.0**
Terminal Station Refurbishment and Modernization (2025-2026)	-	-	-	-	-	5,564.0	**5,564.0**
Terminal Station In-Service Failures (2025)	-	-	-	-	-	1,500.0	**1,500.0**
Replace Power Transformer GFC T2	-	-	-	-	-	600.0	**600.0**
Upgrade Circuit Breakers (Overhauls and Replacements) (2025-2026)	-	-	-	-	-	500.0	**500.0**
Inspect Synchronous Condenser 2 Majorly - WABTS (2025)	-	-	-	-	-	290.0	**290.0**
Upgrade Station Access Road - Various	-	-	-	-	-	200.0	**200.0**
Upgrade Control Buildings	-	-	-	-	-	70.0	**70.0**
Total Terminal Stations	**3,712.0**	**24,236.7**	**42,639.4**	**40,838.5**	**24,263.7**	**26,933.7**	**162,624.0**

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Project Description	Expended to 2020	2021	2022	2023	2024	2025	Total
Transmission							
Wood Pole Line Management Program (2021)	-	2,896.9	-	-	-	-	**2,896.9**
Wood Pole Line Management Program (2022)	-	-	2,745.5	-	-	-	**2,745.5**
Wood Pole Line Management Program (2023)	-	-	-	2,289.1	-	-	**2,289.1**
Wood Pole Line Management Program (2024)	-	-	-	-	2,884.4	-	**2,884.4**
Upgrade Work L23/24	-	-	-	-	-	5,000.0	**5,000.0**
Wood Pole Line Management Program (2025)	-	-	-	-	-	2,841.0	**2,841.0**
Total Transmission	**-**	**2,896.9**	**2,745.5**	**2,289.1**	**2,884.4**	**7,841.0**	**18,656.9**

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Project Description	Expended to 2020	2021	2022	2023	2024	2025	Total
Distribution							
Upgrade of Worst Performing Distribution Feeders (2020–2021)	102.7	3,155.1	-	-	-	-	**3,257.8**
Install Recloser Remote Control - Hampden and Upper Salmon (2020-2021)	71.3	185.3	-	-	-	-	**256.6**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in Central Region (2021)	-	1,985.4	-	-	-	-	**1,985.4**
Provide Service Extensions in Central Region (2021)	-	1,357.4	-	-	-	-	**1,357.4**
Provide Service Extensions in Labrador Region (2021)	-	1,218.6	-	-	-	-	**1,218.6**
Provide Service Extensions in Northern Region (2021)	-	1,164.5	-	-	-	-	**1,164.5**
Upgrade of Worst Performing Distribution Feeders (2021-2022)	-	318.9	805.6	-	-	-	**1,124.5**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in Northern Region (2021)	-	1,033.5	-	-	-	-	**1,033.5**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in Labrador Region (2021)	-	784.7	-	-	-	-	**784.7**
Additions for Load Growth - Happy Valley Line 7	-	617.6	-	-	-	-	**617.6**
Labrador City L22 Voltage Conversion	-	593.6	-	-	-	-	**593.6**
Upgrade of Worst Performing Distribution Feeders (2022-2023)	-	-	662.5	3,776.6	-	-	**4,439.1**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in Central Region (2022)	-	-	2,092.5	-	-	-	**2,092.5**
Provide Service Extensions in Central Region (2022)	-	-	1,620.0	-	-	-	**1,620.0**
Provide Service Extensions in Labrador Region (2022)	-	-	1,449.0	-	-	-	**1,449.0**
Provide Service Extensions in Northern Region (2022)	-	-	1,386.0	-	-	-	**1,386.0**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in Northern Region (2022)	-	-	1,061.8	-	-	-	**1,061.8**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in Labrador Region (2022)	-	-	697.5	-	-	-	**697.5**
Install Recloser Remote Control - Various (2022-2023)	-	-	50.0	526.0	-	-	**576.0**
Additions for Load (2022)	-	-	500.0	-	-	-	**500.0**
Convert La Scie L7 to 25 kV - BWT	-	-	36.2	328.5	-	-	**364.7**
Install Recloser Remote Control - Various (2021-2022)	-	-	150.0	142.6	-	-	**292.6**
Upgrade of Worst Performing Distribution Feeders (2023-2024)	-	-	-	908.6	4,216.6	-	**5,125.2**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in Central Region (2023)	-	-	-	2,134.2	-	-	**2,134.2**

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Project Description	Expended to 2020	2021	2022	2023	2024	2025	Total
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in	-	-	-	1,082.7	-	-	**1,082.7**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in	-	-	-	708.4	-	-	**708.4**
Additions for Load (2023)	-	-	-	500.0	-	-	**500.0**
Install Recloser Remote Control (2023-2024) - Various	-	-	-	25.0	270.0	-	**295.0**
Implement Geographical Information System - Various (Moved from 2021)	-	-	-	100.0	100.0	-	**200.0**
Upgrade of Worst Performing Distribution Feeders (2024-2025)	-	-	-	-	468.5	6,750.0	**7,218.5**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in	-	-	-	-	2,175.9	-	**2,175.9**
Provide Service Extensions in Central Region (2024)	-	-	-	-	1,683.0	-	**1,683.0**
Provide Service Extensions in Labrador Region (2024)	-	-	-	-	1,503.0	-	**1,503.0**
Provide Service Extensions in Northern Region (2024)	-	-	-	-	1,440.0	-	**1,440.0**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in	-	-	-	-	1,112.7	-	**1,112.7**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in	-	-	-	-	719.3	-	**719.3**
Additions for Load (2024)	-	-	-	-	500.0	-	**500.0**
Convert Section of Line to 14.4kV - KGP	-	-	-	-	461.0	-	**461.0**
Install Recloser Remote Control - Various (2024-2025)	-	-	-	-	25.0	270.0	**295.0**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in	-	-	-	-	-	2,037.8	**2,037.8**
Provide Service Extensions in Central Region (2025)	-	-	-	-	-	1,557.0	**1,557.0**
Provide Service Extensions in Labrador Region (2025)	-	-	-	-	-	1,395.0	**1,395.0**
Provide Service Extensions in Northern Region (2025)	-	-	-	-	-	1,332.0	**1,332.0**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in	-	-	-	-	-	1,034.7	**1,034.7**
Additions for Load (2025)	-	-	-	-	-	1,000.0	**1,000.0**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in	-	-	-	-	-	676.3	**676.3**
Upgrade of Worst Performing Distribution Feeders (2025-2026)	-	-	-	-	-	468.5	**468.5**
Total Distribution	**174.0**	**14,435.6**	**14,552.1**	**14,275.6**	**18,720.1**	**18,546.3**	**64,528.6**

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Project Description	Expended to 2020	2021	2022	2023	2024	2025	Total
Rural Generation							
Replace Powerhouse Roofing System - L'Anse Au Loup and St. Anthony Diesel Plant	125.3	1,195.8	-	-	-	-	**1,321.1**
Diesel Plant Ventilation Upgrade - Nain	162.7	690.4	-	-	-	-	**853.1**
Diesel Plant Replacement - Charlottetown		5,194.7	8,628.4	28,561.5	21,255.1	-	**63,639.7**
Diesel Genset Replacements (2021-2022)	-	2,560.6	525.0	-	-	-	**3,085.6**
Install Fire Protection in Diesel Plants - Port Hope Simpson (2021-2022)	-	44.3	1,262.2	-	-	-	**1,306.5**
Overhaul Diesel Units - Various (2021)	-	1,232.9	-	-	-	-	**1,232.9**
Inspect Fuel Storage Tanks - Postville	-	532.6	-	-	-	-	**532.6**
Replace Fuel Storage Tank - Paradise River	-	350.3	-	-	-	-	**350.3**
Diesel Genset Replacements (2022-2023)	-	-	600.0	5,300.0	-	-	**5,900.0**
Overhaul Diesel Units - Various (2022)	-	-	2,500.0	-	-	-	**2,500.0**
Install Fire Protection in Diesel Plants - Mary's Harbour (2022-2023)	-	-	500.0	1,055.0	-	-	**1,555.0**
Upgrade Building Exterior - Postville	-	-	111.6	500.0	-	-	**611.6**
Additions for Load Growth - Isolated Generation Stations - Various	-	-	500.0	-	-	-	**500.0**
Inspect Fuel Storage Tanks - Mary's Harbour (2022)	-	-	100.0	-	-	-	**100.0**
Diesel Genset Replacements (2023-2024)	-	-	-	700.0	6,000.0	-	**6,700.0**
Overhaul Diesel Units - Various (2023)	-	-	-	2,500.0	-	-	**2,500.0**
Install Fire Protection in Diesel Plants - St. Lewis (2023-2024)	-	-	-	500.0	1,000.0	-	**1,500.0**
Additions for Load Growth - Isolated Generation Stations - Various (2023)	-	-	-	500.0	-	-	**500.0**
Inspect Fuel Storage Tanks - Various (2023)	-	-	-	100.0	-	-	**100.0**
Overhaul Diesel Units - Various (2024)	-	-	-	-	2,500.0	-	**2,500.0**
Diesel Genset Replacements (2024-2025)	-	-	-	-	2,400.0	-	**2,400.0**
Install Fire Protection in Diesel Plants (2024-2025)	-	-	-	-	500.0	1,100.0	**1,600.0**
Automate Diesel Plant - Postville	-	-	-	-	100.0	995.0	**1,095.0**
Inspect Fuel Storage Tanks - Various (2024)	-	-	-	-	600.0	-	**600.0**
Additions for Load Growth - Isolated Generation Stations - Various (2024)	-	-	-	-	500.0	-	**500.0**
Diesel Genset Replacements (2025-2026)	-	-	-	-	-	2,771.6	**2,771.6**
Overhaul Diesel Engines	-	-	-	-	-	2,000.0	**2,000.0**
Automate Diesel Plants	-	-	-	-	-	1,600.0	**1,600.0**
Additions for Load	-	-	-	-	-	1,500.0	**1,500.0**
Install Fire Protection In Diesel Plants - Various	-	-	-	-	-	1,000.0	**1,000.0**
Inspect Fuel Storage Tanks - Various	-	-	-	-	-	600.0	**600.0**
Total Generation	**288.0**	**11,801.6**	**14,727.2**	**39,716.5**	**34,855.1**	**11,566.6**	**112,955.0**

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Project Description	Expended to 2020	2021	2022	2023	2024	2025	Total
Properties							
Upgrade Fire Suppression System - Bishop's Falls	91.6	292.6	-	-	-	-	**384.2**
Upgrade Line Depots - Various	-	-	141.0	1,001.3	-	-	**1,142.3**
Upgrade Line Depots - Various (2022-2023)	-	-	398.5	640.9	-	-	**1,039.4**
Upgrade Outside Property - Happy Valley Gas Turbine	-	-	120.0	-	-	-	**120.0**
Replace Roof on Garage - Bishop's Falls	-	-	105.4	-	-	-	**105.4**
Upgrade HVAC System - Stephenville	-	-	104.4	-	-	-	**104.4**
Upgrade Line Depots - Various (2023-2024)	-	-	-	409.4	658.6	-	**1,068.0**
Upgrade Classroom and Boardroom in Main Office - Bishop's Falls	-	-	-	189.2	-	-	**189.2**
Upgrade Line Depots - Various (2024-2025)	-	-	-	-	420.0	670.0	**1,090.0**
Upgrade Outside Property - St. Anthony, Bishop's Falls, Stephenville, WHB (2025-2026)	-	-	-	-	-	652.0	**652.0**
Construct Storage Building - Springdale (2025-2026)	-	-	-	-	-	135.0	**135.0**
Upgrade Outside Property - Deer Lake	-	-	-	-	-	129.0	**129.0**
Upgrade Outside Property - Happy Valley Gas Turbine	-	-	-	-	-	120.0	**120.0**
Total Properties	91.6	292.6	869.3	2,240.8	1,078.6	1,706.0	**6,278.9**
Metering							
Purchase Meters and Metering Equipment (2021)	-	233.4	-	-	-	-	**233.4**
Purchase Meters and Metering Equipment (2022)	-	-	194.8	-	-	-	**194.8**
Purchase Meters and Metering Equipment (2023)	-	-	-	193.9	-	-	**193.9**
Purchase Meters and Metering Equipment (2024)	-	-	-	-	195.0	-	**195.0**
Purchase Meters and Metering Equipment (2025)	-	-	-	-	-	196.8	**196.8**
Total Metering	-	233.4	194.8	193.9	195.0	196.8	**1,013.9**

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Project Description	Expended to 2020	2021	2022	2023	2024	2025	Total
Tools and Equipment							
Replace Light Duty Mobile Equipment	-	549.6	-	-	-	-	**549.6**
Replace Snow Groomer (V7601)	-	331.3	-	-	-	-	**331.3**
Purchase Tools and Equipment Less than $ 50,000 - Labrador Region (2021)	-	212.8	-	-	-	-	**212.8**
Purchase Backhoe - Wabush	-	179.3	-	-	-	-	**179.3**
Purchase Tools and Equipment Less than $ 50,000 - Central Region (2021)	-	150.2	-	-	-	-	**150.2**
Purchase Tools and Equipment Less than $ 50,000 - Northern Region (2021)	-	77.6	-	-	-	-	**77.6**
Purchase Tools and Equipment Less than $ 50,000 - Terminals & Transmission (2021)	-	44.6	-	-	-	-	**44.6**
Purchase 85' Material Handler Aerial Device on Track Unit	-	-	386.0	435.1	-	-	**821.1**
Replace Light Duty Mobile Equipment - Various (2022)	-	-	625.0	-	-	-	**625.0**
Replace Off Road Track Vehicle Unit No. 7698 - Stephenville	-	-	10.0	460.0	-	-	**470.0**
Purchase Tools and Equipment Less than $ 50,000 - Labrador Region (2022)	-	-	202.4	-	-	-	**202.4**
Replace Off Road Track Vehicle Unit No. 7799 - Springdale	-	-	200.0	-	-	-	**200.0**
Replace Back Hoe Unit No. 9813 - HRD	-	-	188.0	-	-	-	**188.0**
Purchase Tools and Equipment Less than $ 50,000 - Central Region (2022)	-	-	144.5	-	-	-	**144.5**
Purchase Tools and Equipment Less than $ 50,000 - Northern Region (2022)	-	-	79.4	-	-	-	**79.4**
Purchase Tools and Equipment Less than $ 50,000 - Terminals & Transmission (2022)	-	-	45.8	-	-	-	**45.8**
Replace Light Duty Mobile Equipment - Various (2023)	-	-	-	630.0	-	-	**630.0**
Replace Off-Road Track Vehicles No. V9829	-	-	-	300.0	-	-	**300.0**
Replace Front End Loader for Bay d'Espoir V9832	-	-	-	253.0	-	-	**253.0**
Purchase Tools and Equipment Less than $ 50,000 - Central Region (2023)	-	-	-	147.8	-	-	**147.8**
Purchase Tools and Equipment Less than $ 50,000 - Northern Region (2023)	-	-	-	81.1	-	-	**81.1**
Purchase Tools and Equipment Less than $ 50,000 - Labrador Region (2023)	-	-	-	56.4	-	-	**56.4**
Purchase Tools and Equipment Less than $ 50,000 - Terminals & Transmission (2023)	-	-	-	46.8	-	-	**46.8**
Replace Off Road Track Vehicle Unit No. 7974 - Stephenville	-	-	-	-	10.0	750.0	**760.0**
Replace Light Duty Mobile Equipment - Various (2024)	-	-	-	-	635.0	-	**635.0**
Purchase Tools and Equipment Less than $ 50,000 - Central Region (2024)	-	-	-	-	116.3	-	**116.3**
Purchase Tools and Equipment Less than $ 50,000 - Northern Region (2024)	-	-	-	-	82.8	-	**82.8**
Purchase Tools and Equipment Less than $ 50,000 - Labrador Region (2024)	-	-	-	-	57.6	-	**57.6**
Purchase Tools and Equipment Less than $ 50,000 - Terminals & Transmission (2024)	-	-	-	-	47.9	-	**47.9**
Replace Heavy Duty Equipment	-	-	-	-	-	1,100.0	**1,100.0**
Replace Light Duty Mobile Equipment - Various (2025)	-	-	-	-	-	500.0	**500.0**
Purchase Tools and Equipment Less than $ 50,000 - Central Region (2025)	-	-	-	-	-	151.7	**151.7**
Purchase Tools and Equipment Less than $ 50,000 - Northern Region (2025)	-	-	-	-	-	84.8	**84.8**
Purchase Tools and Equipment Less than $ 50,000 - Labrador Region (2025)	-	-	-	-	-	59.0	**59.0**
Purchase Tools and Equipment Less than $ 50,000 - Terminals & Transmission (2025)	-	-	-	-	-	48.8	**48.8**
Total Tools and Equipment	**-**	**1,545.4**	**1,881.1**	**2,410.2**	**949.6**	**2,694.3**	**9,480.6**
Total Transmission and Rural Operations	**4,265.6**	**53,421.2**	**73,568.4**	**102,457.6**	**78,901.5**	**67,459.7**	**380,073.9**

Newfoundland and Labrador Hydro
2021 Capital Budget
Five-Year Capital Plan
($000)

Project Description	Expended to 2020	2021	2022	2023	2024	2025	Total
Information Systems							
Software Applications							
Perform Hydro Software Upgrades & Minor Enhancements - Hydro Place (2021)	-	372.1	-	-	-	-	**372.1**
Refresh Cyber Security Infrastructure (2021)	-	217.5	-	-	-	-	**217.5**
Hydro Operational Data Store for EMS (2022)	-	-	181.0	-	-	-	**181.0**
Upgrade Energy Management System - Hydro Place (2022)	-	-	391.0	-	-	-	**391.0**
Perform Software Upgrades and Minor Enhancements - Hydro Place (2022)	-	-	630.0	-	-	-	**630.0**
Refresh Security Software - Hydro Place (2022)	-	-	60.0	-	-	-	**60.0**
Upgrade Energy Management System - Hydro Place (2023)	-	-	-	400.0	-	-	**400.0**
Perform Software Upgrades and Minor Enhancements - Hydro Place (2023)	-	-	-	350.0	-	-	**350.0**
Refresh Security Software - Hydro Place (2023)	-	-	-	60.0	-	-	**60.0**
Upgrade Energy Management System - Hydro Place (2024)	-	-	-	-	410.0	-	**410.0**
Perform Software Upgrades and Minor Enhancements - Hydro Place (2024)	-	-	-	-	360.0	-	**360.0**
Refresh Security Software - Hydro Place (2024)	-	-	-	-	60.0	-	**60.0**
Upgrade Energy Management System - Hydro Place (2025)	-	-	-	-	-	400.0	**400.0**
Perform Software Upgrades and Minor Enhancements - Hydro Place (2025)	-	-	-	-	-	375.0	**375.0**
Refresh Security Software - Hydro Place (2025)	-	-	-	-	-	150.0	**150.0**
Total Software Applications	**-**	**589.6**	**1,262.0**	**810.0**	**830.0**	**925.0**	**4,416.6**

Newfoundland and Labrador Hydro
2021 Capital Budget
Five-Year Capital Plan
($000)

Project Description	Expended to 2020	2021	2022	2023	2024	2025	Total
Computer Operations							
Replace Hydro Personal Computers (2021)	-	905.4	-	-	-	-	**905.4**
Upgrade Core IT/OT Infrastructure (2021)	-	262.8	-	-	-	-	**262.8**
Replace Peripheral Equipment (2021)	-	256.4	-	-	-	-	**256.4**
Upgrade Hydro Energy Control Centre Wall Infrastructure	-	188.5	-	-	-	-	**188.5**
Replace Hydro Personal Computers (2022)	-	-	380.0	-	-	-	**380.0**
Replace Peripheral Equipment (2022)	-	-	215.0	-	-	-	**215.0**
Upgrade Core IT/OT Infrastructure (2022)	-	-	125.0	-	-	-	**125.0**
Replace Hydro Personal Computers (2023)	-	-	-	490.0	-	-	**490.0**
Replace Peripheral Equipment (2023)	-	-	-	260.0	-	-	**260.0**
Upgrade Core IT/OT Infrastructure (2023)	-	-	-	125.0	-	-	**125.0**
Replace Hydro Personal Computers (2024)	-	-	-	-	500.0	-	**500.0**
Replace Peripheral Equipment (2024)	-	-	-	-	275.0	-	**275.0**
Upgrade Core IT/OT Infrastructure (2024)	-	-	-	-	125.0	-	**125.0**
Replace Hydro Personal Computers (2025)	-	-	-	-	-	750.0	**750.0**
Replace Peripheral Equipment (2025)	-	-	-	-	-	225.0	**225.0**
Upgrade Core IT/OT Infrastructure (2025)	-	-	-	-	-	200.0	**200.0**
Total Computer Operations	**-**	**1,613.1**	**720.0**	**875.0**	**900.0**	**1,175.0**	**5,283.1**
Total Information Systems	**-**	**2,202.7**	**1,982.0**	**1,685.0**	**1,730.0**	**2,100.0**	**9,699.7**

Newfoundland and Labrador Hydro
2021 Capital Budget
Five-Year Capital Plan
($000)

Project Description	Expended to 2020	2021	2022	2023	2024	2025	Total
Telecontrols							
Network Services							
Replace Battery Banks and Chargers	-	327.2	-	-	-	-	**327.2**
Replace Radomes (2021) - Various	-	240.4	-	-	-	-	**240.4**
Replace Network Communications Equipment	-	194.0	-	-	-	-	**194.0**
Upgrade Remote Terminal Units	-	183.4	-	-	-	-	**183.4**
Upgrade Site Facilities - Various (2021)	-	48.9	-	-	-	-	**48.9**
Purchase Tools and Equipment Less than $ 50,000 - Network Services (2021)	-	40.0	-	-	-	-	**40.0**
Replace VHF Mobile Radio System - Various	-	-	2,000.0	-	-	-	**2,000.0**
Replace Battery Banks and Chargers - Various (2022)	-	-	496.8	-	-	-	**496.8**
Replace Back-up Generator - Microwave Sites (BGH)	-	-	200.0	200.0	-	-	**400.0**
Upgrade Telecontrol Facilities - GDH	-	-	91.0	295.0	-	-	**386.0**
Replace Network Communications Equipment (2022)	-	-	180.0	-	-	-	**180.0**
Replace Radomes (2022) - Various	-	-	180.0	-	-	-	**180.0**
Replace RTUs (2022) - Various	-	-	100.0	-	-	-	**100.0**
Purchase Tools and Equipment Less than $ 50,000 - Network Services (2022)	-	-	48.6	-	-	-	**48.6**
Upgrade Site Facilities (2022) - Various	-	-	48.0	-	-	-	**48.0**
Replace Power Line Carrier (2023-2024)	-	-	-	90.0	950.0	-	**1,040.0**
Replace Battery Banks and Chargers - Various (2023)	-	-	-	508.3	-	-	**508.3**
Replace Back-up Generator - Microwave Sites (BDH)	-	-	-	200.0	-	-	**200.0**
Replace Network Communications Equipment (2023)	-	-	-	180.0	-	-	**180.0**
Replace Radomes - Various (2023)	-	-	-	180.0	-	-	**180.0**
Replace Network Management Tools - Various	-	-	-	140.0	-	-	**140.0**
Replace RTUs - Various (2023)	-	-	-	100.0	-	-	**100.0**
Purchase Tools and Equipment Less than $ 50,000 - Network Services (2023)	-	-	-	49.7	-	-	**49.7**
Upgrade Site Facilities - Various (2023)	-	-	-	48.0	-	-	**48.0**
Replace Battery Banks and Chargers - Various (2024)	-	-	-	-	520.0	-	**520.0**
Replace Network Communications Equipment (2024)	-	-	-	-	180.0	-	**180.0**
Replace Radomes - Various (2024)	-	-	-	-	180.0	-	**180.0**
Replace RTUs - Various (2024)	-	-	-	-	100.0	-	**100.0**
Purchase Tools and Equipment Less than $ 50,000 - Network Services (2024)	-	-	-	-	49.9	-	**49.9**
Upgrade Site Facilities - Various (2024)	-	-	-	-	48.0	-	**48.0**
Replace Backup Generators - Microwave Sites	-	-	-	-	-	300.0	**300.0**
Replace Battery Banks and Chargers - Various	-	-	-	-	-	199.0	**199.0**
Replace Network Communications Equipment (2025)	-	-	-	-	-	180.0	**180.0**
Replace Radomes - Various (2025)	-	-	-	-	-	180.0	**180.0**
Replace Wifi Network Controller	-	-	-	-	-	150.0	**150.0**
Purchase Tools and Equipment - Various	-	-	-	-	-	50.0	**50.0**
Purchase Tools and Equipment Less than $ 50,000 - Network Services (2025)	-	-	-	-	-	49.9	**49.9**
Upgrade Site Facilities	-	-	-	-	-	48.0	**48.0**
Total Telecontrol	**-**	**1,033.9**	**3,344.4**	**1,991.0**	**2,027.9**	**1,156.9**	**9,554.1**

Newfoundland and Labrador Hydro
2021 Capital Budget
Five-Year Capital Plan
($000)

Project Description	Expended to 2020	2021	2022	2023	2024	2025	Total
Transportation							
Replace Light- and Heavy-Duty Vehicles (2020-2021)	1,625.5	1,583.5	-	-	-	-	**3,209.0**
Replace Light- and Heavy-Duty Vehicles (2021-2022)	-	1,320.9	1,335.1	-	-	-	**2,656.0**
Level 2 Chargers for Electric Vehicles	-	299.8	-	-	-	-	**299.8**
Replace Light- and Heavy-Duty Vehicles (2022-2023)	-	-	1,325.0	741.9	-	-	**2,066.9**
Replace Light- and Heavy-Duty Vehicles (2023-2024)	-	-	-	1,350.0	760.5	-	**2,110.5**
Replace Light- and Heavy-Duty Vehicles (2024-2025)	-	-	-	-	1,355.0	850.0	**2,205.0**
Replace Light- and Heavy-Duty Vehicles (2025-2026)	-	-	-	-	-	2,550.0	**2,550.0**
Total Transportation	**1,625.5**	**3,204.2**	**2,660.1**	**2,091.9**	**2,115.5**	**3,400.0**	15,097.2
Administration							
Replace Elevator Motors and Controls Equipment - Hydro Place	89.1	647.6	-	-	-	-	**736.7**
Replace Transfer Switches and Associated Hardware - Hydro Place	-	197.3	938.5	-	-	-	**1,135.8**
Remove Safety Hazards - Various (2021)	-	199.1	-	-	-	-	**199.1**
Purchase Office Equipment Less Than $50,000 (2021)	-	62.3	-	-	-	-	**62.3**
Refurbish Office Buildings - Various (2022-2023)	-	-	500.0	500.0	-	-	**1,000.0**
Remove Safety Hazards - Various (2022)	-	-	220.0	-	-	-	**220.0**
Purchase Office Equipment Less Than $50,000 (2022)	-	-	63.6	-	-	-	**63.6**
Refurbish Office Buildings - Various (2023-2024)	-	-	-	500.0	500.0	-	**1,000.0**
Remove Safety Hazards - Various (2023)	-	-	-	220.0	-	-	**220.0**
Purchase Office Equipment Less Than $50,000 (2023)	-	-	-	64.8	-	-	**64.8**
Refurbish Office Buildings - Various (2024-2025)	-	-	-	-	500.0	500.0	**1,000.0**
Remove Safety Hazards - Various (2024)	-	-	-	-	220.0	-	**220.0**
Purchase Office Equipment Less Than $50,000 (2024)	-	-	-	-	66.2	-	**66.2**
Upgrade Fire Suppression System	-	-	-	-	-	500.0	**500.0**
Refurbish Office Buildings - Various (2025-2026)	-	-	-	-	-	500.0	**500.0**
Remove Safety Hazards - Various (2025)	-	-	-	-	-	220.0	**220.0**
Upgrade Septic System	-	-	-	-	-	100.0	**100.0**
Replace Circ Pumps Motors and Loop Valves level 1 Mechanical Room	-	-	-	-	-	75.0	**75.0**
Purchase Office Equipment Less Than $50,000 (2025)	-	-	-	-	-	67.3	**67.3**
Total Administration	89.1	1,106.3	1,722.1	1,284.8	1,286.2	1,962.3	7,450.8
Total General Properties	**1,714.6**	**7,547.1**	**9,708.6**	**7,052.7**	**7,159.6**	**8,619.2**	**41,801.8**
Total (Including Allowance for Unforeseen Items)	**14,690.3**	**112,691.4**	**112,424.2**	**144,729.4**	**135,933.2**	**118,794.5**	**639,263.0**

2021 Capital Budget Application

Holyrood Thermal Generating Station Overview
Future Operation and Capital Expenditure Requirements

newfoundland labrador
hydro
a nalcor energy company

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1.0 Background

In Board Order Nos P.U. 5(2012) and P.U. 4(2013), the Board of Commissioners of Public Utilities (“Board”) directed Newfoundland and Labrador Hydro (“Hydro”) to file, in conjunction with its 2014 Capital Budget Application, an overview in relation to the proposed capital expenditures for the Holyrood Thermal Generating Station (“Holyrood TGS”). The Board required the overview to include the following:[1]

- An updated outlook regarding anticipated changes in the role of the Holyrood TGS on the system;
- An updated schedule of anticipated changes in the Holyrood TGS operations that may reasonably be expected to have an impact on capital expenditure requirements;
- A summary description of all proposed Holyrood TGS capital projects, including an explanation of how such projects relate to one another and whether such projects may be impacted by decisions yet to be taken regarding the Holyrood TGS's role on the system;
- A summary guide to all internal and external reports filed in support of the capital expenditure proposals, summarizing alternatives considered and recommendations made; and
- An explanation of the necessity of all proposed capital expenditures in the context of the anticipated changes in the Holyrood TGS operations.

In Board Order No. P.U. 42(2013), the Board further required Hydro to update and file the Holyrood TGS Overview report with future capital budgets. This report contains the update to the future operation and capital expenditure requirements for the Holyrood TGS.

2.0 Introduction

The Holyrood TGS is a critical part of the Island Interconnected System. With three oil-fired generating units providing an installed capacity of 490 MW, the plant represents approximately one third of Hydro’s Island Interconnected System generating capacity and approximately one quarter of the total Island Interconnected System capacity, when included with all other customer-owned generation. Units 1 and

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[1] Board Order No. P.U. 5(2012), at p. 14.

2 were commissioned in 1970 and 1971, respectively, and Unit 3 in 1979. Units 1 and 2 were originally designed to produce 150 MW each and were upgraded to 170 MW in 1988 and 1989, respectively. Unit 3 retains its original configuration and is rated at 150 MW. In 1986, Unit 3 was retrofitted with synchronous condensing capability to provide voltage support on the eastern area of the Island Interconnected System during periods when power generation from this unit is not required.

Figure 1: Holyrood Thermal Generating Station

The three major components of the thermal generating process are the boiler, the turbine, and the generator, with supporting systems such as fuel storage and delivery, controls, and cooling and feed water supply systems. Through combustion of No. 6 heavy fuel oil, the power boiler provides high energy steam to the turbine. The turbine is directly coupled to the generator and provides the rotating energy necessary for the generator to produce rated output power to the Island Interconnected System. The generator itself is pressurized and cooled by hydrogen gas to provide maximum efficiency both in heat transfer and reduced windage losses.[2]

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[2] Windage losses refer to the losses sustained by a machine due to the resistance offered by air to the rotation of the shaft. Windage losses occur in electric rotating machines such as motors and generators.

The Holyrood TGS is necessary to reliably meet both winter peak demand and annual energy requirements. The Holyrood TGS supplies the balance of customer load that cannot currently be met by Hydro's hydroelectric generating facilities, purchases from non-utility generators, and customer-owned generation. Annual production at the Holyrood TGS will vary depending on hydroelectric reservoir storage and inflows. In the existing system configuration, the Holyrood TGS units also provide voltage support to the major load centre on the Avalon Peninsula.

Figure 2 provides the planned level of expenditure for the Holyrood TGS over the five-year capital plan period (2021–2025). Planned expenditures for the 2021–2025 capital plan period total $43.2 million.[3] The projects included in the plan beyond 2021 are required for post-steam operation.

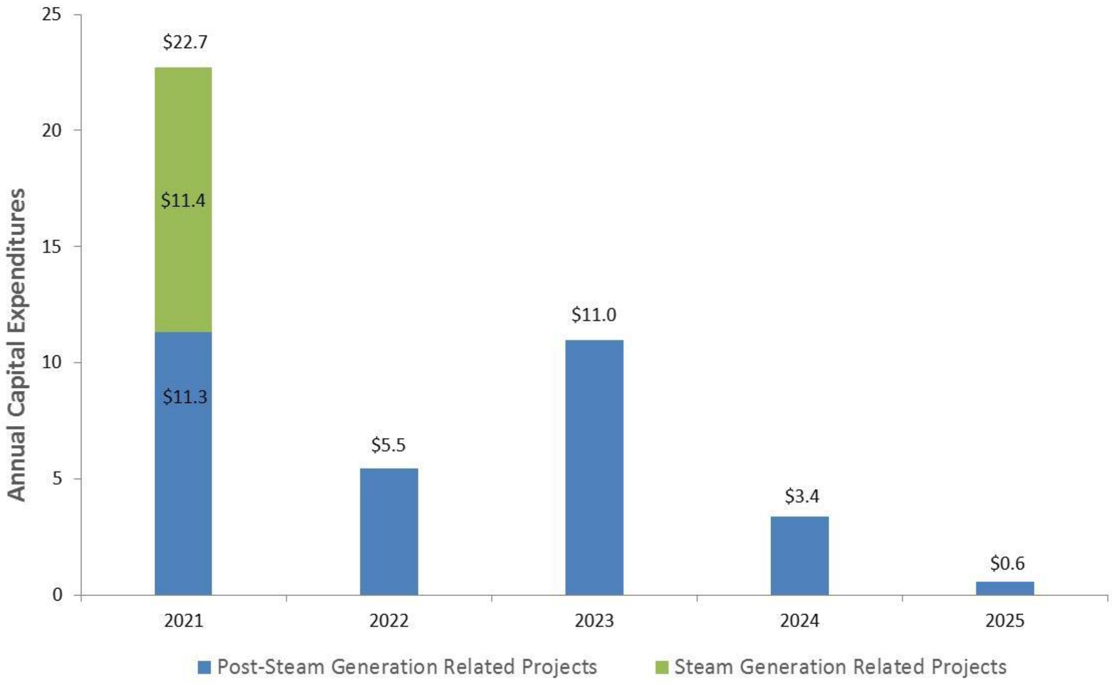

Figure 2: Holyrood TGS Capital Expenditures 2021 to 2025 ($ millions)[4]

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[3] The higher than average expenditures associated with the post-steam generation related projects in 2021 and 2023 are primarily a reflection of year two expenditures of the Rewind Unit 3 stator project approved in 2020 and year two expenditures of an electrical distribution equipment project anticipated to be proposed in 2022, respectively.

[4] Included in the 2021 post-steam generation related projects category is $2.0 million for thermal in-service failures. Depending on the failure type, it could result in a portion of the $2.0 million being attributed to steam generation related projects.

3.0 Current Operational Outlook and Schedule

Hydro has made a commitment to have the Holyrood TGS fully available for generation until March 31, 2022.[5] This commitment was made to ensure reliable service for customers while the Muskrat Falls assets are brought online and proven reliable. Hydro is closely monitoring the progress and performance of the Muskrat Falls assets in-service schedule to assess whether the date for post-steam operation at the Holyrood TGS should be further adjusted and has committed to provide further commentary on this matter to the Board in the fall of 2020.[6]

Throughout 2019 and year-to-date 2020, Holyrood TGS has operated at a higher level of thermal production than was originally contemplated in the 2020 Capital Budget Application due to delays with the in-service of the Labrador-Island Link ("LIL"). This higher level of production, as compared to that originally anticipated, is expected to continue for the remainder of 2020. Where it is technically and economically feasible, Hydro will continue to use lower cost alternatives, such as Maritime Link imports and LIL imports, if available, to offset thermal generation from the Holyrood TGS.

Upon the successful integration and demonstrated reliability of the Muskrat Falls assets, Hydro plans to decommission Units 1 and 2 and the steam components of Unit 3. Unit 3 will continue to operate in synchronous condenser mode only, with no generation capability.[7] Through the *Reliability and Resource Adequacy Study Review*, currently before the Board, Hydro is conducting an assessment of options to modify Holyrood TGS to become a suitable backup facility, and thus be considered a long-term resource. Specifically, this assessment will examine the advantages, disadvantages, and associated costs of potential technology modifications. The results of this assessment are scheduled to be filed with the Board by September 30, 2020.

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[5] "Extension of Holyrood Thermal Generation Station as a Generating Facility," Newfoundland and Labrador Hydro, February 14, 2020.

[6] "Reliability and Resource Adequacy Study Review – Near-Term Reliability Considering the Muskrat Falls Delay," Newfoundland and Labrador Hydro, June 3, 2020.

[7] The systems to be decommissioned once generation is no longer required include the fuel storage and delivery system (including the tank farm and day tank); the boilers, including air systems and emission monitoring systems; the feedwater and condensate systems, including the deaerator systems; and the marine terminal. The systems required for synchronous condenser operation post-steam include Unit 3 synchronous condenser specific equipment, including the unit generator and exciter; and auxiliary systems including electrical, controls, cooling water, fire protection, etc.

4.0 Maintenance Strategy through to Decommissioning

Scheduled overhauls of plant equipment will continue to ensure the assets are fully available for generation and safe for staff to operate. Hydro is diligent in its considerations to upgrade or replace equipment that is at or near the end of its useful service life and/or obsolete to ensure an appropriate balance between reliable service and least-cost provision of service is achieved.

Hydro has committed to maintaining the Holyrood TGS as fully available for generation until March 31, 2022. As such, significant changes to Hydro's maintenance strategy are not planned at this time; however, should additional significant costs be identified, and as is normal practise, diligent consideration will be given to the expenditures prior to application to the Board. Changes in equipment maintenance intervals may be considered depending on annual operating hours; extension beyond more typical time frames may be achieved in some instances, allowing Hydro to reduce cost while maintaining reliability.

During post-steam operations, assets with operational synchronous condenser requirements will continue to be optimally maintained.

5.0 Holyrood 2021 Capital Plan Summary

In light of the material change in production requirements in 2019 and 2020, as well as the extension for readiness to operate to March 31, 2022, additional capital work is ongoing and proposed for 2021.

The 2021 capital project proposals (Table 1, Table 2, and Table 3) were prepared considering asset condition, equipment obsolescence (both end-of-life and availability of support), forecast production requirements, and Hydro's commitment to have the Holyrood TGS fully available to March 31, 2022. The projects outlined within reflect the necessary rehabilitation and replacement projects to ensure customer needs can be met. In the event of unforeseen failure or unexpected as-found condition, adjustments or additions may be required beyond the current plan.

Table 1 provides a summary description of the proposed 2021 capital projects for the Holyrood TGS that are required to ensure the Holyrood TGS is fully available for generation until March 31, 2022. Hydro has included three projects in the 2021 CBA related to steam production at the Holyrood TGS. These projects are: (i) Boiler Condition Assessment and Miscellaneous Upgrades ($3,000,000); (ii) Overhaul

Unit 3 Boiler Feed Pump East ($373,000); and (iii) Overhaul Unit 1 Turbine and Valves ($8,026,600). In addition, a portion of the $2.0 million included in the 2021 CBA for Thermal In-Service Failures may end up being attributed to steam production. Continued safe, reliable operation, typical of past years, requires the proposed work be completed to ensure the Holyrood TGS is fully available until March 31, 2022.

The timing of the in-service of the Muskrat Falls assets and the execution of the proposed steam generation related 2021 capital projects presents a unique circumstance. Top of mind is the importance of balancing cost and reliability. Should the successful integration and demonstrated reliability of the Muskrat Falls assets occur prior to March 31, 2022[8] and/or Hydro obtain clear evidence with respect to the in-service date of the Muskrat Falls assets prior to the execution of the proposed 2021 capital projects, careful consideration will be given to the necessity of executing the full scope of steam generation related capital projects.[9] Where there is opportunity to mitigate some portion of capital costs, Hydro will ensure prudency in its capital expenditures and notify the Board of such change, as appropriate.

Hydro is managing several deteriorating pieces of infrastructure, notably the waste water basin building and fuel oil storage tanks, with the intention of reaching end-of-generation life with minimal refurbishment costs. For the waste water basin building, which will be required to continue processing waste post-steam production, a cost effective long-term solution is proposed in this application to replace the deteriorated and unsafe building structure and facilities with floating insulated covers. To continue to minimize the investment in assets that are not planned for long-term operation, Hydro has been working with Government to extend the operating life of the fuel oil storage tanks and has been successful in extending two of the four tanks to beyond the end of steam date of March 31, 2022. Additional information on the third tank is being prepared for submission to Government and it is expected to also be approved for extension beyond 2022. The fourth tank requires removal from service or refurbishment by the end of 2021. It will be removed from service at that time, with three tanks supporting future operation. Hydro has assessed its operation of the facility with three tanks for the limited period post year end 2021 and has no concerns with operation on three tanks for that short

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[8] Planned retirement date for Units 1 and 2 and steam generation components of Unit 3 at Holyrood TGS.

[9] Where work may have already commenced on the proposed 2021 capital projects, Hydro will consider options for reducing the remaining portion(s) of the project scope and, thus, capital costs as appropriate and technically feasible.

period of time. Minor interventions will continue as a means to mitigate safety and asset integrity risk until approval and execution of the capital projects. Should additional measures be required, Hydro will seek capital refurbishment at that time.

The Unit 3 generator overhaul and upgrade of DCS Controllers and Hardware will replace and upgrade important assets that are required for post-steam operation. This work will ensure long-term reliable operation of these assets during synchronous condenser operation.

Table 1: Holyrood TGS Projects Included in the 2021 Capital Plan

Project	Scope Summary	Proposal Location
Overhaul Unit 3 Generator	This project proposes to overhaul the Unit 3 generator in parallel with the rewind of the stator, which is a previously approved two year project with rewind to be completed in 2021. This will save several hundred thousand dollars due to overlap scope. The overhaul is required to ensure continued reliable operation of the generator in both generation and synchronous condenser operation. Scope will include rotor inspection and electrical testing, inspection and refurbishment of bearings, oil seals, hydrogen seals and hydrogen coolers.	>$500,000 Projects Report in Volume II, Tab 7
Thermal In-Service Failures	The purpose of this program is to allow completion of capital work due to failure of equipment, or the recognition of an incipient failure that cannot wait for the next capital submission cycle. Previously, capital work of this nature required a supplemental submission for approval. This project also includes the purchase of critical capital spares to reduce downtime and increase availability should a failure of a key component occur.	>$500,000 Projects Summary in Volume I, Tab C
Upgrade Distributed Control System Hardware	The existing distributed control system ("DCS") components at Holyrood TGS were installed in the early 2000's and are becoming obsolete. This project proposes the replacement of obsolete DCS hardware that is required to operate the Holyrood TGS as a synchronous condenser facility, including Unit 3 generator, station service, and waste water treatment plant. Replacement of DCS hardware that is required only for steam generation is not included.	>$200,000 and <$500,000 Projects Summary in Volume I, Tab D; Report in Volume II, Tab 8
Upgrade Waste Water Equalization System	This project proposes to replace the severely deteriorated waste water basin building, which is a	>$500,000 Projects Summary in

Project	Scope Summary	Proposal Location
	health and safety concern for Holyrood TGS employees. A cost effective solution has been developed, which will replace the building and infrastructure with floating insulated covers. The basins are required for many years beyond the end of steam generation to process waste from the Holyrood TGS site.	Volume I, Tab C; Report in Volume II, Tab 5
Inspect Chemical Tanks	This project proposes to perform a detailed internal inspection of the acid and caustic tanks in the water treatment plant and waste water treatment plant. The previous assessment in the acid tanks, which was performed in 2010, revealed corrosion damage that required repair. Re-inspection is required to ensure continued safe and reliable operation. Due to their hazardous contents, the tanks require extensive cleaning and passivation before they can be entered safely to complete the inspection. Preparation of the tanks for inspection is a significant activity within this project.	>$500,000 Projects Summary in Volume I, Tab C; Report in Volume II, Tab 6
Overhaul Unit 3 Boiler Feed Pump East	This project proposes to complete an overhaul of the Unit 3 boiler feed pump east. Regular overhauls of boiler feed pumps are required to ensure continued reliable operation	>$200,000 and <$500,000 Projects Summary in Volume I, Tab D
Overhaul Unit 1 Turbine and Valves	This project proposes to complete the regular overhaul of the Unit 1 turbine and turbine valves. Regular overhauls are required to ensure continued safe and reliable operation. The turbine overhaul will include removal of the turbine rotor and stationary blade sections for cleaning and detailed NDE inspection, detailed inspection and refurbishment of the bearings, detailed inspection and refurbishment of high temperature and pressure shells and fasteners, and refurbishment of critical auxiliaries such as the lube oil system. The valve overhaul will include disassembly, detailed measurement and inspection, replacement of components, reassembly and commissioning of the major valves including the stop valve, combined reheat valves, control valves, blowdown valve and non-return valves. Overhaul of the valves and turbine is required for safe control and operation of the steam turbine.	>$500,000 Projects Summary in Volume I, Tab C; Report in Volume II, Tab 1
Boiler Condition Assessment and Miscellaneous Upgrades	The project proposes to complete identified level 2 condition assessments and detailed inspections of high pressure boiler components and high energy piping	>$500,000 Projects Summary in Volume I, Tab C;

Project	Scope Summary	Proposal Location
	components. This work is essential to ensure safe and reliable operation of the boilers. The work that will take place is partially driven by the results of previous condition assessment projects including the 2020 project. Replacements and refurbishments identified through completion of the boiler work, such as the replacement of expansion joints, will be included in the scope.	Report in Volume II, Tab 4.

Table 2 provides a summary of the internal and external reports filed in support of the capital expenditure proposals summarizing the alternatives considered and recommendations made.

Table 2: Reports Filed in Support of the 2021 Project Proposals

Project	Reports filed	Alternatives Considered	Recommendation
Overhaul Unit 3 Generator	-	There are no alternatives	Complete the overhaul
Thermal In-Service Failures	-	There are no alternatives	Complete refurbishments/ replacements as required
Upgrade Distributed Control System Hardware	Schneider Electric Obsolescence Road Map	There are no alternatives	Complete the upgrade
Upgrade Waste Water Equalization System	-	Replace with new building and infrastructure and eliminate building with floating insulated covers	Eliminate building with floating insulated covers
Inspect Chemical Tanks	-	There are no alternatives	Complete the upgrades
Overhaul Unit 3 Boiler Feed Pump East	-	There are no alternatives	Complete the overhaul
Overhaul Unit 1 Turbine and Valves	-	There are no alternatives	Complete the overhaul
Boiler Condition Assessment and Miscellaneous Upgrades	-	There are no alternatives	Complete the overhaul

Table 3 provides an explanation of the necessity of all proposed capital expenditures in the context of steam generation and post-steam generation.

Table 3: 2021 Project Necessity in the Context of Steam and Post-Steam Generation

Major System or Subsystem	Project	Steam Generation	Post-Steam Generation
Fuel Storage and Delivery	No projects included	-	-
Feedwater and Condensate	Inspect Chemical Tanks	Required	Partially Required
	Overhaul Unit 3 Boiler Feed Pump East	Required	-
Boiler	Boiler Condition Assessment and Miscellaneous Upgrades	Required	-
Turbine Generator	Overhaul Unit 3 Generator	Required	Required
	Overhaul Unit 1 Turbine and Valves	Required	-
Cooling Water Systems	No projects included	-	-
Buildings and Grounds	Upgrade Waste Water Equalization	Required	Required
Common Systems	Upgrade DCS Hardware	Required	Required

6.0 Holyrood TGS 2021–2025 Capital Expenditures Outlook

Capital investment will be necessary throughout the period of 2021 to 2025 to ensure continued security of supply and maintenance of the level of service required in generation and synchronous condenser operations. Various types of investments and expenditures for the Holyrood TGS are anticipated, including refurbishment, upgrade or replacement of failed or obsolete equipment, and general plant infrastructure work.

Capital projects proposed are reviewed in light of the future plant requirements and considered essential to fulfill Hydro’s mandate to serve its customers and meet safety and environmental requirements.

The maintenance strategy for the Holyrood TGS to its end-of-life as a generating station is to extend the life of the existing assets at minimum cost through continued preventive maintenance, repair, and rehabilitation, where critical, to provide safe and reliable energy. In cases where repair and rehabilitation are not viable alternatives, and where the associated assets remain critical to operation, assets will be renewed in the least-cost manner. Non-critical assets will receive minimal attention and may be allowed to deteriorate where such action does not significantly increase risk to safe and reliable production. Assets with operational requirements beyond 2022 will continue to be optimally maintained with investment reflecting that continued operation requirement. Data will be collected from inspections, on-line monitoring, and formal condition assessments and used to determine the optimal work plan for the assets in light of the changing role of the Holyrood TGS.

Planned expenditures for the 2021–2025 capital plan period total $43.2 million. The projects included in the plan beyond 2021 are required for post-steam operation. Details regarding the planned capital expenditures are in the "2021–2025 Capital Plan Report," Appendix A, Thermal Plant, p. A-4.

6.1 Depreciation Impacts of Holyrood TGS Life Extension

The extension of the Holyrood TGS to March 31, 2022, in combination with additional capital required to ensure the asset is fully available for generation during that time frame, has created depreciation cost volatility. Hydro anticipates filing a proposal for a deferral account in 2020 to stabilize volatility in Holyrood TGS depreciation expense and provide opportunity for recovery of new capital investment, which is not reflected in current rates, that is associated with ensuring the Holyrood TGS is fully available for generation until its retirement. Should there be potential requirement to extend the Holyrood TGS beyond the March 31, 2022 retirement date, the timing of the application may be impacted.

Holyrood Project Operating and Maintenance Expenditures

2021 Capital Budget Application

Plan of Projected Holyrood Thermal Generating Station Operating Maintenance Expenditures 2021–2030

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2.0 Maintenance Philosophy 2
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Appendix A: Holyrood TGS Ten-Year SEM Expenditures

1.0 Introduction

In Order No. P. U. 14(2004), the Board of Commissioners of Public Utilities ("Board"), directed Newfoundland and Labrador Hydro ("Hydro") to **"**file a ten year plan of maintenance expenditures for the Holyrood Generating Station with its annual capital budget application ("CBA"), until otherwise directed by the Board."[1] As this requirement is specifically related to System Equipment Maintenance ("SEM") costs, capital expenditures have not been included in this report. Capital expenditures for the Holyrood Thermal Generating Station ("Holyrood TGS") are submitted annually to the Board with other Hydro capital proposals as part of the annual CBA and are discussed in the Holyrood Overview.

This report addresses the identified and expected maintenance expenditures for the years 2021–2030 inclusive. With respect to these expenditures, it should be noted that Units 1 and 2, as well as two of the main fuel storage tanks and other associated ancillary equipment, have been in service for 50 years and that Unit 3 and its associated equipment have been in service for 40 years. While many components of this equipment have been replaced and additional items added through the maintenance and capital program over the years, numerous pieces of equipment and components are original.

A ten-year plan of SEM is difficult to accurately complete. The harsh operating environment, evolving production requirements, Muskrat Falls asset in-service schedule, potential outcomes of the assessment of Holyrood TGS modification options for suitability as a backup facility, the shift to synchronous condensing operation, and the age of units may trigger revision of the maintenance plan to address unforeseen events. The plan currently reflects Hydro's commitment to have the Holyrood TGS fully available until March 31, 2022 and the continuation of synchronous condenser function for Unit 3 after that time. Even though expenses for major overhauls are included in capital, some variability in the annual budget will remain as a result of the complexity of numerous components and integrated systems that form a fossil fuel fired thermal electric generating system. This report endeavours to identify the regular variations in the annual operating costs for the Holyrood TGS.

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[1] Board Order No. P.U. 14(2004) at p.166.

2.0 Maintenance Philosophy

In Order No. P. U. 14(2004), the Board stated that "The Board will require NLH's ten-year plan of maintenance expenditures for the Holyrood Generating Station to be updated annually to reflect changing operating circumstances."[2]

Maintenance efforts aim to prevent functional failure and extend the operational life of assets, helping to minimize total asset life cycle cost. The type and amount of maintenance applied is dependent on the criticality of the asset and the impact of failure on service delivery. Hydro seeks to balance the cost of maintenance against the cost of failure and its impact on safe, reliable service when applying maintenance strategies and tactics. There are four main types or categories of maintenance undertaken at the Holyrood TGS: preventive maintenance; corrective maintenance; boiler overhauls; and operating projects.

2.1 Preventive Maintenance

Hydro continues to use up-to-date maintenance techniques and practices to maintain plant efficiency, availability, and reliability. These include preventive, predictive, and condition-based maintenance techniques, which are usually referred to by the overall term of "Preventive Maintenance." The basic principle underlying this approach to maintenance is timely intervention to prevent imminent or catastrophic failure that may cause a substantial safety exposure, an extended unavailability of the unit or system, or an increase in cost.

Preventive maintenance comprises routine inspections, minor checks, and component replacement at specific time intervals to prevent failures that are known, or reasonably expected, to occur within a definable time or operating hour interval during the life of the equipment (e.g., generator brush wear, air and oil filter replacements). This also includes discarding equipment or components when it is less costly than repairing or refurbishing them.

Predictive maintenance involves routine testing of equipment to determine deterioration rates and initiating and carrying out repairs in a timely manner before a failure occurs (e.g. ultrasonic thickness checks on fluid lines to monitor erosion wear rates and non-destructive testing of boiler and turbine components to determine fatigue, wear or corrosion rates, and remaining life). Predictive maintenance

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[2] Board Order No. P.U. 14(2004) at p. 64.

items include such things as boiler and auxiliary equipment annual overhauls, wherein an assessment is made of components or subsystems that are only accessible during these overhauls.

There is also regular or continual monitoring of equipment operating parameters with a comparison of the results with optimum conditions to determine the most economic time to intervene and perform remedial work that is intended to return the equipment to optimum performance levels (e.g., air heater washes, generator winding insulation condition, oil sampling and testing).

Since 2008, the Preventive Maintenance Program has been enhanced to include the extra costs associated with plant cleaning in areas where asbestos and heavy metals have been identified as potential health hazards.

2.2 Corrective Maintenance

In addition to the preventive maintenance techniques outlined, there are also corrective maintenance requirements. These include work performed to identify, isolate, and restore equipment, machines or systems to a level in which it can be operated safely and used for its intended purpose. The requirement of corrective maintenance may arise for various reasons including failure, wear and tear, and harsh environments such as humid or salt laden air. Examples of corrective maintenance include wear and tear on pumps, pipes, and valves in the main and auxiliary systems.

2.3 Boiler Overhauls

Boiler overhauls consist of the maintenance and refurbishment work required to ensure reliable boiler operation for the upcoming season. Boiler overhauls include packages of standard work, defined work, and as-found work. Standard work covers activities that are predictable and required on an annual basis due to normal operation, and wear and tear. Defined work represents planned, specific activities that do not normally occur on an annual basis and addresses issues identified from prior condition inspections and trending. As-found work covers unforeseen issues identified during an ongoing boiler overhaul. In some cases the nature of defined or as-found work meets the criteria for capitalization; in such cases it is not included in SEM.

2.4 Operating Projects

Operating projects are low cost repairs and annual inspections that are required to return structures and equipment to their original or near original operability, to maintain structural integrity, improve efficiency, improve availability, and prevent or reduce environmental risks. Such projects include emissions monitoring and testing, and periodic basin cleaning in the Waste Water Treatment Plant.

3.0 Cost Variability

Preventive maintenance costs are generally incurred annually at a constant level and do not fluctuate significantly. This principle does not apply to corrective maintenance costs, which are unavoidable and usually unpredictable due to the changing energy production demands on the units from year to year. Due to accounting methodology changes approved in Board Order No. P.U. 13(2012), major overhauls and inspections with a frequency of greater than one year are capitalized, reducing the fluctuation in maintenance expenditures that were experienced in prior periods. Projects for the Holyrood TGS are planned on a five-year basis, but as with any plan, it is not fixed or definitive, as other events can cause a shift in the prioritization of such projects. The five-year maintenance plan is updated on a regular basis to reflect any shifts in priority.

4.0 Ten-Year SEM Expenditures

Appendix A sets out the ten-year maintenance plan for the Holyrood TGS.[3] This ten-year plan spans the period during which the role of the Holyrood TGS will change as a result of the in-service of the Muskrat Falls assets and the interconnection between Labrador and the Island. These events significantly impact cost and activity levels at the Holyrood TGS. The projection of operating costs in this report reflects the extension of readiness to operate the Holyrood TGS as a generating facility to March 31, 2022 and the continued operation of Unit 3 as a synchronous condenser.

In the attached ten-year maintenance plan, a single escalation factor of 2.5% per year has been used for 2021–2030 based on an average rate from Hydro’s current corporate assumptions.

5.0 Summary

This plan is based on the SEM budgets developed for 2021 and 2022, which reflect retirements of Units 1 and 2 and the decommissioning of the steam components of Unit 3 as of March 31, 2022. Future years, beyond 2021 and 2022, are adjusted to reflect the plant’s role in the Newfoundland and Labrador

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[3] The ten-year plan format is simplified in comparison to prior years due to financial system reporting changes. Budgets are no longer separated by generating unit and preventive maintenance, corrective maintenance, and non-maintenance activities are no longer separated.

Interconnected System using the best available information, including up-to-date maintenance tactics and known restoration and inspection work, to establish a ten-year forecast of the maintenance projects for the Holyrood TGS. Actual operation will vary based on the operating requirements of the plant, the results of inspections, and assessments of changing equipment conditions.

Appendix A

Holyrood TGS Ten-Year SEM Expenditures

Table A-1: Holyrood TGS Ten-Year SEM Expenditures ($000)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Generating Units										
Materials (inc. Boiler Overhauls)	1,134	345	266	272	279	286	293	300	308	316
Lubes, Chems, Gases	12	12	9	9	10	10	10	10	11	11
Contract Labour (inc. Boiler Overhauls)	4,568	439	337	346	354	363	372	381	391	401
Total Generating Units	**5,713.40**	**796.00**	**611.93**	**627.22**	**642.90**	**658.98**	**675.45**	**692.34**	**709.65**	**727.39**
Common Equipment										
Materials	515	346	266	273	280	287	294	301	309	316
Tools and Operating Supplies	30	30	23	23	24	25	25	26	26	27
Lubes, Chems, Gases	22	22	17	17	18	18	18	19	19	20
Contract Labour (Service Contracts)	1,629	615	473	485	497	509	522	535	548	562
Total Common Equipment	**2,195.10**	**1,012.50**	**778.36**	**797.82**	**817.76**	**838.21**	**859.16**	**880.64**	**902.66**	**925.22**
Environmental										
Materials	167	104	107	109	112	115	118	121	124	127
Tools and Operating Supplies	13	13	14	14	14	15	15	15	16	16
Lubes, Chems, Gases	333	173	177	182	186	191	196	201	206	211
Contract Labour (Service Contracts)	119	19	20	20	171	21	22	22	193	23
Total Environmental	**632.6**	**309.3**	**317.0**	**325.0**	**483.1**	**341.4**	**349.9**	**358.7**	**537.7**	**376.9**
Grand Total	**8,541.10**	**2,117.80**	**1,707.32**	**1,750.00**	**1,943.75**	**1,838.59**	**1,884.56**	**1,931.67**	**2,149.96**	**2,029.46**

A. Capital Budget

2021 Capital Budget Application

Section A: 2021 Capital Budget

Newfoundland and Labrador Hydro
2021 Capital Budget Application
2021 Capital Budget Overview
($000)

	Expended to 2020	2021	Future Years	Total
		($000)		
Generation	8,710.1	50,723.1	20,655.2	**80,088.4**
Transmission and Rural Operations	4,265.6	53,421.2	101,301.1	**158,987.9**
General Properties	1,714.6	7,547.1	2,273.6	**11,535.3**
Allowance for Unforeseen	0.0	1,000.0	0.0	**1,000.0**
Total Capital Budget	**14,690.3**	**112,691.4**	**124,229.9**	**251,611.6**

Newfoundland and Labrador Hydro
2021 Capital Budget Application
2021 Capital Budget: Summary by Category
($000)

	Expended to 2020	2021	Future Years	Total
		($000)		
Generation				
Hydraulic Plant	6,580.2	21,306.2	16,888.6	**44,775.0**
Thermal Plant	1,281.4	22,730.1	915.9	**24,927.4**
Gas Turbines	848.5	6,428.1	2,850.7	**10,127.3**
Tools and Equipment	0.0	258.7	0.0	**258.7**
Total Generation	**8,710.1**	**50,723.1**	**20,655.2**	**80,088.4**
Transmission and Rural Operations				
Terminal Stations	3,712.0	24,236.7	40,263.3	**68,212.0**
Transmission	0.0	2,896.9	0.0	**2,896.9**
Distribution	174.0	12,414.6	805.6	**13,394.2**
Generation	288.0	11,801.6	60,232.2	**72,321.8**
Properties	91.6	292.6	0.0	**384.2**
Metering	0.0	233.4	0.0	**233.4**
Tools and Equipment	0.0	1,545.4	0.0	**1,545.4**
Total Transmission and Rural Operations	**4,265.6**	**53,421.2**	**101,301.1**	**158,987.9**
General Properties				
Information Systems	0.0	2,202.7	0.0	**2,202.7**
Telecontrol	0.0	1,033.9	0.0	**1,033.9**
Transportation	1,625.5	3,204.2	1,335.1	**6,164.8**
Administrative	89.1	1,106.3	938.5	**2,133.9**
Total General Properties	**1,714.6**	**7,547.1**	**2,273.6**	**11,535.3**
Allowance for Unforeseen Items	0.0	1,000.0	0.0	**1,000.0**
Total Capital Budget	**14,690.3**	**112,691.4**	**124,229.9**	**251,611.6**

Newfoundland and Labrador Hydro
2021 Capital Budget Application
2021 Capital Budget: Detailed Breakdown
($000)

Project Description	Expended to 2020	2021	Future Years	Total
	($000)			
Hydraulic Plant				
Hydraulic Generation Refurbishment and Modernization (2020-2021)	6,580.2	10,249.8	0.0	**16,830.0**
Hydraulic Generation Refurbishment and Modernization (2021-2022)	0.0	6,569.6	6,505.5	**13,075.1**
Refurbish Ebbegunbaeg Control Structure	0.0	3,236.8	10,383.1	**13,619.9**
Hydraulic Generation In-Service Failures (2021)	0.0	1,250.0	0.0	**1,250.0**
Total Hydraulic Plant	**6,580.2**	**21,306.2**	**16,888.6**	**44,775.0**
Thermal Plant				
Rewind Unit 3 Stator - Holyrood	1,281.4	5,664.2	0.0	**6,945.6**
Overhaul Unit 1 Turbine and Valves - Holyrood	0.0	8,026.6	0.0	**8,026.6**
Boiler Condition Assessment and Miscellaneous Upgrades - Holyrood	0.0	3,000.0	0.0	**3,000.0**
Thermal In-Service Failures (2021)	0.0	2,000.0	0.0	**2,000.0**
Upgrade Waste Water Equalization System - Holyrood	0.0	1,813.4	547.7	**2,361.1**
Inspect Chemical Tanks - Holyrood	0.0	919.8	0.0	**919.8**
Overhaul Unit 3 Generator - Holyrood	0.0	572.7	0.0	**572.7**
Overhaul Unit 3 Boiler Feed Pump East - Holyrood	0.0	373.0	0.0	**373.0**
Upgrade Distributed Control System Hardware - Holyrood	0.0	360.4	368.2	**728.6**
Total Thermal Plant	**1,281.4**	**22,730.1**	**915.9**	**24,927.4**

Newfoundland and Labrador Hydro
2021 Capital Budget Application
2021 Capital Budget: Detailed Breakdown
($000)

Project Description	Expended to 2020	2021	Future Years	Total
		($000)		
Gas Turbines				
Perform Combustor Inspection - Holyrood Gas Turbine	546.1	2,500.0	2,400.0	**5,446.1**
Replace Fire Suppression System - Happy Valley Gas Turbine	264.6	2,377.9	0.0	**2,642.5**
Install Partial Discharge Monitoring - Holyrood Gas Turbine	37.8	575.0	0.0	**612.8**
Construct Lube Oil Cooler Hood and Containment System - Holyrood Gas Turbin	0.0	318.8	0.0	**318.8**
Purchase Capital Spares - Gas Turbines (2021)	0.0	213.8	0.0	**213.8**
Replace Voltage Regulator - Happy Valley Gas Turbine	0.0	131.3	211.0	**342.3**
Replace Fuel Oil, Lube Oil, and Glycol Pumps - Happy Valley Gas Turbine	0.0	234.7	170.5	**405.2**
Upgrade Compressed Air System - Happy Valley Gas Turbine	0.0	76.6	69.2	**145.8**
Total Gas Turbines	**848.5**	**6,428.1**	**2,850.7**	**10,127.3**
Tools and Equipment				
Purchase Tools and Equipment Less than $50,000 (2021) - Hydraulic Plants	0.0	194.3	0.0	**194.3**
Purchase Tools and Equipment Less than $50,000 (2021) - Gas Turbine	0.0	45.6	0.0	**45.6**
Purchase Tools and Equipment Less than $50,000 (2021) - Thermal Plants	0.0	18.8	0.0	**18.8**
Total Tools and Equipment	**0.0**	**258.7**	**0.0**	**258.7**
Total Generation	**8,710.1**	**50,723.1**	**20,655.2**	**80,088.4**
Terminal Stations				
Terminal Station Refurbishment and Modernization (2020-2021)	3,712.0	5,684.9	0.0	**9,396.9**
Terminal Station Refurbishment and Modernization (2021-2022)	0.0	6,171.6	7,182.0	**13,353.6**
Upgrade Circuit Breakers - Various (2021-2022)	0.0	5,418.8	6,113.9	**11,532.7**
Wabush Terminal Station Upgrades	0.0	2,301.7	9,271.2	**11,572.9**
Terminal Station In-Service Failures (2021)	0.0	1,800.0	0.0	**1,800.0**
Upgrades for Future Retirement of Stephenville Gas Turbine	0.0	1,530.3	8,389.5	**9,919.8**
Additions for Load - Wabush Substation Upgrades	0.0	1,186.7	9,306.7	**10,493.4**
Purchase SF6 Gas Recovery Systems	0.0	142.7	0.0	**142.7**
Total Terminal Stations	**3,712.0**	**24,236.7**	**40,263.3**	**68,212.0**
Transmission				
Wood Pole Line Management Program (2021)	0.0	2,896.9	0.0	**2,896.9**
Total Transmission	**0.0**	**2,896.9**	**0.0**	**2,896.9**

Newfoundland and Labrador Hydro
2021 Capital Budget Application
2021 Capital Budget: Detailed Breakdown
($000)

Project Description	Expended to 2020	2021	Future Years	Total
		($000)		
Distribution				
Upgrade of Worst Performing Distribution Feeders (2020–2021)	102.7	3,155.1	0.0	**3,257.8**
Install Recloser Remote Control - Hampden and Upper Salmon (2020-2021)	71.3	185.3	0.0	**256.6**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetligh	0.0	1,985.4	0.0	**1,985.4**
Provide Service Extensions in Central Region (2021)	0.0	1,357.4	0.0	**1,357.4**
Provide Service Extensions in Labrador Region (2021)	0.0	1,218.6	0.0	**1,218.6**
Provide Service Extensions in Northern Region (2021)	0.0	1,164.5	0.0	**1,164.5**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetligh	0.0	1,033.5	0.0	**1,033.5**
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetligh	0.0	784.7	0.0	**784.7**
Additions for Load Growth - Happy Valley Line 7	0.0	617.6	0.0	**617.6**
Labrador City L22 Voltage Conversion	0.0	593.6	0.0	**593.6**
Upgrade of Worst Performing Distribution Feeders (2021-2022)	0.0	318.9	805.6	**1,124.5**
Total Distribution	**174.0**	**12,414.6**	**805.6**	**13,394.2**
Generation				
Diesel Plant Ventilation Upgrade - Nain	162.7	690.4	0.0	**853.1**
Replace Powerhouse Roofing System - L'Anse Au Loup and St. Anthony Diesel P	125.3	1,195.8	0.0	**1,321.1**
Diesel Plant Replacement - Charlottetown	0.0	5,194.7	58,445.0	**63,639.7**
Diesel Genset Replacements (2021-2022)	0.0	2,560.6	525.0	**3,085.6**
Overhaul Diesel Units - Various (2021)	0.0	1,232.9	0.0	**1,232.9**
Inspect Fuel Storage Tanks - Postville	0.0	532.6	0.0	**532.6**
Replace Fuel Storage Tank - Paradise River	0.0	350.3	0.0	**350.3**
Install Fire Protection in Diesel Plants - Port Hope Simpson (2021-2022)	0.0	44.3	1,262.2	**1,306.5**
Total Generation	**288.0**	**11,801.6**	**60,232.2**	**72,321.8**

Newfoundland and Labrador Hydro
2021 Capital Budget Application
2021 Capital Budget: Detailed Breakdown
($000)

Project Description	Expended to 2020	2021	Future Years	Total
		($000)		
Properties				
Upgrade Fire Suppression System - Bishop's Falls	91.6	292.6	0.0	**384.2**
Total Properties	**91.6**	**292.6**	**0.0**	**384.2**
Metering				
Purchase Meters and Metering Equipment (2021)	0.0	233.4	0.0	**233.4**
Total Metering	**0.0**	**233.4**	**0.0**	**233.4**
Tools and Equipment				
Replace Light Duty Mobile Equipment	0.0	549.6	0.0	**549.6**
Replace Snow Groomer (V7601)	0.0	331.3	0.0	**331.3**
Purchase Tools and Equipment Less than $ 50,000 - Labrador Region (2021)	0.0	212.8	0.0	**212.8**
Purchase Backhoe - Wabush	0.0	179.3	0.0	**179.3**
Purchase Tools and Equipment Less than $ 50,000 - Central Region (2021)	0.0	150.2	0.0	**150.2**
Purchase Tools and Equipment Less than $ 50,000 - Northern Region (2021)	0.0	77.6	0.0	**77.6**
Purchase Tools and Equipment Less than $ 50,000 - Terminals & Transmission (2	0.0	44.6	0.0	**44.6**
Total Tools and Equipment	**0.0**	**1,545.4**	**0.0**	**1,545.4**
Total Transmission and Rural Operations	**4,265.6**	**53,421.2**	**101,301.1**	**158,987.9**

Newfoundland and Labrador Hydro
2021 Capital Budget Application
2021 Capital Budget: Detailed Breakdown
($000)

Project Description	Expended to 2020	2021	Future Years	Total
		($000)		
Information Systems				
Software Applications				
Perform Hydro Software Upgrades & Minor Enhancements - Hydro Place (2021)	0.0	372.1	0.0	**372.1**
Refresh Cyber Security Infrastructure (2021)	0.0	217.5	0.0	**217.5**
Total Software Applications	**0.0**	**589.6**	**0.0**	**589.6**
Computer Operations				
Replace Hydro Personal Computers (2021)	0.0	905.4	0.0	**905.4**
Upgrade Core IT/OT Infrastructure (2021)	0.0	262.8	0.0	**262.8**
Replace Peripheral Equipment (2021)	0.0	256.4	0.0	**256.4**
Upgrade Hydro Energy Control Centre Wall Infrastructure	0.0	188.5	0.0	**188.5**
Total Computer Operations	**0.0**	**1,613.1**	**0.0**	**1,613.1**
Total Information Systems	**0.0**	**2,202.7**	**0.0**	**2,202.7**

Newfoundland and Labrador Hydro
2021 Capital Budget Application
2021 Capital Budget: Detailed Breakdown
($000)

Project Description	Expended to 2020	2021	Future Years	Total
		($000)		
Telecontrol				
Network Services				
Replace Battery Banks and Chargers	0.0	327.2	0.0	**327.2**
Replace Radomes (2021) - Various	0.0	240.4	0.0	**240.4**
Replace Network Communications Equipment	0.0	194.0	0.0	**194.0**
Upgrade Remote Terminal Units	0.0	183.4	0.0	**183.4**
Upgrade Site Facilities - Various (2021)	0.0	48.9	0.0	**48.9**
Purchase Tools and Equipment Less than $ 50,000 - Network Services (2021)	0.0	40.0	0.0	**40.0**
Total Telecontrol	**0.0**	**1,033.9**	**0.0**	**1,033.9**
Transportation				
Replace Light- and Heavy-Duty Vehicles (2020-2021)	1,625.5	1,583.5	0.0	**3,209.0**
Replace Light- and Heavy-Duty Vehicles (2021-2022)	0.0	1,320.9	1,335.1	**2,656.0**
Level 2 Chargers for Electric Vehicles	0.0	299.8	0.0	**299.8**
Total Transportation	**1,625.5**	**3,204.2**	**1,335.1**	**6,164.8**
Administration				
Replace Elevator Motors and Controls Equipment - Hydro Place	89.1	647.6	0.0	**736.7**
Remove Safety Hazards - Various (2021)	0.0	199.1	0.0	**199.1**
Replace Transfer Switches and Associated Hardware - Hydro Place	0.0	197.3	938.5	**1,135.8**
Purchase Office Equipment Less Than $50,000 (2021)	0.0	62.3	0.0	**62.3**
Total Administration	**89.1**	**1,106.3**	**938.5**	**2,133.9**
Total General Properties	**1,714.6**	**7,547.1**	**2,273.6**	**11,535.3**

B. Capital Budget Summary with Multi-Year Projects Separated

2021 Capital Budget Application

Section B: 2021 Capital Budgets with Multi-Year Projects Separated

Newfoundland and Labrador Hydro
2021 Capital Budget: Multi-Year Projects Separated
($000)

	2021
Single Year	
Generation	17,311.6
Transmission and Rural Operations	18,975.2
General Properties	3,708.9
Allowance for Unforeseen Events	1,000.0
Total Projects Under $50,000	197.9
	41,193.6
Multi-Year (2021 Expenditures)	
Multi-Year Projects Commencing in 2021	36,695.7
Multi-Year Projects Commencing in 2020	34,802.1
	71,497.8
Total Capital Budget	**112,691.4**

Newfoundland and Labrador Hydro
2021 Capital Budget
Single-Year Projects Over $50,000
($000)

Project Description	
Generation	
Hydraulic Plant	
Hydraulic Generation In-Service Failures (2021)	1,250.0
Thermal Plant	
Overhaul Unit 1 Turbine and Valves - Holyrood	8,026.6
Boiler Condition Assessment and Miscellaneous Upgrades - Holyrood	3,000.0
Thermal In-Service Failures (2021)	2,000.0
Inspect Chemical Tanks - Holyrood	919.8
Overhaul Unit 3 Generator - Holyrood	572.7
Overhaul Unit 3 Boiler Feed Pump East - Holyrood	373.0
Gas Turbine	
Construct Lube Oil Cooler Hood and Containment System - Holyrood Gas Turbine	318.8
Purchase Capital Spares - Gas Turbines (2021)	213.8
Replace Voltage Regulator - Happy Valley Gas Turbine	131.3
Replace Fuel Oil, Lube Oil, and Glycol Pumps - Happy Valley Gas Turbine	234.7
Upgrade Compressed Air System - Happy Valley Gas Turbine	76.6
Tools and Equipment	
Purchase Tools and Equipment Less than $50,000 (2021) - Hydraulic Plants	194.3
Total Generation	**17,311.6**

Newfoundland and Labrador Hydro
2021 Capital Budget
Single-Year Projects Over $50,000
($000)

Project Description	
Transmission and Rural Operations	
Terminal Stations	
Terminal Station In-Service Failures (2021)	1,800.0
Upgrades for Future Retirement of Stephenville Gas Turbine	1,530.3
Purchase SF6 Gas Recovery Systems	142.7
Transmission	
Wood Pole Line Management Program (2021)	2,896.9
Distribution	
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in Central Region (2021)	1,985.4
Provide Service Extensions in Central Region (2021)	1,357.4
Provide Service Extensions in Labrador Region (2021)	1,218.6
Provide Service Extensions in Northern Region (2021)	1,164.5
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in Northern Region (2021)	1,033.5
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in Labrador Region (2021)	784.7
Additions for Load Growth - Happy Valley Line 7	617.6
Labrador City L22 Voltage Conversion	593.6
Generation	
Overhaul Diesel Units - Various (2021)	1,232.9
Inspect Fuel Storage Tanks - Postville	532.6
Replace Fuel Storage Tank - Paradise River	350.3
Metering	
Purchase Meters and Metering Equipment (2021)	233.4
Tools and Equipment	
Replace Light Duty Mobile Equipment	549.6
Replace Snow Groomer (V7601)	331.3
Purchase Tools and Equipment Less than $ 50,000 - Labrador Region (2021)	212.8
Purchase Backhoe - Wabush	179.3
Purchase Tools and Equipment Less than $ 50,000 - Central Region (2021)	150.2
Purchase Tools and Equipment Less than $ 50,000 - Northern Region (2021)	77.6
Total Transmission and Rural Operations	**18,975.2**

Newfoundland and Labrador Hydro
2021 Capital Budget
Single-Year Projects Over $50,000
($000)

Project Description	
General Properties	
Software Applications	
Perform Hydro Software Upgrades & Minor Enhancements - Hydro Place (2021)	372.1
Refresh Cyber Security Infrastructure (2021)	217.5
Computer Operations	
Replace Hydro Personal Computers (2021)	905.4
Upgrade Core IT/OT Infrastructure (2021)	262.8
Replace Peripheral Equipment (2021)	256.4
Upgrade Hydro Energy Control Centre Wall Infrastructure	188.5
Network Services	
Replace Battery Banks and Chargers	327.2
Replace Radomes (2021) - Various	240.4
Replace Network Communications Equipment	194.0
Upgrade Remote Terminal Units	183.4
Administration	
Remove Safety Hazards - Various (2021)	199.1
Purchase Office Equipment Less Than $50,000 (2021)	62.3
Transportation	
Level 2 Chargers for Electric Vehicles	299.8
Total General Properties	**3,708.9**
Total Single Year Projects Over $50,000	**39,995.7**

Newfoundland and Labrador Hydro
2021 Capital Budget
Projects Over $50,000
Multi-Year Projects
($000)

Multi-Year Projects Commencing in 2021

Project Description	2021	2022	2023	2024	2025	Total
Hydraulic Generation Refurbishment and Modernization (2021-2022)	6,569.6	6,505.5	-	-	-	13,075.1
Terminal Station Refurbishment and Modernization (2021-2022)	6,171.6	7,182.0	-	-	-	13,353.6
Upgrade Circuit Breakers - Various (2021-2022)	5,418.8	6,113.9	-	-	-	11,532.7
Diesel Plant Replacement - Charlottetown	5,194.7	8,628.4	28,561.5	21,255.1	-	63,639.7
Refurbish Ebbegunbaeg Control Structure	3,236.8	3,238.3	3,470.1	3,674.7	-	13,619.9
Diesel Genset Replacements (2021-2022)	2,560.6	525.0	-	-	-	3,085.6
Wabush Terminal Station Upgrades	2,301.7	4,935.5	4,335.7	-	-	11,572.9
Upgrade Waste Water Equalization System - Holyrood	1,813.4	547.7	-	-	-	2,361.1
Replace Light- and Heavy-Duty Vehicles (2021-2022)	1,320.9	1,335.1	-	-	-	2,656.0
Additions for Load - Wabush Substation Upgrades	1,186.7	6,365.1	2,941.6	-	-	10,493.4
Upgrade Distributed Control System Hardware - Holyrood	360.4	368.2	-	-	-	728.6
Upgrade of Worst Performing Distribution Feeders (2021-2022)	318.9	805.6	-	-	-	1,124.5
Replace Transfer Switches and Associated Hardware - Hydro Place	197.3	938.5	-	-	-	1,135.8
Install Fire Protection in Diesel Plants - Port Hope Simpson (2021-2022)	44.3	1,262.2	-	-	-	1,306.5
Total Multi-Year Projects over $50,000 Commencing in 2021	**36,695.7**	**48,751.0**	**39,308.9**	**24,929.8**	**-**	**149,685.4**

Newfoundland and Labrador Hydro
2021 Capital Budget
Projects Over $50,000
Multi-Year Projects
($000)

Multi-Year Projects Commencing in 2020

Project Description	**Expended to 2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Total**
Hydraulic Generation Refurbishment and Modernization (2020-2021)	6,580.2	10,249.8	-	-	-	-	16,830.0
Terminal Station Refurbishment and Modernization (2020-2021)	3,712.0	5,684.9	-	-	-	-	9,396.9
Replace Light- and Heavy-Duty Vehicles (2020-2021)	1,625.5	1,583.5	-	-	-	-	3,209.0
Rewind Unit 3 Stator - Holyrood	1,281.4	5,664.2	-	-	-	-	6,945.6
Perform Combustor Inspection - Holyrood Gas Turbine	546.1	2,500.0	2,400.0	-	-	-	5,446.1
Replace Fire Suppression System - Happy Valley Gas Turbine	264.6	2,377.9	-	-	-	-	2,642.5
Diesel Plant Ventilation Upgrade - Nain	162.7	690.4	-	-	-	-	853.1
Replace Powerhouse Roofing System - L'Anse Au Loup and St. Anthony Diesel Plant	125.3	1,195.8	-	-	-	-	1,321.1
Upgrade of Worst Performing Distribution Feeders (2020–2021)	102.7	3,155.1	-	-	-	-	3,257.8
Upgrade Fire Suppression System - Bishop's Falls	91.6	292.6	-	-	-	-	384.2
Replace Elevator Motors and Controls Equipment - Hydro Place	89.1	647.6	-	-	-	-	736.7
Install Recloser Remote Control - Hampden and Upper Salmon (2020-2021)	71.3	185.3	-	-	-	-	256.6
Install Partial Discharge Monitoring - Holyrood Gas Turbine	37.8	575.0	-	-	-	-	612.8
Total Multi-Year Projects over $50,000 Commencing in 2020	**14,690.3**	**34,802.1**	**2,400.0**	**-**	**-**	**-**	**51,892.4**

C. Capital Projects over $500,000

2021 Capital Budget Application

Section C: Projects over $500,000

Newfoundland and Labrador Hydro
2021 Capital Budget
Projects Over $500,000
($000)

Project Description	Expended to 2020	2021	Future Years	Total	Definition	Classification
Generation						
Hydraulic Generation Refurbishment and Modernization (2020-2021)	6,580.2	10,249.8	-	**16,830.0**	Pooled	Normal
Rewind Unit 3 Stator - Holyrood	1,281.4	5,664.2	-	**6,945.6**	Other	Normal
Perform Combustor Inspection - Holyrood Gas Turbine	546.1	2,500.0	2,400.0	**5,446.1**	Other	Normal
Replace Fire Suppression System - Happy Valley Gas Turbine	264.6	2,377.9	-	**2,642.5**	Other	Normal
Install Partial Discharge Monitoring - Holyrood Gas Turbine	37.8	575.0	-	**612.8**	Other	Normal
Overhaul Unit 1 Turbine and Valves - Holyrood	-	8,026.6	-	**8,026.6**	Other	Normal
Hydraulic Generation Refurbishment and Modernization (2021-2022)	-	6,569.6	6,505.5	**13,075.1**	Pooled	Normal
Refurbish Ebbegunbaeg Control Structure	-	3,236.8	10,383.1	**13,619.9**	Clustered	Normal
Boiler Condition Assessment and Miscellaneous Upgrades - Holyrood	-	3,000.0	-	**3,000.0**	Other	Normal
Thermal In-Service Failures (2021)	-	2,000.0	-	**2,000.0**	Other	Normal
Upgrade Waste Water Equalization System - Holyrood	-	1,813.4	547.7	**2,361.1**	Other	Normal
Hydraulic Generation In-Service Failures (2021)	-	1,250.0	-	**1,250.0**	Other	Normal
Inspect Chemical Tanks - Holyrood	-	919.8	-	**919.8**	Other	Normal
Overhaul Unit 3 Generator - Holyrood	-	572.7	-	**572.7**	Other	Normal
Upgrade Distributed Control System Hardware - Holyrood	-	360.4	368.2	**728.6**	Other	Normal
Total Generation	**8,710.1**	**49,116.2**	**20,204.5**	**78,030.8**		

Newfoundland and Labrador Hydro
2021 Capital Budget
Projects Over $500,000
($000)

Project Description	**Expended to 2020**	**2021**	**Future Years**	**Total**	**Definition**	**Classification**
Transmission and Rural Operations						
Terminal Station Refurbishment and Modernization (2020-2021)	3,712.0	5,684.9	-	**9,396.9**	Pooled	Normal
Diesel Plant Ventilation Upgrade - Nain	162.7	690.4	-	**853.1**	Other	Normal
Replace Powerhouse Roofing System - L'Anse Au Loup and St. Anthony Diesel Plant	125.3	1,195.8	-	**1,321.1**	Pooled	Normal
Upgrade of Worst Performing Distribution Feeders (2020–2021)	102.7	3,155.1	-	**3,257.8**	Pooled	Normal
Terminal Station Refurbishment and Modernization (2021-2022)	-	6,171.6	7,182.0	**13,353.6**	Pooled	Normal
Upgrade Circuit Breakers - Various (2021-2022)	-	5,418.8	6,113.9	**11,532.7**	Other	Normal
Diesel Plant Replacement - Charlottetown	-	5,194.7	58,445.0	**63,639.7**		
Wood Pole Line Management Program (2021)	-	2,896.9	-	**2,896.9**	Other	Normal
Diesel Genset Replacements (2021-2022)	-	2,560.6	525.0	**3,085.6**	Other	Normal
Wabush Terminal Station Upgrades	-	2,301.7	9,271.2	**11,572.9**	Other	Normal
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in Central Region (2021)	-	1,985.4	-	**1,985.4**	Pooled	Normal
Terminal Station In-Service Failures (2021)	-	1,800.0	-	**1,800.0**	Other	Normal
Upgrades for Future Retirement of Stephenville Gas Turbine	-	1,530.3	8,389.5	**9,919.8**	Clustered	Normal
Provide Service Extensions in Central Region (2021)	-	1,357.4	-	**1,357.4**	Pooled	Normal
Overhaul Diesel Units - Various (2021)	-	1,232.9	-	**1,232.9**	Pooled	Normal
Provide Service Extensions in Labrador Region (2021)	-	1,218.6	-	**1,218.6**	Pooled	Normal
Additions for Load - Wabush Substation Upgrades	-	1,186.7	9,306.7	**10,493.4**	Other	Normal
Provide Service Extensions in Northern Region (2021)	-	1,164.5	-	**1,164.5**	Pooled	Normal
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in Northern Region (2021)	-	1,033.5	-	**1,033.5**	Pooled	Normal
Distribution System In-Service Failures, Miscellaneous Upgrades and Streetlight Modernization in Labrador Region (2021)	-	784.7	-	**784.7**	Pooled	Normal
Additions for Load Growth - Happy Valley Line 7	-	617.6	-	**617.6**	Other	Normal
Labrador City L22 Voltage Conversion	-	593.6	-	**593.6**	Other	Normal
Replace Light Duty Mobile Equipment	-	549.6	-	**549.6**	Pooled	Normal
Inspect Fuel Storage Tanks - Postville	-	532.6	-	**532.6**	Other	Mandatory
Upgrade of Worst Performing Distribution Feeders (2021-2022)	-	318.9	805.6	**1,124.5**	Other	Normal
Install Fire Protection in Diesel Plants - Port Hope Simpson (2021-2022)	-	44.3	1,262.2	**1,306.5**		
Total Transmission and Rural Operations	**4,102.7**	**51,221.1**	**101,301.1**	**156,624.9**		

Newfoundland and Labrador Hydro
2021 Capital Budget
Projects Over $500,000
($000)

Project Description	Expended to 2020	2021	Future Years	Total	Definition	Classification
GENERAL PROPERTIES						
Replace Light- and Heavy-Duty Vehicles (2020-2021)	1,625.5	1,583.5	-	**3,209.0**	Pooled	Normal
Replace Elevator Motors and Controls Equipment - Hydro Place	89.1	647.6	-	**736.7**	Other	Normal
Replace Light- and Heavy-Duty Vehicles (2021-2022)	-	1,320.9	1,335.1	**2,656.0**	Pooled	Normal
Replace Hydro Personal Computers (2021)	-	905.4	-	**905.4**	Pooled	Normal
Replace Transfer Switches and Associated Hardware - Hydro Place	-	197.3	938.5	**1,135.8**	Other	Normal
Total General Properties	**1,714.6**	**4,654.7**	**2,273.6**	**8,642.9**		
Total Projects $500,000 and Over	**14,527.4**	**104,992.0**	**123,779.2**	**243,298.6**		

Project Title: Overhaul Unit 1 Turbine and Valves
Location: Holyrood Thermal Generating Station
Category: Generation - Thermal
Definition: Other
Classification: Normal

1.0 Introduction

The Holyrood Thermal Generating Station ("Holyrood TGS") Unit 1 turbine is a critical asset that is required for the generation of 170 MW of power and is required to be fully available for operation through the 2021–2022 winter. Proper functioning of the turbine and valves is required for the safe and reliable operation of Unit 1. Hydro performs turbine overhauls on a nine-year cycle and turbine valves overhauls on a three-year cycle. These overhaul cycles are consistent with the Original Equipment Manufacturer's ("OEM") recommendations.

2.0 Project Description

2.1 Unit 1 Turbine Overhaul

The turbine overhaul scope includes removal of the turbine casings, rotor, diaphragms and bearings. Non-destructive examination and visual inspection will be completed. Auxiliary equipment, including the lube oil system, will be overhauled. Any replacement or refurbishment required to ensure safe operation will be completed.

2.2 Unit 1 Turbine Valve Overhaul

The valve overhaul scope consists of dismantling and refurbishment of all the control valves, main stop valve, combined reheat stop and intercept valves, extraction non-return valves, and blowdown valve.

2.3 Unit 1 Generator Electrical Testing

While on site performing the turbine and valve overhaul, the generator electrical testing of the rotor and stator windings will be completed without dismantling of the generator.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	40.0	0.0	0.0	**40.0**
Labour	781.1	0.0	0.0	**781.1**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	6,114.0	0.0	0.0	**6,114.0**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	397.9	0.0	0.0	**397.9**
Contingency	693.6	0.0	0.0	**693.6**
Total	**8,026.6**	**0.0**	**0.0**	**8,026.6**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Prepare planning documents	January 2021	January 2021
Design:		
Prepare technical conditions for overhaul contract	February 2021	February 2021
Procurement:		
Prepare overhaul contract documents and award contract	February 2021	March 2021
Construction:		
Review materials inventory and supply construction materials	March 2021	November 2021
Perform turbine and valve overhauls and generator testing	June 2021	November 2021
Closeout:		
Prepare closeout documents	November 2021	December 2021

3.0 Project Justification

Based on Hydro’s experience, it has been demonstrated that the duration between overhauls is appropriate and in line with the OEM recommendations. If an overhaul is not completed at this time, the turbine and valves could fail while in operation. Such failure could result in forced unit outages, resulting in the loss of up to 170 MW of generating capacity for several weeks to several months in duration. Given Hydro’s commitment to have the Holyrood TGS fully available for generation until March 31, 2022, the overhaul of the Unit 1 turbine and valves is required.

4.0 Attachment

The report entitled "Overhaul Unit 1 Turbine and Valves - Holyrood" (Volume II, Tab 1) contains further project details.

Project Title: Hydraulic Generation Refurbishment and Modernization (2021–2022)

Location: Various

Category: Generation - Hydraulic

Definition: Pooled

Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") has consolidated much of its hydraulic generation capital work into the Hydraulic Generation Refurbishment and Modernization project. Hydro's philosophies for the assessment of equipment and the selection of capital work for the Hydraulic Generation Refurbishment and Modernization project are outlined in the "Hydraulic Generation Asset Management Overview" (Volume II, Tab 2). Hydro has subdivided all the hydraulic generation assets and created programs for refurbishment and modernization within each division, the programs developed include:

- Hydraulic Generating Units Program;
- Hydraulic Structures Program;
- Reservoirs Program;
- Site Buildings and Services Program;[1] and
- Common Auxiliary Equipment Program.

Hydro continues to develop activities within each program and has submitted a report titled "Hydraulic Generation Refurbishment and Modernization" in the 2021 Capital Budget Application, as well the "Hydraulic Generation Asset Management Overview" document.[2]

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[1] There are no projects proposed for the Site Buildings and Services Program in Hydro's 2021 Capital Budget Application.

[2] There have been no revisions to this document since Hydro's 2020 Capital Budget Application submission. Hydro is including the version that was provided in its 2020 Capital Budget Application in its 2021 Capital budget Application for ease of reference.

2.0 Project Description

Hydro proposes the following program-based activities under the Hydraulic Generation Refurbishment and Modernization Project:

2.1 Hydraulic Generating Units Program

- Turbine and Generator Six-Year Overhauls:
    - Bay d'Espoir Unit 5; and
    - Paradise River Unit.

2.2 Refurbish Generator Stator

- Unit 6 - Bay d'Espoir.

2.3 Hydraulic Structures Program

- Control Structure Refurbishments:
    - Level 2 Condition Assessment – Salmon River Spillway; and
    - Frazil Ice Monitoring Upgrade - Hinds Lake.
- Penstocks:
    - Penstocks Level 2 Condition Assessment - Paradise River.

2.4 Reservoirs Program:

- Upgrade Public Safety Around Dams & Waterways - Bay d'Espoir.

2.5 Site Buildings and Services Program:

- No identified projects in this program for 2021.

2.6 Common Auxiliary Equipment Program:

- Annunciator Panel Replacement – Bay d'Espoir and Hinds Lake ;
- 60 kW Diesel Replacement – Burnt Dam; and
- Replace Air Conditioning Unit – Bay d'Espoir.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2020	2021	Beyond	Total
Material Supply	326.9	335.1	0.0	**662.0**
Labour	1,369.2	1,362.8	0.0	**2,732.0**
Consultant	370.0	137.6	0.0	**507.6**
Contract Work	3,463.3	3,265.0	0.0	**6,728.3**
Other Direct Costs	147.8	184.3	0.0	**332.1**
Interest and Escalation	352.8	742.3	0.0	**1,095.1**
Contingency	539.6	478.4	0.0	**1,018.0**
Total	**6,569.6**	**6,505.5**	**$0.0**	**13,075.1**

3.0 Project Justification

The projects proposed under the Hydraulic Generation and Refurbishment and Modernization Program are required for safety, reliability, and environmental purposes.

4.0 Attachment

The report entitled "Hydraulic Generation Refurbishment and Modernization (2021–2022)" (Volume II, Tab 2) contains further project details.

Project Title: Refurbish Ebbegunbaeg Control Structure
Location: Ebbegunbaeg
Category: Generation - Hydraulic
Definition: Clustered
Classification: Normal

1.0 Introduction

This project is for the refurbishment of the Ebbegunbaeg Control Structure, which was built during the original construction of the Bay d'Espoir hydroelectric project. The Ebbegunbaeg control structure allows for the movement of water between the Meelpaeg Reservoir and Crooked Lake to supply the Upper Salmon and Bay d'Espoir powerhouses and is critical to Hydro's ability to optimize water management within its system and maximize value for customers.

A two-year project was approved in the Newfoundland and Labrador Hydro's ("Hydro") 2019 Capital Budget Application ("CBA") for the refurbishment of the Ebbegunbaeg Control Structure. However, due to the then-unknown condition of the stoplog monorail hoist system and the estimated project cost not reflecting the full project scope, Hydro decided to cancel the original project and submit a new proposal in its 2021 CBA for a four-year program that encompasses the complete scope of the required refurbishment of the structure.[1]

Condition assessments performed by a consultant in 2017 and 2019 identified issues with the substructure, superstructure, and the gates on the structure. Although there were no alternatives identified for the refurbishments required for the structure, there are three alternative approaches to the portion of the project pertaining to the refurbishment of the stoplog monorail hoist system. Hydro completed a cost-benefit analysis on the alternatives for that portion of the project and selected the least-cost option, as part of the overall project.

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[1] Hydro advised the Board of Commissioners of its decision to cancel the Ebbegunbaeg Control Structure Refurbishment project in correspondence dated April 17, 2020.

2.0 Project Description

This project is for the refurbishment of the Ebbegunbaeg Control Structure over four years, from 2021–2024. The planned work to be executed is described below.

- Year 1:
    - Replacement of the stoplog monorail hoist system;
    - Completion of a constructability analysis to determine the optimal approach to take for the required refurbishment; and
    - Minor building improvements to facilitate project execution (e.g., lighting and communications).
- Years 2–4:
    - Gate refurbishments, including:
        - Refurbishment of major embedded parts;
        - Replacement of main rollers/side rollers/springs;
        - Replacement of seals; and
        - Refurbishment of screw hoist.
    - Refurbishment of second stage concrete; and
    - Replacement of wire rope.

The project estimate is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**2023**	**2024**	**Total**
Material Supply	1,107.0	81.7	81.7	81.6	**1,352.0**
Labour	283.9	530.6	533.1	533.5	**1,881.1**
Consultant	120.0	90.0	90.0	90.0	**390.0**
Contract Work	1,238.0	1,829.0	1,825.5	1,825.5	**6,718.0**
Other Direct Costs	29.8	46.9	42.1	42.1	**160.9**
Interest and Escalation	180.2	402.3	640.5	844.7	**2,067.7**
Contingency	277.9	257.8	257.2	257.3	**1,050.2**
Total	**3,236.8**	**3,238.3**	**3,470.1**	**3,674.7**	**13,619.9**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Detail plan for the refurbishment and stoplog monorail hoist and structure including consultant	February 2021	March 2021
Design:		
Consultant to perform constructability analysis and design for stoplog monorail hoist	March 2021	May 2021
Procurement:		
Special material requirements, structural steel and new stoplog monorail hoist	April 2021	May 2021
Construction:		
FEED and stoplog monorail refurb - 2021	June 2021	October 2021
Gate refurbishment - 2022	June 2022	October 2022
Gate refurbishment - 2023	June 2023	October 2023
Gate refurbishment - 2024	June 2024	October 2024
Commissioning:		
Commission: 2021	September 2021	November 2021
Commission: 2022	September 2022	November 2022
Commission: 2023	September 2023	November 2023
Commission: 2024	September 2024	November 2024
Closeout:		
Project closeout	November 2024	December 2024

3.0 Project Justification

This project is required to maintain the reliable operation of the Ebbegunbaeg Control Structure and includes addressing existing safety limitations of the stoplog hoist system.

The deterioration of the gates, main rollers, embedded parts, and lifting systems heavily impacts the reliable operation of this structure. If left unmitigated, the deficiencies identified will continue to deteriorate and will lead to gate failures. Without properly functioning gates, it will be difficult to control the water being released from the Meelpaeg reservoir. This could lead to spilling or potential dam related issues such as overtopping.

4.0 Attachment

The report entitled "Refurbish Ebbegunbaeg Control Structure" (Volume II, Tab 3) contains further project details.

Project Title: Boiler Condition Assessment and Miscellaneous Upgrades
Location: Holyrood Thermal Generating Station
Category: Generation - Thermal
Definition: Other
Classification: Normal

1.0 Introduction

In 2017, Newfoundland and Labrador Hydro ("Hydro") commenced a three-year Condition Assessment and Miscellaneous Upgrades Program for the Holyrood Thermal Generating Station ("Holyrood TGS"). The program was extended for another year in 2020.[1] The approved scope for the program included a Level 2 condition assessment related to internal components of the main steam generators (boilers) and associated external high-energy piping. Throughout the duration of the Boiler Condition Assessment and Miscellaneous Upgrades program, Hydro has proposed and executed various upgrades and replacements to support the reliable operation of the steam generation equipment. This proposal entails the extension of the program for 2021.

2.0 Project Description

2.1 Boiler Condition Assessment and Miscellaneous Upgrades

The primary piece of this work is to perform a Level 2 condition assessment on the internal components of the boilers and associated external high-energy piping to determine what, if any, refurbishment or replacements are required and will include required interventions identified during the assessment work.

Miscellaneous upgrades include the replacement of boiler expansion joints and boiler refractory, which was identified in the 2020 condition assessment as requiring replacement. Additionally, to enable timely completion of necessary work, Hydro proposes to complete items identified in the 2021 Condition Assessment as requiring immediate refurbishment or replacement during the 2021 outage. For those that are material in dollar value and meet capitalization criteria, Hydro proposes to communicate these items to the Board of Commissioners of Public Utilities in its 2021 Capital Expenditures and Carryover report.

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[1] Approved in Board Order No. P.U. 14(2020).

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	162.0	0.0	0.0	**162.0**
Labour	375.1	0.0	0.0	**375.1**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	2,054.3	0.0	0.0	**2,054.3**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	149.5	0.0	0.0	**149.5**
Contingency	259.1	0.0	0.0	**259.1**
Total	**3,000.0**	**0.0**	**0.0**	**3,000.0**

The condition assessment and upgrade work will take place during the outage period for each of the three boilers. The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Complete project planning	January 2021	January 2021
Procurement:		
Order long lead parts	February 2021	March 2021
Construction:		
Perform condition assessment and upgrade work.	April 2021	October 2021
Closeout:		
Prepare closeout documentation.	November 2021	December 2021

3.0 Project Justification

This program has historically been effective and supports the optimal timing of refurbishment and replacement. Given Hydro's commitment to have the Holyrood TGS fully available for generation until March 31, 2022, this project is required to support the continued reliable operation of the Holyrood TGS.

4.0 Attachment

The report entitled "Boiler Condition Assessment and Miscellaneous Upgrades - Holyrood" (Volume II, Tab 4) contains further project details.

Project Title: Thermal In-Service Failures
Location: Holyrood
Category: Generation - Thermal
Definition: Other
Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") conducts asset management activities to proactively identify, replace, repair, or refurbish equipment to minimize the disruption of service and avoid unsafe working conditions due to equipment failure. One of the primary objectives of Hydro's Asset Management Program is to identify refurbishment and replacement activities that require approval by the Board of Commissioners of Public Utilities ("Board") in time to be included in its annual capital budget application. This is achieved through the preventive maintenance program using various condition-based assessments and testing procedures.

Generally, Hydro identifies the refurbishment and replacement work that will be required in time for inclusion in its capital budget applications. However, there are situations where immediate refurbishment or replacement must be completed due to the occurrence of an actual failure, the identification of an imminent failure, or identification of faster than anticipated equipment deterioration. These situations can be caused by events such as vandalism, storm damage, lightning, accidental damage, abnormal system operations, corrosion, wear of mechanical components, etc.

Hydro is proposing this project to secure its ability to undertake immediate capital refurbishment and replacement work[1] that may become required for its Holyrood Thermal Generating Station ("Holyrood TGS") to maintain safe and reliable operations and to ensure the availability of capital spares[2] required to support such work. Examples of the activities that may be undertaken in this project are outlined in Appendix A. Hydro has used historical data and the professional judgement of its asset management personnel to determine the budget for this project.

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[1] This project excludes work which can be executed as either Unforeseen or Capital Budget Supplemental projects.

[2] Capital spares are major spare parts that meet the definition of capital assets that are kept on hand to be used in the event of an unexpected breakdown or failure of equipment, thereby expediting the equipment's return to service. Capital spares are important in reducing periods of interruption in the generation and transmission of electricity.

2.0 Background

The 2019 Thermal In-Service Failures project supported the completion of 28 corrective actions, as outlined in Appendix A. The total expenditure for this project in 2019 was approximately $2.3 million.

3.0 Project Justification

Due to the age and operational requirements of the Holyrood TGS systems and equipment, equipment failures and deterioration will occur. This project provides an effective and timely means for Hydro to undertake the immediate capital refurbishment and replacement work required for the Holyrood TGS to maintain safe and reliable operations and to ensure the availability of capital spares required to support such work. Deferral of the type of work that is typically completed under this project could result in a detrimental impact to customer power supply or an unacceptable risk to safety.

4.0 Project Description

Hydro is proposing to undertake the immediate capital refurbishment and replacement work required for the Holyrood TGS to maintain safe and reliable operations and ensure the availability of capital spares required to support such work. At this time, Hydro does not have any planned capital spare acquisitions; however, throughout 2021, Hydro may purchase capital spares identified by asset management personnel as requiring immediate procurement to avoid deficiencies in its capital spares inventory.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	200.0	0.0	0.0	**200.0**
Labour	308.9	0.0	0.0	**308.9**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	1,391.8	0.0	0.0	**1,391.8**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	99.3	0.0	0.0	**99.3**
Contingency	0.0	0.0	0.0	**0.0**
Total	**2,000.0**	**0.0**	**0.0**	**2,000.0**

As there is no planned refurbishment work, replacement work, or capital spares acquisitions, no project schedule is provided for those activities.

Work executed under this project in 2021 will be reported to the Board in Hydro's 2021 Capital Expenditures and Carryover Report and provided in 2022 as part of the 2023 Capital Budget Application.

5.0 Conclusion

The Thermal In-Service Failures project allows Hydro to undertake timely refurbishment and replacement work that is not included in its preventive maintenance program, supporting Hydro's effort to maintain safe and reliable operations. This project will also allow Hydro to continue to proactively manage the pool of capital spare equipment to support thermal generation operations.

Appendix A

2019 In-Service Failure Activities

Table A-1: 2019 In-Service Failure Activities

Project Title and Location	Expenditure ($000)	Failure Identified	Project Scope
Capital Spares Procurement Holyrood TGS	265.5	The planned scope for the In Service Failures project for 2018 included the procurement of the following spare components: 1. Unit 3 Excitation Transformer 2. Auxiliary Board Transformer 3. dc Lube Oil Pump Motor	The spare components were ordered in 2018 and received in 2019.
Dump Valves Overhaul Holyrood TGS Units 1 and 2	204.4	In 2018, Hydro refurbished the hydraulic system for Unit 1 and Unit 2 control valves as an in-service failure. The refurbishment of the hydraulic systems consumed all of the capital spares in the standby pool. A review of the component failure rate resulted in an update to the standby spare strategy to increase the required number of available spares. In addition, the dump valves, air dryers, and external filters required replacement but were not able to be completed in 2018.	In 2019, the dump valves were refurbished, air dryers were replaced, and external filter units were replaced on Units 1 and 2. Hydraulic servo valves for the Stage 1 turbine hydraulic system were ordered and received in 2019 to serve as spares.
Control Valve Refurbishment Holyrood TGS Unit 2	200.6	On April 12, 2019 while reducing load on Unit 2, the unit experienced a load rejection of 50 MW, causing multiple unstable boiler conditions including a low drum level, causing the unit to trip. During the unit stabilization following the trip, it was observed that the main turbine control valves were open 39%; these valves should close automatically following a trip. The hydraulic system was tested and verified to be in proper operation. An attempt was then made to stroke the main turbine control valves to the open/closed positions, and the valves could not be closed more than 39%, indicating that there was a physical obstruction of the main turbine control valves or the hydraulic cylinder.	The main turbine control valve camshafts were refurbished and the camshaft bearings and hydraulic ram were replaced in 2019.
Capstan Access Platform Replacement Holyrood Marine Terminal	181.5	Inspection revealed that the four capstan extension platforms on the marine terminal had deteriorated due to corrosion and required replacement.	The four capstan access extension platforms were replaced in 2019.

Project Title and Location	**Expenditure ($000)**	**Failure Identified**	**Project Scope**
Circulating Water Elbows Replacement Holyrood TGS Units 2 and 3	174.9	The circulating water elbows for Units 2 and 3 were found to be extensively corroded and leaking. Previous welding repairs on these elbows were found to have limited success.	New elbows were procured, fabricated, and installed on Units 2 and 3 circulating water systems.
Fuel Oil Return Line Replacement Holyrood Marine Terminal	169.1	The marine terminal 4-inch return line was replaced in 2018 as an in-service failure. There was insufficient time in 2018 to replace the associated heat tracing and insulation.	Installation of heat tracing and insulation on the fuel oil return line was completed in 2019.
Forced Draft Fan Bearing Liner Replacement, Holyrood TGS Unit 1	119.3	On June 17, 2018, the Unit 1 East forced draft fan inboard bearing liner failed, which led to a forced outage on Unit 1. In 2018, the inboard bearing liner was replaced with an available spare and the journal (the bearing surface section of the fan shaft) was refurbished.	A new liner was ordered in 2018 and received in 2019, to replace the liner drawn from inventory.
Variable Frequency Drive Spare Cells Holyrood TGS	101.6	Six variable frequency drive cells failed in service, with no impact on unit production. The variable frequency drive system can sustain one cell failure per phase without affecting production. However, if two cell failures occur on the same phase, a voltage imbalance will negatively impact the torque and speed of the forced draft fan motor, thus reducing the amount of combustion air to the boiler and potentially tripping the generating unit.	The six failed cells were replaced using available spares. Three of the failed cells were refurbished and added to inventory as spares. The other three failed cells could not be refurbished; three new cells were purchased to replenish the available spares.
Synchro drive Replacement Holyrood TGS Unit 3	84.2	During the fall of 2018, Holyrood operations were not able to restart the Unit 3 synchronous condenser following a scheduled shutdown. Troubleshooting determined that the Mark VI controller had failed. This controller was obsolete.	The Mark VI controller was replaced with a Mark VIII controller.
Jetty Timbers Replacement Holyrood Marine Terminal	78.2	In 2013, deteriorated timbers on the jetty fender no. 2 were replaced with temporary lumber held together by threaded rods due to a lack of spare timbers available and long lead times related to the procurement of new timbers. These temporary timbers were discovered to be deteriorated and required replacement.	The deteriorated timbers on fender no. 2 were replaced. In addition, spare timbers were purchased and added to the capital spare inventory.

Project Title and Location	**Expenditure ($000)**	**Failure Identified**	**Project Scope**
Distributor Control System Computer Stations Replacement Holyrood TGS	75.5	Seven out of eighteen distributor control system computer stations in the Holyrood Control Room were determined to be obsolete. Three (3) obsolete stations failed between 2018 and 2019 and parts are no longer available.	The seven obsolete distributor control system computer stations were replaced.
East Fuel Oil Pump Replacement Holyrood TGS Unit 1	70.6	In February 2019, it was identified that Unit 1 was unable to achieve full load due to the east heavy fuel oil pump failing to meet performance requirements.	Unit 1 East heavy fuel oil pump was replaced.
High Pressure Feed Water Valves Replacement Holyrood TGS Unit 2	67.9	During Unit 2 operation, leaking gate, check, and safety valves were discovered on the Unit 2 high pressure feed water line.	Leaking valves and connected piping for the high pressure feed water were replaced.
East Fuel Oil Pump Replacement Holyrood TGS Unit 2	67.2	The Unit 2 East fuel oil pump was unable to maintain system operating pressure due to extensive damage on internal components (screw impellers and casing) caused by the abrasive properties of No. 6 heavy fuel oil.	The Unit 2 East fuel oil pump was replaced.
Fuel Oil Pumps Replacement Holyrood TGS Unit 3	56.6	The east and west fuel oil pumps servicing Unit 3 failed and required replacement. Pipe strain was discovered on the suction and discharge flanges on both pumps during the annual 2019 maintenance outage, which contributed to the pump failures.	The east and west fuel oil pumps for Unit 3 were replaced with new pumps and the connecting piping was modified to remove pipe strain on the pumps.
Fuel Oil Mass Flow Meter Replacement Holyrood TGS Unit 1	54.3	Online testing revealed that the mass flow meter and transmitter on Unit 1 was reporting incorrect fuel flows.	The Unit 1 fuel oil mass flow meter and transmitter were replaced with an available spare. A new flowmeter and transmitter was purchased to replace those drawn from the capital spare pool.
Turbine Generator Cooler Control Valve Replacement Holyrood TGS Unit 1	49.2	A high temperature alarm was received on the Unit 1 turbine generator cooling system. Upon investigation, it was determined that the alarm was being caused by binding of the control valve.	The turbine generator cooler control valve and actuator were replaced.

Project Title and Location	Expenditure ($000)	Failure Identified	Project Scope
East Boiler Feedwater Pump Recirculating Valve Overhaul Holyrood TGS Unit 2	39.1	During operation, it was identified that the east boiler feedwater pump recirculating valve was stuck in a partially open position. Further investigation identified damage to the valve's stem, seat, and plug and these components required replacement.	An overhaul was completed on the Unit 2 East boiler feedwater pump recirculating valve to replace the damaged internal components.
VFD Blower Reinforcement Kit Procurement Holyrood TGS	38.7	The forced draft fans have experienced several blower failures since the variable frequency drives were installed. Further investigation into the cause of the blower failures determined that the bearings of the cooling fan motors had been failing due to vibration. The original equipment manufacturer recommended a blower reinforcement kit to address the bearing issues.	Six blower reinforcement kits were purchased and installed.
Boom Deployment Moorings Replacement Holyrood Marine Terminal	35.9	Two of the three boom deployment moorings on the marine terminal failed during a tanker delivery. Upon inspection of the anchors, chains, and buoys, it was determined that the boom deployment moorings all required replacement due to severe corrosion of the chains and deterioration of the concrete anchor structures.	All boom deployment moorings were replaced.
Fire Water Pumps Refurbishment Holyrood TGS	35.3	The electric fire pump was taken out of service to repair a packing leak and damage was discovered to the shaft, bearings, and seals. The jockey pump was also inspected and found to have major cavitation damage on the internal components.	The electric driven fire pump was refurbished to replace the damaged internal components. The jockey pump was replaced with an available spare pump.
Relay Room Condenser Replacement Holyrood TGS	31.9	The tubes of the relay room condenser of one of the stage 1 air conditioning units were leaking and had to be bypassed. With the condenser bypassed, the air conditioning unit is not adequately cooling the stage 1 relay room.	The relay room condenser was replaced.
Fire Water Piping Isolation Valves Replacement Holyrood TGS Fire System	30.9	It was determined that one of the isolation valves of the fire system was passing fluid and required replacement.	The isolation valve and required piping were replaced.

Project Title and Location	**Expenditure ($000)**	**Failure Identified**	**Project Scope**
Vacuum Pump Motors Refurbishment Holyrood TGS Unit 2	27.7	Testing was completed on the motor windings of the Unit 2 north and south vacuum pumps on July 26, 2019. Testing indicated that the windings were shorted to ground. Further assessment indicated a winding short-circuit on the north vacuum pump motor and severe deterioration of the end bell of the south vacuum pump motor.	The north and south vacuum pump motors were refurbished.
Fire Water Distribution Equipment Replacement Holyrood TGS Station	19.6	A leak was discovered in a hydrant takeoff pipe due to crack in the pipe. A hydrant isolation valve was also cracked and leaking.	The failed valve, piping and hydrant were replaced.
Potential Transformers Capital Spares Procurement Holyrood TGS	19.3	On December 9, 2018, two of the six potential transformers on the generator for Unit 1 failed and were replaced with available spares. Following this event, a review of the failure rate resulted in an update to the standby spare strategy to increase the number of available spares from two to six.	Six spare potential transformers and associated fuses were ordered and received in 2019.
Capstan Gear Box Refurbishment Holyrood Marine Terminal	15.2	One of six capstan gearboxes seized and failed to operate in 2019. Assessment of the failed gearbox determined that all bearings and seals required replacement.	The failed gearbox was replaced with an available spare. The failed gearbox was overhauled, tested and added to inventory as a spare.
Battery Cell Capital Spare and Charger Procurement Holyrood TGS	13.2	A review of the reliability of the existing battery bank system concluded that a four-cell spare is required to mitigate the risk of failure. On each battery bank, the batteries are connected in series such that the failure of one battery could result in the entire bank going out of service. To return a bank to operation, the failed battery can be bypassed temporarily. However, the bank would have to be removed from service again to replace the failed battery. By installing an on-site charger and spare four-cell battery, the failed battery could be replaced immediately, thus maintaining the reliability level of the three generating units.	A spare four-cell battery and charger were purchased and installed as a hot standby critical spare.

Project Title: Upgrade Waste Water Equalization System
Location: Holyrood Thermal Generating Station
Category: Generation - Thermal
Definition: Other
Classification: Normal

1.0 Introduction

The Holyrood Thermal Generating Station ("Holyrood TGS") produces large volumes of effluent that must be properly treated and disposed of in accordance with applicable regulatory requirements. The effluent is categorized as either periodic or continuous, depending on its source. Continuous effluent is created through the thermal plant's floor drains, boiler blow down lines, clarifier blow down lines, and general service cooling tanks. Periodic effluent originates from air heater washes, boiler washes, batch reactor waste, and landfill leachate. Treatment requirements differ and are determined based on the type of effluent.

The waste water equalization system at the Holyrood TGS consists of two large concrete basins which contain the effluent and enable the removal of suspended solids and the adjustment of pH levels. These basins are enclosed by a pre-engineered steel building that houses the mechanical and electrical equipment necessary to treat the effluent and prevents precipitation and debris from entering the equalization basins.

The Holyrood TGS will continue to produce effluent during post steam operations. Leachate from the on-site landfill, where boiler ash is disposed of on an annual basis, will continue to be processed in accordance with the Certificate of Approval. Additionally, effluent produced through building floor drains and general service cooling water, which is required during synchronous condense operation, flows through the continuous basin. The waste water equalization system will remain in service during post-steam operations at the Holyrood TGS. Presently, the waste water basin building and its associated equipment is in extremely poor condition. The presence of mold and corroded building components has created a safety concern for the personnel that are required to enter the facility. Mechanical and electrical equipment associated with the treatment system is unreliable and is hindering the effluent treatment process. The facility requires refurbishment to support safe and reliable operation.

2.0 Project Description

The primary objective of this project is to remove the safety hazards associated with the waste water basin building and complete necessary upgrades so that the waste water equalization system can be reliably operated. The proposed scope of work includes:

- Removal and disposal of the existing waste water basin building;
- Cleaning and re-lining the basins;
- Redesign and replacement of existing recirculation pumps, piping, and valves;
- Design, supply, and installation of a baffle system in the continuous basin;
- Design, supply, and installation of a an engineered basin cover system;
- Supply and installation of safety railing around the perimeter of the basins;
- Supply and installation of guard railing to prevent vehicular traffic from inadvertently driving over the basin covers; and
- Supply and installation of exterior lighting around the basin perimeter.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	53.3	273.7	0.0	**327.0**
Labour	378.0	92.9	0.0	**470.9**
Consultant	53.0	0.0	0.0	**53.0**
Contract Work	1,084.5	58.3	0.0	**1,142.8**
Other Direct Costs	4.2	1.6	0.0	**5.8**
Interest and Escalation	83.2	78.5	0.0	**161.7**
Contingency	157.2	42.7	0.0	**199.9**
Total	**1,813.4**	**547.7**	**0.0**	**2,361.1**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Develop scope statement and schedule, conduct risk review	January 2021	February 2021
Design:		
Complete detailed engineering design	February 2021	April 2021
Procurement:		
Material procurement, tender and award installation contracts	March 2021	March 2022
Construction:		
Complete site installation works	July 2021	March 2022
Commissioning:		
Final inspection and acceptance	March 2022	March 2022
Closeout:		
Interest cut off, as-build drawings, project closeout	April 2022	July 2022

3.0 Project Justification

The waste water basin building has severely deteriorated and poses a safety concern for employees due to the mold growth within the facility and the corroded structural steel members. Operationally, the effluent recirculation/transfer system no longer functions as required to ensure treatment of the effluent. The proposed upgrades are required to eliminate the safety hazards associated with the building, enhance the effluent treatment system and provide a long-term, cost-effective solution for wastewater management and processing.

4.0 Attachment

The report entitled “Upgrade Waste Water Equalization System - Holyrood” (Volume II, Tab 5) contains further project details.

Project Title: Hydraulic Generation In-Service Failures
Location: Various
Category: Generation - Hydraulic
Definition: Other
Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") conducts asset management activities to proactively identify, replace, repair, or refurbish equipment to minimize the disruption of service and to avoid unsafe working conditions due to equipment failure. An objective of Hydro's Asset Management Program is to identify refurbishment and replacement activities that require approval by the Board of Commissioners of Public Utilities in time to be included in Hydro's annual Capital Budget Application ("CBA"). The identification is done through the preventive maintenance program using various condition based assessments and testing procedures.

Hydro has had success in projecting the deterioration rate of equipment for submission of refurbishment or replacement work into capital budget applications. However, there are situations where immediate refurbishment or replacement must be completed due to the occurrence of an actual failure, the identification of an incipient failure, or determination of faster than anticipated equipment deterioration. These situations can be caused by events such as vandalism, storm damage, lightning, accidental damage, abnormal system operations, cavitation, existing installation deficiencies, etc.

Hydro is proposing that within this project it will undertake the immediate capital refurbishment and replacement work[1] required for its hydraulic generating stations and water reservoirs to maintain safe and reliable operation and to ensure the availability of capital spares[2] required to support such work. These activities will be undertaken in accordance with the philosophies outlined throughout the "Hydraulic Generation Asset Management Overview" found in Appendix A of Hydro's Hydraulic Generation Refurbishment and Modernization (2021–2022) Report (see Volume II, Tab 2) document.

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[1] This work will not include actions that more appropriately can be executed as Unforeseen or Capital Budget Supplemental projects.

[2] Capital spares are major spare parts that meet the definition of capital assets that are kept on hand to be used in the event of an unexpected breakdown or failure of equipment thereby expediting the return of the equipment to service. Capital spares are important in reducing periods of interruption in the generation and transmission of electricity.

Hydro uses historical data and the judgement of asset management personnel to predict the magnitude of the Hydraulic Generation In-Service Failures project budget.

2.0 Background

2.1 Operating Experience

The 2019 Hydraulic Generation In-Service Failures project consisted of 12 corrective actions with a total expenditure of $1.4 million. The corrective actions are detailed in Appendix A.

3.0 Project Justification

Due to the nature of hydraulic equipment and infrastructure, unanticipated failures and deterioration will occur. This project provides an effective and timely means to undertake the immediate capital refurbishment and replacement work required for hydraulic equipment and infrastructure to maintain safe and reliable operation and to ensure the availability of capital spares required to support such work.

Deferral of work that is justified under this project could result in a detrimental impact to customer power supply or an unacceptable risk to worker or public safety.

4.0 Project Description

Hydro is proposing to undertake the immediate capital refurbishment and replacement work required for its hydraulic generating stations and water reservoirs, as needed, to maintain safe and reliable operation and to ensure the availability of capital spares required to support such work. At this time, Hydro does not have any planned capital spare acquisitions; however, throughout 2021, Hydro may purchase capital spares identified by asset management personnel as requiring immediate procurement to offset deficiencies in its capital spares.

Hydro’s estimated project cost of the Hydraulic Generation In-Service Failures project for 2021 is presented in Table 1. Based on the expenditures noted in Appendix A and current expenditures under the 2020 Hydraulic Generation In-Service Failures project, Hydro proposes the same amount for 2021 that was approved in the 2020 Capital Budget Application.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	667.8	0.0	0.0	**667.8**
Labour	487.9	0.0	0.0	**487.9**
Consultant	20.0	0.0	0.0	**20.0**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	74.3	0.0	0.0	**74.3**
Contingency	0.0	0.0	0.0	**0.0**
Total	**1,250.0**	**0.0**	**0.0**	**1,250.0**

As there are no planned activities for refurbishment or replacement work, no schedule is provided for those activities.

Work executed under this project in 2021 will be reported to the Board of Commissioners of Public Utilities in Hydro’s 2021 Capital Expenditures and Carryover Report and also provided in 2022 as part of the 2023 Capital Budget Application.

5.0 Conclusion

The Hydraulic In-Service Failures project allows Hydro to undertake timely refurbishment and replacement work that is not included in its preventive maintenance program, supporting Hydro’s effort to maintain safe and reliable operations. This project will also allow Hydro to continue to proactively manage the pool of capital spare equipment to support hydraulic operations.

Appendix A

2019 In-Service Failure Activities

Table A-1: 2019 In-Service Failure Activities

Project Title and Location	Expenditure ($000)	Failure Identified	Project Scope
Coffer Dam 8 (CD-8) Riprap Refurbishment Cat Arm	701.4	On July 30, 2019, an annual inspection was completed on the Cat Arm Dams. Approximately 27% riprap loss was noted during the inspection on CD-8. Riprap is the erosion protection layer on the embankment dams and loss of riprap leaves the dam internal components susceptible to further damage, especially by ice. Continued loss of riprap would lead to the requirement for more extensive rehabilitation and possibly a dam breach.	Riprap was replaced on CD-8. Material was processed from nearby quarry, transported via barge to CD-8, and placed using heavy equipment.
Capital Spares Hinds Lake and Cat Arm	313.3	The following equipment was determined to be required for the standby pool, to allow fast responsive action to future failures of long lead equipment: 1. Hinds Lake Service Station Transformer ($114.3); 2. Hinds Lake Bearing Oil Cooler/Turbine Cooler/Generator Air Cooler ($84.4); 3. Hinds Lake Circuit Breaker ($32.8); and 4. Cat Arm Excitation Transformer ($81.7) to enable responsive action to failures.	The spare equipment was procured for the standby pool.
Crane Bus Bar Replacement Paradise River	71.3	The powerhouse crane conductor bars warped out of shape and no longer provide a safe electric power distribution pathway for the entire overhead crane.	A direct replacement of the bus bar system was procured and installed.
Partial Discharge Analyzer Replacement Bay d'Espoir	66.6	The current Partial Discharge Analyzer has been in service for approximately 25 years and was identified to be faulty with a broken communication port. This Partial Discharge Analyzer was obsolete and discontinued by the manufacturer.	A new Partial Discharge Analyzer was procured and installed.
Maintenance Air Compressor Replacement Bay d'Espoir Powerhouse 1	46.4	The air compressor used for maintenance and as emergency back-up was seized and became non-operational.	A replacement air compressor was procured.
Control Room Air Conditioning Unit Cat Arm	40.4	The control room air conditioning unit failed due to corroded copper tubing and fittings.	A replacement air conditioning unit was procured in 2018 and installed in 2019.

Project Title and Location	Expenditure ($000)	Failure Identified	Project Scope
Generator Guide and Thrust Bearing Replacement Bay d’Espoir Unit 3	39.8	Unit 3 experienced abnormal vibration levels during operation and intervention was required for reliable generation. Offline disassembly and inspection revealed that the thrust and guide bearing assemblies had extensive wear and required replacement.	The existing generator thrust and guide bearing assemblies were replaced.
Fire Alarm System Replacement West Salmon Dam	31.2	The existing fire alarm system had been in operation since 2002. Replacement parts were no longer available and the system was indicating sensor faults due to failure of alarm system components.	Replacement fire alarm panels and field devices were procured and installed.
Fire Pump Replacement Hinds Lake	25.0	Fire Pump No. 2 was in service since 1980. The internal components of the pump as well as the casing had deteriorated to the point where the pump was no longer available for continued operation, thus requiring immediate replacement.	A new fire pump to replace the Fire Pump No. 2 was procured in 2019 and will be installed under the 2020 Hydraulic In-Service Failures project.
Oil Skimmer Replacement Bay d’Espoir Powerhouse 2	15.3	The oil skimmer consists of a mop, motor, housing, and switch. The mop was severely worn causing entanglement issues and required replacement. Replacement components for the oil skimmer are no longer available.	A replacement oil skimmer was procured and installed.
Waste Oil Storage Tank Replacement Cat Arm	13.4	The 960 Liter double-walled waste oil tank experienced a loss of vacuum in the interstitial space, indicating an internal leak, which could not be repaired.	A new waste oil tank was procured and installed.
Fire Alarm System Replacement Granite Canal	10.3	The existing fire alarm system has been in operation since 2002. Replacement parts were no longer available and the system was indicating sensor faults due to failing alarm system components.	Procurement of replacement alarm panels and field devices was completed in 2019 and installation will occur in 2020, under the 2020 Hydraulic In-Service Failures project, when road conditions allow access to site.

Project Title: Inspect Chemical Tanks
Location: Holyrood Thermal Generating Station
Category: Generation - Thermal
Definition: Other
Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") conducts asset management activities to proactively identify, replace, repair, or refurbish equipment to minimize the disruption of service and to avoid unsafe working conditions due to equipment failure. The Water Treatment Plant ("WTP") at Holyrood Thermal Generation Station ("Holyrood TGS") utilizes storage tanks that contain sulfuric acid (H_2SO_4) and caustic (NaOH Sodium Hydroxide). The chemicals are used in the water treatment process to convert raw water into deionized boiler feedwater for steam production. They are also used by the Waste Water Treatment Plant ("WWTP") to treat site drainage waste water and leachate from the site landfill. Total seven tanks are currently in use to store sulfuric acid, caustic and mixing purpose. Hydro is proposing to inspect and refurbish chemical tanks to maintain safe and reliable operation of the Holyrood TGS.

2.0 Project Description

This project will include a Level 2 internal inspection and engineering assessment of the chemical tanks, associated piping, and valves. The inspection would consist of removing the asset from service, cleaning and gas testing the chemical storage tanks and inspection of the tank and piping internals by a third party specialist using standard non-destructive testing technologies including ultrasonic thickness measurement, wet fluorescent magnetic particle, radiographic surveys and guided wave measurements as Per ASME/API Codes. Any deficiencies found during the inspection that could compromise the reliability of the system will be addressed under the project while the assets are out of service.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	60.0	0.0	0.0	**60.0**
Labour	345.3	0.0	0.0	**345.3**
Consultant	100.0	0.0	0.0	**100.0**
Contract Work	290.0	0.0	0.0	**290.0**
Other Direct Costs	3.0	0.0	0.0	**3.0**
Interest and Escalation	43.6	0.0	0.0	**43.6**
Contingency	77.9	0.0	0.0	**77.9**
Total	**919.8**	**0.0**	**0.0**	**919.8**

3.0 Justification

The three boilers at Holyrood TGS require treated feedwater in order to produce suitable steam for power generation. The chemical tanks are necessary components of the water treatment plant and are required for operation during steam production. The caustic tanks will also be an important component to service the waste water treatment plant which will remain in service after final steam production. Liquid Storage Tanks containing hazardous materials are required by API and ASME Codes to be inspected every ten years. Out of service inspections are necessary to ensure that the tanks are structurally sound, suitable for operation, and not at risk of releasing chemicals into the environment. The results of the inspection will be used to inform any immediate work to be completed and to develop future maintenance and capital plans. This project will ensure the safe and reliable operation of the existing equipment without the need for full replacement.

This project is required to maintain safe and reliable operation of the Thermal Generation Station.

4.0 Attachment

The report entitled "Inspect Chemical Tanks - Holyrood" (Volume II, Tab 6) contains further project details.

Project Title: Overhaul Unit 3 Generator
Location: Holyrood Thermal Generating Station
Category: Generation
Definition: Other
Classification: Normal

1.0 Introduction

The three major components of the Holyrood Thermal Generating Station ("Holyrood TGS") units are the power boiler, turbine, and generator. Through combustion of No. 6 fuel oil, the power boiler provides high-energy steam to the turbine. The turbine is directly coupled (or connected) to the generator and provides the rotating energy necessary for the generator to produce rated output power. To support safe and reliable operation, the generators are overhauled on a six-year cycle. The last overhaul for the Unit 3 generator was in 2016; however, as several of the activities required for the Unit 3 generator overhaul are also completed during the stator refurbishment, Hydro is proposing to complete the generator overhaul a year early to avail of the cost efficiencies that can be achieved as a result of the shared work scope between these two projects. If approved, Unit 3 will be disassembled during the approved Rewind Unit 3 Stator project in 2021.[1] Executing this project in 2021 in conjunction with the Rewind Unit 3 Stator project rather than completing it as a stand alone project in 2022 will provide cost savings of approximately $500,000.

2.0 Project Description

The scope of the Holyrood TGS Unit 3 generator overhaul consists of:

- Detailed visual inspection of the rotor and its components;
- Testing of the rotor and its components;
- Detailed inspection, cleaning, and minor refurbishment of the generator's mating surfaces;
- Detailed inspection, cleaning, and minor refurbishment or replacement if required of the generator's bearings;
- Detailed inspection, cleaning, and minor refurbishment or replacement if required of the generator's oil and hydrogen seals;

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[1] Approved in Board Order No. P.U. 6(2020).

- Detailed inspection, cleaning, testing, and minor refurbishment of the generator's hydrogen coolers;
- Lube oil flush; and
- Detailed inspection, cleaning and minor refurbishment of the generator's seal oil systems.

The project estimate is shown in Table 1. This estimate is based on the project being executed in conjunction with the stator rewind.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	0.0	0.0	0.0	**0.0**
Labour	25.3	0.0	0.0	**25.3**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	494.1	0.0	0.0	**494.1**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	27.3	0.0	0.0	**27.3**
Contingency	26.0	0.0	0.0	**26.0**
Total	**572.7**	**0.0**	**0.0**	**572.7**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Outage planning	February 2021	March 2021
Design:		
Identification of parts, test parameters, procedures and acceptable results	Not required for this project as it will be completed as part of the 2021 Rewind Unit 3 Stator project.	
Procurement:		
Purchasing and ordering of required parts and equipment	March 2021	April 2021
Construction:		
Carry out the overhaul in parallel with the stator refurbishment work	June 2021	July 2021
Commissioning:		
Verification of results and energization of the unit	August 2021	August 2021
Closeout:		
Lessons learned and final disbursements	September 2021	October 2021

3.0 Project Justification

This project is required to support the safe and reliable operation of Holyrood TGS Unit 3 at rated output, and reliable operation as a synchronous condenser after the Holyrood TGS is no longer required as a generating station. The overhaul will return the generator and auxiliary systems to design specifications such that they can perform safely and efficiently. The overhaul will also identify any internal conditions that could lead to premature failure of the equipment if not corrected or controlled.

4.0 Attachment

The report entitled "Overhaul Unit 3 Generator - Holyrood" (Volume II, Tab 7) contains further project details.

Project Title: Upgrade Distributed Control System Hardware
Location: Holyrood
Category: Generation - Thermal
Definition: Other
Classification: Normal

1.0 Introduction

The Holyrood Thermal Generating Station ("Holyrood TGS") Distributed Control System ("DCS") consists of hardware and software components that control and monitor plant equipment such as boilers, turbines, breakers, and transformers. Control is performed automatically via processors and/or interactively via operators utilizing computer stations known as Human Machine Interfaces ("HMIs").

The DCS hardware consists of processors, input/output ("I/O") modules, computer stations, network switches, and servers. Software installed on the DCS hardware provides control, setpoint adjustments, alarms, trip actions, and historical information collection of connected equipment. According to the vendor's product lifecycle, a large percentage of the processors, computer stations, network switches and servers at the Holyrood TGS are obsolete or will be obsolete in the near future. This includes many of the components required for post-steam operation.

2.0 Project Description

This project includes the replacement of obsolete or soon to be obsolete DCS hardware such as processors, servers, computer stations, and network switches in only the areas required for post-steam operation, which include:

- Unit 3 (will be used as a Synchronous Condenser; burner management not required);
- Station Service; and
- Waste Water Treatment Plant.

Replacing DCS hardware for these three areas will require six redundant processors, two servers, four computer stations, and three network switches.

Schneider Electric, the Original Equipment Manufacturer ("OEM"), will complete the software configurations for the new equipment.

As part of the upgrade, the OEM will complete factory acceptance testing at its own facility using all new DCS hardware to complete functional checks of hardware and software. After the DCS hardware is accepted, it will be shipped to the Holyrood TGS and installed and commissioned during the following planned maintenance outage. The new equipment will be installed under the supervision of an OEM representative.

The project estimate is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	0.0	5.0	0.0	**5.0**
Labour	36.3	106.4	0.0	**142.7**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	268.2	178.8	0.0	**447.0**
Other Direct Costs	4.6	1.8	0.0	**6.4**
Interest and Escalation	20.4	47.0	0.0	**67.4**
Contingency	30.9	29.2	0.0	**60.1**
Total	**360.4**	**368.2**	0.0	**728.6**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	**Start Date**	**End Date**
Planning:		
Preparing detailed schedule	February 2021	March 2021
Design:		
Detailed design	February 2021	April 2021
Procurement:		
Contract award	May 2021	June 2021
Factory Acceptance Testing:		
Verification of new hardware and software at OEM's site	September 2021	September 2021
Construction/Commissioning:		
Replacement of processors, computer stations, network switches, and servers	June 2022	July 2022
Closeout:		
Prepare closeout activities	November 2022	November 2022

3.0 Project Justification

Schneider Electric was contracted in 2018 to provide a "Lifecycle Assessment Summary and Upgrade Planning Roadmap" that outlines the lifecycle phases of the DCS hardware installed at the Holyrood TGS. The report contains two main findings:

- Most of the computer stations, servers, and network switches are either already obsolete or will be obsolete by February 2023; and
- The main control processors, FCP270 and ZCP270, were withdrawn from sales in 2017 and 2018, respectively, and will only receive guaranteed support from the OEM until January 2023.

The OEM identifies DCS hardware components as obsolete when they are no longer able to offer support, maintenance, repair, or replacements for them. This lack of support increases the probability of an extended outage if components fail during operation. For example, as the processors currently offered by the manufacturer are not hot swappable with the existing processors, an extended shutdown would be required to reprogram and test a new processor to ensure continued functionality.

Continued use of obsolete DCS hardware would negatively impact the post-steam reliability of the Holyrood TGS. Therefore, a planned approach to replacement is prudent.

4.0 Attachment

The report entitled "Upgrade Distributed Control System Hardware - Holyrood" (Volume II, Tab 8) contains further project details.

Project Title: Terminal Station Refurbishment and Modernization (2021–2022)
Location: Various
Category: Transmission and Rural Operations
Definition: Pooled
Classification: Normal

1.0 Project Description

Terminal stations play a critical role in the transmission and distribution of power across the province. Terminal stations contain electrical equipment such as transformers, circuit breakers, instrument transformers, disconnect switches, and all associated protection and control relays and equipment required to protect, control, and operate the province's electrical grid. Terminal stations act as transition points in the transmission system and interface points with the lower voltage distribution and generation systems. Newfoundland and Labrador Hydro ("Hydro") has 69 terminal stations across the Island and Labrador Interconnected Systems.

Hydro replaces or refurbishes failing or failed terminal station assets to ensure the delivery of safe, reliable, least-cost electricity in an environmentally responsible manner.

In the 2021 Capital Budget Application, Hydro proposes the following activities under the Terminal Station Refurbishment and Modernization project:

- Replacement of instrument transformers;
- Replacement of disconnect switches;
- Replacement of surge arrestors;
- Refurbishment and modernization of power transformers;
- Grounding upgrades;
- Refurbishment of equipment foundations;
- Installation of fire suppression systems in control buildings;
- Replacement of terminal station lighting;
- Replacement of battery banks and chargers; and

- Protection, control, and monitoring replacements and modernization.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2020**	**2021**	**Beyond**	**Total**
Material Supply	2,120.2	1,139.6	0.0	3,259.8
Labour	1,656.0	2,585.9	0.0	4,241.9
Consultant	815.0	746.1	0.0	1,561.1
Contract Work	852.7	1,487.7	0.0	2,340.4
Other Direct Costs	156.5	251.9	0.0	408.4
Interest and Escalation	110.5	420.6	0.0	531.1
Contingency	460.7	550.2	0.0	1,010.9
Total	**6,171.6**	**7,182.0**	**0.0**	**13,353.6**

The Terminal Station Refurbishment and Modernization project is a consolidation of various asset management programs for the refurbishment, replacement, or installation of terminal station assets. Descriptions of these assets and Hydro's asset management strategies are found in the "Terminal Station Asset Management Overview" ("Asset Management Overview").

The Terminal Station Refurbishment and Modernization project does not include projects related to growth or isolated issues for a particular terminal station; these projects are proposed separately.

Hydro will continue to maintain individual records with regards to the asset capital, maintenance and retirement expenditures, assessments, and performance.

2.0 Project Justification

Hydro replaces or refurbishes assets that have deteriorated, or pose a safety or environmental risk, such as those assets containing polychlorinated biphenyl ("PCB"). The replacement of such assets is required to ensure Hydro continues to deliver safe, reliable, least-cost electricity in an environmentally responsible manner. Further details on Hydro's philosophies for the assessment of equipment condition and selection and justification of projects can be found in the Asset Management Overview.

3.0 Future Plans

Hydro will submit a proposal for the Terminal Station Refurbishment and Modernization project on an annual basis.

4.0 Attachments

The reports entitled “Terminal Station Refurbishment and Modernization (2021–2022)” and “Terminal Station Asset Management Overview” (Volume II, Tab 9) contain further project details.

Project Title: Upgrade Circuit Breakers
Location: Various Locations
Category: Terminal Stations
Definition: Other
Classification: Normal

1.0 Introduction

Circuit breakers are critical components of the power system. Located in terminal stations, circuit breakers perform switching actions which are necessary to complete, maintain, and interrupt current flow under normal or fault conditions. The reliable operation of circuit breakers is essential to protect and maintain the stability of the power system.

This proposal is for the refurbishment and replacement of 46 kV, 66 kV, 138 kV and 230 kV circuit breakers. The refurbishment and replacement of the identified circuit breakers is required to ensure system reliability, safety, and compliance with federal environmental regulations related to removing polychlorinated biphenyls (“PCBs”),[1] which are present in the bushings of Newfoundland and Labrador Hydro’s (“Hydro”) oil circuit breakers.

The circuit breakers selected for refurbishment and replacement in 2021 and 2022 are part of Hydro’s long-term asset management plan for circuit breaker replacement and refurbishment. The circuit breakers proposed for refurbishment and replacement in this project were identified using a similar methodology as that reflected in Hydro’s previous 5-year Upgrade Circuit Breakers project, which was approved by the Board of Commissioners of Public Utilities (“Board”) in 2015 as part of Hydro’s 2016 Capital Budget Application.[2]

2.0 Project Description

This project includes the refurbishment and replacement of select 46 kV, 66/69 kV, 138 kV, and 230 kV circuit breakers.[3] Two refurbishments and five replacements are planned for 2021 and four

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[1] The *Canadian Environmental Protection Act* includes PCB Regulations (SOR/2008-273) which provide end-of-use dates for various concentrations of PCBs.

[2] Report provided in “2016 Capital Budget Application,” Newfoundland and Labrador Hydro, vol 2, tab 8. Approved in Board Order No. P.U. 33(2015).

[3] The three voltage levels of circuit breakers are 66/69 kV, 138 kV and 230 kV. 46 kV circuit breakers are in the same voltage class of equipment as 66/69 kV circuit breakers.

refurbishments and nine replacements are planned for 2022. The scope of work also includes upgrades to the station service at the Wabush Terminal Station to accommodate the new breakers.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	1,480.0	782.0	0.0	**2,262.0**
Labour	1,199.6	1,227.7	0.0	**2,427.3**
Consultant	468.0	755.2	0.0	**1,223.2**
Contract Work	1,724.0	2,392.0	0.0	**4,116.0**
Other Direct Costs	66.6	34.9	0.0	**101.5**
Interest and Escalation	233.6	662.6	0.0	**896.2**
Contingency	247.0	259.5	0.0	**506.5**
Total	**5,418.8**	**6,113.9**	**0.0**	**11,532.7**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Open project/initial planning/scheduling	January 2021	February 2021
Detailed Design (Year 1):		
Conduct site visits/complete detailed design	January 2021	February 2021
Procurement (Year 1):		
Order breakers		
Tender and award contract(s) for Year 1 overhauls		
Tender and award contract(s) for Year 1 breaker replacements		
Award consultant engineering contract(s) for Year 1	February 2021	April 2021
Construction/Commissioning (Year 1):		
Year 1 breaker replacements and overhauls	April 2021	October 2021
Detailed Design (Year 2):		
Conduct site visits		
Complete detailed design	November 2021	January 2022
Procurement (Year 2):		
Tender and award contract(s) for Year 2 overhauls		
Tender and award contract(s) for Year 2 breaker replacements		
Award consultant engineering contract(s) for Year 2		
Tender and award contract for the Wabush Terminal Station AC station service upgrades	February 2022	April 2022
Construction/Commissioning (Year 2):		
Year 2 breaker replacements and overhauls		
Wabush Terminal Station AC station service upgrades	April 2022	October 2022
Closeout:		
Project completion/closeout	November 2022	December 2022

3.0 Project Justification

This project is required for Hydro to provide safe, reliable electrical service, and to comply with federal PCB regulations. For reliability purposes, air blast circuit breakers will not be refurbished and are scheduled for replacement by 2023. To comply with federal PCB regulations, oil circuit breakers will not be refurbished and are scheduled for replacement prior to 2025. To ensure the appropriate balance between cost and reliability for customers, Hydro is focused on optimizing the useful life of its in-service sulphur hexafluoride circuit breakers. As such, refurbishment is typically scheduled after 20 years of service and replacement is planned to occur at approximately 40 years of service, depending on the condition and operational history of the circuit breaker.

4.0 Attachment

The report entitled "Upgrade Circuit Breakers - Various (2021–2022)" (Volume II, Tab 10) contains further project details.

Project Title: Distribution In-Service Failures, Miscellaneous Upgrades, and Street Light Modernization
Location: Various
Category: Transmission and Rural Operations
Definition: Pooled
Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") provides direct service to over 38,000 customers within its service area. The distribution system serving these customers requires normal upgrading of individual structures and equipment, including street lights, on an as-required basis to correct issues identified as a result of operational field inspections or storm damage. This is an annual single-year project[1] that provides a budget allotment based on past expenditures within the regions to address in-service failures of distribution equipment, required localized upgrades due to service deficiencies, and small-scale replacements due to storm damage.

Hydro is also proposing to include its street light modernization program in the scope of this project as the replacement of the remaining Mercury Vapor ("MV") and High Pressure Sodium ("HPS") street lights in Hydro's distribution system with Light Emitting Diode ("LED") street lights will be completed as part of Hydro's routine street light replacement work;[2] such work falls under the scope of distribution in-service failures and miscellaneous upgrades. Hydro has determined that the most cost-effective method of transitioning its existing street lights to LED street lights is to replace them during required visits as opposed to repairing or replacing the existing MV or HPS street light more immediately. Hydro expects it will take approximately six years to convert the remaining MV and HPS street lights on the Island Interconnected System using this approach.

2.0 Background

2.1 Distribution System

Hydro maintains its distribution system through regular preventive maintenance inspections. As a result of these inspections, defects are identified and individual replacements of structures or equipment are

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[1] This project was named "Upgrade Distribution Systems" in previous Capital Budget Applications.
[2] Typically, a Hydro line crew will visit a street light at least once over a six-year period to replace a bulb, ballast, or photocell.

sometimes required. In addition, storm damage can also necessitate replacement of distribution infrastructure.

Five-year historical expenditures under this annual project are provided in Table 1. Based on historical expenditures, Hydro forecasts an anticipated project estimate for the following year. In some cases, Contributions in Aid of Construction ("CIAC") are required and are applied under Hydro's CIAC Policy.

Table 1: Five-Year Historical Expenditures

Region	2015		2016		2017		2018		2019	
	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual
Central	1,720	1,887	1,870	1,877	1,870	1,671	1,870	1,706	1,910	2,015
Northern	1,210	730	880	993	1,120	924	880	1,079	890	716
Labrador	410	370	900	709	900	610	900	420	670	649
Total	**3,340**	**2,987**	**3,650**	**3,579**	**3,890**	**3,205**	**3,650**	**3,205**	**3,470**	**3,380**

2.2 Street lights

Hydro's distribution system includes approximately 7,700 street lights. Hydro has been using LED street lights in Ramea, Nain, and Cartwright which have yielded positive results (e.g., lower maintenance requirements, greater energy efficiency, and enhanced reliability and quality of lighting). Additionally, the price of LED street lights has decreased in recent years.

3.0 Project Justification

Hydro's historical expenditures related to in-service failures and upgrades on the distribution system have been relatively consistent as reflected in the 2015–2019 actual expenditures shown in Table 1. Deferral of this project is not viable as a certain level of expenditure is required annually to address failed equipment and service deficiencies to maintain reliable service to customers.

The capital investment to modernize street lights is justified based on the long-term cost savings and reliability benefits to customers. Hydro's proposal to replace MV and HPS street lights with LED street lights is consistent with Newfoundland Power's plan to transition to LED street lights and will result in reduced street and area light rates to Hydro's customers. Figure 1 provides the cumulated estimated costs of LED street lights compared to HPS street lights over 20 years.

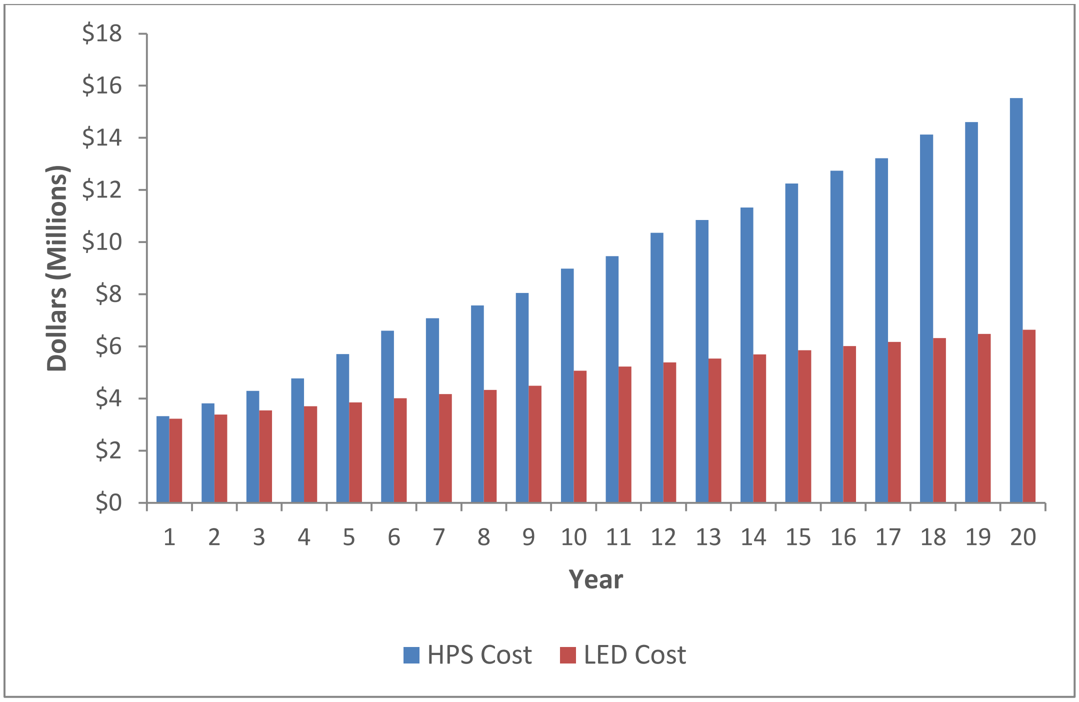

Figure 1: Cumulative Estimated 20-Year Cost Savings[3]

4.0 Project Description

The distribution in-service failures and miscellaneous upgrades portion of this project relates to annual expenditures required to upgrade the distribution system in response to in-service failures of equipment and the requirement to address localized service deficiencies, as well as small-scale infrastructure replacements due to storm damage.

The project also includes expenditures related to the replacement of existing street lights with LED street lights as Hydro works to complete the retirement of HPS and MV street lighting in its system.

Table 2 provides the estimate for this project. The portion of the budget related to distribution upgrades is approximately $3.3 million while street light modernization accounts for approximately $0.5 million in 2021.[4] Appendix A provides the total forecast cost of the street light modernization program; future year investments related to street light modernization will be proposed as part of the annual capital budget application process.

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[3] Including maintenance, energy consumption, and demand.

[4] TRO Northern: $124,828; TRO Central: $197,986; TRO Labrador: $188,777.

Table 2: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	2,262.5	0.0	0.0	**2,262.5**
Labour	1,312.8	0.0	0.0	**1,312.8**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	128.8	0.0	0.0	**128.8**
Other Direct Costs	2.8	0.0	0.0	**2.8**
Interest and Escalation	186.7	0.0	0.0	**186.7**
Contingency	0.0	0.0	0.0	**0.0**
Subtotal	**3,893.6**	**0.0**	**0.0**	**3,893.6**
Cost Recoveries	(90.0)	0.0	0.0	(90.0)
Total	**3,803.6**	**0.0**	**0.0**	**3,803.6**

The project estimate is shown by Transmission and Rural Operations ("TRO") region in Table 3.

Table 3: Estimate for 2021 Upgrade Distribution Systems ($000)

Region	Budget
Central	1,985.4
Northern	1033.5
Labrador	784.7
Total	**3,803.6**

5.0 Conclusion

This is an annual, single-year project which provides a budget allotment for correction of issues identified through operational inspections and for as-required upgrades to the distribution system. During the course of normal work on street lights in 2021, Hydro proposes to begin the systematic replacement of MV and HPS street lights on the Island Interconnected System with LED street lights as they provide cost savings over the life of the street light.

Appendix A

Distribution In-Service Failures, Miscellaneous Upgrades, and Street Light Modernization

Table A-1: Total LED Conversion Costs – All Regions

LED Fixture Size (W)	Fixture Count	Cost per LED ($)	Materials ($)	Labour ($)	Total ($)
100	6,415	170	1,090,550	1,283,000	2,373,550
150	746	300	223,800	149,200	373,000
250	485	400	194,000	97,000	291,000
400	40	600	24,000	8,000	32,000
				Total	**3,069,550**

Project Title: Wood Pole Line Management Program (2021)
Location: Various
Category: Transmission and Rural Operations - Transmission
Definition: Other
Classification: Normal

1.0 Introduction

The Wood Pole Line Management Program is an annual program that promotes early detection of deteriorated poles and other line components. Early detection is required to avoid potential safety hazards and identify poles that are at early stages of decay to ensure that corrective measures can be taken to extend the expected useful life of the poles. This program is a least-cost strategy to wood pole line management, as investments made in regular inspection and early detection of issues extends the useful life of the poles, supports the deferral of line reconstruction, and prevents forced outages.

2.0 Project Description

Under the Wood Pole Line Management Program, data from transmission line inspections is analyzed on an annual basis and recommendations are made, as required, for refurbishment or replacement of deteriorated line components including poles, structures, hardware, and conductors. Recommended work is generally completed in the subsequent year; however, in cases where components are deemed unable to last another year, Hydro replaces or refurbishes issues in the current year.

The purpose of the Wood Pole Line Management Program is to detect and treat deteriorating wood poles and line components before the integrity of the structures is jeopardized. If the deterioration of the structures or components is not detected early, the reduced integrity of the structure could affect the reliability of the line and present safety issues and hazards for Hydro personnel and the general public.

The Wood Pole Line Management Program inspection schedule generally schedules older lines first and works toward newer lines. The specific lines and the number of poles included in the program are reviewed on an annual basis and may be modified based on the following criteria: age; priority (radial or redundant); and known problems.

The project estimate shown in Table 1 includes the inspection and treatment of the lines identified for 2021 and the estimated costs of refurbishment or replacement of poles in 2021 which were identified through the 2020 inspections as requiring such work.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	159.3	0.0	0.0	**159.3**
Labour	1,709.1	0.0	0.0	**1,709.1**
Consultant	100.0	0.0	0.0	**100.0**
Contract Work	234.1	0.0	0.0	**234.1**
Other Direct Costs	479.9	0.0	0.0	**479.9**
Interest and Escalation	139.2	0.0	0.0	**139.2**
Contingency	75.3	0.0	0.0	**75.3**
Total	**2,896.9**	**0.0**	**0.0**	**2,896.9**

3.0 Project Justification

There are no alternatives to undertaking the activities outlined in this program. The program employs a balanced ten-year inspection cycle that includes inspection, treatment, and replacement, as required, following reliability-centered maintenance principles. Deferral of the program would be detrimental to program execution, effectiveness, and resource balancing.

In 2005, the Board determined that this approach was justified and prudent, stating:

> This approach is a more strategic method of managing wood poles and conductors and associated equipment and is persuaded that the new WPLM Program, based on RCM principles, will lead to an extension of the life of the assets, as well as a more reliable method of determining the residual life of each asset. One of the obvious benefits of RCM will be to defer the replacement of these assets thereby resulting in a direct benefit to the ratepayers.[1]

The Wood Pole Line Management Program is an important part of Hydro’s ongoing maintenance. It is aligned with Hydro’s responsibility to provide safe and reliable service to customers at the lowest possible cost. Therefore, Hydro proposes to continue the Wood Pole Line Management Program in 2021.

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[1] Board Order No. P.U. 53(2004) at p.23/13–18.

4.0 Attachment

The report entitled "Wood Pole Line Management Program (2021)" (Volume II, Tab 11) contains further project details.

Project Title: Diesel Genset Replacements (2021–2022)

Location: Nain

Category: Transmission and Rural Operations - Distribution Labrador

Definition: Other

Classification: Normal

1.0 Introduction

The community of Nain is located on the north coast of Labrador where Newfoundland and Labrador Hydro ("Hydro") provides electrical service to approximately 500 customers. Electricity is supplied by Hydro's diesel generating plant, which currently contains four diesel generating units ("gensets"); one rated at 860 kW, two rated at 865 kW, and one at 1,275 kW. The load profile in Nain has been increasing steadily over the past decade.

Unit 574 has a persistent overheating issue and has been derated from 865 kW to 550 kW. Hydro is proposing the replacement of Unit 574 to maintain reliable operation of the Nain Diesel Generating Station ("Nain DGS").

2.0 Project Description

This project is proposed to replace Unit 574 with a new 925 kW 1,200 rpm diesel genset. The project scope also includes a new exhaust stack, radiator, fuel cooler, aftercooler, switchgear with breaker, motor control center ("MCC") for station service upgrade, and all other equipment necessary to ensure reliable operation. Upgrades to some existing protection and control equipment will be required including additions to the MCC programmable logic controller ("PLC") Cabinet, modifications to the Main PLC and Human-Machine Interface configuration, and modification/testing of PLC logic.

The project estimate is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	973.5	0.0	0.0	**973.5**
Labour	680.6	341.3	0.0	**1,021.9**
Consultant	275.0	0.0	0.0	**275.0**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	301.7	0.0	0.0	**301.7**
Interest and Escalation	120.6	154.1	0.0	**274.7**
Contingency	209.2	29.6	0.0	**238.8**
Total	**2,560.6**	**525.0**	**0.0**	**3,085.6**

3.0 Project Justification

Unit 574 at Nain has been derated due to an overheating problem. After many consultations with the manufacturer and incurring repeated high maintenance costs with extended unit outages, Hydro has decided it is not feasible to continue operating this unit. Hydro proposes to forgo the next planned overhaul of Unit 574 and replace the genset as Hydro is not confident that another overhaul will fix the current overheating issue.

This project is required to meet Hydro's firm capacity criteria and maintain reliable operation of the Nain DGS.

4.0 Attachment

The report entitled "Diesel Genset Replacements" (Volume II, Tab 12) contains further project details.

Project Title: Wabush Terminal Station Upgrades
Location: Wabush
Category: Terminal Stations
Definition: Other
Classification: Normal

1.0 Introduction

This project involves the replacement of critical assets, transformers T4 and T5, as well the addition of a new capacitor bank to support Newfoundland and Labrador Hydro's ("Hydro's") ability to provide firm supply for customers in accordance with the criteria established for the transmission system in western Labrador.

2.0 Project Description

This project includes the replacement of two transformers, T4 and T5, with new 125 MVA units and the addition of one capacitor bank and associated equipment. The scope of work includes the following:

- Removal of existing 230/46 kV transformers T4 and T5;
- Purchase and installation of two, 230/46 kV, 75/100/125 MVA transformers, complete with on-load tap changers, and protection upgrades for T5;
- Purchase and installation of one, 23 MVar capacitor bank stage complete with grounding switches, inrush reactor, 72.5 kV, 2000 A, 40 kA circuit breaker including current transformers ("CT") and one 72.5 kV disconnect switch on Bus B1.
- Purchase and installation of new 4/0 ground grid, equipment grounds, and fence grounding;
- Purchase and installation of new conductors and cables required to interconnect equipment;
- Modifications to existing protection and control panels to accommodate the new transformers and capacitor bank;
- Modifications to existing Supervisory Control and Data Acquisition ("SCADA") system to add new capacitor bank;
- Purchase and Installation of electrical connectors, 2" aluminum bus, insulators, and conductors for new circuit breaker bay;

- All necessary civil work required to accommodate the new equipment and upgrades; and
- Engineering design study for capacitor bank addition.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	6.6	771.6	158.1	**936.3**
Labour	357.1	540.1	322.8	**1,220.0**
Consultant	0.0	23.1	0.0	**23.1**
Contract Work	1,560.8	2,626.2	2,863.9	**7,050.9**
Other Direct Costs	23.7	44.8	54.0	**122.5**
Interest and Escalation	116.0	434.0	605.1	**1,155.1**
Contingency	237.5	495.7	331.8	**1,065.0**
Total	**2,301.7**	**4,935.5**	**4,335.7**	**11,572.9**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Project setup activities	January 2021	March 2021
Design:		
Engineering design study for capacitor bank addition	March 2021	June 2021
Civil Engineering design for yard extension	January 2021	May 2021
Engineering design for T4 replacement	January 2022	April 2022
Engineering design for T5 replacement and protection upgrades	January 2023	April 2023
Procurement:		
Procurement of capacitor bank	July 2021	March 2022
Procurement of two, 125 MVA transformers	April 2021	June 2022
Construction:		
Civil construction contract	June 2021	October 2021
Transformer T4 replacement	July 2022	August 2022
Capacitor bank construction	July 2022	October 2022
Transformer T5 replacement	July 2023	August 2023
Commissioning:		
T4 commissioning	July 2022	August 2022
Capacitor bank commissioning	September 2022	October 2022
T5 commissioning	July 2023	August 2023
Closeout:		
Project closeout activities	October 2023	December 2023

3.0 Project Justification

This project is required to maintain reliable service to industrial customers in western Labrador and to meet forecasted load growth. The customer load in western Labrador is forecast to reach 379.9 MW by winter 2020–2021 and 383.3 MW by the end of the 25-year study period. The transfer capability of the existing Labrador West Transmission System in winter is 350 MW under normal operating conditions with all of Hydro’s assets in service. Under existing system conditions, power supplied to the Iron Ore Company of Canada and Wabush Mines must be limited such that the total coincident peak for the system does not exceed 350 MW.

4.0 Attachment

The report entitled “Wabush Terminal Station Upgrades” (Volume II, Tab 13) contains further project details. Attachment 3 provides details related to the proposed project and how it will support reliable supply for customers in western Labrador in consideration of a 25-year load forecast.

Project Title: Terminal Station In-Service Failures
Location: Various
Category: Transmission and Rural Operations - Terminal Stations
Definition: Other
Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") conducts asset management activities to proactively identify, replace, repair, or refurbish equipment to minimize the disruption of service and to avoid unsafe working conditions due to equipment failure. An objective of Hydro's Asset Management Program is to identify refurbishment and replacement activities that require approval by the Board of Commissioners of Public Utilities in time to be included in its annual Capital Budget Application. The identification is done through the preventive maintenance program using various condition based assessments and testing procedures.

Hydro has had success in projecting the deterioration rate of equipment for submission of refurbishment or replacement work into capital budget applications. However, there are situations where immediate refurbishment or replacement must be completed due to the occurrence of an actual failure, the identification of an incipient failure, or determination of faster than anticipated equipment deterioration. These situations can be caused by events such as: vandalism; storm damage; lightning; accidental damage; abnormal electrical system operations; corrosion; etc.

Hydro is proposing that within this project it will undertake the immediate capital refurbishment and replacement work[1] required for Terminal Stations to maintain safe and reliable operation and to ensure the availability of capital spares[2] required to support such work. These activities will be undertaken in accordance with the philosophies outlined throughout the "Terminal Station Asset Management Overview" (see Volume II, Tab 9). Examples of the activities that may be undertaken in this project are

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[1] This work will not include actions that more appropriately can be executed as Unforeseen or Capital Budget Supplemental projects.

[2] Capital spares are major spare parts that meet the definition of capital assets that are kept on hand to be used in the event of an unexpected breakdown or failure of equipment thereby expediting the return of the equipment to service. Capital spares are important in reducing periods of interruption in the generation and transmission of electricity.

outlined in Appendix A. Hydro uses historical data and the judgement of asset management personnel to predict the magnitude of the Terminal Station In-Service Failures project budget.

2.0 Background

2.1 Operating Experience

The 2019 Terminal Station In-Service Failures project consisted of 14 corrective actions with a total expenditure of approximately $1.7 million. The corrective actions are detailed in Appendix A.

3.0 Project Justification

Due to the nature of Terminal Station systems and equipment, unanticipated failures and deterioration will occur. This project provides an effective and timely means to undertake the immediate capital refurbishment and replacement work required for Terminal Stations to maintain safe and reliable operation and to ensure the availability of capital spares required to support such work.

Deferral of work that is justified under this project could result in a detrimental impact to customer power supply or an unacceptable risk to worker or public safety.

4.0 Project Description

Hydro is proposing to undertake the immediate capital refurbishment and replacement work required for its Terminal Stations to maintain safe and reliable operation and to ensure the availability of capital spares required to support such work. At this time, Hydro does not have any planned capital spare acquisitions; however, throughout 2021, Hydro may purchase capital spares identified by asset management personnel as requiring immediate procurement to offset deficiencies in its capital spares.

The estimate for this project is shown in Table 1. Hydro has reassessed the Terminal Station In-Service Failures project budget for 2021 based on the average of the actual expenditures from 2018[3] and 2019[4] and the approved Terminal Station In-Services Failures project budget for 2020[5] and increased the budget from the $1.5 million proposed and approved in the 2020 CBA.

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[3] Approximately $2.3 million.
[4] Approximately $1.7 million.
[5] Approximately $1.5 million.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	1,146.4	0.0	0.0	1,146.4
Labour	259.4	0.0	0.0	259.4
Consultant	100.8	0.0	0.0	100.8
Contract Work	200.0	0.0	0.0	**200.0**
Other Direct Costs	14.2	0.0	0.0	**14.2**
Interest and Escalation	79.2	0.0	0.0	**79.2**
Contingency	0.0	0.0	0.0	**0.0**
Total	**1,800.0**	**0.0**	**0.0**	**1,800.0**

As there is no planned refurbishment or replacement work or capital spares acquisitions, no project schedule is provided for those activities.

Work executed under this project in 2021 will be reported to the Board of Commissioners of Public Utilities in Hydro's 2021 Capital Expenditures and Carryover Report, and also provided in 2022 as part of the 2023 Capital Budget Application.

5.0 Conclusion

The Terminal Station In-Service Failures project allows Hydro to undertake timely refurbishment and replacement work that is not included in its preventive maintenance program, supporting Hydro's effort to maintain safe and reliable operations. This project will also allow Hydro to continue to proactively manage the pool of capital spare equipment to support terminal station operations.

Appendix A

2019 In-Service Failure Activities

Table A-1: 2019 In-Service Failure Activities

Project Title and Location	Expenditure ($000)	Failure Identified	Project Scope
Circuit Breaker B3T5 Replacement Bay d'Espoir Terminal Station 1	466.2	Unit 5 at Bay d'Espoir was being prepared for synchronization with both sides of circuit breaker B3T5 being energized. Before automatic synchronization was initiated, the system experienced a B Phase voltage dip of approximately 20 to 30 kV and Transformer T5 tripped an overcurrent relay. The overcurrent relay then commanded breaker B3T5 to open, but it was already in the open position. As a result, breaker failure protection operated and cleared Bus 3 (1.3 seconds later) which included both Unit 5 and Unit 6. Upon further review of the fault records it was determined the breaker had passed current on phase B indicating an internal flash over. Further Doble testing, SF_6 gas quality testing and follow up with the original equipment manufacturer's engineering team confirmed there was an internal flashover of phase B and the breaker required replacement.	Breaker B3T5 was replaced. The original equipment manufacturer refurbished the failed circuit breaker at a cost to Hydro of only the transportation to and from the factory. The refurbished breaker will serve as a spare.
Circuit Breaker B3T6 Replacement Bay d'Espoir Terminal Station	386.0	While taking Bay d'Espoir Unit 6 off line during a controlled shutdown, breaker failure protection for breaker B3T6 operated causing Bus 3 to clear (0.2 seconds later) and Unit 5 to come offline. When breaker B3T6 was opened, the system experienced a C-Phase fault on the breaker. Upon further review of the fault records, it was determined that breaker B3T6 had passed current on phase C indicating a possible internal flashover. Further doble testing, SF_6 gas quality testing and follow up with the original equipment manufacturer's engineering confirmed there was an internal flashover of phase C and immediate replacement was required.	Breaker B3T6 was replaced. The original equipment manufacturer refurbished the failed circuit breaker at no cost to Hydro. The refurbished breaker will serve as a spare.
Circuit Breaker B2T4 Replacement Bay d'Espoir Terminal Station	354.2	Bay d'Espoir Unit 4 was being prepared for synchronizing with both sides of B2T4 being energized. During synchronization the system experienced a voltage dip on A-Phase and tripped transformer T4 overcurrent relay. The overcurrent relay then commanded breaker B2T4 to open	Breaker B2T4 was replaced. The original equipment manufacturer will refurbish the failed circuit breaker at no cost to Hydro. The refurbished breaker will be used at an alternate

Project Title and Location	**Expenditure ($000)**	**Failure Identified**	**Project Scope**
		but it was already in the open position. As a result, breaker failure protection operated and cleared Bus 2 which included both Unit 4 and Unit 3. Upon further review of the fault records it was determined breaker B2T4 had passed current on phase A in the open position indicating a possible internal flashover. Further SF_6 gas quality testing of A-Phase showed SO_2 in the gas which also indicates that the breaker had an internal fault. An original equipment manufacturer technician was onsite and breaker B2T4 was opened for inspection; it was confirmed that A-Phase had experienced an internal fault.	location under the Breaker Replacement Program.
Station Service Transformer SS2 Replacement Wabush Terminal Station	192.9	Station Service Transformer SS2 failed due to an internal fault. The fault resulted in damage that open-circuited phases of the winding. This station service transformer required replacement in order to restore station service transformer redundancy and also provide a grounding source for Bus 15 and Bus 16. In the Wabush Terminal Station, with one station service transformer out of service and the grounding source removed from Bus 15 and Bus 16, the tie breaker must be closed resulting in only one Synchronous Condenser being operational. This in turn causes a reduction in the load that can be supplied to Labrador West and possible load restrictions to Iron Ore Company of Canada.	Wabush Terminal Station Service Transformer SS2 was replaced.
Purchase Spare Current Transformers ("CT") for Churchill Falls	92.6	One spare 230 kV CT and one spare 230 kV current transformer/power transformer ("CT/PT") combination unit is required for the standby equipment pool due to the long lead time to acquire these units from the manufacturer. Acquisition of a replacement unit could take up to 18 months. This delay could result in long-term outage to customers and reduced system reliability.	One spare 230 kV CT and one spare 230 kV CT/PT combination unit were purchased for the standby equipment pool.
Disconnect Switch L12-1/L12-G1 Replacement	86.4	138 kV L12-1/L12-G1 disconnect switch had a damaged ground switch which was unrepairable. The disconnect switch was 50 years old and replacement parts were not	138 kV L12-1/L12-G1 disconnect switch was replaced.

Project Title and Location	Expenditure ($000)	Failure Identified	Project Scope
Bay L'Argent Terminal Station		readily available. Replacement of this disconnect switch with a spare disconnect from the standby equipment pool was required.	
69 kV Breaker Refurbishment Hawke's Bay Terminal Station	56.6	B1L21 is a 69 kV circuit breaker that was identified as leaking SF_6 gas to atmosphere. This is an environmental concern as SF_6 is a potent greenhouse gas. As well, leaking gas could result in a flashover of the breaker or a catastrophic failure resulting in loss of service to customers and compromising the integrity of the electrical system in the area.	69 kV breaker B1L21 was refurbished.
X1 Surge Arrestor Replacement Bottom Brook Terminal Station	28.4	Surge arrester X1 on Bottom Brook transformer T1 failed on June 19, 2019 causing loss of power to the terminal station leaving customers in Burgeo, Doyles, and Stephenville area without power for approximately 4 hours. Transformer T3 was brought online to restore power to the affected customers. Immediate replacement of the arrester was required to get T1 back into service. There was no obvious reason for this failure. Engineering review identified that an appropriate overvoltage rating for the surge arrestors in this installation is 115 kV, whereas existing arresters are rated for 98 kV. It was therefore recommended that all three surge arrestors be replaced (X1, X2, and X3) to avoid a repeat event on the other phases.	X1, X2, and X3 surge arresters on Transformer T1 were replaced.
TL207 A-Phase Capacitive Voltage Transformer Replacement Sunnyside Terminal Station	19.0	During a scheduled TL 207 Outage, Doble Testing was performed on all three Capacitive Voltage Transformers. Test results were good. On re-energization of TL 207, the A-Phase Capacitive Voltage Transformer failed across its surge suppression device, burning open and melting/heating adjacent wiring and sealing gland plate. Immediate replacement was required to restore TL 207.	TL207 A-Phase Capacitive Voltage transformer was replaced.
Transformer T5 B-Phase Potential Transformer Replacement	16.1	During scheduled 6 year maintenance, Doble Testing revealed elevated Power Factor values that were two to three times expected values on Transformer T5 B-Phase potential Transformer. Thorough cleaning	Transformer T5 B-Phase Potential Transformer was replaced.

Project Title and Location	Expenditure ($000)	Failure Identified	Project Scope
Holyrood Terminal Station		and multiple tests were run to confirm results. A comparison was completed of four similar units on Hydro's system (same type, same vintage), that further showed this unit to be failing. Immediate replacement was required to restore 69 kV Bus 7 and Transformer T5 to full function.	
Compressor Replacement Grand Falls Converter Station	14.5	Grand Falls Converter Station Compressor A failed and was damaged on January 10, 2019. An assessment concluded that it was not repairable and must be replaced.	A direct replacement compressor was purchased and installed.
L34T1 A-Phase Current Transformer Replacement Upper Salmon Terminal Station	14.0	During an outage to Upper Salmon L34T1, an oil leak was identified under L34T1 A-Phase CT. Immediate replacement was required to prevent equipment failure, customer outage and/or collateral damage to other equipment.	L34T1 A-Phase CT was replaced.
B1L39 A-Phase Current Transformer Replacement Deer Lake Terminal Station	12.1	B1L39, a 138 kV current transformer at Deer Lake Terminal Station installed in 1977, was identified as leaking oil. Immediate replacement was required to prevent equipment failure and possible outage and/or collateral damages to other equipment.	B1L39 A-Phase CT was replaced.
Transformer T2 Surge Arrester Replacement St. Anthony Diesel Plant	5.6	The H2 Surge Arrester on transformer T2 at the St. Anthony Diesel Plant failed on September 30, 2019 causing loss of the availability of power from the diesel generating units. Immediate replacement was required to return transformer T2 to service and allow Hydro to utilize diesel generation to complete a major outage planned for Oct 2, 2019.	H2 Surge Arrester on Transformer T2 was replaced.

Project Title:	Upgrades for Future Retirement of Stephenville Gas Turbine
Location:	Bottom Brook and Stephenville Terminal Stations
Category:	Transmission and Rural Operations
Definition:	Clustered
Classification:	Normal

1.0 Introduction

Under normal operation, customer loads in the Stephenville area are supplied at the Stephenville Terminal Station via the 230 kV transmission line TL 209. Newfoundland Power operates a 66 kV transmission network that is used to supply individual customers. If an outage is experienced on transmission line TL 209 or Stephenville Terminal Station transformer T3 during peak conditions, Newfoundland and Labrador Hydro (“Hydro”) operates the 50 MW Stephenville Gas Turbine to supply customer load. Under light load conditions, the Stephenville area can be supplied via Newfoundland Power’s 66 kV network between the Bottom Brook Terminal Station and the Stephenville Terminal Station; however, under heavy load conditions, the Bottom Brook Terminal Station transformer T2 does not have the capacity to supply the Stephenville area without the support of the Stephenville Gas Turbine. Therefore, a transformer or transmission line outage after the retirement of the Stephenville Gas Turbine, which is scheduled to occur in 2022, could result in unserved energy. Such an exposure is a violation of Hydro’s Transmission Planning Criteria.[1]

Upgrades are required at the Bottom Brook Terminal Station and Stephenville Terminal Station to minimize the risk of customer outages due to a transformer or transmission line failure. These upgrades include: (i) the addition of a power transformer and associated equipment at the Bottom Brook Terminal Station, (ii) grounding system modifications at the Bottom Brook Terminal Station and the Stephenville Terminal Station, and (iii) the reconfiguration of the Stephenville Terminal Station due to the removal of transformer T1 and the installation of a second station service supply.

2.0 Project Description

The scope of work includes the design, procurement, construction, and commissioning of equipment in the Stephenville Terminal Station and the Bottom Brook Terminal Station required to supply customers

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[1] When the Stephenville Gas Turbine is removed from service, customers in the Stephenville–Bottom Brook loop will be the only customers within a looped network in the Island transmission system with an exposure for unserved energy resulting from a transformer or transmission line outage. In all other looped networks, such an exposure would be considered a violation to the Transmission Planning Criteria.

in the Stephenville area during an outage to either Stephenville Terminal Station transformer T3 or transmission line TL 209 after the retirement of the Stephenville Gas Turbine.

The scope of work includes the following:

- Bottom Brook Terminal Station:
  - Installation and assembly of spare 230/66 kV, 40/53.3/66.7 MVA transformer in Bottom Brook Terminal Station;
  - Procurement and installation of:
    - A transformer oil containment system;
    - One, 230 kV, 1200 A circuit breaker;
    - One, 72.5 kV, 2000 A circuit breaker;
    - Two, 230 kV, 1200 A motor operated disconnect switches;
    - Three, 72.5 kV, 1200 A disconnect switches;
    - Three, 72.5 kV potential transformers;
    - 66 kV underground cables; and
    - Power and control cables for new equipment;
  - Relocation and installation of one 72.5 kV, 2000 A circuit breaker;
  - Protection, control, and communications upgrades for new equipment;
  - Removal of existing concrete foundations;
  - Installation of concrete foundations for new equipment;
  - Installation of buswork and take off structures including overhead conductor; and
  - Commissioning of new equipment.
- Stephenville Terminal Station:
  - Removal of two, 72.5 kV circuit breakers;
  - Removal of five, 72.5 kV disconnect switches;
  - Electrical isolation of Stephenville transformer T1;

  - Procurement and installation of:
    - One, 66/0.6 kV grounding transformer;
    - One, 72.5 kV power fuses; and
    - Power and control cables for new equipment;
  - Installation of concrete foundations for new equipment;
  - Protection, control and communications upgrades for new equipment;
  - Modification of buswork; and
  - Commissioning of new equipment.

The project estimate is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2020	2021	Beyond	Total
Material Supply	410.0	2,034.0	0.0	**2,444.0**
Labour	677.9	814.8	0.0	**1,492.7**
Consultant	92.0	312.8	0.0	**404.8**
Contract Work	0.0	3,225.4	0.0	**3,225.4**
Other Direct Costs	40.3	89.4	0.0	**129.7**
Interest and Escalation	66.1	617.8	0.0	**683.9**
Contingency	244.0	1,295.3	0.0	**1,539.3**
Total	**1,530.3**	**8,389.5**	**0.0**	**9,919.8**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Scope, schedule, cost, risk, quality and communications planning	January 2021	February 2021
Design:		
Site visit, engineering design, outage scheduling	March 2021	March 2022
Procurement:		
Specify and order materials, tender and awarding of contracts	May 2021	July 2022
Construction:		
Installation of new equipment	May 2022	November 2022
Commissioning:		
Commissioning of new equipment	August 2022	November 2022
Closeout:		
As-built drawing review, project financial closeout, post implementation review	November 2022	December 2022

3.0 Project Justification

Hydro intends to retire the Stephenville Gas Turbine in 2022. After the retirement of the Stephenville Gas Turbine, the existing configuration of supplying Stephenville area customers via Bottom Brook Terminal Station transformer T2 and Newfoundland Power transmission line 400L will not provide full back up capacity. Without the Stephenville Gas Turbine in service, the loss of 230 kV transmission line TL 209 and/or Stephenville Terminal Station transformer T3 could result in customer interruption and/or outages and is a violation of the Transmission Planning Criteria. This project is required to maintain customer reliability.

4.0 Attachment

The report entitled “Upgrades for Future Retirement of Stephenville Gas” (Volume II, Tab 14) contains further project details.

Project Title: Provide Service Extensions (2021)

Location: Various

Category: Transmission and Rural Operations - Distribution

Definition: Pooled

Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") provides direct service to over 38,000 customers within its service areas. Hydro provides service hookups on an as-required basis using customer-driven service requests. This is a single-year project to provide an annual allotment for new service connections and street lights,[1] based on past expenditures and forecasted activity within the regions.

2.0 Background

Hydro receives service requests for residential and general service, driven by local growth and activity within Hydro's three service regions: Central, Northern, and Labrador. Service requests can include residential developments, the addition of cabin developments, and new business developments. Each customer requires interconnection to the local distribution service system. Service requests are received by Hydro's Customer Service Team and plans are developed by the local regions to provide the service extensions required to meet the service requests. In some cases, Contributions in Aid of Construction ("CIAC") are required, and are applied under Hydro's CIAC Policy.

Five-year historical expenditures under this annual project are provided in Table 1.

Table 1: Five Year Historical Expenditures ($000)[2]

Region	2015		2016		2017		2018		2019	
	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual
Central	1,600	1,437	1,751	1,842	1,750	1,531	1,660	1,103	1,810	1,074.9
Northern	1,460	1,371	1,218	1,498	1,470	1,623	1,270	1,220	1,460	1,037.3
Labrador	3,020	2,198	2,720	1,242	1,930	1,522	1,590	1,297	1,430	1,265
Total	**6,080**	**5,006**	**5,689**	**4,582**	**5,150**	**4,675**	**4,520**	**3,620**	**4,700**	**3,377.2**

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[1] New streetlights installed are the Light Emitting Diode ("LED") type.

[2] Numbers may not add due to rounding.

3.0 Project Justification

In recent years, Hydro has seen an overall decline in the requirement for service extensions on the distribution system, as reflected in the actual expenditures from 2015 to 2019 shown in Table 1. The proposed project estimate, as provided in Table 2, is based on an analysis of the historical expenditures within the past five years for the provision of service extensions by region, supplemented with regional planning input regarding anticipated future activity levels. The project estimate by region is shown in Table 3.

While Hydro will plan the work under this project as efficiently as possible, Hydro is obligated to provide the requested services and deferral is not an option.

4.0 Project Description

This is a single-year project to provide an annual allotment for new service connections and street lights, based on past expenditures and forecasted activity within the regions. Specific details regarding the actual activity are not available.

Table 2: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	1,910.7	0.0	0.0	1,910.7
Labour	1,623.4	0.0	0.0	1,623.4
Consultant	0.0	0.0	0.0	0.0
Contract Work	126.1	0.0	0.0	126.1
Other Direct Costs	100.3	0.0	0.0	100.3
Interest and Escalation	180.0	0.0	0.0	180.0
Contingency	0.0	0.0	0.0	0.0
Subtotal	**3,940.5**	**0.0**	**0.0**	**3,940.5**
Cost Recoveries	(200.0)	0.0	0.0	(200.0)
Total	**3,740.5**	**0.0**	**0.0**	**3,740.5**

Table 3: Estimate for 2021 Service Extensions ($000)

Region	Budget[3]
Central	1,357.4
Northern	1,164.5
Labrador	1,218.6
Total	**3,740.5**

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[3] Net of costs recovered through CIAC.

5.0 Conclusion

Hydro provides service hookups on an as-required basis using customer-driven service requests in its service areas. This project is an annual allotment, adjusted from year to year depending on historical expenditures, for Hydro's connection of new residential and general service requests.

Project Title: Overhaul Diesel Units (2021)
Location: Various
Category: Transmission and Rural Operations - Generation
Definition: Pooled
Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro's ("Hydro") diesel unit overhaul plan has been developed to ensure the reliability of diesel units at its diesel generating stations. Hydro has 23 diesel generating stations, 19 of which are prime power stations serving a total of approximately 4,400 customers. To support reliable operation of diesel engines, major overhauls are required periodically to achieve the expected service lives and provide reliable operation. This includes overhaul of diesel unit alternators, which are typically required only once in the lifetime of the generating set.

Hydro overhauls 1,200 rpm engines after 30,000 hours of operation with replacement after 120,000 hours. Engines that operate at 1,800 rpm are overhauled after 20,000 hours of operation with replacement after 100,000 hours. Hydro has determined, based upon the cost of replacement parts, that it may be cost comparable to replace the engine instead of overhauling it, if an engine is available with acceptable delivery. If an overhaul occurs it will include replacement or refurbishment of such items as:

- Pistons;
- Liners;
- Main bearings;
- Connecting rod bearings;
- Fuel injectors;
- Oil cooler;
- Turbo charger;
- Water pump;
- Oil pump;

- Cylinder heads;
- Fuel lines;
- Fuel pumps; and
- Gaskets.

As the costs of parts can fluctuate, in 2021 Hydro will assess and execute the least-cost alternative for each of the engines requiring overhaul.

2.0 Project Description

This project will overhaul the following diesel engines:

- Grey River 2067;
- Black Tickle 582;
- Mary's Harbor 2090;
- Cartwright 2086;
- Rigolet 2081; and
- Hopedale 2054.

In addition, Rigolet 2081 will have its alternator overhauled:

Occasionally, a unit in one of the diesel plants experiences an issue that necessitates an unplanned overhaul, or reaches the number of operating hours that requires an overhaul earlier than anticipated. Where appropriate, Hydro may complete such an overhaul under this project and, if possible, defer one of the units planned for completion in 2021.

The project estimate is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	790.0	0.0	0.0	**790.0**
Labour	211.8	0.0	0.0	**211.8**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	10.0	0.0	0.0	**10.0**
Other Direct Costs	65.0	0.0	0.0	**65.0**
Interest and Escalation	48.4	0.0	0.0	**48.4**
Contingency	107.7	0.0	0.0	**107.7**
Total	**1,232.9**	**0.0**	**0.0**	**1,232.9**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Schedule annual overhauls	February 2021	September 2021
Procurement:		
Purchase overhaul components	March 2021	October 2021
Installation:		
Complete overhaul	April 2021	November 2021
Commissioning:		
Testing after overhaul	April 2021	November 2021
Closeout:		
Release for service and asset assignment	December 2021	December 2021

3.0 Project Justification

Hydro's diesel generating stations are isolated and in most cases are the sole sources of power to the community. Hydro's current maintenance philosophy is to complete an engine overhaul on 1,800 rpm diesel engines every 20,000 hours, and 30,000 hours for 1,200 rpm units. Performing overhauls too frequently results in additional expenditure for negligible improvement in reliability. The overhaul intervals are considered to be the optimum interval for providing least-cost, reliable electrical service.

4.0 Attachment

The report entitled "Overhaul Diesel Units - Various (2021)" (Volume II, Tab 15) contains additional project details.

Project Title: Additions for Load - Wabush Substation Upgrades
Location: Wabush Substation
Category: Terminal Stations
Definition: Other
Classification: Normal

1.0 Introduction

The Wabush Substation provides power to the town of Wabush. Load forecasts indicate that this substation requires upgrades to ensure it has the capacity to meet the forecasted peak loads. These upgrades will also improve the reliability of this substation. These upgrades include the addition of transformer capacity, the installation of breakers and other electrical equipment, the installation of a Supervisor Control and Data Acquisition ("SCADA") system, the replacement of the control building, and distribution system upgrades.

This project is required to ensure a reliable supply to the Wabush Substation customers.

2.0 Project Description

This is a three-year project to complete a number of upgrades within the Wabush Substation. The project consists of the following:

- Removal of 46/12.5 kV transformers T3 and T5. Transformers to be stored for possible future use;
- Removal of all manual disconnect switches associated with transformers T3 and T5;
- Removal of 46 kV circuit breaker WA36-CB1, associated disconnects, bypass switch, and surge arrester;
- Purchase and installation of one, 46/4.16-12.5 kV, 20/26.7 MVA transformer complete with on-load tap changer ;
- Upgrades to 12.5 and 46 kV bus work, including the replacement of any 1/0 conductor 46 kV bus work with 4/0 conductor;
- Purchase and installation of three, 2000 A, 15 kV vacuum circuit breakers complete with two sets of current transformers ("CT") for secondary of each power transformer;

- Purchase and installation of one, 2000 A, 15 kV vacuum circuit breaker complete with two sets of CTs and two disconnect switches;
- Purchase and installation of three, 46 kV motor operated disconnect switches to be located between bus B4 and the three transformers;
- Purchase and installation of three, 12.5 kV disconnect switches to be located between bus B5 and transformer T6 and between bus B3 and transformers T4 and T7;
- Purchase and installation of six sets of surge arresters to be installed on each side of transformers T4, T6 and T7;
- Purchase and installation of new 72.5 kV, 2000 A SF_6 breaker complete with two sets of CTs, two motor-operated disconnect switches (one with a line to ground switch), and a bypass-fused disconnect switch to replace WA36-CB1;
- Purchase and installation of one 400 A, 12.5 kV voltage regulator bank to be installed on feeder L13;
- Purchase of one spare 400 A voltage regulator;
- Purchase and installation of a gang-operated disconnect switch to serve as a tie switch between feeder L11 and feeder L13;
- Purchase and implementation of a SCADA system;
- Purchase and installation of protection and control equipment including transformer protection panels, bus protection panel, feeder protection panel, and battery banks and chargers;
- Replacement of the control building and integration of the Automated Metering Equipment to the new control building;
- Upgrades to the station grounding; and
- All necessary civil work required to accommodate the new equipment and upgrades.

1 The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	2023	Total
Material Supply	120.0	1,736.2	547.1	**2403.3**
Labour	325.9	391.0	356.6	**1,073.5**
Consultant	0.0	188.8	206.8	**395.6**
Contract Work	577.8	3,018.3	1,146.9	**4,743.0**
Other Direct Costs	7.5	39.9	48.8	**96.2**
Interest and Escalation	52.5	453.4	404.7	**910.6**
Contingency	103.0	537.5	230.7	**871.2**
Total	**1,186.7**	**6,365.1**	**2,941.6**	**10,493.4**

2 The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning: Open project and review schedule	January 2021	February 2021
Design: Conduct site visits and complete detailed design	February 2021	March 2021
Procurement 1: Order long lead items and tender and award contracts	April 2021	May 2021
Construction/Commissioning (Year 1): Complete yard extension and order and install voltage regulators	June 2021	September 2021
Procurement 2: Order long lead items for upcoming year and tender and award contracts	October 2021	February 2022
Construction/Commissioning (Year 2): Install power transformer, 46 kV breaker, and disconnect switches, and install control building	May 2022	October 2022
Procurement 3: Order long lead items for upcoming year and tender and award contracts	October 2022	February 2023
Construction/Commissioning (Year 3): Install low voltage breakers and disconnect switches, complete communication upgrades, and remove old control building	May 2023	October 2023
Closeout: Project closeout	November 2023	December 2023

3.0 Project Justification

The substation has a total installed capacity (at 25°C ambient) of 37.3 MVA. The firm transformation capacity (this is the total station capacity less the transformer with the largest rating) of the substation is 20.6 MVA. Load forecasts indicate that the peak demand for the Wabush Substation is expected to reach 22.3 MW by the winter of 2021. The substation's firm capacity has already been exceeded by approximately 10%, and load forecasts predict that peak loads will increase.

If a transformer at the Wabush Substation were to fail under peak load conditions, there would be serious impacts to the customers supplied from this substation. If the failure occurred during the winter peak load, the installation of a spare transformer (T5) would be hampered due to the cold temperatures experienced in this area. The installation of the spare would still leave the station with a deficit of capacity, and peak loading would require rotating customer outages.

The replacement of a failed transformer is a lengthy process, which generally requires 12–24 months from the time the project is sanctioned.

In addition to the concerns with the transformer capacity, this substation lacks the modern protection equipment used to permit the isolation of electrical faults. Therefore, customers on multiple feeders would be affected by faults within the station. This substation also lacks the modern communication equipment used to provide detailed real time loading and status of the equipment throughout the station. This information provides operational data and assists with trouble shooting and investigations of issues when anomalies occur.

4.0 Attachment

The report entitled "Additions for Load - Wabush Substation Upgrades" (Volume II, Tab 16) contains further project details.

Project Title: Addition for Load Growth - Happy Valley Line 7
Location: Transmission and Rural Operations - Labrador
Category: General Properties
Definition: Other
Classification: Normal

1.0 Introduction

Recent load growth in North West River and Sheshatshiu, served by the Happy Valley Distribution System in Labrador East, has caused voltage regulators HV7-VR1 and HV7-VR3 to operate above their planning rating during periods of peak load. This equipment overload reduces the reliability of the distribution system as overloaded equipment is at a higher risk of failure. This project is being proposed to accommodate the forecasted load growth on the system and ensure continued reliability of the distribution system.

2.0 Project Description

This project involves replacing the two 200 A voltage regulator banks on Line 7, HV7-VR3 and HV7-VR2, with 300 A voltage regulators. This project will add approximately 3,000 kW of capacity to Line 7 before the voltage regulation limits of the regulators are reached. Based on the current load growth expectations this excess capacity will be able to support the growing load for at least the next 10 years. Figure 1 shows a picture of a typical set of 200 A voltage regulators used by Newfoundland and Labrador Hydro ("Hydro").

Figure 1: Typical Hydro 200 A Voltage Regulator Bank

The project estimate is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	300.0	0.0	0.0	**300.0**
Labour	120.3	0.0	0.0	**120.3**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	100.0	0.0	0.0	**100.0**
Other Direct Costs	13.1	0.0	0.0	**13.1**
Interest and Escalation	29.2	0.0	0.0	**29.2**
Contingency	53.5	0.0	0.0	**53.5**
Total	**617.6**	**0.0**	**0.0**	**617.6**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	**Start Date**	**End Date**
Planning: Project start-up	February 2021	February 2021
Design: Engineering/field assessment/contract administration	February 2021	July 2021
Procurement: Materials procurement	March 2021	June 2021
Construction: Monitor construction activities	July 2021	July 2021
Commissioning: Inspection performed by local operations crews	August 2021	August 2021
Closeout: Project closeout	August 2021	September 2021

3.0 Project Justification

This project is justified on the requirement to meet the growing electricity needs of Hydro’s customers on Line 7 of the Happy Valley Distribution System, while ensuring reliable operation of distribution equipment. Based on recent load readings Hydro has determined that two sets of voltage regulators on Line 7 are operating above their equipment rating at peak. Two alternatives were considered to eliminate this overload condition and it was determined that replacing the regulators was the least cost alternative.

4.0 Attachment

The report entitled “Addition for Load Growth - Happy Valley Line 7” (Volume II, Tab 17) contains further project details.

Project Title: Labrador City L22 Voltage Conversion

Location: Labrador City

Category: Transmission and Rural Operations

Definition: Other

Classification: Normal

1.0 Introduction

The Cooper Hill Substation, located in Labrador City, supplies 4.16 kV power via distribution line 22 ("L22") which services the Labrador Mall and approximately 35 residential customers. L22 is the only distribution line originating from the Cooper Hill Substation, where the voltage is stepped down through transformer T1 from 46 kV to 4.16 kV. In the event of a failure of Cooper Hill T1 it is estimated that restoration of L22 would take approximately one week.

2.0 Project Description

This project involves converting the voltage of L22 to 25 kV, and connecting L22 to a distribution line originating in the Vanier Substation. This will involve the purchase and installation of five 1 MVA 25 kV/600 V pad-mounted distribution transformers and one 1 MVA 25 kV/600 V pad-mounted distribution transformer to serve as a spare.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	337.0	0.0	0.0	**337.0**
Labour	58.3	0.0	0.0	**58.3**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	95.0	0.0	0.0	**95.0**
Other Direct Costs	20.0	0.0	0.0	**20.0**
Interest and Escalation	32.3	0.0	0.0	**32.3**
Contingency	51.0	0.0	0.0	**51.0**
Total	**593.6**	**0.0**	**0.0**	**593.6**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Resource planning	January 2021	February 2021
Design:		
Conduct site visits, detailed design	January 2021	May 2021
Procurement:		
Materials ordered	January 2021	May 2021
Construction:		
Monitor construction activities	May 2021	August 2021
Commissioning:		
Inspection performed by local operations crews	August 2021	September 2021
Closeout:		
Project closeout	September 2021	November 2021

3.0 Project Justification

This project is required to ensure reliable electrical supply to customers presently connected to the Cooper Hill Substation. The project will eliminate the risk of an extended outage should Cooper Hill T1 fail.

The Cooper Hill Substation serves the only remaining 4.16 kV loads in Labrador City. T1 in the Cooper Hill Substation is 43 years old, which is near the end of its useful life. It showed signs of deterioration in the latest dissolved gas analysis test and is being monitored closely. In the existing configuration, there is no online alternative supply transformer in Cooper Hill Substation. As the customers on L22 are supplied at 4.16 kV, if T1 failed, the load cannot be transferred to another substation. Also, there is no mobile substation located in Labrador to provide a backup supply in the event of a substation transformer failure.

A number of alternatives were considered to address the issue, including: deferral; relocating the Vanier Substation spare transformer and installing it in Cooper Hill Substation; converting L22 from 4.16 kV to 25 kV and installing 25 kV pad-mounted transformers to service the Labrador Mall; and converting L22 from 4.16 kV to 25 kV and installing platform mounted stepdown transformer banks to service the Labrador Mall. The least-cost alternative is to convert L22 to a 25 KV line with pad-mounted transformers. This alternative will also eliminate the need for Cooper Hill Substation and additional 4.16 kV spares.

4.0 Attachment

The report entitled "Labrador City L22 Voltage Conversion" (Volume II, Tab 18) contains further project details.

Project Title: Replace Light-Duty Mobile Equipment
Location: Various
Category: General Properties - Transportation
Definition: Pooled
Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro (”Hydro”) operates a fleet of light-duty mobile equipment comprised of approximately 120 snowmobiles, 70 ATVs, 120 trailers, and other miscellaneous equipment. The fleet is distributed across Hydro’s operating areas throughout the province and is utilized on a daily basis to support staff engaged in the maintenance and repair of the electrical system.

This project provides for the replacement of light-duty mobile equipment that meets the established replacement criteria. This project will contribute to the reliable operation of Hydro’s Light-Duty Mobile Equipment Fleet.

2.0 Project Description

This project proposes the replacement of 11 ATVs, 27 snowmobiles, and 10 light-duty trailers.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	497.7	0.0	0.0	**497.7**
Labour	0.0	0.0	0.0	**0.0**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	27.0	0.0	0.0	**27.0**
Contingency	24.9	0.0	0.0	**24.9**
Total	**549.6**	**0.0**	**0.0**	**549.6**

3.0 Project Justification

This project is necessary to maintain a reliable light-duty equipment fleet. Failure to replace these units will lead to increasing maintenance costs and less reliable equipment. This equipment is often used in remote areas and must be reliable to ensure user safety.

4.0 Attachment

The report entitled “Replace Light-Duty Mobile Equipment” (Volume II, Tab 19) contains further project details.

Project Title: Inspect Fuel Storage Tanks
Location: Postville
Category: Transmission and Rural Operations - Rural Generation
Definition: Other
Classification: Mandatory

1.0 Introduction

To comply with regulatory requirements, maximize the service life of its assets, and adhere to its Environmental Policy and Guiding Principles, Newfoundland and Labrador Hydro ("Hydro") has formalized its tank inspections into a coordinated program. The program uses the tank inspection guidelines outlined by The American Petroleum Institute ("API") and the Underwriters' Laboratories of Canada as the basis for setting the inspection intervals.

In 2021, Hydro proposes to carry out internal inspections for its diesel fuel storage tanks in Postville, Labrador. The inspection will ensure regulatory compliance, enable deficiencies to be identified and addressed and ensure that the tanks are structurally sound, suitable for operation, and not at risk of releasing fuel into the environment.

2.0 Project Description

The scope of work for this project involves the completion of internal tank inspections and, where applicable, the completion of any required work identified during the inspection. The tanks to be inspected under this proposal include two 319,000 liter, vertical fuel storage tanks at the Postville Diesel Generating Station.

The project scope includes:

- Draining and cleaning of the tank in preparation for the inspection;
- Comprehensive inspection of all accessible tank components;
- Ultrasonic thickness surveys of the floor, shell, roof, and nozzles;
- Implementation of temporary site storage, where required; and
- Completion of the upgrades identified during the inspection.

Upgrade costs have been included based on expected condition from similar tank inspections in the past.

The project estimate is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	0.0	0.0	0.0	**0.0**
Labour	86.8	0.0	0.0	**86.8**
Consultant	45.0	0.0	0.0	**45.0**
Contract Work	324.6	0.0	0.0	**324.6**
Other Direct Costs	6.8	0.0	0.0	**6.8**
Interest and Escalation	23.1	0.0	0.0	**23.1**
Contingency	46.3	0.0	0.0	**46.3**
Total	**532.6**	**0.0**	**0.0**	**532.6**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	**Start Date**	**End Date**
Planning:		
Scope statement, schedule, risk review	February 2021	February 2021
Design:		
Prepare tender package	March 2021	April 2021
Procurement:		
Tender and award	April 2021	May 2021
Construction:		
Complete vertical tank cleaning and inspection	July 2021	August 2021
Commissioning:		
Final inspection and acceptance	August 2021	September 2021
Closeout:		
Project completion, final billing, and lessons learned	September 2021	November 2021

3.0 Project Justification

To satisfy the operating terms and conditions, outlined by the Department of Municipal Affairs and Environment, Hydro must ensure that its fuel storage tanks are inspected pursuant to the relevant API standard and maintained in a reliable operating condition. During the tank inspection Hydro will determine and complete the required work to ensure the tank complies with operational standards, as well as plan for the replacement of those assets that are nearing the end of service life.

4.0 Attachment

The report entitled "Inspect Fuel Storage Tanks - Postville" (Volume II, Tab 20) contains further project details.

Project Title: Upgrade of Worst Performing Distribution Feeders (2021–2022)

Location: Various

Category: Transmission and Rural Operations

Definition: Other

Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") uses two approaches to maintain or improve distribution system reliability performance. One approach is detailed in the Distribution System In-Service Failures, Miscellaneous Upgrades, and Streetlight Modernization Project (Volume I, Section C), which Hydro uses to address smaller distribution replacements. The other approach is outlined in this document and addresses larger refurbishment requirements. These larger efforts are determined by reliability performance analysis and condition assessments.

This project includes the upgrade of distribution feeders located in the Farewell Head system that have been prioritized through reliability performance analysis and confirmed as requiring upgrades based on recent condition assessments.

2.0 Project Description

An overview of the work to be completed in this project is:

2.1 FHD-L4 Feeder:

- Replace sections of deteriorated conductor, approximately 3 km;
- Reroute approximately 2 km off road section; and
- Reposition three-phase Voltage Regulator Bank, FO4-VR1.

2.2 FHD-L5 Feeder:

- Replace 20 deteriorated poles, 4 cribs and associated hardware;
- Replace approximately 8 km of deteriorated conductor;
- Install a three-phase sectionalizer; and

- Install Fault Circuit Indicators.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	208.8	51.2	0.0	**260.0**
Labour	56.3	116.4	0.0	**172.7**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	0.0	463.0	0.0	**463.0**
Other Direct Costs	13.2	40.6	0.0	**53.8**
Interest and Escalation	12.8	67.3	0.0	**80.1**
Contingency	27.8	67.1	0.0	**94.9**
Total	**318.9**	**805.6**	**0.0**	**1,124.5**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	**Start Date**	**End Date**
Planning:		
Resource planning	January 2021	January 2022
Design:		
Conduct site visits, detailed design	January 2021	October 2021
Procurement:		
Materials ordered	November 2021	March 2022
Construction:		
Construction	May 2022	September2022
Closeout:		
Project closeout	September 2022	November 2022

3.0 Project Justification

This project is justified based on the current asset conditions and reliability performance of the distribution feeders referred to in this report.

4.0 Attachment

The report entitled “Upgrade of Worst Performing Distribution Feeders (2021–2022)” (Volume II, Tab 21) contains further project details.

Project Title: Replace Light- and Heavy-Duty Vehicles (2021–2022)
Location: Various
Category: General Properties - Transportation
Definition: Pooled
Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") operates a fleet of vehicles comprised of approximately 270 light-duty vehicles (cars, pickup trucks, and vans) and 65 heavy- duty vehicles (aerial devices, material handlers, and boom trucks). The fleet is distributed across Hydro's operating areas throughout the province and is utilized on a daily basis to support staff engaged in the maintenance and repair of our electrical system.

The project provides for the replacement of light-duty and heavy-duty vehicles that meet the established replacement criteria. Hydro has revised its criteria for light-duty vehicles to extend the age and kilometre threshold,[1] and Hydro's replacement criteria for both light- and heavy-duty vehicles are similar to other utilities. Hydro's replacement criteria are similar to other utilities. This project will contribute to the safe and reliable operation of Hydro's light- and heavy-duty fleet.

2.0 Project Description

This project proposes the replacement of 26 light-duty vehicles and six (6) heavy-duty vehicles.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	1,196.2	1,126.7	0.0	**2,322.9**
Labour	0.0	0.0	0.0	**0.0**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	64.9	152.1	0.0	**217.0**
Contingency	59.8	56.3	0.0	**116.1**
Total	**1,320.9**	**1,335.1**	**0.0**	**2,656.0**

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[1] Hydro revised its criteria for light-duty vehicles to extend the age and kilometre thresholds. The age threshold is extended to 7 years versus the prior 5–7 years and the kilometre threshold is extended to >200,000 km versus the prior >150,000 km. The revised threshold for light-duty vehicles is reflected in Table 1.

3.0 Project Justification

This project will contribute to the reliable operation of Hydro’s light- and heavy-duty fleet, necessary for efficient deployment of resources and the safe and timely response to events potentially impacting the supply of power to customers

4.0 Attachment

The report entitled “Replace Light- and Heavy-Duty Vehicles (2021–2022)” (Volume II, Tab 22) contains further project details.

Project Title: Replace Hydro Personal Computers (2021)
Location: Hydro Place
Category: General Properties - Information Systems
Definition: Pooled
Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") personnel have assigned laptop, desktop, or work station computers to access business software applications. To support its business and maintain operational reliability for its software applications and information, Hydro must keep computing devices and accessories current.

2.0 Background

2.1 Existing System

Hydro operates and maintains approximately 313 desktop computers, 502 laptops, 75 workstations, 58 ruggedized mobile computers, and 273 thin-client computing devices. A preliminary analysis based on existing device age has identified 128 desktop computers, 139 laptops, 3 workstations, and 42 ruggedized mobile computers that are due for replacement in 2021. Hydro has included an estimated replacement of 300 monitors in this budget for failure replacement and new computer setups.

2.2 Operating Experience

The equipment proposed for replacement was purchased in 2014–2015. Hydro schedules replacement of desktop/workstation computers on a six-year life cycle and laptop/rugged-mobile computers on a five-year life cycle. Devices identified in this budget have been in service for a period of more than five years and have exceeded the expected reliable lifespan. The replacement of monitors and other ancillary hardware are assessed based on failure, compatibility, and application requirements. A process is completed to re-image and re-deploy any computers in cases where users retire or move outside the organization and the computer has not reached the maximum age/lifespan identified above. Hydro has a life cycle criterion for computing devices similar to other companies, including Newfoundland Power.

3.0 Project Justification

Computing infrastructure must be maintained at a level necessary to provide the required performance and capacity to effectively run business applications.

If computing devices are not kept current, the following scenarios could occur:

- Inability to install new software applications and upgrade existing applications;
- Decreased processing speed and increased potential for lost data;
- Unsupported operating systems for patches and vulnerability updates; and
- Decreased productivity during the repair or reimaging process.

4.0 Analysis

4.1 Identification of Alternatives

Hydro evaluated the following alternatives:

- Deferral; and
- Replacement of computer equipment.

4.2 Evaluation of Alternatives

4.2.1 Deferral

Under this alternative, the planned replacement of these computing devices would be deferred by a year. There is an increased technical risk of the existing equipment no longer supporting new applications, interfaces, and other technologies required to connect and operate with power generation/distribution devices, business-applications, and related technology. Analysis of this option has shown that the risk is not acceptable. Higher maintenance costs are also incurred when operating these devices beyond Hydro’s current replacement criteria.

4.2.2 Replacement of Computing Devices

Under this alternative, computers identified as being deployed and in service for over five years (for mobile laptop computers) and over six years (for desktop/workstation/thin-client computers) will be replaced throughout 2021 following Hydro’s established replacement criteria to maintain adequate service-levels for business continuity and ensure electronic business data is secure.

4.3 Recommended Alternative

Hydro recommends the replacement of computer infrastructure that has been in service for more than five/six years based on the equipment type and associated replacement life cycle.

5.0 Project Description

A preliminary analysis based on existing device age has identified 128 desktop computers, 139 laptops, 3 workstations, and 42 ruggedized mobile computers. An anticipated quantity of 300 monitors for new computer setups or failure replacements is also included in the budget. A reassessment of equipment to be replaced will occur in January 2021 as the proposed quantities are a forecast based upon life cycle retirements and the number of new units required to accommodate new software applications or work methods.

The project estimate is shown in Table 1. This estimate has a higher materials cost for 2021 due to the increased quantity of ruggedized mobile computer replacements that were purchased in 2016 and are due for replacement as they have reached the end of their five-year lifespan.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	674.1	0.0	0.0	**674.1**
Labour	59.2	0.0	0.0	**59.2**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	74.6	0.0	0.0	**74.6**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	16.8	0.0	0.0	**16.8**
Contingency	80.7	0.0	0.0	**80.7**
Total	**905.4**	**0.0**	**0.0**	**905.4**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Create requests for proposals, schedules, secure resources	January 2021	April 2021
Design:		
Create project plan	February 2021	June 2021
Procurement:		
Award RFPs, order materials	March 2021	November 2021
Construction:		
Implement upgrades	March 2021	November 2021
Commissioning:		
Go live with upgrades	May 2021	November 2021
Closeout:		
Project closeout	September 2021	December 2021

6.0 Conclusion

Using personal computing devices that are approaching end of life could impede Hydro's ability to ensure business software applications execute effectively and electronic business data is secure. This project is proposed to replace personal computing devices and accessories approaching end of life following Hydro's established replacement criteria.

Project Title:	Replace Transfer Switches and Associated Hardware
Location:	Hydro Place
Category:	Administration
Definition:	Other
Classification:	Normal

1.0 Introduction

Hydro Place is located in St. John's, Newfoundland and includes the Energy Control Center ("ECC"), hardware associated with Newfoundland and Labrador Hydro's ("Hydro") company-wide computer network, and other key corporate infrastructure. In the event of a power outage Hydro Place has two backup diesel generators and other electrical equipment to provide power to this critical infrastructure.

The electrical equipment used to provide backup power to the ECC and other critical loads within Hydro Place includes automatic transfer switches, synchronization controls, and 600 V circuit breakers. These components are original to the construction of Hydro Place in the early 1990s. This equipment is no longer supported by manufacturers and spare parts are difficult to obtain. In January 2020, a condition assessment of the Hydro Place Emergency Power System was completed by a consultant. This assessment indicated that refurbishment of some of the equipment within the emergency power system is required to minimize the risk of a prolonged failure.

2.0 Project Description

The scope of this project includes:

- The replacement of four automatic transfer switches;
- The replacement of two synchronization control modules located within the emergency power switchgear panel, which perform the start-up and synchronization of the backup diesel generators; and
- The replacement of six 600 V circuit breakers located within the emergency power switchgear panel, which are connected to the emergency bus.

The project estimate is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	0.0	0.0	0.0	**0.0**
Labour	80.5	54.2	0.0	**134.7**
Consultant	90.0	27.6	0.0	**117.6**
Contract Work	0.0	706.2	0.0	**706.2**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	9.7	71.7	0.0	**81.4**
Contingency	17.1	78.8	0.0	**95.9**
Total	**197.3**	**938.5**	**0.0**	**1,135.8**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	**Start Date**	**End Date**
Planning:		
Open project, initial planning, and scheduling	January 2021	March 2021
Detailed Design/Procurement:		
Complete detailed design and tender and award supply and install contract	April 2021	September 2021
Construction/Commissioning:		
Removal of old equipment and installation and commissioning of new equipment	May 2022	June 2022
Closeout:		
Project completion and closeout	July 2022	September 2022

3.0 Project Justification

There are four automatic transfer switches included within the backup power system. Fabrication of replacement parts for these units stopped over five years ago.

The emergency power switchgear panel includes two synchronization control modules that handle the start-up and synchronization of the two, 300 kW backup diesel generators. Parts are no longer supported as the technology is obsolete.

The emergency power switchgear panel also includes six, 600 V circuit breakers that are connected to the emergency bus. The Original Equipment Manufacturer, Federal Pioneer of these circuit breakers no longer exists and replacement parts are no longer produced or supported by Schneider Electric, which provides support for this equipment. The proposed solution is to replace these breakers with retrofit kits.

The intent of the backup system is to provide emergency power to the building and, most importantly, the ECC. If a piece of equipment were to fail suddenly, there are no stock replacement parts readily available to promptly address this failure. This has the potential to cause substantial downtime to the emergency power system.

4.0 Attachment

The report entitled "Replace Transfer Switches and Associated Hardware - Hydro Place" (Volume II, Tab 23) contains further project details.

D. Capital Projects over $200,000 and less than $500,000

2021 Capital Budget Application

Section D: Projects over $200,000 but less than $500,000

Newfoundland and Labrador Hydri
2021 Capital Budget
Projects Over $200,000 and Under $500,000
($000)

Project Description	**Expended to 2020**	**2021**	**Future Years**	**Total**	**Definition**	**Classification**
Generation						
Overhaul Unit 3 Boiler Feed Pump East - Holyrood	0.0	373.0	0.0	**373.0**	Other	Normal
Construct Lube Oil Cooler Hood and Containment System - Holyrood Gas Turbine	0.0	318.8	0.0	**318.8**	Other	Mandatory
Purchase Capital Spares - Gas Turbines (2021)	0.0	213.8	0.0	**213.8**	Other	Normal
Replace Voltage Regulator - Happy Valley Gas Turbine	0.0	131.3	211.0	**342.3**	Other	Normal
Replace Fuel Oil, Lube Oil, and Glycol Pumps - Happy Valley Gas Turbine	0.0	234.7	170.5	**405.2**	Other	Normal
Total Generation	**0.0**	**1,271.6**	**381.5**	**1,653.1**		
Transmission and Rural Operations						
Upgrade Fire Suppression System - Bishop's Falls	91.6	292.6	0.0	**384.2**	Other	Normal
Install Recloser Remote Control - Hampden and Upper Salmon (2020-2021)	71.3	185.3	0.0	**256.6**	Pooled	Normal
Replace Fuel Storage Tank - Paradise River	0.0	350.3	0.0	**350.3**	Other	Mandatory
Replace Snow Groomer (V7601)	0.0	331.3	0.0	**331.3**	Other	Normal
Purchase Meters and Metering Equipment (2021)	0.0	233.4	0.0	**233.4**	Pooled	Mandatory
Purchase Tools and Equipment Less than $ 50,000 - Labrador Region (2021)	0.0	212.8	0.0	**212.8**	Pooled	Normal
Total Transmission and Rural Operations	**162.9**	**1,605.7**	**0.0**	**1,768.6**		
General Properties						
Perform Hydro Software Upgrades & Minor Enhancements - Hydro Place (2021)	0.0	372.1	0.0	**372.1**	Other	Normal
Replace Battery Banks and Chargers	0.0	327.2	0.0	**327.2**	Pooled	Normal
Level 2 Chargers for Electric Vehicles	0.0	299.8	0.0	**299.8**	Pooled	Justifiable
Upgrade Core IT/OT Infrastructure (2021)	0.0	262.8	0.0	**262.8**	Other	Normal
Replace Peripheral Equipment (2021)	0.0	256.4	0.0	**256.4**	Other	Normal
Replace Radomes (2021) - Various	0.0	240.4	0.0	**240.4**	Pooled	Normal
Refresh Cyber Security Infrastructure (2021)	0.0	217.5	0.0	**217.5**	Other	Normal
Total General Properties	**0.0**	**1,976.2**	**0.0**	**1,976.2**		
Total Projects Over $200,000 and Under $500,000	**162.9**	**4,853.5**	**381.5**	**5,397.9**		

Project Title: Overhaul Unit 3 Boiler Feed Pump East - Holyrood
Location: Holyrood Thermal Generating Station
Category: Generation - Thermal
Definition: Other
Classification: Normal

1.0 Introduction

To support the continued safe and reliable operation of the Holyrood Thermal Generating Station ("Holyrood TGS") at rated output through the 2021–2022[1] winter operating season, Newfoundland and Labrador Hydro ("Hydro") is proposing to overhaul the Holyrood TGS Unit 3 boiler feed pump east. The Holyrood TGS Unit 3 boiler feed pump east is one of two pumps that supply the high-pressure feed water required for steam production in Boiler No. 3.[2]

The two boiler feed pumps receive water from the deaerator tank and feed it to high pressure heaters and the boiler. Boiler feed pumps have historically been overhauled every six years. Individually, each pump supports 70–80 MW of generation and, operating together, they support the full generation capability of Unit 3 (150 MW).

Boiler feed pumps are exposed to high temperatures, high pressure, and high flow velocity; all of this contributes to significant wear on the equipment. If an overhaul is not completed, the pump could fail while in operation. Such failure would result in the reduction of 70–80 MW of generating capacity from Unit 3 for several weeks. An overhaul is necessary to maintain Hydro's safety and reliability standards, including Hydro's ability to meet customer demand during peak periods.

2.0 Background

The Holyrood TGS Unit 3 boiler feed pump east was last overhauled in 2014 and was originally due for overhaul in 2020. At the time of Hydro's 2019 and 2020 Capital Budget Applications, it was anticipated that the Holyrood TGS would transition from normal production to standby over the 2019 to 2020 time period and, as such, would have lower levels of production. As a result, Hydro determined that it was

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[1] In a letter dated February 14, 2020, Hydro advised the Board of Commissioners of Public Utilities ("Board") of its decision to extend the operation of the Holyrood TGS as a generating facility to March 31, 2022.
[2] The overhaul of the Unit 3 boiler feed pump west was approved for completion in 2020 as per Board Order No. P.U. 14(2020).

appropriate to extend the overhaul period. Given Hydro's more recent commitment to have the Holyrood TGS fully available for generation until March 31, 2022, this project is required.[3]

2.1 Existing Equipment

The Holyrood TGS Unit 3 boiler feed pump east, shown in Figure 1, was originally installed in 1979. Each of the two boiler feed pumps (east and west) provides 50 percent of the high pressure feed water required for steam production in the Unit 3 boiler. The pump has eleven stages of impellers and is driven by a 3,000 horse power motor. It is capable of pumping 4,119 litres per minute at a pressure of 18,616 kPa. It draws feed water at a temperature of 148°C before pumping it to the high pressure heaters.

Figure 1: Unit 3 Boiler Feed Pump East

2.2 Operating Experience

Hydro's experience with the boiler feed pumps has demonstrated that overhaul every six years is appropriate based on the observations made during previous overhauls. Additionally, this cycle is consistent with Original Equipment Manufacturer ("OEM") recommendations.

Unit 3's boiler feed pump east was last overhauled in 2014. At that time, Hydro replaced the volute impeller cartridge with a refurbished spare and the existing volute impeller cartridge was removed, refurbished, and stored as a spare for use in the next boiler feed pump overhaul. The planned 2020

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[3] "Extension of Holyrood Thermal Generation Station as a Generating Facility," Newfoundland and Labrador Hydro, February 14, 2020.

overhaul, in line with the six-year cycle, was originally deferred based on assumptions regarding the operation of Holyrood TGS at that time.

3.0 Justification

The overhaul is required to ensure that the pump is in good operating condition and can contribute to the reliable operation of Unit 3 to ensure the Holyrood TGS is fully available as a generating facility until March 31, 2022. A failure of the Unit 3 boiler feed pump east could result in the unplanned loss of 70–80 MW of generating capacity for several weeks.

4.0 Analysis

4.1 Identification of Alternatives

The following alternatives were considered:

- Deferral;
- Condition-based refurbishment; and
- Overhaul.

4.2 Evaluation of Alternatives

4.2.1 Deferral

Given the higher than anticipated levels of production at the Holyrood TGS to date, as compared to the original forecast, as well as extension for readiness to operate as a generating facility to March 31, 2022, a continued extension of this overhaul beyond seven years increases the risk of an in-service failure of the pump and, therefore, poses an unacceptable level of risk for this pump. A boiler feed pump failure while in operation could result in a loss of 70–80 MW of generation capacity for several weeks while the pump is repaired. Additionally, not completing the overhaul at this time could result in the use of the spare volute impeller cartridge, leaving no spare available in the event of a failure of the west boiler feed pump. Hydro has determined that this alternative poses an unacceptable level of risk to reliable generation supply.

4.2.2 Condition-Based Refurbishment

Hydro collects some condition-related data while the pump is in-service from installed instrumentation. Additional data is collected through measurement and testing performed during annual preventive maintenance. To date, the data collected through each of these means has not proven to be adequately comprehensive to inform an accurate prediction as to the likelihood of failure in advance of the next planned outage, or if the unit can operate reliably through to the next planned outage. Hydro has determined that, due to the limited information available, making decisions based on asset condition is not a viable alternative for boiler feed pumps.

4.2.3 Overhaul

Overhaul consists of the disassembly, inspection, reassembly, and re-commissioning of the boiler feed pump east. Boiler feed pumps operate under high wear conditions. The six-year overhaul cycle was recommended by the OEM and supported by Hydro’s third-party consultant, Wood Canada Limited, which was engaged by Hydro to provide an opinion on this and other projects. Additionally, as operation since the last overhaul in 2014 has been typical to that of previous cycles and forecast operation is expected to remain consistent with previous years, overhaul at this time is prudent and necessary. Many components of the pump can erode, crack, or otherwise fail, leading to poor pump performance or sudden failure. In some circumstances, failures of certain components have resulted in collateral damage to the pump barrels, requiring additional repair and associated costs. Therefore, overhaul is required to support the continued safe and reliable operation of the Holyrood TGS Unit 3.

4.3 Recommended Alternative

Hydro recommends the overhaul of the Unit 3 boiler feed pump east in 2021.

Failure of Holyrood TGS boiler feed pump east while in service could result in a reduction of 70–80 MW of generation capability for several weeks. Overhauling the pump at this time is necessary to ensure it is in good operating condition. As Holyrood TGS is to be fully available for generation until March 31, 2022, and on the basis that Hydro has only one spare volute impeller cartridge to serve both pumps, Hydro recommends the refurbishment alternative to manage the risk of failure of the boiler feed pump within an acceptable level.

The timing of the in-service of the Muskrat Falls assets and the execution of the proposed steam generation related 2021 capital projects presents a unique circumstance. Should the successful integration and demonstrated reliability of the Muskrat Falls assets occur prior to March 31, 2022[4] and/or Hydro have clear evidence with respect to the in-service date of the Muskrat Falls assets prior to

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[4] Planned retirement date for Units 1 and 2 and steam generation components of Unit 3 at Holyrood TGS.

the execution of the proposed 2021 capital projects, careful consideration will be given to the necessity of executing the full scope of steam generation related capital projects.[5] Where there is opportunity to mitigate some portion of capital costs, Hydro will ensure prudency in its capital expenditures and notify the Board of such change, as appropriate.

5.0 Project Description

This project consists of the disassembly, inspection, reassembly, and re-commissioning of Holyrood TGS Unit 3 boiler feed pump east. During overhaul, parts, including the volute impeller cartridge, are replaced as necessary. If required, the volute impeller cartridge will be replaced with a refurbished cartridge from Hydro’s spares inventory. The volute impeller cartridge which is removed from the pump will then be refurbished and returned to inventory as a critical spare to support both of the Unit 3 boiler feed pumps prior to the next winter operating season. Figure 2 shows the volute impeller cartridge.

Figure 2: Refurbished Volute Impeller Cartridge.

Disassembly and reassembly will be executed by internal resources. The overhaul of the volute impeller cartridge will be performed by an experienced feed water pump service contractor. The service contractor will be engaged to do the following:

- Perform a detailed condition assessment of the assembly of the entire pump through on-site inspection;
- Provide recommendations and guidance with respect to on-site disassembly and reassembly; and
- Off-site condition assessment and refurbishment of the volute impeller cartridge, if required.

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[5] Where work may have already commenced on the proposed 2021 capital projects, Hydro will consider options for reducing the remaining portion(s) of the project scope, and thus capital costs, as appropriate and technically feasible.

Plant personnel will assist as required, oversee the work protection application, and provide additional support as required.

The project estimate is shown in Table 1

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	5.0	0.0	0.0	**5.0**
Labour	120.4	0.0	0.0	**120.4**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	195.0	0.0	0.0	**195.0**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	20.6	0.0	0.0	**20.6**
Contingency	32.0	0.0	0.0	**32.0**
Total	**373.0**	**0.0**	**0.0**	**373.0**

The overhaul is planned to take place during the planned Unit 3 outage. Following the overhaul, the pump will be returned to service and the volute impeller cartridge will be refurbished and placed into inventory as a critical spare. The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	**Start Date**	**End Date**
Planning:		
Preparation of planning documentation	January 2021	February 2021
Design:		
Prepare technical specifications for the overhaul and technical support	February 2021	March 2021
Procurement:		
Award overhaul and technical support contracts	April 2021	April 2021
Construction:		
Mobilize contractors, perform pre-shutdown checks, and isolations	April 2021	April 2021
Dismantle, inspect, and reassemble pump using spare volute impeller cartridge	April 2021	May 2021
Refurbish old volute impeller cartridge and place in spare inventory	April 2021	September 2021
Closeout:		
Prepare closeout documentation	October 2021	December 2021

6.0 Conclusion

To support the continued safe and reliable operation of Unit 3 at the Holyrood TGS at its rated output through the 2021–2022 winter operating season, Hydro recommends refurbishing the Unit 3 boiler feed pump east. The boiler feed pumps are typically overhauled on a six-year frequency; however, the Unit 3 boiler feed pump east was last overhauled in 2014. Based on historic and forecast production, an overhaul of the Unit 3 boiler feed pump east is required in 2021.

Project Title: Construct Lube Oil Cooler Hood and Containment System
Location: Holyrood Gas Turbine
Category: Generation - Gas Turbines
Definition: Other
Classification: Mandatory

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") owns and operates a 123 MW gas turbine located at the Holyrood Thermal Generating Station ("Holyrood TGS"). The gas turbine was commissioned in 2015.

A lube oil system supplies oil to lubricate and cool the main bearings and the associated seal assemblies in the gas turbine and generator. This system includes an oil cooler that is used to reduce the temperature of the oil as it leaves the bearings after picking up heat from these bearings.

The oil cooler is installed outside the gas turbine building on a gravel surface without a snow hood or oil containment system. The lack of a snow hood reduces the efficiency of the oil cooler and increases the corrosion rate of its components. The lack of an oil containment system increases the risk of an oil spill that could cause environmental contamination.

2.0 Background

2.1 Existing Equipment

The lube oil is pumped from a tank through pipes to the main bearings. As it passes through the bearings it picks up heat and leaves at a higher temperature. It then passes through a bundle of finned tubes in the cooler. Two fans, mounted on the lube oil cooler, force atmospheric air around the finned tubes to remove heat from the oil and reduce its temperature. It is then returned through pipes to the lube oil tank for pump recirculation through the system[1]. The system runs 24 hours a day, 7 days a week due to turning gear operation to ensure availability of the unit. Figure 1 shows the lube oil cooler at the Holyrood Gas Turbine.

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[1] The lube oil cooler and associated piping contains approximately 3,500 L of lube oil. The main lube oil tank contains an additional 12,000–14,000 L.

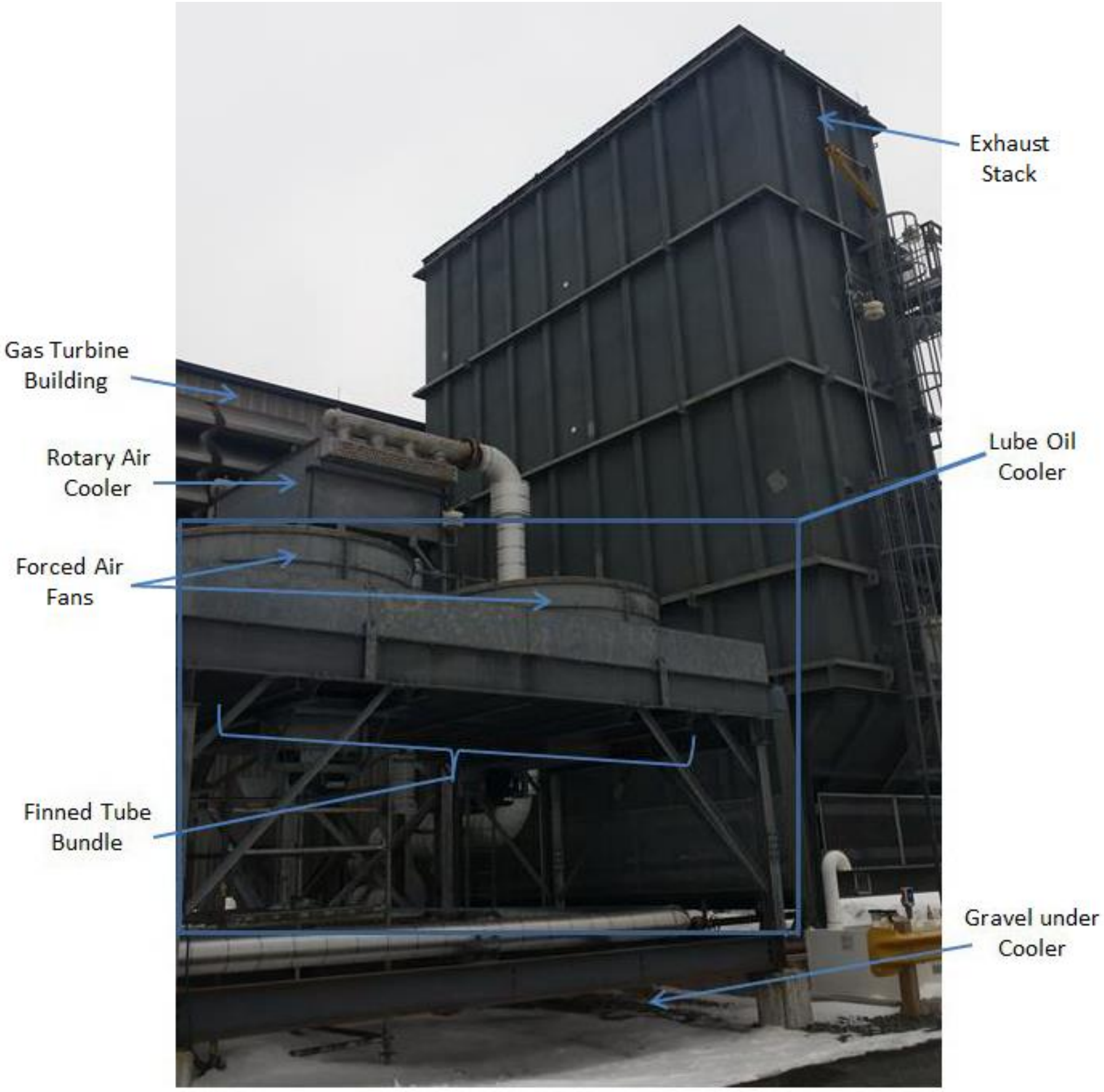

Figure 1: Lube Oil Cooler – Holyrood Gas Turbine

2.2 Operating Experience

The lube oil cooler has experienced several minor oil leaks that operations personnel have been able to control. However, if a significant leak occurs, oil will spill onto the gravel surface and contaminate the soil under the lube oil cooler and surrounding area.

As shown in Figure 1, other gas turbine equipment (rotary air cooler, exhaust stack) is mounted near and above the lube oil cooler. There is a risk that components of the other equipment may fall due to failure of support attachments and potentially damage the lube oil cooler, possibly resulting in an oil leak. The installation of a snow hood would mitigate this risk. Additionally, accumulations of snow and ice could fall from system components and damage the cooling system. Furthermore, the lack of a snow hood has resulted in the accumulation of snow on the cooler. This accumulation decreases the efficiency of the cooler and can affect the reliability of the Holyrood Gas Turbine.

3.0 Justification

Hydro identified the requirement for a containment system based on previous, minor leaks from the lube oil cooler and associated piping and with consideration of the potential risk associated with a significant leak. As the gas turbine lube oil system operates 24 hours per day, 7 days a week and is not attended at all times, an oil leak from the lube oil cooler has the potential to go undetected for a period of time and, without containment, could result in a significant spill to the ground and nearby environment. The remediation of such a spill could potentially require significant resources and impact the availability of generation from the gas turbine for up to four weeks.

The lube oil cooler snow hood is justified on the basis that it mitigates the risk of damage to the lube oil cooler due to falling objects and also protects from snow accumulation, which decreases the efficiency of the lube oil cooler.

4.0 Analysis

4.1 Identification of Alternatives

Hydro evaluated the following alternatives:

- Deferral, and
- Construction of lube oil cooler snow hood and containment system.

4.2 Evaluation of Alternatives

Deferral of this project poses an unacceptable risk of an oil spill which would contaminate the environment and the potential for an extended outage of the gas turbine. Deferral would also result in continued inefficiency of the lube oil cooler.

4.3 Recommended Alternative

Hydro recommends the construction of a lube oil cooler snow hood and containment system in 2021.

5.0 Project Description

The scope of this project includes the following items at the Holyrood Gas Turbine:

- Construction of a snow hood over the lube oil cooler; and
- Construction of an oil containment system under the lube oil cooler.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	0.0	0.0	0.0	**0.0**
Labour	98.1	0.0	0.0	**98.1**
Consultant	32.2	0.0	0.0	**32.2**
Contract Work	120.4	0.0	0.0	**120.4**
Other Direct Costs	0.3	0.0	0.0	**0.3**
Interest and Escalation	17.6	0.0	0.0	**17.6**
Contingency	50.2	0.0	0.0	**50.2**
Total	**318.8**	**0.0**	**0.0**	**318.8**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Open project and develop scope statement and detailed schedule	January 2021	February 2021
Design:		
Prepare snow hood and oil containment system design	March 2021	May 2021
Tendering:		
Develop tender package for supply and installation contract	May 2021	June 2021
Construction:		
Procure contractor materials	July 2021	September 2021
Complete site installation works	September 2021	October 2021
Closeout:		
Prepare closeout documents	October 2021	November 2021

6.0 Conclusion

The lube oil cooler at the Holyrood Gas Turbine was installed in 2015 on a gravel surface without a snow hood or an oil containment system. The lack of a snow hood and oil containment system presents an unacceptable risk of environmental contamination if a leak occurs in the oil cooler. To minimize this risk, Hydro is proposing to construct a snow hood and an oil containment system for the lube oil cooler.

Project Title: Purchase Capital Spares - Gas Turbines
Location: Holyrood and Happy Valley Gas Turbines
Category: Generation - Gas Turbines
Definition: Other
Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") has identified critical components that, when purchased and located as spare parts at its gas turbine plants, will shorten forced outages in the event of a failure of existing components. The components are identified as critical based on their: impact on generating capacity, lead time for procurement, the operating condition of in-service components and previous experience of failed components. Evaluation of Hydro's critical spare inventory is conducted annually with the objective of improving the reliability of Hydro's gas turbines.

Capital spares are major spare parts that meet the definition of capital assets. Hydro has identified a number of capital spares that are required for the Holyrood and Happy Valley Gas Turbine plants.

2.0 Background

2.1 Existing Equipment

2.1.1 Fuel Flow Divider- Holyrood Gas Turbine

The fuel flow divider is a critical component of the Holyrood Gas Turbine fuel oil and water injection ("FOWI") skid. The flow divider consists of a manifold and a series of gears, orifices, and piping that ensures the constant and even flow of fuel to each of the gas turbine fuel burners.

Figure 1 shows the fuel flow divider at the Holyrood Gas Turbine.

Figure 1: Fuel Flow Divider – Holyrood Gas Turbine

2.1.2 Fuel Oil Pumps - Happy Valley Gas Turbine

There are three fuel oil pumps that supply fuel oil to the gas turbine engine. The primary and auxiliary pumps are ac-motor driven. The auxiliary pump is used in the event of issues with the primary pump. The third pump is an emergency dc-motor driven unit and is used in the event of issues with both the primary and auxiliary pumps or if the ac power is lost.

Figure 2 shows the fuel oil pumps at the Happy Valley Gas Turbine.

Figure 2: Fuel Oil Pumps – Happy Valley Gas Turbine

Happy Valley Lube Oil Pump

Lube oil pumps supply oil to lubricate and cool the main bearings and their seal assemblies. Lubrication is provided by a primary pump and an emergency pump. The primary pump is ac motor driven and the emergency pump is dc motor driven. The emergency pump automatically starts in the event of issues with the primary ac pump or loss of dc power. The ac and dc lube oil pumps are both mounted on the lube oil tank. The motors on the top of the tank and the pumps are submersed inside the tank as shown in 3.

Figure 3: Lube Oil Pumps – Happy Valley Gas Turbine

2.2 Operating Experience

2.2.1 Fuel Flow Divider - Holyrood Gas Turbine

The fuel flow divider is original to the Holyrood Gas Turbine. It was placed in service in 2015. As the fuel flow divider ensures the equal flow of fuel to each of the gas turbines combustors, its failure could result in the derating or removal of the gas turbine unit from service due to an excessive blade path temperature spread. Currently the fuel flow divider is contributing to an issue with the blade path temperature spread of the unit.

2.2.2 Fuel Oil and Lube Oil Pumps - Happy Valley Gas Turbine

The fuel oil and lube oil pumps and associated motors at the Happy Valley Gas Turbine have been in service since 1992. They are obsolete and cannot be promptly replaced should a failure occur. Hydro is proposing a separate project within the 2021 Capital Budget Application to replace these motors and pumps.[1]

2.2.3 General

The fuel flow divider and pumps have long lead procurement times (16 to 20 weeks). Spares will be required to be readily available in the event of an unexpected failure of corresponding installed components to minimize the downtime of the gas turbines.

3.0 Analysis

3.1 Identification of Alternatives

Hydro evaluated the following alternatives:

1) Deferral; and

2) Purchase Capital Spares.

3.2 Evaluation of Alternatives

The deferral of purchasing these critical capital spares poses a risk of extended outage of the gas turbines in the event of an unexpected failure of corresponding installed components. It could take 16 to 20 weeks to procure the replacement parts following an in-service failure.

3.3 Recommended Alternative

Hydro recommends purchasing the capital spares. These capital spares have long procurement times and it is Hydro’s objective to have these spares on site to minimize potential outage duration should a failure occur.

The current condition of the Holyrood Gas Turbine fuel flow divider is contributing to an increase in the blade path temperature spread in the gas turbine engine. This indicates that the fuel flow divider has a high risk of failure, which could lead to derating or removal of the gas turbine from service if there is no spare readily available.

The spare pumps for the Happy Valley Gas Turbine are required to reduce the down time in the event of an in-service failure of the pumps.

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[1] Capital Spares available during the replacement project address the risk of early equipment failure and leverages efficiencies from the replacement project.

4.0 Project Description

This project will procure the following Capital Spares:

- A fuel flow divider for the Holyrood Gas Turbine.
- A fuel oil pump, complete with one dc motor, for the Happy Valley Gas Turbine.
- A lube oil pump, complete with one ac motor and one dc motor, for the Happy Valley Gas Turbine.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	180.0	0.0	0.0	180.0
Labour	8.8	0.0	0.0	8.8
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	6.1	0.0	0.0	6.1
Contingency	18.9	0.0	0.0	18.9
Total	213.8	0.0	0.0	213.8

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Open project; Prepare scope statement	January 2021	January 2021
Design:		
Prepare technical specifications.	February 2021	April 2021
Tendering:		
Prepare tendering packages; Award contracts.	May 2021	July 2021
Procurement:		
Supply and deliver fuel flow divider and pumps.	July 2021	November 2021
Closeout:		
Prepare closeout documents.	December 2021	December 2021

5.0 Conclusion

Critical spares inventories are evaluated by Hydro annually. Recent evaluations identified capital spares required for the Holyrood and Happy Valley Gas Turbine plants. These spares will facilitate an expedited return to service should a gas turbine experience an outage due to the failure of an in-service critical component. It is the intention of Hydro to purchase these capital spares and have them on site to provide ongoing, reliable service to customers.

Project Title: Replace Voltage Regulator – Happy Valley Gas Turbine

Location: Happy Valley Gas Turbine

Category: Generation - Gas Turbine

Definition: Other

Classification: Normal

1.0 Introduction

The Happy Valley Gas Turbine Automatic Voltage Regulator ("AVR") is a device that uses the static excitation system to maintain an acceptable generator terminal voltage and control of the reactive power flow from the generator. The AVR is required for the gas turbine to generate electricity; therefore, a failure of the AVR will result in an outage to the unit. The Original Equipment Manufacturer ("OEM") for the AVR no longer supports the existing device, and spare components for the AVR are no longer available. This could greatly delay the return to service of the gas turbine upon failure of an AVR component.

2.0 Background

2.1 Existing Equipment

The AVR uses the turbine's static excitation system to maintain an acceptable generator terminal voltage and control reactive power flow from the generator. Brush is the OEM of the AVR model, shown in Figure 1, which consists of a series of analog cards mounted in a panel.

Figure 1: AVR Front Panel

2.2 Operating Experience

The AVR was installed in 1992. The AVR malfunctioned in December 2018 when a shorted conductor caused a blown fuse in the AVR. As a result, the generator did not have terminal voltage and the unit was unavailable to operate. The fuse was replaced and the unit put back in service.

During the investigation into this failure in early 2019, Newfoundland and Labrador Hydro ("Hydro") became aware that the OEM had declared the AVR obsolete. While the resolution to the outage was to replace a fuse, this incident highlighted the potential long term outage that could take place should the AVR malfunction again. The OEM has challenges providing engineering support and is very limited in its ability to service and repair the existing AVR. The expected last date for spare part availability for this model AVR was in 2010 and Hydro does not have spare components in inventory. The AVR has been in service for 28 years and, due to insufficient OEM support and lack of available spare components, it is considered to be at the end of its useful life. A failure of an AVR component could lead to an extended unit outage.

3.0 Justification

The AVR is a critical component for operation of the unit as it maintains the generator terminal voltage at an acceptable level. A failure of an AVR component will lead to an outage of the gas turbine, and it will be unavailable to return to service until the issue is resolved. The OEM has stated that the existing AVR is obsolete and short-term support for the AVR is limited. The OEM also stated there are no available stock components and failed components will have to be sent back to them for attempted repair. The OEM describes their long-term approach for the existing AVR as providing site specific support to upgrade the AVR to their supported models. The OEM was on site to do a survey of the AVR in May 2019. Based on this visit, they developed a list of AVR components to be upgraded and a list of recommendations for future actions to complete the upgrade. It is based on these factors that Hydro is proposing the project to replace the AVR at the Happy Valley Gas Turbine.

4.0 Analysis

4.1 Identification of Alternatives

Hydro evaluated the following alternatives:

- Deferral; and
- Replacement of the AVR.

4.2 Evaluation of Alternatives

4.2.1 Deferral

Hydro considered deferring this project one or more years as alternative. Should the AVR not be replaced in 2021–2022, Hydro will have to assume the risk of an AVR malfunction occurring at the Happy Valley Gas Turbine through additional winter operating seasons. If a failure occurred, the unit would not be able to return to service until the issue with the AVR was resolved. Depending on the resource availability of the OEM, they may not have any support available with knowledge of the obsolete AVR. In addition, if a component completely fails or if there is damage to the AVR chassis, Hydro would have to ship the damaged component to the OEM for them to attempt a repair. This would leave the unit unavailable for an extended period of time.

The unavailability of the Happy Valley Gas Turbine presents a risk to customers in eastern Labrador as this unit is the source of backup capacity for the region. Under normal operations, customers in eastern Labrador are supplied via a 138 kV transmission line connected at Muskrat Falls Terminal Station #2. When the transmission line is out of service, the Happy Valley Gas Turbine is placed online and provides up to 25 MW of capacity. On the basis of the Canadian Electricity Association ("CEA") statistics for 138 kV lines, the expected forced unavailability of the interconnection would be defined by a frequency of 0.2812 per year[1] and a duration of 12 hours. Without the gas turbine, a complete outage for all customers in eastern Labrador would be required in the event of any planned or unplanned interruptions of the 138 kV network.

It is noted that the existing AVR has performed well since being installed causing very few forced outages to the unit; however, operating the unit through one or more winter operating seasons without

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[1] The outage frequency for the Muskrat Falls to Happy Valley Interconnection is calculated to be 0.2812 (0.7811 occurrences/100km.a × 36 km).

upgrading the AVR presents an unacceptable risk of customer outages. Therefore, deferral is not recommended.

4.2.2 Replacement of the AVR

Replacement of the AVR consists of removing and disposing of the existing AVR as well as installing and commissioning a new one. The anticipated useful life of the new AVR is between 15 and 20 years. It will be fully supported by the OEM and have spare components readily available. In addition to improving reliability, the new AVR will consist of newer digital components and have several features to make it operate better than the existing AVR. The new AVR would also have two fully independent controllers that act as a hot standby for each other. The replacement of the AVR at this time is necessary as it will support the continued safe and reliable operation of the Happy Valley Gas Turbine.

4.3 Recommended Alternative

Hydro recommends that the AVR at the Happy Valley Gas Turbine be replaced as part of a project in 2021–2022.

Due to the fact that the existing AVR has been declared obsolete by the OEM, deferring this project presents a risk to reliability. A failure to a component of the AVR would lead to an extended unit outage as it could take significant time to get the existing part repaired by the OEM. Hydro also does not have spare components available in inventory.

5.0 Project Description

Replacement of the existing AVR at the Happy Valley Gas Turbine consists of the removal and disposal of the existing AVR and the purchase, installation, and commissioning of a new one. It will be installed inside the existing panel, so the supplier will need to complete a site visit to confirm the new AVR will fit in this cabinet.

The anticipated useful life of a new AVR is expected to be between 15 and 20 years.

The deliverables for this project are as follows:

- Develop a specification for the procurement of new AVR;
- Develop drawings for the installation of the new AVR;

- Remove and dispose of existing AVR;
- Delivery and installation of new AVR; and
- Commissioning of new AVR.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	16.2	22.7	0.0	**38.9**
Labour	84.1	96.4	0.0	**180.5**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	10.0	50.2	0.0	**60.2**
Other Direct Costs	1.9	3.2	0.0	**5.1**
Interest and Escalation	8.6	24.6	0.0	**33.2**
Contingency	10.5	13.9	0.0	**24.4**
Total	**131.3**	**211.0**	**0.0**	**342.3**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	**Start Date**	**End Date**
Planning:		
Project launch and site visit	January 2021	February 2021
Design:		
Gather information, perform design work for AVR	March 2021	May 2021
Procurement:		
Issue contract for AVR, acquire misc. materials	May 2021	February 2022
Construction:		
Installation of AVR	April 2022	May 2022
Commissioning:		
Full test of AVR, unit online	May 2022	May 2022
Closeout:		
As-Built drafting, project closeout	July 2022	August 2022

6.0 Conclusion

To support the continued safe and reliable operation of the Happy Valley Gas Turbine, Hydro recommends replacing the AVR. The existing AVR is obsolete and has limited support from the OEM. An AVR malfunction would result in a unit outage and could result in the unit being unavailable for a significant period of time, as new components cannot be procured and damaged components would have to be sent back to the OEM for repair.

Attachment 1

Brush Prismic Superseded Products Notice

Superseded Products: BRUSH MAVR, PRISMIC A30, A30-M & MicroAVR

1. Introduction

As a consequence of the continuing development of semiconductor devices and the related ceasing of manufacture of older semiconductor devices it is becoming increasingly difficult to manufacture components for Brush PRISMIC A30, A30-M and MicroAVR excitation controllers.

This document explains how BRUSH is able to continue to provide support for owners of systems utilising these excitation controller products which are essential to enable operation of critical power generation facilities.

2. Short Term Support Available for Owners of Generators with PRISMIC A30, A30-M or MicroAVR Units

In order to provide short term support, BRUSH has arranged to hold stock of a limited number of A30 and MicroAVR components in order to make these products available for purchase when required as essential spares.

It is important to note that the available stock of components is limited.

It is also important to note that engineering support for older systems is becoming challenging as engineers spend time satisfying the much greater demand for new installations using improved software tools and the enhanced functionality delivered with more recent systems.

3. Medium and Long Term Support for Owners of Generators with PRISMIC A30, A30-M or MicroAVR Units

In addition to the short term support described above BRUSH is able to offer site specific excitation system upgrades whereby MAVR, PRISMIC A30, A30-M or MicroAVR units are replaced using the latest fully supported components.

As generator excitation systems generally remain in service for many years, providing enhanced power system reliability without significant intervention, sometimes plant maintenance planning inadvertently omits consideration of these systems.
Therefore BRUSH strongly recommends owners to review their support needs for generator excitation systems and to contact BRUSH for advice on the various options available for particular installations.

As Brush is the original equipment manufacturer of the MAVR, PRISMIC A30, A30-M and MicroAVR Brush has been able to design the updated excitation controllers using largely the same form fit and function, in particular using the same connector plug and socket arrangements. This means that site-work costs and interruptions to production are minimised whilst the system is refreshed to enable full support and enhanced functionality to be provided. Note that power system stabilizer requirements may necessitate engineering study and updated settings to accommodate the latest regulatory requirements and updated excitation control systems.

Fully Supported Latest Products:

	 PRISMIC A32	 PRISMIC A3100	
Expected Last Parts Date:	2026	2033	
First Entered Service:	2006	2013	

Superseded Products:

	 PRISMIC A30/A30-M	 MicroAVR	 MAVR
Expected Last Parts Date:	2018	2017	2010
First Entered Service:	1998	1989	1974

	MAVR	MicroAVR	PRISMIC A30 & A30-M	PRISMIC A32	PRISMIC A3100
Expected Last Date for Parts Availability	2010	2017	2018	2026	2033
Date First Entered Service	1974	1989	1998	2006	2013
Dual Redundant High Integrity System	✓	✓	✓	✓	✓
Hot Swap of Control Cards	Possible on some special systems	✓	✓	✘	✓
Hot Swap of Power Module	✘	✘	✘	✘	✓
Flux Limiter	✘	✓	✓	✓	✓
Intelligent Standby Channel with Limiters	✘	✘	✘	✓	✓
Synchronizer Included	✘	✘	✘	✘	✓
Voltage / PF Control	✓	✓	✓	✓	✓
Detection of Rotating Diode Failure	✓	✓	✓	✓	✓
Over & Under Excitation Limiters / Monitors	✓	✓	✓	✓	✓
Remote Communications	✘	✘	Modbus serial only	✓	✓
Data Logging	✘	✘	Very basic	✓	✓
Stator Current Limiter	✘	✘	✘	✓	✓
Rotor Earth Fault Indication	✘	✘	✘	✓	✓
Integrated Power System Stabilizer	External unit possible (older systems no longer allowed in WECC)	External unit possible (older systems no longer allowed in WECC)	External unit possible (older systems no longer allowed in WECC)	✓	✓
Negative Field Forcing	Special	✘	A30-M only	✓	✓
Remote Setpoints	Motorised Potentiometer	Via Digital Input	Via Digital Input	✓	✓
Operator Console Panel Computer	✘	✘	✘	✓ Built In Operator Console	Optional Operator Console Panel Computer
Commissioning HMI Software for Commissioning Laptop	✘	Use Psion Series 2 or Terminal Application	✓ Windows Software Included	✓ Windows Software Included	✓ Windows Software Included
VT Sensing	1 or 3 Phases	1 or 3 Phases	1 or 3 Phases	1 or 3 Phases	1 or 3 Phases
Maximum Continuous Field Current	20 Amps	20 Amps	20 Amps	20 Amps	20 Amps
VRef Control Accuracy	+/- 0.5%	+/- 0.5%	+/- 0.5%	+/- 0.25%	+/- 0.20%

Project Title: Replace Fuel Oil, Lube Oil, and Glycol Pumps

Location: Happy Valley Gas Turbine

Category: Generation - Gas Turbines

Definition: Other

Classification: Normal

1.0 Introduction

The Happy Valley Gas Turbine is located in Happy Valley-Goose Bay and was commissioned in 1992. It is a source of backup capacity for loads supplied at Happy Valley Terminal Station in the event of the interruption of supply from the 138 kV network and can provide up to 25 MW of capacity for the Labrador Interconnected Transmission System.[1]

The Happy Valley Gas Turbine has several auxiliary systems that are required for its operation. They include fuel oil, lube oil, and glycol cooling systems. All systems utilize pumps to supply fluids at a specific pressure and flow rate to ensure the reliable operation of the gas turbine as designed by the Original Equipment Manufacturer, Pratt and Whittney.

Figure 1: Happy Valley Gas Turbine Building

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[1] This capacity will also be available to the Island Interconnected System upon the reliable operation of the Labrador-Island Link.

2.0 Background

2.1 Existing Equipment

Three fuel oil pumps supply fuel oil to the gas turbine engine. The primary and auxiliary pumps are ac motor driven. The auxiliary pump is used in the event of trouble with the primary pump. The third pump is an emergency unit and is dc motor driven and used in case of trouble with both the primary and auxiliary pumps or if the ac power is lost.

Figure 2 shows the fuel oil pumps at the Happy Valley Gas Turbine.

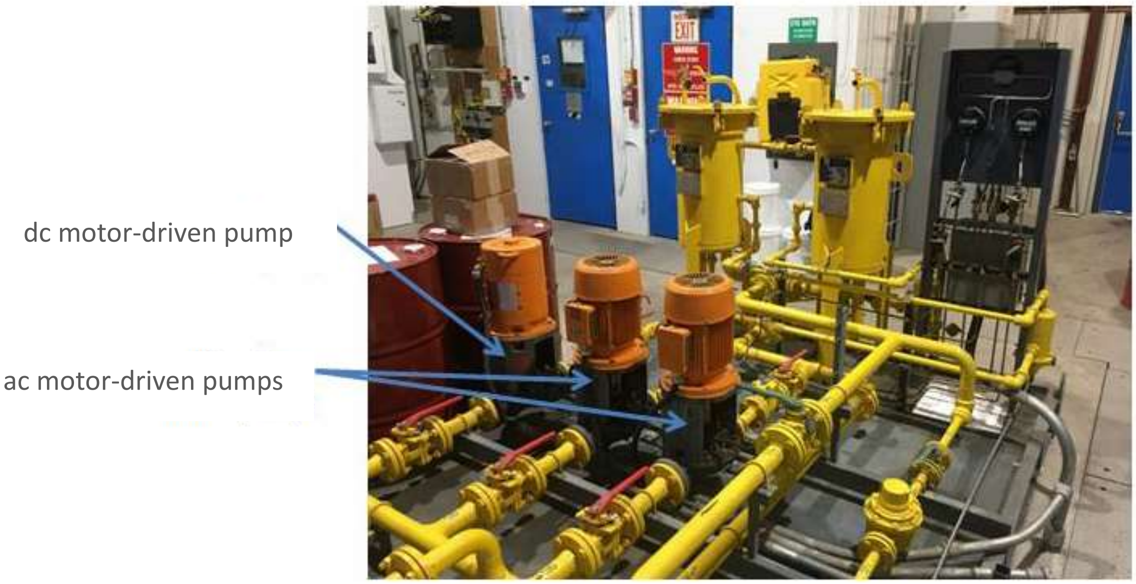

Figure 2: Fuel Oil Pumps - Happy Valley Gas Turbine

Lube oil pumps supply oil to lubricate and cool the main bearings and their seal assemblies. Lubrication is provided by a primary pump and an emergency pump. The primary pump is ac motor driven and the emergency pump is dc motor driven. The emergency pump automatically starts in the event of trouble with the primary ac pump or loss of dc power. Both ac and dc lube oil pumps are mounted on the lube oil tank with the motors on the top of the tank and the pumps submersed inside the tank (Figure 3).

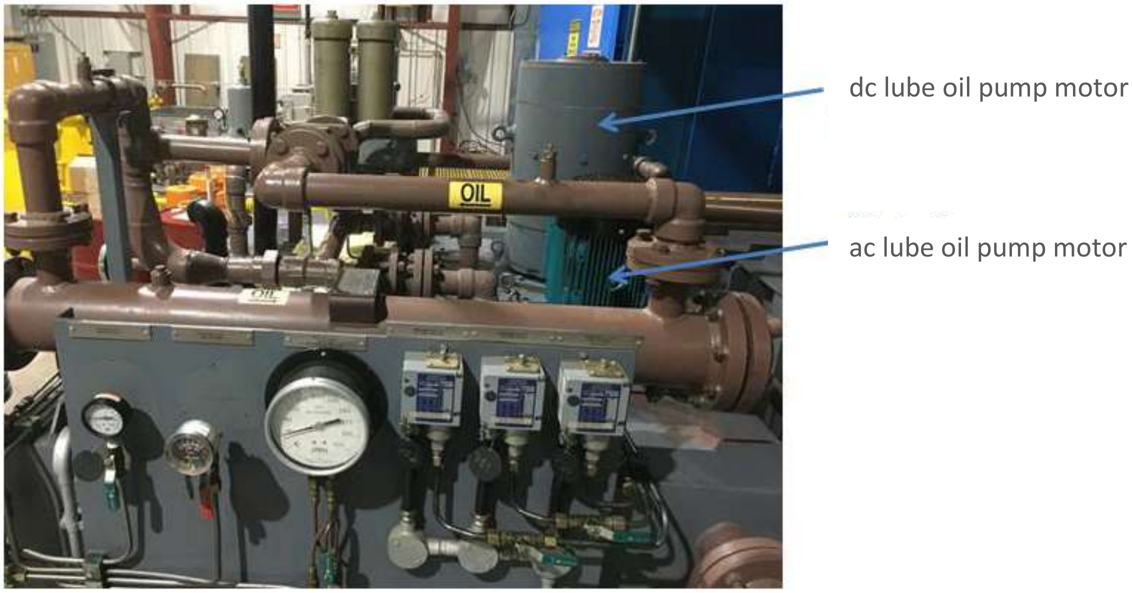

Figure 3: Lube Oil Pumps - Happy Valley Gas Turbine

Glycol is used to cool the generator’s lubricating oil. It is circulated through an air cooler using an ac motor driven pump. Figure 4 shows the glycol pump at the Happy Valley Gas Turbine.

Figure 4: Glycol Pump - Happy Valley Gas Turbine

2.2 Operating Experience

All of the pumps installed at the Happy Valley Gas Turbine are original to the plant (1992) and are now obsolete. Spare components and replacement parts have a limited availability and long procurement times. The failure of these pumps will limit the operation and potentially result in the gas turbine becoming unavailable until a replacement pump can be sourced and installed.

3.0 Analysis

3.1 Identification of Alternatives

Newfoundland and Labrador Hydro ("Hydro") evaluated the following alternatives:

- Deferral and
- Replace fuel oil, lube oil, and glycol pumps.

3.2 Evaluation of Alternatives

3.2.1 Deferral

Under this alternative, the fuel oil, lube oil, and glycol pumps engineering would not start in 2021 and the pumps would not be replaced in 2022. These pumps are past their useful life expectancy and are obsolete. The failure of the lube oil pumps to supply the lubricating oil or failure of the glycol pumps to supply glycol to the lubricating oil cooler could lead to major damage of main bearings on the power turbine and generator. The failure of the fuel oil pumps could lead to an extended outage of the gas turbine as these pumps are obsolete and their spare parts have a limited availability and long procurement times. Hydro does not recommend deferral of this project.

3.2.2 Replace fuel oil, lube oil and glycol pumps

Under this alternative new fuel oil, lube oil, and glycol pumps would be procured in 2021 and installed in 2022.

3.3 Recommended Alternative

Hydro recommends the replacement of the fuel oil, lube oil, and glycol pumps as these pumps are obsolete and critical to maintain reliability of the Happy Valley Gas Turbine.

4.0 Project Description

The scope of this project includes the supply and installation of the following pumps and motors at the Happy Valley Gas Turbine:

- Two, ac motor-driven fuel oil pumps;
- One, dc motor-driven fuel oil pump;
- One, ac motor-driven lube oil pump;
- One, dc motor-driven lube oil pump; and
- One, ac motor-driven glycol pump.

Procurement will be completed in 2021 with the installation completed in 2022.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	152.5	0.0	0.0	**152.5**
Labour	46.0	130.4	0.0	**176.4**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	5.2	4.3	0.0	**9.5**
Interest and Escalation	10.6	22.3	0.0	**32.9**
Contingency	20.4	13.5	0.0	**33.9**
Total	**234.7**	**170.5**	**0.0**	**405.2**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Open project, prepare scope statement, and detailed schedule	January 2021	January 2021
Design:		
Prepare technical conditions	April 2021	April 2021
Procurement:		
Prepare request for proposals for technical conditions and award contract	February 2021	April 2021
Prepare tender packages to supply pumps and award contracts	May 2021	July 2021
Supply and deliver pumps	July 2021	November 2021
Installation:		
Install pumps	June 2022	September 2022
Commissioning:		
Perform testing and commissioning of pumps	September 2022	September 2022
Closeout:		
Prepare closeout package	November 2022	December 2022

5.0 Conclusion

The fuel oil, lube oil, and glycol pumps at the Happy Valley Gas Turbine are 28 years old and obsolete. This project will replace these pumps to maintain reliability of the Happy Valley Gas Turbine for backup generation and voltage support to the eastern region of Hydro’s Labrador Interconnected System.

Project Title: Replace Fuel Storage Tank
Location: Paradise River
Category: Transmission and Rural Operations - Generation
Definition: Other
Classification: Mandatory

1.0 Introduction

The Paradise River Diesel Generating System ("Paradise River DGS") is the sole source of electrical generation for the community of Paradise River, Labrador. The vacuum on the only fuel storage tank has failed and cannot be repaired, necessitating replacement of the tank. This project consists of cleaning and disposing of the Paradise River DGS's existing fuel tank and replacing it with two, 8,000 L tanks, as well as replacing the bulk piping from the fuel tank to the generating unit.[1]

2.0 Background

2.1 Existing Equipment

The Paradise River DGS contains three diesel generating units each with a rated capacity of 50 kW. A single, 45,400 L, horizontal, double-walled fuel storage tank provides the necessary fuel supply for the plant. The existing tank has the capacity to store enough fuel to meet requirements for four months during winter load demands.

2.2 Operating Experience

The Paradise River DGS horizontal fuel storage tank was installed in 2005 and, since 2007, has had issues maintaining the vacuum pressure inside the tank. Since 2007, Hydro has attempted to remedy the loss in pressure including replacing various valves and gauges. While these efforts have temporarily restored the pressure of the tank, over time the pressure was lost again and the issue persists. The loss of vacuum pressure is indicative of a leak in the double-walled structure.

An external tank inspection was completed in 2015 in accordance with Hydro's external tank inspection program. The 2015 inspection found a substantial amount of corrosion on the surface of the tank and recommended recoating if the rate of corrosion increased. The next external inspection was scheduled

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[1] The new tank and its associated piping will be installed to meet the *Newfoundland and Labrador Storage of Gasoline and Associated Products Regulations ("GAP Regulations").*

to take place in 2020; however, based on its current condition, it is clear that continued corrosion has occurred. Figure 1 and Figure 2 show the current condition of the fuel tank.

Figure 1: Failed Epoxy Coating and Rust on Tank (Side View)

Figure 2: Failed Epoxy Coating and Rust on Tank (Top View)

3.0 Justification

The Paradise River DGS fuel storage tank requires internal and external repairs. Externally, the epoxy coating must be sandblasted and repainted. Internally, the tank's vacuum is failing to maintain pressure, indicating a leak inside the double wall structure. Hydro's efforts to restore the vacuum have been unsuccessful.

In its current condition, it is unlikely that the tank will pass its next inspection. Further, without correction or replacement, Hydro is at risk of experiencing a fuel leak which could cause environmental contamination and potential safety concerns. Hydro must address the deficits of the existing tank at this point in time, either through repair or replacement.

4.0 Analysis

4.1 Identification of Alternatives

Hydro evaluated the following alternatives:

- Alternative 1: Repairing and recoating the existing tank. This will require temporary, GAP Regulations certified, fuel storage to allow for continuous operation of the diesel plant during construction. The tank would be repaired, the vacuum pressure would be restored, the exterior would be sandblasted, and the epoxy coating would be restored.

- Alternative 2: Replace tank with a smaller tank (18,000 L). In this alternative, a new tank would be installed next to the existing tank. The new tank would be installed prior to disconnecting the existing tank, allowing the plant to continue operations during installation of the new tank. In this alternative, the bulk piping would also be replaced.

- Alternative 3: Replace existing tank with two smaller tanks (8,000 L). One tank would be installed prior to cleaning and disposing of the existing tank, allowing the plant to continue operations. Once the old tank was removed, the second tank would be installed in its place. In this alternative, the bulk piping would also be replaced.

- Alternative 4: Defer project and complete 2020 inspection. Hydro would complete the inspection as per the original schedule and wait until those findings are returned to initiate repairs or replacement.

4.2 Evaluation of Alternatives

As Hydro is already aware of persistent issues that it believes will cause the tank to fail inspection, it does not recommend delaying the replacement of this tank until the inspection is complete. Further, the loss of vacuum has been determined to be indicative of a leak in the double-wall structure which increases the risk of fuel spill and subsequent environmental damage. This approach would not be prudent.

In locations where a single tank serves as the only fuel storage mechanism for a diesel plant, Hydro has been replacing the existing tank (when required) with multiple, smaller tanks to increase the reliability of the system and allow for maintenance and inspections to be performed without requiring temporary storage or plant outages. For this reason, replacing the existing tank with a single smaller tank was not considered a technically viable option. Therefore, it was not included in the cost-benefit analysis.

A cost-benefit analysis was completed on the two remaining alternatives: (i) repair and recoat the existing tank, and (ii) replace tank with two smaller tanks. For the purposes of the analysis it was assumed that a horizontal fuel tank has a 30-year service life. As the existing tank is already fifteen years old, it was assumed that it would be replaced 15 years into the study period. Hydro also assumed that the annual maintenance costs would be the same for both options, with the exception of the costs associated with temporary fuel storage which would be required to complete inspections in the alternative where Hydro would repair and recoat the existing tank. The cost-benefit analysis found that replacing the existing tank with two smaller tanks was the least-cost option. A summary of the results of the analysis are shown in Table 1.

Table 1: Cost-Benefit Analysis Summary Table ($)

Alternatives	Net Present Value	Difference in Net Present Value from Least-Cost Alternative
Alternative 1: Repair existing tank	306,602	57,626
Alternative 3: Replace with two, 8,000 L tanks	249,976	0

4.3 Recommended Alternative

Hydro recommends replacing the existing tank with two smaller 8,000 L tanks. Two tanks of this size provide approximately six weeks of bulk storage for the diesel plant during peak demand periods,[2] which Hydro has determined to be adequate as fuel can be delivered to the Paradise River DGS by truck. Installing two tanks will allow maintenance and internal inspections to be completed without requiring a plant outage or a temporary storage solution. Having two tanks also enhances reliability as the diesel plant would have up to three weeks of fuel remaining in one tank should one of the two tanks fail, and could likely continue to operate until the failed tank could be either repaired or replaced.

5.0 Project Description

The scope of work includes the following:

- Purchasing and installing two, new, 8,000 L double-wall vacuum sealed, horizontal fuel tanks;
- Cleaning and disposal of the existing 45,400 L tank; and
- Connecting the new tanks to the fuel distribution system and replacing the bulk piping.

The project estimate is shown in Table 2.

Table 2: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	30.0	0.0	0.0	**30.0**
Labour	99.6	0.0	0.0	**99.6**
Consultant	15.2	0.0	0.0	**15.2**
Contract Work	151.3	0.0	0.0	**151.3**
Other Direct Costs	7.0	0.0	0.0	**7.0**
Interest and Escalation	16.8	0.0	0.0	**16.8**
Contingency	30.4	0.0	0.0	**30.4**
Total	**350.3**	**0.0**	**0.0**	**350.3**

The anticipated project schedule is shown in Table 3.

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[2] As determined by Hydro's Rural Generation Planning's fuel forecasting for Paradise River.

Table 3: Project Schedule

Activity	Start Date	End Date
Planning:		
Budget review, scope statement, schedule, and risk Assessment	January 2021	March 2021
Design:		
Detailed design and tender package	February 2021	February 2021
Procurement:		
Fabrication and delivery of new tanks	March 2021	June 2021
Construction:		
Installation of tanks and piping	July 2021	August 2021
Commissioning:		
Testing tanks and piping	July 2021	August 2021
Closeout:		
Project completion, interest cut-off, and lessons learned	October 2021	December 2021

6.0 Conclusion

The existing horizontal fuel storage tank for Paradise River DGS was scheduled for inspection in 2020; however, based on its current condition and the known issues with the loss of vacuum pressure, the tank needs to be either repaired or replaced. A cost-benefit analysis has determined that replacement of the existing tank with two, smaller, 8,000 L tanks, sized for the fuel storage requirements for the community of Paradise River, is the least-cost alternative to maintain a reliable fuel supply.

Project Title: Replace Snow Groomer (V7601)
Location: Cat Arm
Category: General Plant
Definition: Other
Classification: Normal

1.0 Introduction

This proposal is for the replacement of a snow groomer located at the Cat Arm Hydroelectric Generating Station ("Cat Arm"). The existing groomer is a Bombardier BR 180 which is used to groom the access road to the Cat Arm facility and transport personnel and supplies as required. This groomer is currently 18 years old and is at the end of its service life. Heavy equipment similar to this snow groomer has replacement criteria of approximately 15 years.

2.0 Background

2.1 Existing Equipment

The Cat Arm groomer is a 2003 Bombardier BR 180 that was purchased in 2002.

2.2 Operating Experience

The Cat Arm facility is located on the Northern Peninsula and experiences significant snow fall each year. The groomer is used at the Cat Arm facility to groom the access road during the winter and to transport personnel and supplies as required. Over the past few years the groomer has experienced reliability issues, such as starting, overheating, and alternator problems. The groomer is now at the end of its service life.

3.0 Justification

This project is justified based on the vehicles age and condition. This snow groomer has been servicing the Cat Arm facility for the past 18 years and it is at the end of its service life which was anticipated to be 15 years. The vehicle has now reached a point where the reliability and availability of this unit is in question. Considering the critical service this vehicle provides the replacement is justified at this time.

4.0 Analysis

4.1 Identification of Alternatives

Hydro evaluated the following alternatives:

- Alternative 1: Defer; and
- Alternative 2: Replacement.

4.2 Evaluation of Alternatives

4.2.1 Alternative 1: Defer

Under this alternative, replacement of the snow groomer would not take place in 2021. The current unit is beyond the replacement criteria of 15 years. Deferring the replacement of this unit further is not recommended.

4.2.2 Alternative 2: Replacement

The replacement unit is estimated to be approximately $330,000 and will have a life span of approximately 15 years.

4.3 Recommended Alternative

Hydro recommends the purchase of a new groomer for the Cat Arm facility.

5.0 Project Description

This project is for the purchase of a snow groomer for the Cat Arm facility. The current groomer is a Bombardier BR 180 the proposed new unit will have similar specifications to meet the needs in Cat Arm.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	300.0	0.0	0.0	**300.0**
Labour	0.0	0.0	0.0	**0.0**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	16.3	0.0	0.0	**16.3**
Contingency	15.0	0.0	0.0	**15.0**
Total	**331.3**	**0.0**	**0.0**	**331.3**

6.0 Project Schedule

The anticipated project schedule for the groomer replacement project in 2021 is presented Table 2.

Table 2: Project Schedule

Activity	**Start Date**	**End Date**
Planning: Project setup, develop scope statement, etc.	February 2021	March 2021
Technical Specifications: Develop technical specifications for the new equipment for tender	March 2021	April 2021
Procurement: Tender the specifications for the new unit and award tender winner	May 2021	June 2021
Delivery: Have new unit delivered to operating group	September 2021	October 2021
Closeout: Project completion certificate and lessons learned	October 2021	November 2021

7.0 Conclusion

The snow groomer at the Cat Arm facility is at the end of its service life and needs to be replaced. This piece of equipment supports the operating group over the winter months providing a groomed trail to the powerhouse and to act as a personnel and material transporter for any scheduled or unscheduled work in Cat Arm. The reliability of this groomer is critical for safe travel to Cat Arm and to support any on going work during the winter.

Project Title: Purchase Meters and Metering Equipment
Location: Various
Category: Transmission and Rural Operations - Metering
Definition: Pooled
Classification: Mandatory

1.0 Introduction

Revenue meters enable Newfoundland and Labrador Hydro ("Hydro") to accurately record energy demand and power consumption by its customers. Under the Government of Canada's *Electricity and Gas Inspection Act and Regulations,*[1] Hydro is mandated by Measurement Canada to ensure that in-service meters are accurate, in good working condition, and removed from service before the meter expiry date. Under the legislation, Hydro receives Retest Orders requiring Hydro to test specific meter types and vintage for accuracy. Hydro also receives customer requests to test the accuracy of meters.

2.0 Background

2.1 Existing Equipment

Metering equipment includes the following types of devices used to record electrical consumption:

- Self-contained meters with current flow up to 200 A (commonly referred as single-phase or single-phase demands). These include meter types 2S and 2SD;
- Transformer-rated meters, where the primary current is reduced to a value that can be recorded by the meter. This is accomplished through the use of instrument transformers. These are usually three-phase metering installations and include meter types 3S, 4S, 9S, 12S, 16S, etc.; and
- Metering tanks and/or replacement parts for metering tanks.

2.2 Operating Experience

Revenue meters and required associated equipment[2] are procured annually to replace those removed from inventory for field use. This inventory must be adequate to:

- Supply meters required by new customer service requests;

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[1] *Electricity and Gas Inspection Act*, RSC, 1985, c-E-4 and *Electricity and Gas Inspection Regulations,* SOR/86-131.
[2] Items such as metering tanks, potential transformers, current transformers, and collectors.

- Facilitate execution of Federal Government Retest Orders, customer accuracy testing requests, and to replace meters that fail related testing; and
- Replace meters due to damage, technology change, and obsolescence.

Annually, Hydro completes Federal Government Retest Orders that involve sample testing of specific meter types for which replacements are required to be kept on hand in case of retest failure. Failure of meter testing is rare but may require replacement of all meters of that type and installation. The useful life of meters may be extended provided those meters continue to pass testing, which is completed at designated time intervals, as outlined in Measurement Canada's standard "S-S-06 Sampling for Isolated Lots." Initial installation of meters is for a 12-year term and whether that term can be extended is determined by sample testing conducted each year.

3.0 Justification

Revenue meters and associated equipment are required to be purchased each year so that meters are available for new service applications and for replacements due to government retest, damaged meters, technology changes, and obsolescence. Failure to replace meters that are due to be replaced may result in monetary penalties as per the new requirements under the *Electricity & Gas Inspection Act and Regulations.*

It is more economical to purchase new electronic meters than it is to certify and seal electromechanical meters because the capital and operating costs of the new electronic meters is less than the cost of re-sealing electromechanical meters.

4.0 Analysis

4.1 Identification of Alternatives

Hydro considered the following options:

- Deferral; and
- Purchase Meters and Metering Equipment.

4.2 Evaluation of Alternatives

4.2.1 Deferral

Under this alternative, Hydro would not replace meters and metering equipment in 2021 and would not be compliant with Measurement Canada. Deferral is not a viable option.

4.2.2 Purchase Meters and Metering Equipment

Under this alternative, required meters and metering equipment are replaced in 2021. Revenue meters enable Hydro to accurately record energy and power consumption by its customers. This alternative would satisfy Hydro's requirement to maintain an inventory of all metering equipment, including all types of meters, to satisfy annual government mandated annual testing, new customer installations, replacement of damaged meters, and changes in technology.

4.3 Recommended Alternative

Hydro proposes to purchase meters and metering equipment to facilitate the provision of reliable and accurate revenue metering for customers and ensure compliance with the *Electricity and Gas Inspection Act and Regulations*.

5.0 Project Description

This project consists of purchasing 120 demand meters and 908 residential meters directly from the manufacturer intact with the seal of Measurement Canada as well as required associated equipment.

The project estimate is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	165.4	0.0	0.0	**165.4**
Labour	29.9	0.0	0.0	**29.9**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	8.8	0.0	0.0	**8.8**
Interest and Escalation	8.8	0.0	0.0	**8.8**
Contingency	20.5	0.0	0.0	**20.5**
Total	**233.4**	**0.0**	**0.0**	**233.4**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Prepare meter order	January 2021	January 2021
Design:		
Prepare drawings	January 2021	February 2021
Procurement:		
Order meters and equipment	January 2021	April 2021
Construction:		
Install meters and equipment	May 2021	December 2021
Commissioning:		
Verify installation	May 2021	December 2021
Closeout:		
Project closeout	December 2021	December 2021

6.0 Conclusion

Hydro must provide reliable and accurate revenue metering to maintain compliance with the *Electricity and Gas Inspection Act and Regulations*. This project is proposed to enable Hydro to meet this requirement.

Project Title: Purchase Meters and Metering Equipment
Location: Various
Category: Transmission and Rural Operations - Metering
Definition: Pooled
Classification: Mandatory

1.0 Introduction

Revenue meters enable Newfoundland and Labrador Hydro ("Hydro") to accurately record energy demand and power consumption by its customers. Under the Government of Canada's *Electricity and Gas Inspection Act and Regulations,*[1] Hydro is mandated by Measurement Canada to ensure that in-service meters are accurate, in good working condition, and removed from service before the meter expiry date. Under the legislation, Hydro receives Retest Orders requiring Hydro to test specific meter types and vintage for accuracy. Hydro also receives customer requests to test the accuracy of meters.

2.0 Background

2.1 Existing Equipment

Metering equipment includes the following types of devices used to record electrical consumption:

- Self-contained meters with current flow up to 200 A (commonly referred as single-phase or single-phase demands). These include meter types 2S and 2SD;
- Transformer-rated meters, where the primary current is reduced to a value that can be recorded by the meter. This is accomplished through the use of instrument transformers. These are usually three-phase metering installations and include meter types 3S, 4S, 9S, 12S, 16S, etc.; and
- Metering tanks and/or replacement parts for metering tanks.

2.2 Operating Experience

Revenue meters and required associated equipment[2] are procured annually to replace those removed from inventory for field use. This inventory must be adequate to:

- Supply meters required by new customer service requests;

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[1] *Electricity and Gas Inspection Act*, RSC, 1985, c-E-4 and *Electricity and Gas Inspection Regulations,* SOR/86-131.
[2] Items such as metering tanks, potential transformers, current transformers, and collectors.

- Facilitate execution of Federal Government Retest Orders, customer accuracy testing requests, and to replace meters that fail related testing; and
- Replace meters due to damage, technology change, and obsolescence.

Annually, Hydro completes Federal Government Retest Orders that involve sample testing of specific meter types for which replacements are required to be kept on hand in case of retest failure. Failure of meter testing is rare but may require replacement of all meters of that type and installation. The useful life of meters may be extended provided those meters continue to pass testing, which is completed at designated time intervals, as outlined in Measurement Canada's standard "S-S-06 Sampling for Isolated Lots." Initial installation of meters is for a 12-year term and whether that term can be extended is determined by sample testing conducted each year.

3.0 Justification

Revenue meters and associated equipment are required to be purchased each year so that meters are available for new service applications and for replacements due to government retest, damaged meters, technology changes, and obsolescence. Failure to replace meters that are due to be replaced may result in monetary penalties as per the new requirements under the *Electricity & Gas Inspection Act and Regulations.*

It is more economical to purchase new electronic meters than it is to certify and seal electromechanical meters because the capital and operating costs of the new electronic meters is less than the cost of re-sealing electromechanical meters.

4.0 Analysis

4.1 Identification of Alternatives

Hydro considered the following options:

- Deferral; and
- Purchase Meters and Metering Equipment.

4.2 Evaluation of Alternatives

4.2.1 Deferral

Under this alternative, Hydro would not replace meters and metering equipment in 2021 and would not be compliant with Measurement Canada. Deferral is not a viable option.

4.2.2 Purchase Meters and Metering Equipment

Under this alternative, required meters and metering equipment are replaced in 2021. Revenue meters enable Hydro to accurately record energy and power consumption by its customers. This alternative would satisfy Hydro's requirement to maintain an inventory of all metering equipment, including all types of meters, to satisfy annual government mandated annual testing, new customer installations, replacement of damaged meters, and changes in technology.

4.3 Recommended Alternative

Hydro proposes to purchase meters and metering equipment to facilitate the provision of reliable and accurate revenue metering for customers and ensure compliance with the *Electricity and Gas Inspection Act and Regulations*.

5.0 Project Description

This project consists of purchasing 120 demand meters and 908 residential meters directly from the manufacturer intact with the seal of Measurement Canada as well as required associated equipment.

The project estimate is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	165.4	0.0	0.0	**165.4**
Labour	29.9	0.0	0.0	**29.9**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	8.8	0.0	0.0	**8.8**
Interest and Escalation	8.8	0.0	0.0	**8.8**
Contingency	20.5	0.0	0.0	**20.5**
Total	**233.4**	**0.0**	**0.0**	**233.4**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Prepare meter order	January 2021	January 2021
Design:		
Prepare drawings	January 2021	February 2021
Procurement:		
Order meters and equipment	January 2021	April 2021
Construction:		
Install meters and equipment	May 2021	December 2021
Commissioning:		
Verify installation	May 2021	December 2021
Closeout:		
Project closeout	December 2021	December 2021

6.0 Conclusion

Hydro must provide reliable and accurate revenue metering to maintain compliance with the *Electricity and Gas Inspection Act and Regulations*. This project is proposed to enable Hydro to meet this requirement.

Project Title: Replace Battery Banks and Chargers
Location: Various
Category: General Properties – Network Services
Definition: Pooled
Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") uses 48 Vdc[1] battery banks and battery chargers to power its communications equipment and ensure continuity of service in the event of a station service power loss. Hydro establishes criteria for battery bank and charger service life based on performance, reliability, physical condition, and availability of support from the manufacturer.

This project consists of the replacement of the 48 Vdc battery banks and battery charger systems at the Doyles, Indian River, Bottom Brook #1, and Springdale Terminal Stations.

2.0 Background

2.1 Existing Equipment

Hydro uses 48 Vdc flooded cell battery banks and battery chargers to power its Supervisory Control and Data Acquisition ("SCADA"), voice, data, teleprotection, and networking equipment. Hydro's Energy Control Center ("ECC") uses SCADA communications equipment for full-time remote monitoring and control of Hydro's electrical grid. If this communication link is lost due to a 48 Vdc power system failure then the ECC's ability to control the grid is impeded and service reliability may be affected.

All battery banks and battery chargers at all four terminal stations will be at or near the end of service life in 2021. Additionally, the battery banks are showing signs of deterioration and the chargers are obsolete.

Details of the battery banks and chargers for all four terminal stations are included in Table 1 and Table 2.

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[1] Volt Direct Current ("Vdc").

Table 1: Summary of Battery Banks

Location	Manufacturer	Model	Battery Type	Installation Date
Doyles Terminal Station	C&D Technologies	KCT-270	Flooded Lead-Calcium	2001
Indian River Terminal Station	C&D Technologies	KCT-450	Flooded Lead-Calcium	2001
Bottom Brook Terminal Station #1	C&D Technologies	LCT-1008	Flooded Lead-Calcium	2004
Springdale Terminal Station	C&D Technologies	KCT-360	Flooded Lead-Calcium	2003

Table 2: Summary of Chargers

Location	Manufacturer	Model	Installation Date
Doyles Terminal Station	Argus	RST 48-50	2001
Indian River Terminal Station	Argus	RST 48-50	2001
Bottom Brook Terminal Station #1	Argus	RST 48-50	2004
Springdale Terminal Station	Argus	RST 48-50	2003

2.2 Operating Experience

Flooded cell battery banks are generally installed with a life expectancy of 20 years. Replacement is based on age and a combination of other factors, as follows:

- Capacity (determined through discharge testing) must exceed 80% of manufacturer’s rating;
- Cell impedance (determined through annual testing); and
- Physical characteristics such as leaks, cracks, swelling, evidence of electrolyte crystallization, and deterioration of plate condition (determined through semi-annual inspections).

Battery chargers are tested during the completion of battery maintenance to ensure they can meet the rated load requirements. The replacement of chargers is based on past failures of similar model chargers, physical condition, manufacturer support, availability of spares, and service age.

The reliability of Hydro’s 48 Vdc battery banks is supported by routine maintenance and inspections that are in alignment with the Institute of Electrical and Electronics Engineers (“IEEE”) Standard 450-2010 - IEEE Recommended Practice for Maintenance, Testing and Replacement of Vented Lead-Acid Batteries for Stationary Applications.

In each of the four sites identified for replacement, inspections have revealed numerous physical characteristics that indicate that it is necessary to replace the battery banks. A summary of the current condition of the equipment is provided in Table 3. As per IEEE standard 450-2010, replacement of individual battery cells is not recommended for a battery bank at or near the end of its useful life due to the incompatibility of operating characteristics of individual cells. Complete replacement of the respective battery banks is the recommended approach in order to ensure reliable back-up power.

Table 3: Summary of Current Condition – 48 Vdc

Location	Physical Condition					High Float Voltage (cell)	Failure to Hold Charge	Cell Impedance (Upward Trend)	Capacity <80%	Age ≥ 20 years[2]
	Leaks	Cracks	Swelling	Crystallization	Plate Deterioration					
Doyles Terminal Station	✓		✓							✓
Indian River Terminal Station	✓			✓	✓					✓
Bottom Brook Terminal Station #1	✓	✓		✓	✓			✓		
Springdale Terminal Station	✓			✓						

The battery chargers at each site were installed at the same time as the respective battery banks and are designed to meet the load requirements of the communications equipment and the charging needs of the battery bank. The units presently in service are considered obsolete. The Argus model RST48/50 charger unit is no longer serviceable by the original equipment manufacturer.

3.0 Analysis

3.1 Identification of Alternatives

Hydro evaluated the following alternatives:

- Alternative 1: Deferral; and
- Alternative 2: Replacement of battery banks and chargers.

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[2] At time of planned replacement

3.2 Evaluation of Alternatives

3.2.1 Deferral

Deferral would require Hydro to extend the service life of the battery banks past the 20-year life recommended by the manufacturer, despite the physical deterioration identified during inspection. Hydro would also have to continue to rely on obsolete Argus RST 48-50 chargers for which spare parts and manufacturer support are no longer available. Deferring this project presents two major concerns:

1) Procurement lead times are typically 3–4 months for battery banks and 2 months for charger systems. These are custom designed systems and must be planned in advance. Unplanned outages to these systems would result in the ECC losing monitoring and control ability of the affected station(s) until temporary solutions are put in place. An isolated station would likely need to be continually staffed in order to prevent extended customer outages until a replacement system could be put in place.
2) Replacement would be required on an emergency basis with increased costs due to installation overtime and expedited shipments from suppliers. Extra costs would also be incurred for the purchase and installation of temporary banks or chargers to allow for continued operations while permanent equipment is procured and installed.

3.2.2 Replacement of Battery Banks and Chargers

Under this alternative, the battery banks and chargers would be replaced based on age and condition following Hydro’s established practices which have historically supported reliable service. This alternative provides sufficient time to ensure least-cost procurement and installation.

3.3 Recommended Alternative

Hydro recommends replacement of the four, 48 Vdc battery bank and charger systems in 2021 in order to minimize the potential of a SCADA outage and additional costs associated with emergency replacement.

4.0 Project Description

This project consists of the replacement of the 48 Vdc battery banks and charger systems at the Doyles, Indian River, Bottom Brook #1, and Springdale Terminal Stations.

The project estimate is shown in Table 4.

Table 4: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	148.0	0.0	0.0	**148.0**
Labour	63.3	0.0	0.0	**63.3**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	60.0	0.0	0.0	**60.0**
Other Direct Costs	11.8	0.0	0.0	**11.8**
Interest and Escalation	15.9	0.0	0.0	**15.9**
Contingency	28.2	0.0	0.0	**28.2**
Total	**327.2**	**0.0**	**0.0**	**327.2**

The anticipated project schedule is shown in Table 5.

Table 5: Project Schedule

Activity	Start Date	End Date
Planning:		
Prepare project plan and site visits	January 2021	February 2021
Design:		
Complete battery bank and charger design and specifications, complete battery bank tender package, and complete installation tender package	February 2021	March 2021
Procurement:		
Issue purchase orders for battery banks, chargers, and field install	March 2021	April 2021
Construction:		
Install battery banks and chargers	July 2021	September 2021
Commissioning:		
Site inspections	July 2021	September 2021
Closeout:		
Project closeout	October 2021	December 2021

5.0 Conclusion

The 48 Vdc equipment at the Doyles, Indian River, Bottom Brook #1, and Springdale Terminal Stations is reaching the end of its service life. Additionally, the equipment is showing signs of physical deterioration and the original equipment manufacturer is no longer providing replacement parts. This project is proposed to replace the batteries and chargers to support reliable operation of 48 Vdc power for the operation of Hydro’s communications equipment at these locations.

Project Title: Level 2 Chargers for Electric Vehicles
Location: Various
Category: General Properties
Definition: Pooled
Classification: Justifiable

1.0 Introduction

In Order No. P.U. 7(2020), the Board of Commissioners of Public Utilities ("Board") approved Newfoundland and Labrador Hydro's ("Hydro") installation of 14 Level 3 chargers and 14 Level 2 chargers, generally along the Trans-Canada Highway on the island portion of the province. This project, expected to be complete in 2020, supports the integration of electric vehicles as a least-cost option within Hydro's fleet.

Hydro intends to install 18 Level 2 electric vehicle chargers at nine Hydro-owned sites across the province. This project is eligible for federal funding which, if approved, will provide approximately 30% of the total project cost.

2.0 Background

Electric vehicles use electricity for propulsion versus gasoline used in internal combustion engines. The use of electricity is more efficient than gasoline and, therefore, electric vehicles cost less to operate. Electric vehicles also typically require less maintenance as they have fewer moving parts when compared to internal combustion engine vehicles. As such, Hydro is seeking to integrate electric vehicles within its fleet with a view towards achieving operating and maintenance savings. To enable the use of fleet electric vehicles, charging infrastructure at Hydro-owned sites is required in advance of acquiring further electric vehicles, which is expected to commence in late 2021 and continue throughout the five-year capital plan period.

2.1 Existing Equipment

While some Hydro sites have access to electric vehicle charging via Level 1 plugs (standard 120 Vac plug types), charging at Level 1 chargers typically provides four kilometres of range per hour of charge versus 40 kilometers of range per hour at a Level 2 charger. As the electric vehicles purchased for fleet will include modern electric vehicles with approximately 400 kilometres of range, charging electric vehicles at the Level 1 speed is not practical for fleet purposes and would not permit Hydro to achieve the full benefit associated with electric vehicles. Further, many sites do not have Level 1 plug access near existing parking facilities.

2.2 Operating Experience

Hydro has one electric fleet vehicle at its St. John's location and two level 2 chargers. This equipment is approximately one year old and Hydro is still gathering operating experience with electric vehicles and charging equipment in the context of fleet usage. It is Hydro's intent to expand the use of electric vehicles in its fleet through a phased approach.

3.0 Justification

Electric vehicles offer the opportunity for Hydro to decrease operating expenses associated with fleet vehicles while maintaining the same level of service to its customers. Adding electric vehicles to Hydro's fleet has the added benefit of supporting and promoting electrification in the province which, when adopted broadly, has the opportunity to contribute to rate mitigation efforts.[1] In order to fully avail of and understand the potential benefits associated with electric vehicles in Hydro's fleet, supporting charging infrastructure is required. Funding opportunities currently exist to offset the cost of this infrastructure which may not be available in future years.

3.1 Identification of Alternatives

Hydro evaluated the following alternatives:

- No investment in electric vehicle charging infrastructure and continued use of gasoline-powered fleet vehicles; or
- Invest in electric vehicle charging infrastructure while funding options exist and pilot the use of electric fleet vehicles.

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[1] As noted in the "Conservation Potential Study," prepared by Dunsky Energy Consulting ("Dunsky") for both Hydro and Newfoundland Power Inc., electric vehicles have a large potential to increase energy sales in the province. However, as noted by Dunsky in vol. 1, at p. xviii. "The adoption of Light-Duty Vehicles in Newfoundland and Labrador is well below national and global projections . . . . This is primarily caused by the lack of public charging infrastructure, which is forecast to significantly constrain the growth of the LDV market moving forward."

3.2 Evaluation of Alternatives

Table 1 provides the forecast costs and benefits of acquiring an electric fleet vehicle versus a comparable internal combustion engine vehicle.

Table 1: Gasoline vs Electric Fleet Vehicles

Particulars	**Dodge Journey**	**Toyota Rav4**	**Hyundai Kona EV**
Base Price	26,140	28,090	44,999
Federal Rebate	-	-	(5,000)
Net Capital Cost	**26,140**	**28,090**	**39,999**
Annual Fuel Cost	3,190	2,270	-
Annual Electricity Cost	-	-	173
Annual Maintenance Cost	1,048	1,048	551
Estimated Annual Operating	4,238	3,318	724
Life Cycle Cost: 4 Years	43,092	41,362	42,895
Life Cycle Cost: 6 Years	51,568	47,998	44,343
Life Cycle Cost: 8 Years	60,044	54,634	45,791

For each vehicle compared in Table 1 Hydro has assumed purchase of the base models for fleet use,[2] 25,000 kilometres driven annually, model specific fuel economy and electric efficiency ratings, gasoline price of $1.15 per litre, electricity cost at the marginal value of exports assumed to be 4 cents per kWh, and annual maintenance costs based on a third-party study.[3] Residual values have not been included due to the lack of reliable data with respect to depreciation associated with modern high range electric vehicles.

The results of Table 1 show that the Hyundai Kona electric vehicle has a higher initial capital cost when compared to the gasoline powered alternatives. However, this is offset by the Federal Government's Zero Emission Vehicle incentive of $5,000,[4] and lower annual operating and maintenance costs ranging from $2,600 to $3,500 per year. As a result, in comparison to the Dodge Journey, the electric Hyundai Kona alternative results in a simple break even of 3.9 years and lifecycle savings ranging from $7,200 to $14,300 for 6 and 8 year useful lives, respectively. In comparison to the Toyota Rav4, the electric Hyundai Kona alternative results in a simple break even of 4.6 years and lifecycle savings ranging from $3,700 to $8,800 for 6 and 8 year useful lives, respectively.

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[2] Delivery and other initial purchase fees are assumed to be consistent across all models.

[3] Average maintenance costs for both gasoline and electric powered vehicles taken from "Comparing Fuel and Maintenance Costs of Electric and Gas Powered Vehicles in Canada," 2° Institute, September, 2018.

[4] "Zero Emissions Vehicles," Transport Canada, January 31, 2020. <https://tc.canada.ca/en/road-transportation/innovative-technologies/zero-emission-vehicles>

3.3 Recommended Alternative

Hydro recommends the investment in charging infrastructure to support the expansion of electric vehicles in its fleet. Electric fleet vehicles have the potential for operations and maintenance savings relative to their gasoline counterparts.

Hydro has made an application to the Government of Canada's Zero Emission Vehicle Infrastructure Program which, if successful, will provide funding of $5,000 per charger or $90,000 towards the project. It is not known if this funding will be available in future years; therefore, Hydro is seeking approval to build Level 2 chargers at Hydro-owned sites in 2021 as deferring the project may result in the loss of funding opportunity and a material increase in project cost.

Based on the potential cost savings, Hydro is proposing to proceed with the project and install 18 Level 2 chargers at nine Hydro-owned sites across the province.

4.0 Project Description

Hydro is proposing to install 18 Level 2 electric vehicle chargers at the following Hydro-owned sites. A listing of sites is provided in Table 2.

Table 2: Project Details

Location	Level 2 Connectors
Holyrood	2
Whitebourne	2
Bishops Falls	2
Bay D'Espoir	2
Deer Lake	2
Port Saunders	2
St. Anthony	2
Happy Valley-Goose Bay	2
Wabush	2

Each installation will include a single bollard with dual J1772 level 2 charger connections, positioned between charging stalls to permit charging by two electric vehicles simultaneously. In order to complete this installation, each site will require underground electrical connections to the main building supply, and installation of a concrete pad and bollards. A typical installation is shown in Figure 1.

Figure 1: Duel Port Single Bollard Installation

1 The estimate for this project, not including potential government funding, is provided in Table 3.

Table 3: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	75.0	0.0	0.0	**75.0**
Labour	29.4	0.0	0.0	**29.4**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	117.0	0.0	0.0	**117.0**
Other Direct Costs	6.9	0.0	0.0	**6.9**
Interest and Escalation	25.8	0.0	0.0	**25.8**
Contingency	45.7	0.0	0.0	**45.7**
Total	**299.8**	**0.0**	**0.0**	**299.8**

2 The anticipated project schedule is shown in Table 4.

Table 4: Project Schedule

Activity	Start Date	End Date
Planning:		
Project initiation	January 2021	January 2021
Design:		
Electrical/Civil design	February 2021	April 2021
Procurement:		
Purchase of EV chargers/material	February 2021	June 2021
Tender of electrical/civil contract	May 2021	May 2021
Construction:		
Construction of EV charger sites	August 2021	October 2021
Commissioning:		
Final hookup and commissioning	October 2021	November 2021
Closeout:		
Project closeout	December 2021	December 2021

5.0 Conclusion

This investment supports the further integration of electric vehicles within Hydro's fleet, expected to commence in late 2021 and continue throughout the five-year capital plan. Electric vehicles offer the opportunity for operating and maintenance savings relative to gasoline powered alternatives, while continuing to provide customers with the same level of reliable service on a least-cost basis. Hydro has made an application for government funding, which if approved, will offset approximately 30% of the capital cost of this project and will be required to be expended in 2021.

Given the foregoing, this project is justified and consistent with Hydro's legislative requirement to provide least-cost, reliable service to customers.

Project Title: Upgrade Core IT/OT Infrastructure (2021)
Location: Hydro Place
Category: General Properties
Definition: Other
Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") maintains back-end server and storage equipment to permit Operational Technology ("OT") software applications and Information Technology ("IT") services to function in conjunction with the Energy Management System ("EMS") in order to support the operation and reliability of the electrical grid. This project proposes the replacement of datacenter equipment such as servers and storage that are used to provide back-end IT/OT services to facilitate running Hydro software applications and services.

2.0 Background

Hydro has an ongoing refresh program to maintain hardware performance. The current server and storage hardware replacement life cycle is to replace devices after five years. Devices being replaced from this budget have been in service for a period of more than five years and have exceeded the expected reliable lifespan.

2.1 Existing Equipment

Hydro's OT and IT infrastructure includes over 180 servers, 7 TB of RAM, 400 TB of disk storage, and a variety of Windows and Linux operating systems. Hydro's servers and storage are used on a continuous basis and are active for the life of the equipment. These devices are used to maintain and monitor the electrical utility system.

2.2 Operating Experience

This budget proposal is for life cycle replacement of datacenter hardware in Hydro's core IT/OT infrastructure. The equipment proposed for replacement was purchased in 2014–2015. Industry best practice is to replace servers and storage devices on a five-year life cycle. Hydro's servers and storage are used on a continuous basis and are active for the life of the equipment. Hydro has a five-year warranty on its server and storage infrastructure. After the five-year warranty period expires, the equipment is placed on a vendor maintenance program which is reviewed and renewed quarterly until the devices are replaced. To ensure reliability, Hydro's standard is to use enterprise grade hardware for EMS and applications.

3.0 Justification

This project is required to ensure reliable operability of Hydro's IT systems. Hydro must keep critical infrastructure current in order to adequately support its business needs. The server infrastructure will be at or near end of life in 2021 and will need to be replaced to ensure that the infrastructure is reliable and vendor supported. The devices identified for replacement no longer have vendor support and spare parts have been discontinued. In addition, the functions and services reliant on this infrastructure are at risk as security and support patches for the operating systems and hardware are no longer available.

4.0 Analysis

4.1 Identification of Alternatives

Hydro evaluated the following alternatives:

- Deferral; and
- Replacement of Servers.

4.2 Evaluation of Alternatives

4.2.1 Deferral

Under this alternative, systems would be operated for one additional year beyond the planned life cycle. After analyzing the higher maintenance costs to run at or near end life, in addition to the increased technical risk of the existing equipment no longer supporting new technologies required to interface with other servers, storage, and network technology, this option was considered high risk.

The applications and systems contained within the Hydro OT server infrastructure environments are critical systems for providing monitoring and maintenance of the power grid. If key components fail, replacement parts are difficult to procure and the process to upgrade or replace could take up to eight weeks before the applications and services are placed back into production. This would impact efficiency of operations and as such, this alternative is not viable.

4.2.2 Replacement of Servers

Under this alternative, several components of the OT server and storage hardware which were purchased more than five years ago will be replaced. This includes devices such as servers, storage capacity expansion, and cabling.

Upgrading the server hardware, which is at end life, is critical to ensure reliability. In 2021, this hardware will be at the end of the five to six year life cycle. Running it past this period adds significant risk that the hardware will fail and also makes sourcing replacement parts very difficult.

As such, Hydro proposes to upgrade its core infrastructure in 2021.

4.3 Recommended Alternative

Hydro recommends the replacement of the core IT infrastructure components that have been in service for more than five years. If this infrastructure is not replaced and the environments encounter a failure, Hydro could experience up to eight weeks of potential downtime, which would have an impact on the efficiency of operations.

5.0 Project Description

This project involves the replacement, addition, and upgrade of hardware components related to Hydro’s EMS server and storage infrastructure. To ensure that Hydro has a reliable and secure environment to support EMS Information System operations, each year core IT infrastructure components are identified for refresh and replacement.

In 2021, seven servers used by the EMS are to be replaced and one data center will have cabling and rack components upgraded.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	179.8	0	0	**179.8**
Labour	53.9	0	0	**53.9**
Consultant	0.0	0	0	**0.0**
Contract Work	0.0	0	0	**0.0**
Other Direct Costs	0.0	0	0	**0.0**
Interest and Escalation	5.7	0	0	**5.7**
Contingency	23.4	0	0	**23.4**
Total	**262.8**	**0.0**	**0.0**	**262.8**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Open project, review schedule, and create request for proposal(s)	January 2021	April 2021
Design:		
Create project plan	February 2021	June 2021
Procurement:		
Tender and award supply and installation contract	March 2021	November 2021
Construction:		
Install hardware/software	April 2021	November 2021
Commissioning:		
Implementation and commissioning new equipment	May 2021	November 2021
Closeout:		
Project closeout	October 2021	December 2021

6.0 Conclusion

Hydro must keep its server and storage infrastructure current in order to ensure the reliability of core business applications and to prevent downtime that could impact operation efficiency. Hydro proposes the upgrade of hardware components related to the EMS server and storage infrastructure to ensure that Hydro has a reliable and secure environment to support EMS Information System operations.

Project Title: Replace Peripheral Equipment (2021)
Location: Hydro Place
Category: General Properties
Definition: Other
Classification: Normal

1.0 Introduction

The Replace Peripheral Equipment project includes replacement of Multi-Function Printer Devices (“MFDs”), laser-printers, a plotter, video-conference units, video-display projectors, and digital-signage media-player controllers that have exceeded the recommended lifespan.

2.0 Background

Newfoundland and Labrador Hydro (“Hydro”) maintains peripheral equipment for document printing, scanning, and presentation at a level required to reliably function and support business processes for Hydro’s operations.

2.1 Existing Equipment

Hydro has an ongoing refresh program to maintain the reliability and performance of peripheral hardware. The current peripheral hardware replacement life cycle is five years. Devices to be replaced under this project have been in service for a period of more than five years and have exceeded their expected useful life. Replacement parts may not be available after maintenance agreements and warranties have expired.

2.1.1 Age of Equipment or System

The decision to replace a peripheral device is based on the following criteria:

- Age and failure status;
- Availability of alternate printing;
- Availability of support;
- Product roadmap and availability of features; and
- Hydro’s printing requirements and number of users.

2.2 Operating Experience

The equipment proposed for replacement was purchased in 2014–2015. Industry best practices indicate that the typical service life for a peripheral device is four to five years. Hydro's peripheral device life-cycle plan of operating peripheral equipment for five years is comparable to other companies in the utility industry, including Newfoundland Power.

3.0 Justification

Hydro must keep its peripheral infrastructure current in order to adequately support its business needs. This project aims to replace equipment in a planned and consistent manner and ensures peripheral devices are available and reliable. The units scheduled for replacement in 2021 have all been in service for five or more years and their maintenance contracts and warranties have expired. If this infrastructure is not replaced and the equipment encounters a failure, Hydro could experience up to eight weeks of potential downtime for the associated services from the failed piece of equipment, which would have an impact on the efficiency of operations.

4.0 Analysis

4.1 Identification of Alternatives

Hydro evaluated the following alternatives:

- Deferral; and
- Replacement of Peripheral Devices.

4.2 Evaluation of Alternatives

4.2.1 Deferral

Under this alternative, peripheral devices and associated systems planned for replacement in 2021 would be operated for an additional year during which time repairs would be completed and after which the devices would be replaced. After analyzing the higher maintenance costs to run at or near end of life, in addition to the increased technical risk of the existing equipment no longer supporting new technologies required to interface with other computer, server, storage, and network technology, this option was determined to be unacceptable due t the importance of such devices to Hydro's day-to-day operations.

When service-affecting components fail, sourcing the availability of replacement parts for devices already in service for more than five years becomes difficult and the process to upgrade or replace these systems/components could take up to eight weeks before the affected services are placed back into production. This would negatively impact the efficiency of daily operations in many facilities and as such, this alternative is not viable.

4.2.2 Replacement of Peripheral Devices

Under this alternative, several peripheral hardware devices including devices such as printers, page scanners, and video-projectors will be replaced in 2021 to ensure reliability of the affected services.

Operating these devices beyond 2021 adds significant risk that the hardware will fail and also makes sourcing replacement parts very difficult.

4.3 Recommended Alternative

Hydro recommends the replacement of peripheral devices and components that have been in service for more than five years.

5.0 Project Description

Analysis based on evaluation of existing deployed devices currently in service shows 3 MFDs, 29 small MFDs, 6 projectors, 5 laser printers, 3 boardroom display upgrades, 4 video conferencing units, and 5 media presentation appliances are due to be replaced in 2021.

The project estimate is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	188.9	0	0	**188.9**
Labour	22.7	0	0	**22.7**
Consultant	0.0	0	0	**0.0**
Contract Work	16.3	0	0	**16.3**
Other Direct Costs	0.0	0	0	**0.0**
Interest and Escalation	5.8	0	0	**5.8**
Contingency	22.7	0	0	**22.7**
Total	**256.4**	**0.0**	**0.0**	**256.4**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Open project, review schedule, create requests for proposal(s)	January 2021	April 2021
Design:		
Conduct site visits, create project plan	February 2021	June 2021
Procurement:		
Tender and award supply and installation contract	March 2021	November 2021
Construction:		
Install hardware/software	April 2021	November 2021
Commissioning:		
Implementation and commissioning new equipment	May 2021	November 2021
Closeout:		
Project closeout	September 2021	December 2021

6.0 Conclusion

To support its business processes, Hydro must maintain peripheral devices at a reliable level. If peripheral infrastructure is not kept current, there is an increased risk of failure and downtime that will negatively impact productivity. This project is a cost effective approach to keeping Hydro's peripheral infrastructure functioning efficiently.

Project Title: Replace Radomes
Location: Various
Category: General Properties - Telecontrol
Definition: Pooled
Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") is proposing a project for the replacement of microwave antenna radomes in 2021.[1] Hydro's radome asset management replacement criteria are based on operational experience and the manufacturers' recommendations and are focused on reducing the probability of electrical system outages resulting from radome failure. Radomes are replaced at different sites throughout the network each year, depending on age and condition. The radome replacement schedule for 2021–2025 is provided in Appendix A.

2.0 Background

2.1 Existing Equipment

Hydro has a network of microwave radios by which corporate communications and system data are transmitted. The microwave radio system provides the backbone for all corporate voice and data communications. Traffic carried over the microwave system includes:

- Teleprotection signals for the provincial transmission system;
- Data pertaining to the provincial Supervisory Control and Data Acquisition System ("SCADA");
- Data pertaining to the corporate administrative system; and
- Operational and administrative voice systems.

Microwave radio signals are transmitted from one location to the next using parabolic antennas attached to towers. These antennas are mounted at heights of up to 120 metres and range in diameter from two to five metres. At such extreme heights, the antennas are subjected to high wind and ice loading when storms occur and must be protected. To provide this protection, the feed horns of the antennas, which are responsible for sending and receiving microwave radio signals, are covered with a

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[1] Radomes are the protective covers that enclose the delicate components of the microwave antennas in Hydro's microwave radio system.

flexible covering, stretched over the antenna shroud, known as the radome. These covers are made of advanced plastics known as Hypalon and Teglar that prevent the accumulation of ice and snow that could bend or break the feed horn, and do not interfere with the microwave radio signals. The white cover illustrated in Figure 1 is an example of a radome on an uninstalled antenna.

Figure 1: Microwave Antenna with Radome

Damage to radomes can occur in several ways. Exposure to wind, sun, rain, and ice causes the radomes to deteriorate over time. When the radome weakens, tears form in the fabric, as shown in Figure 2. Left unchecked, the tears quickly grow in size (Figure 3) and the material can be torn free by wind. Such tears may result in severe damage to the delicate antenna components.

Figure 2: Tear in Radome

Figure 3: Heavily Damaged Radome

Other modes of failure are less common. Ice falling from the tower can damage radome components, such as the hardware that hold the radome in place, as shown in Figure 4. Vandalism by the use of shotguns, rocks, or other projectiles has also occurred at sites that are accessible by road. Each of these occurrences has the potential to damage the radome and make it prone to complete failure.

Figure 4: Missing Radome Mounts

There are 77 radomes throughout Hydro's system. They are installed on towers from St. John's west to Deer Lake, and south to Bay d'Espoir. Figure 5 shows Hydro's Telecommunication Network.

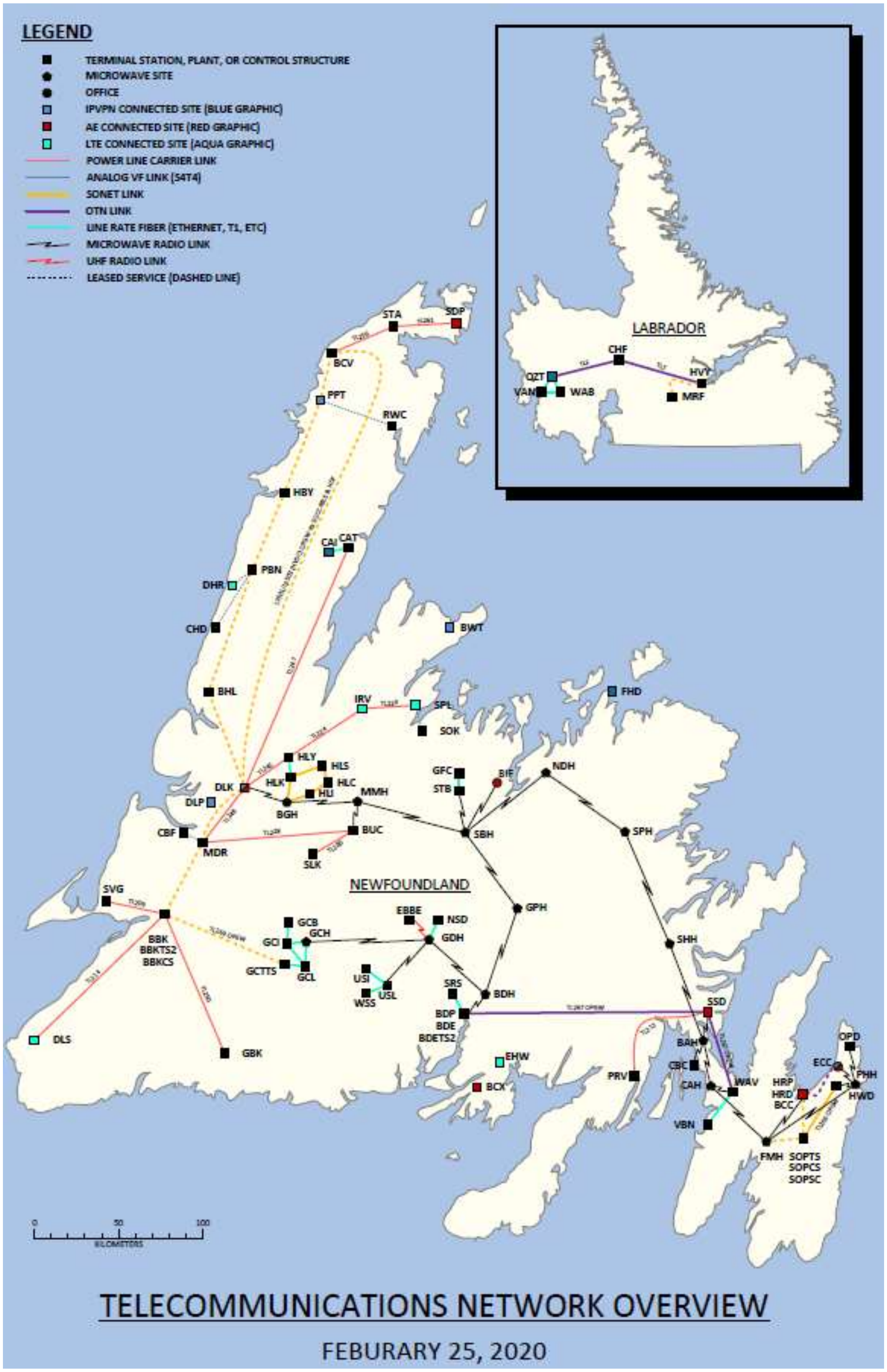

Figure 5: Telecommunications Network including Microwave Towers

The original microwave communications system was installed in 1979 and consisted of nine towers that connected the Bay d'Espoir generating facility to the Stony Brook Terminal Station and west to Hinds Lake Hydraulic Generation Plant and Deer Lake Terminal Station. In 2001, the microwave network was expanded by adding 11 towers on the East Coast from Hydro Place in St. John's to Sunnyside Terminal Station and all stations in between. The last expansion occurred in 2003, linking Bull Arm Hill to Sandy Brook Hill with the construction of three new towers. This provided reliable communications between Bay d'Espoir and all the major 230 kV terminal stations. Each of these towers has between one and seven parabolic dishes that are protected by a radome cover.

To avoid the logistical challenges that would be created by replacing all radomes in the same year, the replacement program is distributed over multiple years. The current schedule for the next five years is included in Appendix A.

Under the replacement program, some radomes will be left in-service for periods longer than recommended to avoid in-service failure of the radomes, Hydro has developed an inspection program to identify radomes that are torn or otherwise damaged, as illustrated in Figure 3.

These radomes must be replaced as soon as damage is identified to ensure the integrity of the microwave system. A radome failure could result in failure of the microwave system. The impact of a microwave failure today could have a greater effect than the incident of 1996 (further discussed in Section 2.2) due to the fact that teleprotection signals, which protect transmission lines in the event of a system disturbance, are now transmitted using the microwave network. Today, protection signals for 17 of Hydro's 24 critical 230 kV transmission lines are carried on the microwave network. Therefore, a microwave failure would cause the Energy Control Centre ("ECC") to lose control of the system stations and could likely cause and/or extend customer outages.

2.2 Operating Experience

2.2.1 Outage Statistics

In the winter of 1996, a wind storm resulted in the failure of two separate radomes at the Sandy Brook Hill and Mary March Hill microwave sites, which caused a significant and sustained outage to a part of Hydro's telecommunication network. Despite routine inspections, the radomes were torn and the radome material became entangled in the antenna feed horns. As a result, critical components at both sites were irreparably damaged and the antennas required replacement. Once the storm cleared and the cause of the outage was identified, antennas could not be replaced until three weeks later, due to lead times associated with material procurement and weather-related delays.

In total, the microwave radio system was out of service for approximately six weeks. During that time, temporary leased telecommunications services were procured and installed, resulting in unanticipated labour and materials costs.

There have been no other telecommunication outages caused by radome failures since the 1996 wind storm.

2.2.2 Vendor Recommendations

As a result of the costs and outage time associated with the 1996 storm, personnel from Hydro consulted with manufacturers to develop a proactive radome replacement plan. Based on discussions with representatives from radome manufacturers Andrew Solutions (now CommScope) and CableWave, the following replacement frequency was developed:

- CableWave radomes (made of Hypalon material) should be replaced on a seven-year cycle; and
- CommScope radomes (made of Teglar material) should be replaced on an eight-year cycle.

CommScope radomes, with a slightly longer life, cannot be substituted for CableWave radomes on CableWave antennas due to the structural differences associated with each type of antenna.

3.0 Justification

Radomes have an average life of seven or eight years depending on the radome brand and must be replaced before failure. Radome failures are unacceptable as damage to microwave dishes would result in extensive telecommunications outages and costly repairs. A microwave failure would cause the ECC to lose control of the system stations and likely cause and/or extend customer outages. Loss of teleprotection capability could result in damage to Hydro’s electrical equipment.

4.0 Analysis

4.1 Identification of Alternatives

Hydro considered the following options:

- Deferral; and
- Scheduled replacement of radomes.

4.2 Evaluation of Alternatives

4.2.1 Deferral

Prolonged use of a radome beyond its recommended replacement date increases the likelihood of an extended telecommunications outage that would negatively impact the integrity of Hydro's energy systems. Minor radome damage cannot be repaired and can quickly result in radome failure. Deferral is not recommended.

4.3 Recommended Alternative

Radomes should be replaced proactively based on vendor's recommendations of useful life.

5.0 Project Description

The proposed project includes replacement of 14 radomes at various locations as shown in Appendix A.

The project estimate is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	0.0	0.0	0.0	**0.0**
Labour	73.7	0.0	0.0	**73.7**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	136.6	0.0	0.0	**136.6**
Other Direct Costs	8.4	0.0	0.0	**8.4**
Interest and Escalation	10.9	0.0	0.0	**10.9**
Contingency	10.8	0.0	0.0	**10.8**
Total	**240.4**	**0.0**	**0.0**	**240.4**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	**Start Date**	**End Date**
Planning:		
Prepare project plan and site visits	January 2021	February 2021
Design:		
Complete tender package	February 2021	March 2021
Procurement:		
Purchase radomes	April 2021	April 2021
Construction:		
Install radomes	May 2021	September 2021
Commissioning:		
Site inspections	October 2021	October 2021
Closeout:		
Project closeout	November 2021	December 2021

6.0 Conclusion

Hydro’s Radome Replacement Program is based on operational experience and manufacturers’ recommendations and is necessary to prevent outages caused by radome damage. Due to operational risks associated with the failure of corporate microwave equipment, it is necessary for Hydro to take a proactive approach to managing the risk associated with failures of microwave antenna radomes.

Appendix A

Radome Replacement Schedule

Table A-1: Site Name Abbreviations

Abbreviation	Site Name
BAH	Bull Arm Hill Microwave/Repeater
BDE	Bay d'Espoir Terminal Station
BDH	Bay d'Espoir Hill Microwave/Repeater
BFI	Bishop Falls Office
BGH	Blue Grass Hill Microwave/Repeater
BUC	Buchans Terminal Station
CAH	Chapel Arm Hill Microwave/Repeater
CBC	Come By Chance Terminal Station
DLK	Deer Lake Terminal Station
DLP	Deer Lake Passive Repeater
ECC	Energy Control Center
FMH	Four Mile Hill Microwave/Repeater
GCH	Granite Canal Hill Microwave
GDH	Godaleich Hill Microwave/Repeater
GPH	Gull Pond Hill Microwave
HRP	Holyrood Plant
HWD	Hardwoods Terminal Station
MMH	Mary March Hill Microwave
NDH	Notre Dame Hill
OPD	Oxen Pond Terminal Station
PHH	Petty Harbour Hill Microwave/Repeater
SBH	Sandy Brook Hill Microwave
SHH	Shoal Harbour Hill
SPH	Square Pond Hill
SSD	Sunnyside Terminal Station
STB	Stony Brook Terminal Station
USL	Upper Salmon Plant
WAP	Western Avalon Passive Repeater
WAV	Western Avalon Terminal Station

Table A-2: 2021 Radome Replacements

		Antenna			
Tower	**Direction**	**Size**	**Vendor**	**Model #**	**Last Replaced**
BDE	BDH	1.8m(6')	CW	DA6-71hp	2014
BDH	GPH	1.8m(6')	CW	DA6-71hp	2014
BDH	BDE	1.8m(6')	CW	DA6-71hp	2014
BFI	SBH	2.4m(8')	Andrew	HP8-71GE	2013
BUC	MMH	1.8m(6')	CW	DA6-71hp	2014
DLK	DLP	4.5m(15')	Gabriel	SR15-71B	2013
FMH	PHH (div)	1.8m(6')	Andrew	HP6-71E	2013
NDH	SPH (main)	3.6m(12')	Andrew	HP12-71E	2013
NDH	SPH (div)	3.6m(12')	Andrew	HP12-71E	2013
NDH	SBH (main)	3.6m(12')	Andrew	HP12-71E	2013
NDH	SBH (div)	3.6m(12')	Andrew	HP12-71E	2013
SBH	NDH (main)	3.6m(12')	Andrew	HP12-71E	2013
SBH	NDH (div)	3.0m(10')	Andrew	HP10-71D	2013
SBH	BFI	2.4m(8')	Andrew	HP8-71GE	2013

Table A-3: 2022 Radome Replacements

		Antenna			
Tower	**Direction**	**Size**	**Vendor**	**Model 3**	**Last Replaced**
BDH	GPH	2.4m(8')	Andrew	HP8-71D	2014
BDH	GDH	3.0m(10')	Andrew	HP10-71D	2014
SHH	BAH (main)	2.4m(8')	Andrew	HP8-71GE	2014
SHH	BAH (div)	2.4m(8')	Andrew	HP8-71GE	2014
SHH	SPH (main)	3.6m(12')	Andrew	HP12-71E	2014
SHH	SPH (div)	3.6m(12')	Andrew	HP12-71E	2014
SPH	SHH (main)	3.6m(12')	Andrew	HP12-71E	2014
SPH	SHH (div)	3.6m(12')	Andrew	HP12-71E	2014
SPH	NDH (main)	3.6m(12')	Andrew	HP12-71E	2014
SPH	NDH (div)	3.6m(12')	Andrew	HP12-71E	2014

Table A-4: 2023 Radome Replacements

		Antenna			
Tower	**Direction**	**Size**	**Vendor**	**Model #**	**Last Replaced**
GPH	SBH (div)	3.6m(12')	CW	DA12-71hp	2016
GPH	BDH	1.8m(6')	CW	DA6-71hp	2016
SBH	GPH	3.6m(12')	CW	DA12-71hp	2016
SBH	STB	1.8m(6')	CW	DA6-71hp	2016

Table A-5: 2024 Radome Replacements

		Antenna			
Tower	**Direction**	**Size**	**Vendor**	**Model #**	**Last Replaced**
BAH	CAH	2.4m(8')	Andrew	HP8-71D	2016
BAH	CBC	1.8m(6')	Andrew	HP6-71E	2016
BAH	SSD	1.8m(6')	Andrew	HP6-71E	2016
GPH	SBH (main)	3.6m(12')	Andrew	HP12-71E	2016
GPH	BDH	2.4m(8')	Andrew	HP8-71D	2016
SBH	GPH	3.6m(12')	Andrew	HP12-71E	2016
SBH	MMH	3.0m(10')	Andrew	HP10-71D	2016

Table A-6: 2025 Radome Replacements

		Antenna			
Tower	**Direction**	**Size**	**Vendor**	**Model #**	**Last Replaced**
MMH	BUC	1.8m(6')	CW	DA6-71HP	2018
PHH	FMH (main)	3.0m(10')	Andrew	HP10-71D	2017
STB	SBH	1.8m(6')	CW	DA6-71HP	2018

Project Title: Refresh Cyber Security Infrastructure (2021)
Location: Hydro Place
Category: General Properties
Definition: Other
Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro's ("Hydro") increasing reliance on information and operational systems and its expanding data networks increases exposure to security threats to Hydro's Information Technology ("IT") and Operating Technology ("OT") infrastructure. This project will refresh Hydro's cyber security tools and improve Hydro's cyber threat detection and mitigation capabilities.

2.0 Background

Hydro maintains security management software applications, IT/OT systems, and equipment to permit OT software applications and IT services to support the secure operation and reliability of associated Hydro's IT environments.

2.1 Existing Equipment and Services

Hydro maintains licensing and vendor support for several cyber security software programs to ensure it has the required capability to manage cyber security threat detection and remediation activities. Ensuring Hydro's servers, storage, and endpoint computer devices are protected by antivirus, intrusion-detection, and related services is vital to the reliable and secure operation of IT/OT computing environments.

2.2 Operating Experience

Hydro's security software tools are used by OT security staff and OT support staff on a daily basis. While Hydro has been successful in protecting its IT/OT assets from malicious threats to date, continual updates and improvements are necessary to protect against the global growth and increasing sophistication of cyber threats and the cyber-criminal industry.

Hardware devices being proposed for upgrade in this project have been in service for a period of more than five years and have exceeded the expected reliable lifespan of those products. Industry best practice is to replace cyber security-related devices on a maximum five-year cycle. Hydro has a five-year warranty on its server and storage infrastructure. After the five-year warranty period expires, the equipment is placed on a vendor maintenance program, which is reviewed and renewed quarterly until the devices are replaced.

3.0 Justification

External threats to Hydro's computer systems are mitigated through the use of anti-virus tools and detection/intrusion prevention appliances. Internet access is tightly controlled and managed by security appliances and software that help reduce the risk of potential computer viruses.

Hydro requires reliable cyber security infrastructure to mitigate risks to: (i) operational technology security (e.g., loss of Hydro's critical infrastructure's stability and processing capability due to hardware/software failure or threat of virus attacks), (ii) availability of information (e.g., loss of communication across the wide area network), and (iii) corporate data loss (e.g., loss of data through cybercriminal malware and attacks).

Additionally, a serious incident involving the loss of corporate data or access to critical business, plant, or energy control systems would result in unplanned costs to contain, investigate, and remediate the incident, as well as investments to change systems or processes, if required.

4.0 Analysis

4.1 Identification of Alternatives

Hydro evaluated the following alternatives:

- Deferral; and
- Refresh cyber security infrastructure.

4.2 Evaluation of Alternatives

4.2.1 Deferral

If this project is deferred, it would limit the methods available to prevent or mitigate emerging cyber security risks and the processes available to prevent those cyber security risks from affecting the reliability and integrity of Hydro's OT systems.

The applications and systems contained within the Hydro OT cyber security environments monitor and manage aspects of systems which are critical for delivering applications and communications services for reporting, monitoring, and maintenance of the power grid. If key components of the security management systems fail, replacement parts are not readily available and the process to upgrade or replace could take up to eight weeks before the applications and services are placed back into production. This would negatively impact the efficiency of Hydro's operations. As such, deferral of this project is not viable as it presents an unacceptable risk to Hydro's ability to reliably operate its systems.

4.2.2 Refresh Cyber Security Infrastructure

In this alternative, several components of Hydro's cyber security environments will be upgraded or replaced to maintain the required level of service. Upgrading the associated hardware that is at the end of its useful life is critical to ensure reliability. In 2021, this hardware will have exceeded the five-year production life cycle.

4.3 Recommended Alternative

Hydro recommends the upgrade or replacement of specific cyber security IT infrastructure components which have been identified as requiring upgrades to improve security management features/capacity, as well as replacement of devices that have been in service for more than five years. If this infrastructure is not upgraded or replaced and the environments encounter a failure or do not meet the required level of coverage for security protection, Hydro could potentially experience material downtime for key services, which would have an impact on the efficiency, reliability, and security of operations.

5.0 Project Description

This project involves the replacement, addition, and upgrade of software and IT/OT hardware components related to Hydro Energy Management System ("EMS") cyber security systems and managed environments. To ensure that Hydro has a reliable and secure environment to support EMS information system operations, cyber security components are analyzed on an annual basis to identify components that require upgrade, expansion, refresh, additional licensing or replacement.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	118.0	0	0	**118.0**
Labour	65.1	0	0	**65.1**
Consultant	10.3	0	0	**10.3**
Contract Work	0.0	0	0	**0.0**
Other Direct Costs	0.0	0	0	**0.0**
Interest and Escalation	4.8	0	0	**4.8**
Contingency	19.3	0	0	**19.3**
Total	**217.5**	**0.0**	**0.0**	**217.5**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning: Open project, review schedule, create request for proposal(s)	January 2021	April 2021
Design: Conduct site visits, complete detailed design, internal review of consultant drawings and design	February 2021	June 2021
Procurement: Tender and award supply and installation contract	March 2021	November 2021
Construction: Install hardware/software	April 2021	November 2021
Commissioning: Implementation and commissioning new equipment	May 2021	November 2021
Closeout: Project closeout	October 2021	December 2021

6.0 Conclusion

Hydro’s computer systems and network infrastructure require continuous protection from cyber threats. Hydro continuously evaluates its security tools and services to ensure its systems are secure. Hydro proposes this project to ensure it has adequate cyber security tools to mitigate security threats to IT/OT infrastructure and software.

E. Capital Projects over $50,000 and less than $200,000

2021 Capital Budget Application

Section E: Projects over $50,000 but less than $200,000

Newfoundland and Labrador Hydro
2021 Capital Budget
Projects Over $50,000 but less than $200,000
($000)

Project Description	Expended to 2020	2021	Future Years	Total	Definition	Classification
Generation						
Purchase Tools and Equipment Less than $50,000 (2021) - Hydraulic Plants	-	194.3	-	**194.3**	Pooled	Normal
Upgrade Compressed Air System - Happy Valley Gas Turbine	-	76.6	69.2	**145.8**	Other	Normal
Total Generation	**-**	**270.9**	**69.2**	**340.1**		
Transmission and Rural Operations						
Purchase Backhoe - Wabush	-	179.3	-	**179.3**	Other	Justifiable
Purchase Tools and Equipment Less than $ 50,000 - Central Region (2021)	-	150.2	-	**150.2**	Pooled	Normal
Purchase SF6 Gas Recovery Systems	-	142.7	-	**142.7**	Other	Normal
Purchase Tools and Equipment Less than $ 50,000 - Northern Region (2021)	-	77.6	-	**77.6**	Pooled	Normal
Total Transmission and Rural Operations	**-**	**549.8**	**-**	**549.8**		
General Properties						
Remove Safety Hazards - Various (2021)	-	199.1	-	**199.1**	Other	Mandatory
Replace Network Communications Equipment	-	194.0	-	**194.0**	Pooled	Normal
Upgrade Hydro Energy Control Centre Wall Infrastructure	-	188.5	-	**188.5**	Other	Normal
Upgrade Remote Terminal Units	-	183.4	-	**183.4**	Pooled	Normal
Purchase Office Equipment Less Than $50,000 (2021)	-	62.3	-	**62.3**	Pooled	Normal
Total Generation Properties	**-**	**827.3**	**-**	**827.3**		
Total Projects Over $50,000 and Under $200,000	**-**	**1,648.0**	**69.2**	**1,717.2**		

Project Title: Upgrade Compressed Air System
Location: Happy Valley Gas Turbine
Category: Generation - Gas Turbines
Definition: Other
Classification: Normal

1.0 Introduction

The Happy Valley Gas Turbine is located in Happy Valley-Goose Bay and was commissioned in 1992. It is a source of backup capacity for loads supplied at Happy Valley Terminal Station in the event of the interruption of supply from the 138 kV network and can provide up to 25 MW of capacity for the Labrador Interconnected System.[1]

The Happy Valley Gas Turbine has several auxiliary systems that are required for operation. These systems include the compressed air system which supplies air at a specific pressure and flow rate to ensure the reliable operation of the gas turbine as designed by the Original Equipment Manufacturer ("OEM"), Pratt and Whittney.

This project proposes the upgrade of the compressed air system to maintain the reliability of the Happy Valley Gas Turbine. Figure 1 shows the Happy Valley Gas Turbine facility.

Figure 1: Happy Valley Gas Turbine Facility

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[1] This capacity will also be available to the Island Interconnected System upon the reliable operation of the Labrador-Island Link.

2.0 Background

2.1 Existing Equipment

The compressed air system at the Happy Valley Gas Turbine consists of two reciprocating compressors, which are shown in Figure 2, a single air dryer and storage tank, piping, valves, and controls.

There are 11 pressure safety valves ("PSVs") on the compressed air system as follows:

- Six PSVs on compressors;
- Three PSVs on air dryer; and
- Two PSVs on air piping.

The primary function of the compressed air system is to start the gas generator. The compressed air system is also used for the operation of the exhaust stack snow doors, inlet filter cleaning, and shop air.

Figure 2: Air Compressors at the Happy Valley Gas Turbine

2.2 Operating Experience

The compressed air system at the Happy Valley Gas Turbine is original to the plant and was placed in service in 1992.

Recently, the air dryer has not been able to dry the air to an acceptable level. This has contributed to the system's inability to start the gas generator on particularly cold days. The moisture in the compressed air condenses and freezes inside the snow door pneumatic cylinders and its associated supply piping, which causes the cylinders to stick and prevent operation of the gas turbine. Sourcing replacement components for the air dryer is challenging due to its age. The compressed air header piping (see Figure 3) that supplies air to open and close the stack snow doors (shown in Figure 1) has experienced leakage, which is resulting in increased run time for the compressors and air dryer.

Figure 3: Snow Door Air Header at the Happy Valley Gas Turbine

Currently, one of the two compressors requires replacement. The other compressor was replaced less than five years ago and does not need replacement at this time. Two air compressors and the air dryer located at the Wabush Terminal Station in Labrador were removed from service as they are no longer required and are compatible for use at the Happy Valley Gas Turbine.

Preventive maintenance is regularly performed on the compressed air system and corrective maintenance performed as required. Both compressors have been overhauled in the last 10 years and the PSVs on the compressed air system are typically replaced every five years to ensure proper operation and relief of excess air pressure, which could damage the equipment and affect the safety of workers.

3.0 Analysis

3.1 Identification of Alternatives

Newfoundland and Labrador Hydro (“Hydro”) evaluated the following alternatives:

- Deferral; and
- Upgrade the compressed air system.

3.2 Evaluation of Alternatives

3.2.1 Deferral

In this alternative, the upgrade of the compressed air system would be deferred. Due to the age and deteriorated condition of compressed air system components, Hydro does not recommend this alternative as it presents an unacceptable risk to the operation of the Happy Valley Gas Turbine.

3.2.2 Upgrade Compressed Air System

In this alternative, the compressed air system would be upgraded in 2021–2022. The air dryer has not been able to dry the air to an acceptable level, contributing to the inability of the system to start the gas generator on particularly cold days. The compressed air system components at the Happy Valley Gas Turbine are original to the plant and have been experiencing operating issues due to their age and deteriorated condition.

3.3 Recommended Alternative

Hydro recommends the upgrade of the compressed air system to support the reliable operation of the Happy Valley Gas Turbine.

4.0 Project Description

If approved, the following work will be completed at the Happy Valley Gas Turbine:

- Replacement of the existing air dryer with the air dryer from the Wabush Terminal Station;
- Replacement of one of the two existing air compressors with an air compressor from the Wabush Terminal Station;
- Replacement of the snow door air header and auxiliaries such as lubricator, filter, and valves; and

- Replacement of the PSVs on the compressed air system.

The project estimate is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	15.0	0.0	0.0	**15.0**
Labour	43.3	43.8	0.0	**87.1**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	7.5	7.5	0.0	**15.0**
Other Direct Costs	0.0	4.3	0.0	**4.3**
Interest and Escalation	4.2	8.0	0.0	**12.2**
Contingency	6.6	5.6	0.0	**12.2**
Total	**76.6**	**69.2**	**0.0**	**145.8**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Open project, prepare scope statement, and detailed schedule	January 2021	February 2021
Procurement:		
Procure snow door air header piping and PSVs	March 2021	July 2021
Construction:		
Install air dryer	July 2021	September 2021
Install air compressor, snow door air header piping, and PSVs	July 2022	September 2022
Commissioning:		
Perform testing and commissioning of compressed air system	October 2022	October 2022
Closeout:		
Prepare closeout documents	November 2022	December 2022

5.0 Conclusion

The majority of the compressed air system components at the Happy Valley Gas Turbine are original to the plant, including the air dryer, one of the two air compressors, and piping. These components have been experiencing operating issues due to their age and deteriorated condition. If approved, this project will upgrade the compressed air system to maintain the reliable operation and availability of the Happy Valley Gas Turbine.

Project Title: Purchase Backhoe
Location: Wabush
Category: General Properties - Transportation
Definition: Other
Classification: Justifiable

1.0 Introduction

This project is for the purchase of a backhoe in Wabush. Currently, work on the distribution lines, Wabush Line Depot, and Wabush Terminal Station utilizes a contracted backhoe with operator for any lifting and digging requirements. Newfoundland and Labrador Hydro's ("Hydro") analysis indicates that the purchase of a backhoe is least-cost compared to the existing approach.

2.0 Background

Currently, there is no Hydro-owned backhoe in Wabush; Hydro uses a contracted unit with operator to provide the required services.

2.1 Operating Experience

The contracted backhoe Hydro uses in Wabush is used to dig holes for line construction (e.g., pole and anchor placement) and clearing access ways for construction. The backhoe is also required for unloading materials and equipment for both the Wabush Line Depot and Terminal Station.

3.0 Justification

This project is financially justified as the least-cost option for activities requiring this type of equipment in Wabush. The unit can also be used in the winter for snow clearing.

4.0 Analysis

4.1 Identification of Alternatives

Hydro evaluated the following alternatives:

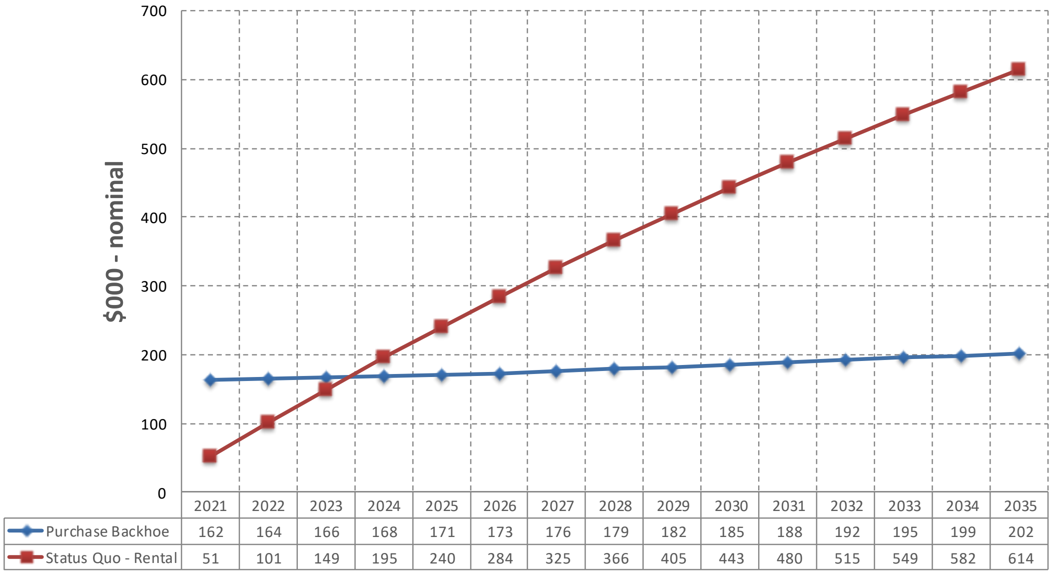
- Alternative 1: Purchase Backhoe
- Alternative 2: Status Quo Rental

4.2 Evaluation of Alternatives

Both alternatives were analysed over the expected useful life of a backhoe, approximately 15 years. For the status quo option of using a rental, rental costs from October 2018 to September 2019 were assumed to be the average annual cost. Labour costs associated with the Purchase Backhoe option were included in the cost-benefit analysis. The results of the cost-benefit analysis are shown in Table 1, which shows that purchasing a backhoe is the least-cost option by a material margin. Figure 1 indicates that the payback period for this purchase is expected to be achieved in the fourth year of ownership.

Table 1: Purchase Backhoe – Wabush – Cost-Benefit Analysis
Alternative Comparison Cumulative Net Present Value (2020)

Alternatives	Cumulative Net Present Value (CPW)	CPW Differences between Recommended Alternative and the Least-Cost Alternative
Purchase Backhoe	202,228	-
Status Quo – Rental	614,237	412,009



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Purchase Backhoe	162	164	166	168	171	173	176	179	182	185	188	192	195	199	202
Status Quo - Rental	51	101	149	195	240	284	325	366	405	443	480	515	549	582	614

Figure 1: Cost Benefit Analysis Chart

4.3 Recommended Alternative

The recommended option is to purchase a backhoe in 2021. The purchase of this equipment will provide savings to customers while maintaining the same level of service.

5.0 Project Description

This project is for the purchase of a new backhoe complete with a bucket, digger, and forklift option. The backhoe will also have rubber tires so the unit can be used in the winter for snow clearing.

The project estimate is shown in Table 2.

Table 2: Project Estimate ($000)

Project Cost	**2021**	**2020**	**Beyond**	**Total**
Material Supply	155.0	0.0	0.0	**155.0**
Labour	0.0	0.0	0.0	**0.0**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	8.8	0.0	0.0	**8.8**
Contingency	15.5	0.0	0.0	**15.5**
Total	**179.3**	**0.0**	**0.0**	**179.3**

6.0 Project Schedule

The anticipated project schedule for the Purchase Backhoe project in 2021 is presented Table 3.

Table 3: Project Schedule

Activity	**Start Date**	**End Date**
Planning:		
Project setup, develop scope statement, etc.	February 2021	March 2021
Technical Specifications:		
Develop technical specifications	April 2021	May 2021
Procurement:		
Tender/award	May 2021	June 2021
Delivery:		
Have new unit delivered to operating group	August 2021	September 2021
Closeout:		
Project completion certificate, lessons learned	October 2021	November 2021

7.0 Conclusion

Hydro uses a backhoe for various activities throughout the year in Wabush. Owning a backhoe to perform these activities is the least-cost option.

Project Title: Purchase SF_6 Gas Recovery Systems
Location: Various
Category: General Plant
Definition: Other
Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") is responsible for 184 high-voltage breakers that include sulfur hexafluoride ("SF_6") as the insulation medium. Hydro installs SF_6 breakers as deteriorated breakers are replaced and when additional breakers are required to meet system expansion. While SF_6 is used industry wide for high voltage breakers due to its excellent dielectric strength, it is a harmful greenhouse gas that is 22,800 times more powerful than carbon dioxide.

The SF_6 gas degrades during the operation of breakers, particularly when the breaker is interrupting fault current. To ensure the quality of the SF_6 gas and the reliable operation of a SF_6 breaker, Hydro's preventive maintenance procedures require that the gas be tested each time a breaker needs to be topped up with SF_6 gas. Further, Hydro's asset management strategy for SF_6 circuit breakers requires overhauls be performed in a planned fashion every 20 years. On occasion, SF_6 circuit breakers experience issues due to gasket failures or leaks. During overhauls or gasket replacement SF_6 gas is removed from the breaker and temporarily stored in an empty cylinder. To complete this work, SF_6 gas recovery equipment is required to ensure that SF_6 gas is not released into the environment.

2.0 Background

2.1 Existing Equipment

At present, Hydro has one SF_6 gas recovery unit which is normally located at Bishop's Falls. This unit can support the work in the central and eastern parts of the province. However, addressing issues that require gas reclaiming equipment in the western and northern parts of the Island and Labrador are a challenge. Transporting the unit to and from Labrador presents logistical challenges and increases the risk of damage during transport.

2.2 Operating Experience

Hydro's existing SF_6 gas recovery unit has performed well but one unit is not adequate to allow prompt response and effective coordination of work across the various regions of the province.

3.0 Justification

The impact of having only one SF$_6$ gas recovery unit is that the response time to address issues that require gas reclaiming equipment in the western and northern parts of the Island and Labrador will be a challenge due to the increasing number of SF$_6$ breakers in service. The response times in dealing with urgent critical circuit breaker issues will be jeopardized. SF$_6$ gas is a potent greenhouse gas that is potentially harmful to the environment, and Hydro strives to ensure that no SF$_6$ gas is lost to the atmosphere while performing overhauls or gasket replacement on circuit breakers. Gas recovery systems allow for zero losses during gas handling.

4.0 Analysis

4.1 Identification of Alternatives

Hydro evaluated the following alternatives:

- Deferral; and
- Purchase two additional SF$_6$ reclaiming units.

4.2 Evaluation of Alternatives

4.2.1 Deferral

Having only one SF$_6$ reclaiming unit for the Island and Labrador is not acceptable due to ineffective coordination of work, delayed response times, and the potential for release of harmful gases to the atmosphere. The option of not proceeding with this project in 2021 was considered and is not recommended by Hydro given the number of SF$_6$ breakers in service throughout the province.

4.2.2 Purchase Two Additional SF$_6$ Reclaiming Units

Due to the criticality of the breakers for the eastern and central parts of the province it is recommended that the existing unit service the central and eastern areas and another unit be purchased for the western and northern parts of the Island and another for Labrador. Circuit breakers are critical assets required for the safe and reliable operation of the electrical system and issues with circuit breakers need to be promptly addressed.

4.3 Recommended Alternative

Hydro is recommending the purchase of two additional SF_6 reclaiming units to provide more effective coordination of work and help minimize environmental risks associated with the handling of SF_6 gas during circuit breaker work.

5.0 Project Description

This project consists of the purchase of two SF_6 gas recovery units. One unit would be located in Labrador while the other unit would be located in Stephenville for the Stephenville/Northern Peninsula area. The existing unit will service the Avalon (Whitbourne) and Central (Bishop’s Falls) areas.

The project estimate is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2021	2022	Beyond	Total
Material Supply	104.0	0.0	0.0	**104.0**
Labour	20.1	0.0	0.0	**20.1**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	6.2	0.0	0.0	**6.2**
Contingency	12.4	0.0	0.0	**12.4**
Total	**142.7**	**0.0**	**0.0**	**142.7**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Project initiation and planning	January 2021	February 2021
Procurement:		
Specification and procurement	March 2021	April 2021
Delivery:		
Equipment delivery, review of Original Equipment Manufacturer documentation, testing and verification of equipment	September 2021	September 2021
Closeout:		
Project closeout	October 2021	November 2021

6.0 Conclusion

Hydro uses high voltage breakers that include SF_6 as the insulation medium. SF_6 is a greenhouse gas, and should not be released during necessary work on breakers. SF_6 gas recovery units allow work to proceed while minimizing the risk of releasing SF_6 to the environment, and ensuring high gas quality for placing the gas back into the breaker. At present, Hydro owns one SF_6 gas recovery unit and requires two additional units to allow prompt servicing of circuit breakers in all areas of the province.

Project Title: Remove Safety Hazards

Location: Various

Category: General Properties - Administrative

Definition: Other

Classification: Mandatory

1.0 Introduction

This project is required to address safety hazards that are identified within Newfoundland and Labrador Hydro's ("Hydro") Safe Work Observation Program ("SWOP"). This project ensures that potential hazards that can be rectified through capital work can be efficiently completed in a timely manner.

2.0 Background

Safety hazards are identified through Hydro's SWOP by employees, contractors, and others who access Hydro facilities. Often mitigation of the safety concerns can be accomplished through an operating or procedural change, communication, or an operating budget item. In some cases assessment of the issue and the associated recommendation concludes that a mitigation measure is a capital item. If so, a cost estimate is completed for the mitigation work, which is submitted to Hydro's Engineering and Technology department for consideration under the Remove Safety Hazards project. These requests are reviewed, and if warranted, the funding is approved by the Senior Manager of Project Execution.

2.1 Operating Experience

In Hydro's "2019 Capital Budget Application," the Board of Commissioners of Public Utilities approved a budget of $198,600 to address safety hazards in the workplace. Table 1 lists the projects completed in 2019, which total approximately $210,900.

Table 1: Projects Completed in 2019

Location	Project Description	Cost ($000)
Bay d'Espoir	Replace 600 V quick-connect receptacles	39.8
Holyrood TGS[1]	Replace pedestrian guard rails in the vicinity of the Pump House intake	65.3
Holyrood TGS	Install anti-slip mats in the Waste Water Basin building	15.3
Holyrood TGS	Add fencing at Quarry Brook Dam and add signage at cooling water discharge into Conception Bay	11.0
Holyrood TGS	Replace deteriorated main entrance walkway	79.5
Total		**210.9**

Table 2 shows the budget and actual expenditures for years 2016 to 2020.

Table 2: Capital Expenditure History

Year	Capital Budget ($000)	Actual Expenditures ($000)
2020	$198.6	-
2019	$198.6	$210.9
2018	$199.4	$166.3
2017	$198.6	$185.9
2016	$199.3	$175.4

3.0 Justification

The project is justified on Hydro's requirement to provide a safe work environment for its employees in compliance with the Newfoundland and Labrador *Occupational Health and Safety Regulations, 2012*:[2]

> 14. (1) An employee shall ensure, so far as is reasonably practicable, that all buildings, structures, whether permanent or temporary, excavation, machinery, workstations, places of employment and equipment are capable of withstanding the stress likely to be imposed upon them and of safely performing the functions for which they are used or intended.
>
> (2) An employer shall ensure that necessary protective clothing and devices are used for the health and safety of his or her workers.

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[1] Holyrood Thermal Generating Station ("Holyrood TGS").

[2] *Occupational Health and Safety Regulations*, Nfld Reg 5/12, s.14.

In an effort to avoid injury or incident, Hydro has initiated the SWOP. The SWOP involves workers actively looking for safety hazards and problems that may otherwise go unnoticed, which could lead to serious health and/or safety issues for Hydro customers, employees, contractors, and the general public. This project provides Hydro with the budget to address unsafe situations where capital work is identified as the solution and enables Hydro to respond quickly to address unsafe conditions rather than waiting for the normal capital budget process. These deficiencies, as reported under SWOP, need to be immediately corrected to provide a safe work environment.

4.0 Project Description

This project will allow Hydro to promptly address safety hazards as they are identified through Hydro's SWOP. A component of this program involves identifying and reporting conditions that can potentially lead to an incident or an accident. The project estimate is shown in Table 3.

Table 3: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	100.0	0.0	0.0	**100.0**
Labour	89.6	0.0	0.0	**89.6**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	9.5	0.0	0.0	**9.5**
Contingency	0.0	0.0	0.0	**0.0**
Total	**199.1**	**0.0**	**0.0**	**199.1**

As this project relates to unanticipated safety issues, no schedule is available.

5.0 Conclusion

Some safety hazards, identified in Hydro's SWOP, require prompt corrective actions. Hydro is proposing this project to allow for timely corrective actions that are capital in nature.

Project Title: Replace Network Communications Equipment
Location: Various
Category: General Properties - Telecontrol
Definition: Pooled
Classification: Normal

1.0 Introduction

The Newfoundland and Labrador Hydro ("Hydro") Communications Network transports protection and control data and voice traffic between offices, terminal stations, generating stations, and the Energy Control Centre as required to operate the electrical system and to conduct business functions. There are approximately 600 networking devices. The project will replace 20 devices that are End-of-Life[1] and End-of-Support[2] from the vendor. Devices at End-of-Support are vulnerable to hardware and software defects and security threats.

2.0 Background

This project is focused on maintaining up to date network hardware. The industry standard average for network lifecycle is five years. Hydro typically maintains network hardware for eight to twelve years based on past performance and typically tries to remove these elements from service within one to two years from the End-of-Support date.

An analysis, based on device criticality, is performed every year to prioritize replacement of network devices. Devices in the field, such as those in small offices, would obtain a lower classification than devices that support critical network transport.

2.1 Existing Equipment

Hydro currently has 16 Cisco 2800 series routers in its communications network that have been deemed End-of-Life since 2011 and End-of-Support since 2016. In 2021, Hydro proposes the replacement of all 16 of these routers with updated technology equivalents from the same vendor, Cisco Systems ("Cisco"). These routers are required for voice communications and local network access to field locations.

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[1] An End-of-Life component is obsolete but support remains available from the vendor under a service contract.
[2] An End-of-Support component is no longer supported by the vendor.

In addition, four of Hydro's core network switches in Hydro Place will reach their End-of-Support on April 31, 2021. After this date, Cisco will no longer provide hardware or software support to these devices. The network core is the most critical component in the Hydro administrative network, controlling all routing between the remote Hydro offices, Hydro Place, and Hydro's network data centre. Disruption of the network core would result in disruption of business services and would cause widespread interruption of operations throughout Hydro.

A list of the devices proposed to be replaced is provided in Appendix A.

2.2 Operating Experience

Cisco networking devices have been proven to be reliable and secure when properly maintained and kept up to date. Cisco regularly releases software updates to address any identified deficiencies as well as security updates. Timely security updates and patches have become increasingly critical in recent years requiring the latest generation of devices. These updates only continue until Cisco deems the devices End-of-Support as per its product life cycle management and the devices are no longer attached to a valid service contract.

3.0 Justification

Cisco has a defined lifecycle management process. Once Cisco announces an End-of-Life of a particular device they typically provide support for these devices for up to five years (End-of-Support). After the device reaches the End-of-Support date they no longer receive hardware replacement or software updates which could leave these devices vulnerable to defects, security threats, and delays in replacing failed devices. The project will replace 20 devices that are End-of-Life and End-of-Support from the vendor.

4.0 Analysis

4.1 Identification of Alternatives

Hydro evaluated the following alternatives:

- Deferral;
- Replace identified devices with Cisco products; and
- Replace identified devices with alternate vendor products.

4.2 Evaluation of Alternatives

4.2.1 Deferral

The existing 2800 series routers slated for replacement in 2021 have functioned since 2015 (End-of-Support) without software upgrades. Software upgrades are a critical component in Hydro's security plan. Without effective security updates Hydro would not have the ability to mitigate security vulnerabilities on exposed devices. Deferring the replacement of these devices would leave Hydro vulnerable. In addition, by 2021 these devices will have been in service for approximately 12–15 years and are at increased risk of hardware failure.

The network core is the most critical component in the Hydro network. A failure in the network core would result in significant disruption of the business operations of Hydro. If the network core was compromised, from a hardware failure or security vulnerability, there would be impacts on all business and information systems that rely on the functionally of the core network. Without a maintenance agreement, a network core disruption could leave the systems unavailable for several days or possibly weeks while new equipment is ordered and provisioned. Deferring the core upgrade would put Hydro in a significant risk category when the maintenance agreement ends in 2021.

4.2.2 Replace Identified Devices with Cisco Systems Products

Hydro currently manages and maintains 561 Cisco network devices in the administrative network. Hydro currently uses several backend management systems from Cisco which maintain and manage the network devices, including Cisco Prime and Cisco Identity Services Engine. Working in a single vendor environment has several advantages:

- Reduction of training cost for support personnel;
- Management of maintenance contracts is simplified; and
- Interoperability of platforms is less complex.

4.2.3 Replace Identified Devices with Alternate Vendor Products

Incorporating an alternate vendor would decrease the efficiency of the network management teams and would require the implementation of multiple management platforms. Hydro has negotiated a significant volume discount with Cisco in the form of a standing offer which provides competitive discounts that negate any potential cost savings from the introduction of an alternate vendor.

4.3 Recommended Alternative

Hydro recommends replacing the identified devices in 2021 in order to address risks associated with hardware and software vulnerabilities for devices which reach vendor End-of-Support. Cisco products are recommended based on compatibility with existing management platforms as well as operational efficiencies. Deferring the replacement of these devices increases the likelihood of a network outage which would significantly impact the productivity of Hydro's workforce.

5.0 Project Description

The project includes the replacement of 16 Cisco 2800 series routers and four of Hydro's core network switches located in Hydro Place.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	95.0	0.0	0.0	**95.0**
Labour	71.5	0.0	0.0	**71.5**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	10.8	0.0	0.0	**10.8**
Contingency	16.7	0.0	0.0	**16.7**
Total	**194.0**	**0.0**	**0.0**	**194.0**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning: Scope Statement, develop resource and network outage schedule	January 2021	February 2021
Design: Network drawings and design packages, refine Bill of Materials	February 2021	March 2021
Procurement: Submit requisition for Cisco equipment (Standing Offer)	March 2021	April 2021
Construction: Configure and install new equipment	April 2021	May 2021
Commissioning: Test network connectivity	May 2021	November 2021
Closeout: Update As-Built drawings and closeout project	November 2021	December 2021

6.0 Conclusion

The Hydro Communications Network provides connectivity for users to access business critical systems that enable day-to-day operations. The core network devices in Hydro Place are the most critical component in the Hydro administrative network and any interruption would not only affect internal business operations but would also impact customer services. The identified routers are required to provide network connectivity to field locations and any failure of these devices would impact the ability to work safely at these locations.

Operating outside of vendor maintenance agreements presents significant risk to Hydro. The upgrade of network devices under this project is essential to ensuring high availability and security of administrative network operations.

Appendix A

Proposed Devices for Replacement

Table A-1: Site List

Device Location	Device Name	Current Device Model	Replacement Device Model
Hydro Place	6509-HydroPlace-A	Cisco 6509	C9500CY-24Y4C
Hydro Place	6509-HydroPlace-B	Cisco 6509	C9500CY-24Y4C
Hydro Place	COMMS-ROOM-Core1	Cisco 3750	C9200-48PXG
Hydro Place	COMMS-ROOM-Core2	Cisco 3750	C9200-48PXG
Buchans	buc-rtr-01-01-a	Cisco 2800	Cisco 4300
Bull Arm Hill	bah-rtr-01-01-a	Cisco 2800	Cisco 1111
Granite Canal Hill	gch-rtr-01-01-a	Cisco 2800	Cisco 1111
Petty Hr Hill	phh-rtr-01-01-a	Cisco 2800	Cisco 1111
Upper Salmon	usl-rtr-01-01-a	Cisco 2800	Cisco 1111
Chapel Arm Hill	cah-rtr-01-01-a	Cisco 2800	Cisco 1111
Oxen Pond	OPD-ADMIN-RTR01	Cisco 2800	Cisco 1111
Granite Canal	GCL-CAMP-RTR	Cisco 2800	Cisco 4300
Sops Arm	SOPS-ARM-LD-RTR-A	Cisco 2800	Cisco 1111
Fogo Island	FOGO-LD-RTR-A	Cisco 2800	Cisco 1111
Mary's Hr	MARYS-HBR-RTR-A	Cisco 2800	Cisco 1111
Grand Falls	GFC-A	Cisco 2800	Cisco 4300
Exploits Generation	EGN-PLANT-RTR-01-01	Cisco 2800	Cisco 4300
Blue Grass Hill	bgh-rtr-01-01-a	Cisco 2800	Cisco 1111
Godaliech Hill	gdh-rtr-01-01-a	Cisco 2800	Cisco 1111
Come By Chance	CBC-ADMIN-RTR01	Cisco 2800	Cisco 1111

Project Title: Upgrade Hydro Energy Control Centre Wall Infrastructure
Location: Hydro Place
Category: General Properties
Definition: Other
Classification: Normal

1.0 Introduction

The Upgrade Hydro Energy Control Centre (“ECC”) Wall Infrastructure project proposes the replacement of servers, and upgrades to the software that draws the real time image of the province’s electrical grid on the ECC display wall in Hydro Place. The real time image display provides information regarding the status of equipment such as generators and breakers, and analog information that shows the condition of the province's electrical grid.

2.0 Background

Newfoundland and Labrador Hydro (“Hydro”) maintains servers and software at a level required to reliably function and support business processes for the operation of the organization.

2.1 Existing Equipment

The ECC display wall consists of 24 Mitsubishi display panel screens that are connected to six physical servers with multi display ports that are joined together at the server running specialized Activu software. This software displays an image that stretches across all screens to represent a real time view of the province’s electrical energy grid. This critical piece of infrastructure provides the ECC with a current view of the status of Hydro’s electrical system.

2.2 Operating Experience

Hydro has had a display wall in operation since 1989. The server infrastructure was installed with the control system at that time; it was interfaced with an upgraded control system in 2005 and again in 2014–2015. The server hardware has a life cycle of six to seven years and is due to be replaced in 2021.Hydro has experienced reduced reliability and increased maintenance requirements in recent years due to persistent hardware and software issues.

3.0 Justification

Hydro must keep critical infrastructure current in order to adequately support its business needs. The display wall is used by the ECC operators to provide situational awareness across the system, including visible notification of alarms, transmission voltages, etc. This is especially important during restoration operation, allowing the operators to see the big picture and the effects that restoration progress is having on the system. While operator monitors can also display system information, the operator monitors are more focussed on the station level, and the display wall is system wide. Inability to use the display wall would limit operator system visibility and could hamper efforts to maintain the system. The server infrastructure is critical to operation of the display wall. The server infrastructure will be either at or near end of life in 2021 and will need to be replaced to ensure that the infrastructure is reliable and vendor supported. This project is required to ensure reliable operability of Hydro's ECC display wall.

4.0 Analysis

4.1 Identification of Alternatives

Hydro evaluated the following alternatives:

- Deferral; and
- Upgrade ECC display wall infrastructure.

4.2 Evaluation of Alternatives

4.2.1 Deferral

Under this alternative, the server hardware, video cards, cables, and operating system would be operated for one more year beyond the planned life cycle. After analyzing the lack of available replacement parts for the video card components, the higher maintenance costs to run the servers at or near end-of-life, and increased risk of the technology no longer supporting new technologies required to plug into the display wall, this option was considered high risk.

The ECC display wall is a critical system for the maintenance of Hydro's power grid and Hydro is already experiencing reduced reliability associated with end-of-life system components. If a component fails, replacement parts are difficult to procure. The current operating systems are near end-of-life and the video cards are not capable of functioning on newer versions of Microsoft Windows and will become obsolete.

This alternative is not viable as it presents an unacceptable operating risk to one of Hydro's critical systems.

4.2.2 Upgrade ECC Display Wall Infrastructure

Under this alternative, the ECC display wall's server hardware will be replaced. This includes the servers, cabling, display cards, and an upgrade of server operating systems. This will also include virtualizing, where possible, physical machines into virtual machines, installing the most up to date Microsoft server operating systems, which extends mainstream support to 2023 and extended support until 2027, and installing the latest patched version of the Activu software.

Upgrading the server hardware that is at end-of-life is critical to ensure reliability. In 2021, this hardware will be at the end of the seven year life cycle. Running it past this period adds significant risk that the hardware will fail and also makes sourcing replacement parts very difficult.

4.3 Recommended Alternative

Hydro recommends the upgrading of the ECC display wall infrastructure in 2021 to maintain its reliable operation.

4.4 Project Description

This project includes the upgrading of the ECC display wall infrastructure as noted in Section 4.2.2.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	76.4	0	0	**76.4**
Labour	30.1	0	0	**30.1**
Consultant	60.9	0	0	**60.9**
Contract Work	0	0	0	**0**
Other Direct Costs	0	0	0	**0**
Interest and Escalation	4.4	0	0	**4.4**
Contingency	16.7	0	0	**16.7**
Total	**188.5**	**0.0**	**0.0**	**188.5**

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Open project, review schedule, and create Request for Proposals	January 2021	March 2021
Design:		
Conduct site visits, complete detailed design, and internal review of consultant drawings and design	March 2021	May 2021
Procurement:		
Tender and award supply and installation contract	June 2021	August 2021
Construction:		
Install hardware/software	September 2021	October 2021
Commissioning:		
Commissioning of new equipment	October 2021	November 2021
Closeout:		
Project closeout	November 2021	December 2021

5.0 Conclusion

To support the continued reliable operation of the ECC display wall, Hydro recommends the Upgrade Hydro Energy Control Centre Wall Infrastructure project in 2021. The display wall infrastructure will be either at or near end of life in 2021 and will need to be replaced to ensure reliable operability of the display wall.

Project Title: Upgrade Remote Terminal Units
Location: Various Sites
Category: General Properties - Telecontrol
Definition: Pooled
Classification: Normal

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") uses remote terminal units ("RTU") to remotely control its equipment and to transmit data from the equipment site to the Energy Control Centre ("ECC") at Hydro Place. Hydro's older RTUs are GE Multilin D20M++/ME models. The processor card for these models was discontinued by the manufacturer in the late 1990s but repair services continued to be provided. In 2014, electronic components became unavailable and the manufacturer is no longer repairing defective modules. Due to the discontinuation of the components and repair services, the Multilin D20 M++/ME model is considered obsolete. Hydro plans to replace the obsolete RTUs through a phased approach, with seven proposed for replacement through this project. Hydro expects to propose additional RTU upgrades in future capital budget applications to avail of the advanced functionality of the newer processors, and sites will be chosen based on other planned capital/operations work occurring at the same time.

2.0 Background

2.1 Existing Equipment

A critical component of Hydro's Supervisory Control and Data Acquisition ("SCADA") network is the GE Multilin D20-based RTU. This equipment is used in substations, generating stations, and other parts of the network to collect data and communicate it back to the ECC for monitoring of Hydro's system and to allow the ECC to send signals to stations to control electrical equipment. Hydro has used the D20 RTU since the early 1990s and currently has 72 units in service throughout the province.

Table 1 shows the inventory of existing D20 processor units in service.

Table 1: D20 Installed Base

GE Multilin D20 Process Model	Installed Base
D20M++/ME (1990s/2000s)	43
D20MX (2013+)	29
Total	**72**

2.2 Operating Experience

The GE D20 RTU processors have proven to be reliable for Hydro and, combined with regular maintenance, have helped to minimize SCADA outages. The most recent failure, which took place in July 2014, required the use of a spare RTU to complete repairs as GE indicated that they can no longer repair defective D20M++/ME modules.

In 2014, electronic components for the D20M++ became unavailable and the manufacturer is no longer repairing defective modules. When obsolete processors fail while in-service, Hydro replaces the processor with a newer model. Hydro continues planned replacements of the obsolete processors to minimize the potential impacts on the system.

3.0 Justification

All older D20M++/ME RTU processor cards have been discontinued by the manufacturer. Due to the unavailability of electronics components, the manufacturer will no longer accept defective modules for repair. D20 processor failures will lead to forced and unscheduled upgrades of the D20 RTU, resulting in machine outages which may last multiple days and during which the ECC will not have the ability to monitor or control the affected station(s). Isolated stations would likely need to be continually staffed during this time in order to prevent extended customer outages. Upgraded processors also have enhanced monitoring, control, and security functionality.

4.0 Analysis

4.1 Identification of Alternatives

Hydro considered the following options:

- Deferral; and
- Upgrade seven RTUs.

4.2 Evaluation of Alternatives

4.2.1 Deferral

Deferring this project presents two primary concerns:

1) Prolonged use of the existing processors increases the risk of a prolonged SCADA outage if a processor fails.
2) Upgrades of equipment elsewhere in a plant or terminal station typically include enhanced SCADA protocols, which cannot be utilized if they are unsupported by the RTU. Returning to the station at a later date when the RTU is upgraded to make further SCADA changes is typically not practical or cost effective. As a result, the opportunity to provide enhanced monitoring of station equipment is lost and enhanced security protocols between the ECC and the RTU cannot be implemented.

4.2.2 Upgrade Seven RTUs

In this alternative, the D20M++/ME processor modules in seven older GE Multilin D20 RTUs will be replaced with the latest model of the D20 processor, the D20MX. Replacement with new D20MX processors will support reliability and provides increased functionality through advanced communications features, such as ethernet and secure authentication, which are available in newer processors.

4.3 Recommended Alternative

Hydro recommends replacing seven of its older D20M++/ME RTU processors to minimize the potential of a SCADA outage and to avail of the enhanced monitoring, control, and security functionality of newer D20MX processors.

5.0 Project Description

Hydro is proposing the replacement of seven GE Multilin D20M++/ME RTUs with the latest model D20MX processor at terminal stations located at Deer Lake, Daniel's Harbour, Bear Cove, Berry Hill, Stephenville, and the master for Rattling Brook (located at the ECC). Hydro may modify the location of the replacement processor modules should other network modernization projects facilitate completing RTU upgrades at the same time.

All upgrades will be fully tested in a lab environment before deployment to the field due to the critical role that the RTUs play in the monitoring and control of the network. The proposed project will be completed using Hydro personnel.

The project estimate is shown in Table 2.

Table 2: Project Estimate ($000)

Project Cost	**2021**	**2022**	**Beyond**	**Total**
Material Supply	82.8	0.0	0.0	**82.8**
Labour	74.1	0.0	0.0	**74.1**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	9.4	0.0	0.0	**9.4**
Interest and Escalation	8.8	0.0	0.0	**8.8**
Contingency	8.3	0.0	0.0	**8.3**
Total	**183.4**	**0.0**	**0.0**	**183.4**

The anticipated project schedule is shown in Table 3.

Table 3: Project Schedule

Activity	**Start Date**	**End Date**
Planning:		
Prepare Project Plan and site visits	January 2021	February 2021
Design:		
Complete tender package	February 2021	March 2021
Procurement:		
Purchase upgrade kits	April 2021	April 2021
Construction:		
Install upgrade kits	May 2021	September 2021
Commissioning:		
Site inspections	October 2021	October 2021
Closeout:		
Project closeout	November 2021	December 2021

6.0 Conclusion

Hydro recommends the replacement of older, obsolete D20M++/ME RTU processors with D20MX processors to reduce the potential of extended SCADA outages and to avail of the enhanced monitoring, control, and security functionality of newer D20 processors. Hydro will continue to propose additional RTU upgrades in future capital budget applications so as to avail of the advanced functionality of the newer processors. Sites will be chosen based on other planned capital/operations work.

Appendix A

D20 M++/ME Locations

Site	Location	Site Type	Replacement Date[1]
DLK	Deer Lake	Terminal Station	2021
RBK	Rattling Brook	Master (ECC)	2021
RDK	Roddickton	Plant	2021
DHR	Daniel's Harbour	Terminal Station	2021
STL	Stephenville	Turbine/Terminal Station	2021
BHL	Berry Hill	Terminal Station	2021
BCV	Bear Cove	Terminal Station	2021
IRV	Indian River	Plant	TBD
SPR	Springdale	Terminal Station	TBD
DLP	Deer Lake Power	Plant	TBD
GBK	Grandy Brook	Terminal Station	TBD
CWH	Cow Head	Plant	TBD
STA	Star Lake	Terminal Station	TBD
MDR	Massey Drive	Terminal Station	TBD
PRV	Paradise River	Plant	TBD
PRI	Paradise River	Intake	TBD
SBK	South Brook	Terminal Station	TBD
STB	Stony Brook	Terminal Station	TBD
USL	Upper Salmon	Plant	TBD
LOC	Local (Hydro Place)	Building	TBD
BDP-2	Bay d'Espoir 2	Plant	TBD
BDP-2R	Bay d'Espoir 2 Remote	Plant	TBD
HVY	Happy Valley	Terminal Station	TBD
GFL	Grand Falls	Frequency Converter	TBD
PPT	Plum Point	Terminal Station	TBD
EBB	Ebbegunbaeg	Dam	TBD
GCL	Granite Canal	Plant	TBD
FHD	Farewell Head	Terminal Station	TBD
MAK	Makkovik	Diesel	TBD
VBN	Voisey Bay	Terminal Station	TBD
QTZ	Quartzite	Terminal Station	TBD
VAN	Vanier	Terminal Station	TBD
BDE-2	Bay d'Espoir	Terminal Station Two	TBD
BBK-TS1	Bottom Brook 1	Terminal Station One	TBD
BDE-PH1	Bay d'Espoir 1	Powerhouse	TBD
CAT	Cat Arm	Plant	TBD
CBC	Come By Chance	Terminal Station	TBD
DLS	Doyles	Terminal Station	TBD
HLY	Howley	Terminal Station	TBD
CAI	Cat Arm Intake	Intake	TBD
HRP	Holyrood	Plant	TBD
USC	Upper Salmon	Concentrator	TBD

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[1] 2021 locations will be finalized at the beginning of the year based on other planned capital/operations work to best avail of the advanced functionality of the newer processors.

F. Leasing Costs

2021 Capital Budget Application

Section F: Leasing Costs

There are no items for this section.

G. Capital Expenditures
2016–2025

2021 Capital Budget Application

Section G: Capital Expenditures 2016–2025

	Actuals				Budget					
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Generation	64,260.2	39,101.5	59,756.8	38,087.2	20,789.2	50,966.0	28,390.1	34,462.0	49,115.0	41,958.6
Transmission and Rural Operations	130,612.0	293,203.1	90,300.3	78,348.1	81,223.3	48,897.5	74,283.7	103,172.9	79,616.8	68,175.0
General Properties	9,068.8	8,436.3	6,928.0	10,139.7	5,563.6	7,588.8	9,750.3	7,094.4	7,201.3	8,660.9
Total Capital Expenditures	**203,941.0**	**340,740.8**	**156,985.1**	**126,575.0**	**107,576.1**	**107,452.4**	**112,424.2**	**144,729.4**	**135,933.2**	**118,794.5**

Note: 2020 Budget does not include $7,638,200 approved in Board Order P.U. 14(2020).

H. 2020 Capital Expenditures
Overview

2021 Capital Budget Application

Section H: 2020 Capital Expenditures Overview

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Appendix A: Financial Statements

1.0 Variance Explanations

Explanations are provided below for projects whose overall expenditures, on a total project basis, have a forecasted variance of more than $100,000 and 10% from the budgeted amount. Due to this being a mid-year report, variances are based on focused management and reforecasting efforts, and are subject to change throughout the year as the projects proceed. Actual variances at completion of each project will be discussed in the annual Capital Expenditures and Carryover Report when annual expenditures are final.

1.1 Hydraulic Generation Projects

1) Hydraulic Generation Refurbishment and Modernization (2018–2019) – Various Sites

	Original Budget ($000)	Forecast to Completion ($000)	Variance ($000)
Project	14,608.5	12,384.5	(2,224.0)

This is a two-year project (2018–2019) that commenced in 2018 and has carried over into 2020. The forecasted variance in overall project expenditures is attributed to a reduced volume of work compared to the original estimate for the Bay d'Espoir Unit 2 turbine overhaul completed in 2018. Upon disassembly of the turbine, it was found that the discharge wear ring was able to be refurbished in-place, rather than be replaced as originally planned.

2) Refurbish Powerhouse Station Services – Bay d'Espoir

	Original Budget ($000)	Forecast to Completion ($000)	Variance ($000)
Project	4,347.1	3,847.2	(499.9)

This is a three-year project (2017–2019) that commenced in 2017 and has carried over into 2020. Most of the upgrades to the station services in Bay d'Espoir Powerhouses 1 and 2 were completed in 2019. Panel board replacements in both powerhouses are now expected to be completed in 2020. The variance in overall project expenditures is attributed to the actual costs for engineering and materials being less than originally estimated.

1.2 Gas Turbine Generation Projects

3) Replace Main Fuel Valves - Hardwoods

	Original Budget ($000)	Forecast to Completion ($000)	Variance ($000)
Project	404.2	240.8	(163.4)

This is a one-year project which commenced in 2019 and has carried over into 2020. The new fuel valves were purchased and preparatory construction work was completed in 2019; however, the gas turbine generation outage necessary to complete the construction and commissioning was not available in 2019. The remaining work has been rescheduled for completion in 2020. The forecasted variance in overall project expenditures is attributed to the actual purchase cost of the new valves being less than originally estimated.

1.3 Terminal Stations Projects

4) Implement Terminal Station Flood Mitigation – Springdale

	Original Budget ($000)	Forecast to Completion ($000)	Variance ($000)
Project	974.0	1,270.4	296.4

This is a two-year project (2018–2019) that commenced in 2018 and has carried over into 2020. During engineering design, it was determined that the original project alternative to construct a retention berm outside of Hydro's property would cost significantly more than originally estimated. Further evaluation of project alternatives in 2019 demonstrated that the construction of a retention berm along the perimeter of the terminal station could also effectively achieve the desired level of flood mitigation and is the least cost alternative. The change in project alternative resulted in a revised project estimate and carry over of the project construction into 2020, to allow for design and environmental assessment in 2019. The forecasted variance in overall project expenditures is attributed to this revised estimate. The project construction is scheduled to commence in September 2020 and is expected to be completed this year.

5) Terminal Station Refurbishment and Modernization – Various Sites

	Original Budget ($000)	Forecast to Completion ($000)	Variance ($000)
Project	26,795.7	18,122.5	(8,673.2)

This is a two-year project (2018–2019) that commenced in 2018 and has carried over into 2020. The project includes a number of consolidated program-type projects across several sites and a focused refurbishment at Wabush Terminal Station.

The forecasted variance in total project expenditure is primarily attributed to the capital programs for insulators, disconnect switches, power transformers, and the Wabush Terminal Station refurbishment. The variance is attributed to work being completed for less than the original material and labour estimates and the cancellation or re-scheduling of various project scope items due to new asset condition information, changing priorities for system reliability, or balancing of the overall work plan.

Work scopes that are forecasted to be completed for less than the original estimates include:

- Insulators and disconnect switch replacements at various sites;
- Power transformer upgrades at various sites; and
- Refurbishment work at the Wabush Terminal Station.

Cancelled scope items include:

- The replacement bushings for Bay d'Espoir Transformer T3 and Holyrood T7, cancelled due to a changed long-term asset plan for these transformers.

The following scope items were transferred into the 2019–2020 Terminal Station Refurbishment and Modernization project, which has sufficient budget for this work:

- Transformer bushing replacements for Bay d'Espoir T10, Parson's Pond T1, South Brook T1, Hardwoods GT1 and Wabush T6;
- Installation of transformer moisture reduction systems for Oxen Pond T2 and Happy Valley T3;
- Replacement of a disconnect switch at Rattle Brook; and

- Procurement and installation of insulators at Happy Valley and St. Anthony Airport.

6) Terminal Station Refurbishment and Modernization – Various Sites

	Original Budget ($000)	Forecast to Completion ($000)	Variance ($000)
Project	29,952.9	26,152.3	(3,800.6)

This is a two-year project (2019–2020) that commenced in 2019 and includes a number of consolidated program-type projects across several sites and a focused refurbishment at Wabush Terminal Station.

The forecasted variance in total project expenditure is primarily attributed to an updated forecast for the work to refurbish Wabush Terminal Station. For that work, the actual and forecasted costs for the procurement of replacement circuit breakers is less than originally estimated. Power transformer upgrades at various sites and the digital fault recorder upgrade at Berry Hill are also forecasted to be completed for less than the original estimates.

The following items were removed from the project scope due to newly acquired condition assessment information indicating that the work was not immediately required:

- Bay d’Espoir Transformer T1 moisture reduction; and
- Granite Canal Transformer T1 bushing replacement.

1.4 Rural Generation Projects

7) Additions for Load Growth - Isolated Generation Systems

	Original Budget ($000)	Forecast to Completion ($000)	Variance ($000)
Project	2,182.5	2,622.0	439.5

This is a two-year project (2019–2020) that commenced and was substantially completed in 2019, with final project activities scheduled for 2020. The project scope includes the construction of a new vertical fuel storage tank and associated earth dyke upgrades in Makkovik. The variance in 2019 expenditures is attributed to an increase in quantity of earthwork required to complete upgrades to the existing dyke, identified during engineering design. The contract costs for mobilization and the tank construction were higher than originally estimated. Prior to contract award, an updated net present value of project alternatives was completed and it was confirmed that the original alternative remains least cost.

8) Replace Automation Equipment - St. Anthony

	Original Budget ($000)	**Forecast to Completion ($000)**	**Variance ($000)**
Project	1,873.3	2,248.2	374.9

This is a two-year project (2018–2019) that commenced in 2018 and has carried over into 2020. The project was substantially completed in 2019 with the physical assets installed. Progamming and commissioning activity is continuing in 2020. The forecasted variance in total project expenditure is attributed to the overall construction and programming effort being more than the original project estimate.

1.5 Terminal Station In-Service Failures

Original Budget: **$1,500,000**

Current Projects (Table 1): **$217,300 (Estimate to June 30, 2020)**

Table 1: Terminal Station In-Service Failures

Project Title and Location	**Forecast ($000)**	**Failure Identified**	**Project Scope**
Breaker Refurbishment, Doyles and St. Anthony Terminal Stations	152.2	B1L15 at Doyles Terminal Station and B1C3 at St. Anthony Terminal Station are 69 kV circuit breakers that have been identified as leaking sulfur hexafluoride (SF_6) gas to atmosphere. The leaking of SF_6 to atmosphere is an environmental concern with the gas being known as the most harmful greenhouse gas. Leaking gas could result in a flashover of the breaker or a catastrophic failure resulting in loss of service to customers and compromising the integrity of the electrical system in the area.	Refurbish 69 kV breakers B1L15 at Doyles Terminal Station and B1C3 at St. Anthony Terminal Station.
Purchase Spare Disconnect Switch	35.9	In 2019, a 145 kV disconnect was used from the stand-by equipment pool to replace a failed disconnect at Bay L'Argent Terminal Station. In order to maintain adequate spare availability, a replacement 145 kV disconnect is required.	Purchase of one 145 kV disconnect switch for the stand by equipment pool.

Project Title and Location	Forecast ($000)	Failure Identified	Project Scope
Synchronous Condenser #2 (SC2) Human Machine Interface (HMI) Upgrade, Wabush Terminal Station	29.2	The existing HMI for SC2 is no longer functional and vendor support for the associated software has been discontinued. The HMI is required to provide oversight of operating parameters, as well as access to logged historical operating data for the synchronous condenser. Failure to have access to this data will result in the unavailability of key information for operations oversight, failure/event analysis and management purposes. Purchase of a spare HMI, complete with software, is also warranted based on the criticality of this equipment, for both SC2 and SC1.	Upgrade the existing HMI for SC2 with new software. Purchase a spare HMI, complete with software, as a spare for both SC2 and SC1.

1
1.6 Hydraulic Generation In-Service Failures

Original Budget: **$1,250,000**

Current Projects (Table 1): **$1,110,800 (Estimate to June 30, 2020)**

Table 2: Hydraulic In-Service Failures

Project Title and Location	Forecast ($000)	Failure Identified	Project Scope
Capital Spares, Granite Canal and Upper Salmon	487.2	The following equipment was determined to be required for the standby pool, to allow fast responsive action to future failures of long lead time equipment: 1) Excitation Transformer, Granite Canal ($79.1) 2) Intake Transformer T2, Upper Salmon ($408.1)	The following spare components are to be procured: Excitation Transformer, Granite Canal; and Intake Transformer T2, Upper Salmon. For the Upper Salmon transformer, civil works will be constructed for a laydown area including oil containment, and the transformer will be electrically commissioned.

Project Title and Location	Forecast ($000)	Failure Identified	Project Scope
Units 1–6 Spare Generator Thrust and Guide Bearing Assemblies, Bay d'Espoir	274.0	Presently there is one spare thrust and guide bearing assembly for Units 1–6, and it has been determined that a second spare assembly is required for risk mitigation. Over the period of 2017–2019 there have been bearing failures of the Unit 2 thrust bearing and the Unit 3 thrust and guide bearings, which were discovered during maintenance activities. There is a high probability that similar failures could occur on the other units. If a failed bearing is not too severely damaged, it can be refurbished and maintained as a spare. Refurbishment of a bearing can take 18–22 weeks depending on fabricator availability. If a failed bearing is severely damaged, a new bearing would need to be procured to replenish the spare, and fabrication of a new bearing would take 20–25 weeks depending on fabricator availability.	One set of spare thrust and guide bearings that will fit Bay d'Espoir Units 1–6 will be procured.
Unit 3 Generator Thrust and Guide Bearing Assembly Refurbishment, Bay d'Espoir	110.5	Unit 3 was experiencing abnormal vibration for multiple months. The inspection revealed that the thrust and guide bearing assembly was worn past the point of operation and could no longer be placed into reliable service.	The failed bearing assembly was removed from service and replaced with the available spare bearing assembly. The failed bearing assembly will be re-babbitted and refurbished.
Unit 7 Turbine Guide Bearing Refurbishment, Bay d'Espoir	79.1	The Unit 7 turbine guide bearing failed in service.	The failed Unit 7 turbine guide bearing was replaced with the available spare. The failed bearing assembly will be re-babbitted and refurbished.

Project Title and Location	Forecast ($000)	Failure Identified	Project Scope
Unit Breaker Replacement, Paradise River	70.0	The unit breaker failed to close resulting in a forced outage on November 18, 2019 rendering the hydro generating plant unavailable for approximately one week. The investigation revealed that the charging motor had failed and a mechanical shaft was bent. The charging motor was replaced; however the bent mechanical shaft could not be fixed and the breaker was placed back into service with the bent shaft. Further inspection during a unit outage revealed that the open and close gear mechanism showed signs of deterioration, there was noticeable wear on the gear teeth. Pieces of metal from the gear teeth were discovered in the interior breaker housing; these were removed, but further wear could cause a short circuit, if the metal pieces contaminate the electrical parts of the breaker. The breaker requires replacement.	A new unit breaker will be procured and installed.
Fire Panel Replacement, Granite Canal	55.0	The existing fire alarm system for the powerhouse has been in operation since 2002. Replacement parts are no longer available and the system has been indicating sensor faults due to failing alarm system components. The panels and field devices require replacement.	Procurement of replacement fire alarm panels and field devices was completed under the 2019 Hydraulic In-Service Failures project. Installation will occur in 2020.
Fire Pump Replacement, Hinds Lake	20.3	Fire Pump No. 2 had been in service since 1980. The internal components of the pump as well as the casing have deteriorated to the point where the pump is no longer viable for continued operation, thus requiring replacement.	Procurement of a replacement fire pump was completed under the 2019 Hydraulic In-Service Failures project. Installation was completed in 2020.

Project Title and Location	Forecast ($000)	Failure Identified	Project Scope
Shaft Seal Replacement, Granite Canal	14.7	The unit turbine shaft carbon seal leakage rate was at a point where all three head cover drainage pumps and could not stop the water from entering the turbine pit. The water level rose and the unit tripped offline on March 24, 2020 and March 25, 2020 due to the water levels in the turbine pit. Investigation determined that the shaft carbon seal was exhibiting signs of damage and requires replacement. When the seal was removed, scoring was found on the sealing faces that resulted in the replacement of the carbon seal to ensure the drainage pumps would keep up with the leakage rate and the unit would not be forced offline.	The turbine shaft carbon seal and related components will be replaced.

1 1.7 Thermal Generation In-Service Failures

Original Budget: **$2,000,000**

Current Projects (Table 1): **$899,000 (Estimate to June 30, 2020)**

Table 3: Thermal Generation In-Service Failures

Project Title and Location	Forecast ($000)	Failure Identified	Project Scope
Cooling Water Outfall Pipe Replacement, Holyrood Unit 3	227.0	In February of 2020, sink holes were discovered in the vicinity of the Stage 2 (Unit 3) circulating water discharge line from the Seal Pit to the outfall into Holyrood Bay. This indicated a leak in the cooling water discharge line, which was confirmed through a dye test. A consultant has been engaged and an inspection of the pipeline was completed during the Unit 3 outage in May 2020. It was confirmed that a section of the discharge pipe, below where the sink hole appeared, is in very poor condition and must be replaced before the next operating season. The consultant has recommended that the best option is to install a new pipe section inside the existing 84 inch pipeline.	A section of the Unit 3 cooling water outfall pipe will be replaced in the fall of 2020.

Project Title and Location	Forecast ($000)	Failure Identified	Project Scope
Waste Water Treatment Building Roof Replacement, Holyrood Thermal Generating Station	115.0	The Waste Water Treatment Plant (WWTP) was installed in 1992. There have been no major upgrades to the roof since its original installation. The WWTP processes effluent from the periodic basin which originates from air heater washes, boiler washes, batch reactor waste and landfill leachate. In May 2020, a large leak was identified in the roof of the WWTP. Upon investigating the leak, it was discovered that the roof failed and requires a full replacement. The roof replacement is required before the next 2020–2021 operating season. The building contains sensitive equipment that is required to allow the continued treatment of effluent from the periodic basin.	The Waste Water Treatment Plant roof will be replaced in the fall of 2020.

Project Title and Location	**Forecast ($000)**	**Failure Identified**	**Project Scope**
High Pressure Feed Water Control Valves Overhaul, Holyrood Unit 3	100.0	The Boiler Feed Pumps (BFP) provide high pressure feed water to the boiler during operation. The BFPs take feed water from the deaerator storage tank and pump it through the high pressure feed water heaters, economizer, and into the boiler steam drum. The feed water is then converted into superheated steam in the boiler which then flows to the steam turbine. Feed water systems are controlled with valves to help regulate flow to the boiler. The feed water control valves regulate flow leaving the BFP discharge. The high pressure feed water leaves the BFPs and is pumped to the high pressure heaters before entering the boiler. The control valves help regulate this flow by allowing some of the feed water to by-pass the high pressure heaters and recirculate back to the deaerator. The feed water flow to the high pressure heaters is controlled based on operating loads and the amount of water is needed to feed the boiler for steam production. During unit operation, the feed water control valves were noticed to be passing fluid while in the closed position. During the annual Unit 3 outage, the valves were disassembled and it was found that wear on main internal sealing components was causing both valves to pass.	The Unit 3 feed water control valves will be overhauled in the fall of 2020.

Project Title and Location	**Forecast ($000)**	**Failure Identified**	**Project Scope**
Fuel Oil Suction Strainers Replacement, Holyrood Units 1 and 2	70.0	The fuel oil suction strainers are on the inlet supply to the fuel oil heating and pumping sets which are fed from the main fuel oil tanks. They are the last filter to capture foreign components before they enter the fuel oil pumps, fuel oil heaters, piping and boiler burner system (burner tips). The strainers are duplex basket type which means there are two parallel basket housing compartments. At any given time, only one strainer is in service and the other strainer is isolated to allow basket removal and cleaning while online. The Units 1 and 2 fuel oil suction strainers are 1969 vintage equipment and the internal sealing components of the strainers have worn over time, making it difficult to obtain a seal between the left and right sides of the strainer housings.	The Unit 1 and 2 fuel oil strainers will be replaced during the Unit 1 and 2 annual outages in the fall of 2020.
Stack Winch System Replacement, Holyrood Thermal Generating Station	70.0	The Holyrood Thermal Generating Station has 3 boiler stacks, 1 for each thermal unit. Each stack has a mid-way platform which contains an environmental monitoring station. These stations provide continuous emissions monitoring (CEM) for Carbon Monoxide, Carbon Dioxide, Nitrous Oxide, Sulfur Dioxide and Oxygen. They are examined and maintained regularly in order to maintain compliancy with environmental regulations and the plant’s certificate to operate. As required by Federal regulations, a third party contractor completes a yearly test on the CEM equipment to ensure it is measuring data accurately. Critical tools and equipment used to service and test the CEMs are brought to the mid-way platform using the stack winch system. In March of 2020, the winch systems were inspected on all 3 stacks, failed the annual inspection, and now require replacement, so that maintenance and testing can be completed on the CEM stations to ensure compliance with government regulations for emissions monitoring.	The mechanical winch systems on all three stacks will be replaced in the fall of 2020.

Project Title and Location	Forecast ($000)	Failure Identified	Project Scope
West Fuel Oil Pump Replacement, Holyrood Unit 2	60.0	The Unit 2 East and West fuel oil pumps provide No. 6 heavy fuel oil to the boiler for combustion in the steam cycle process. One pump operates as the primary while the second is in standby mode as a backup. During a load test in January of 2020, the West pump was unable to maintain system pressure on its own and could only achieve a maximum load of 140 MW. The East pump was started to boost fuel oil header pressure to the burners which allowed the unit to reach full load of 175 MW. On February 8, 2020 the West pump was replaced to ensure a suitable backup is in place should the East pump fail. The West pump had been in service since December 20, 2014. The abrasive properties of No. 6 heavy fuel oil damages the pump internal components (screw impellers and casing) making replacement the only option due to the extent of the damage. No. 6 heavy fuel oil is made of residual oil by products from the refining process which contains varying levels of silicates and heavy metals that contribute to its abrasiveness and internal pump wear.	The Unit 2 West Fuel Oil Pump will be replaced during the Unit 2 annual outage.
Low Load Control Valve Replacement, Holyrood Unit 2	50.0	The Boiler Feed Pumps (BFP) provide high pressure feed water to the boiler during operation. The low load control valve on the Unit 2 BFP system was found to be leaking during start-up in June 2020, which contributed to the unit's failed start-up attempt. Assessment by maintenance personnel verified deterioration on the valve's major internal components (plug and seat ring). The damaged components could not be repaired and were replaced with parts available in the warehouse.	The Unit 2 low load control valve will be replaced during the annual Unit 2 outage.

Project Title and Location	**Forecast ($000)**	**Failure Identified**	**Project Scope**
Variable Frequency Drive Cell Spares Replacement, Holyrood Thermal Generating Station	40.0	Five variable frequency drive cells failed in service, with no impact on unit production. The variable frequency drive system is able to handle one cell failure per phase without affecting production. However, if two cell failures occur on the same phase, a voltage imbalance will negatively impact the torque and speed of the forced draft fan motor, thus reducing the amount of combustion air to the boiler and potentially tripping the generating unit.	The five failed cells were replaced using available spares. Five of the failed cells were refurbished and added to inventory as spares.
Fire Water Pump Spare Procurement, Holyrood Thermal Generating Station	35.0	In 2019, the electric fire pump was taken out of service to repair a packing leak and damage was discovered to the shaft, bearings, and seals. The jockey pump was also inspected and found to have major cavitation damage on the internal components.	The electric driven fire pump was refurbished in 2019 to replace the damaged internal components. The jockey pump was replaced in 2019 with an available spare pump. A spare electric driven fire pump and a spare fire jockey pump were procured and received in the first quarter of 2020.

Project Title and Location	Forecast ($000)	Failure Identified	Project Scope
Jetty Capstan Gear Box Refurbishment, Holyrood Thermal Generating Station	25.0	The Holyrood Thermal Generating Station receives approximately 10–12 shipments of Bunker "C" Fuel Oil via tanker ships annually in order to operate the Holyrood Thermal Generating Station. The tanker ships dock at the fuel offloading facility and are secured into position via six Capstans during the fuel offloading process. The six Capstans are equipped with electrically driven gearboxes to secure the mooring lines for the tanker ship. All six Capstans are required to be in operation in order to safely dock the ships. One of the six Capstan Gearboxes seized, failed to operate and was replaced with an available spare. The failed Gearbox was then disassembled to assess the condition and determine if an overhaul would be possible. The assessment revealed that all bearings and seals required replacement, bushings for multiple cells required replacement and/or machining, and that a successful overhaul would be achievable.	The failed jetty capstan gearbox was replaced with an available spare, and the removed gearbox will be overhauled and returned as a spare in 2020.
Extraction Pump Expansion Joints Replacement, Holyrood Unit 3	20.0	After steam passes through the Low Pressure stage of the turbine, it forms condensate and collects in the condenser. The Unit 3 extraction pumps draws liquid condensate from the condenser and pumps it through low pressure heat exchangers before recycling it back to the boiler for steam production. Both pumps are required to be in-service to achieve full loading of Unit 3. The expansion joints are installed between the condenser outlet piping and the pump's suction inlet to accommodate vertical/horizontal movement caused by heating/cooling cycles such as start-up. The expansion joints have deteriorated over time causing them to crack and leak which causes air to be drawn into the line through the cracks. This causes increased backpressure in the condenser which affects the unit's ability to reach full load. The expansion joints have been temporarily repaired with plastic wrapping to reduce leakage.	The Unit 3 extraction pump expansion joints will be replaced in the fall of 2020.

Project Title and Location	Forecast ($000)	Failure Identified	Project Scope
Overhaul Dump Valves, Holyrood Units 1 and 2	20.0	Unit 1 tripped off line on November 3, 2018 as a result of turbine steam control valves closing without receiving the command from the control system to do so. An investigation concluded that hydraulic system contamination was the cause of the unit trip. Hydro proceeded to refurbish the hydraulic system on Unit 1. The Unit 2 hydraulic system is identical to that for Unit 1 and, while no failures had occurred, Hydro determined it was reasonable to expect that the system for Unit 2 was in the same contaminated condition as for Unit 1. The following issues supported the conclusion that the system was contaminated: (i) the control valve actuator was showing signs of seal deterioration, with smearing deposits noted on the shaft; and (ii) the right hand intercept valve did not fully stroke during on-line testing. Refurbishment was required to prevent a failure, which was likely to occur prior to or during the next winter operating season. In 2018, the refurbishment of Unit 1 hydraulic system consumed all of the capital spares in the standby pool. A review of the component failure rate resulted in an update to the standby spare strategy to increase the required number of available spares.	In 2018, the hydraulic system for the Unit 1 control valves was refurbished. This included replacement of servo valves, cleaning or replacement of hydraulic actuators, replacement of actuator seals, replacement of filters, cleaning of hydraulic fluid coolers, flushing of the entire system, and replacement of the hydraulic fluid. Also in 2018, the hydraulic system for the Unit 2 control valves was refurbished. This included replacement of servo valves, cleaning or replacement of hydraulic actuators, replacement of actuator seals, replacement of filters, cleaning of hydraulic fluid coolers, flushing of the entire system, and replacement of the hydraulic fluid. In 2019, the dump valves were refurbished, air dryers were replaced and external filter units were replaced on Units 1 and 2. Hydraulic servo valves for stage 1 turbine hydraulic system were ordered in 2019. One has been received in 2020 and another expected to be received in the fall of 2020.

Project Title and Location	Forecast ($000)	Failure Identified	Project Scope
Air Heater Condensate Check Valves Replacement, Holyrood Unit 1	15.0	Steam Coil Air Heaters (SCAHs) are used to add heat to incoming boiler combustion air at lower loads to ensure exhaust gas temperatures stay elevated. The SCAHs warm the incoming air which in turn keeps the exhaust gas temperature at the appropriate level above the sulfuric acid dew point to prevent stack corrosion. The SCAHs provide heat to the incoming combustion air using auxiliary boiler steam that passes through a set of metal finned coils. The condensate check valve on the Unit 1 air heater system failed during the 2019–2020 operating season due to water hammer. Water hammer causes the check valve disk to swing open and slam shut. This line is particularly susceptible to water hammer as a result of the large elevation difference between the storage tank on the first floor and the deaerator on the eighth floor. Water hammer can also occur at low load operation when the pressure is equal to or greater than the pumping pressure from the condensate pumps. The bolted head bonnet on the check valve has failed and is leaking condensate which poses a safety risk. The extent of the damage is beyond repair and full replacement is required.	The Unit 1 air heater condensate check valve will be replaced during the annual Unit 1 outage.
Forced Draft Fan Bearing Liner Capital Spare Procurement, Holyrood Thermal Generating Station	15.0	The forced draft fan bearing liner failed in 2019.	The failed forced draft fan bearing liner was replaced with an available spare in 2019. A new liner was ordered and received in 2020.
West Boiler Feed Water Pump Motor Spare Procurement, Holyrood Unit 2	15.0	The West boiler feed water pump motor failed in 2019.	The failed feed water pump motor was replaced with an available spare in 2019. A new motor was ordered and received in 2020.

Project Title and Location	**Forecast ($000)**	**Failure Identified**	**Project Scope**
South Vacuum Pump Inlet Valve Replacement, Holyrood Unit 3	12.0	During the 2019–2020 operating season, the Unit 3 South Vacuum Pump inlet valve began experiencing operational issues. The motorized butterfly valve is operated remotely from the control room. When the pump is started or stopped from the control room, the valve is supposed to automatically open or close, but the valve consistently jams when tested. Repairs can not be completed because the valve is obsolete and replacement parts are no longer available.	The Unit 3 South Vacuum Pump Inlet Valve will be replaced in the fall of 2020.
West Boiler Feed Water Pump Safety Valves Replacement, Holyrood Unit 3	10.0	The Boiler Feed Pumps (BFP) provide high pressure feed water to the boiler during operation. The BFPs take feed water from the deaerator storage tank and pump it through the high pressure feed water heaters, economizer, and into the boiler steam drum. The feed water is converted into superheated steam in the boiler which then flows to the steam turbine. There are safety relief valves on each BFP suction and discharge lines which are designed to relieve excess pressure to protect the pump and associated piping from dangerous overpressure conditions. The suction line safety relief valves on the BFPs have failed in-service and are relieving pressure from the line while in operation under normal operating conditions. The valves are damaged beyond repair and replacement is required.	The Unit 3 West boiler feed water pump safety valves will be replaced in the fall of 2020.

Appendix A

Financial Statements

Total Capital Project Variance
2020 Overview
($000)

Asset Type	Board Approved Budget	Total Project Expenditures and Forecast	Variance
HYDRAULIC	56,204	53,811	(2,393)
THERMAL	9,336	9,336	0
GAS TURBINES	24,128	18,653	(5,475)
TERMINAL STATIONS	123,280	111,103	(12,178)
TRANSMISSION	22,771	22,771	0
DISTRIBUTION	18,106	18,106	0
RURAL GENERATION	28,707	29,521	814
PROPERTIES	1,378	1,378	0
METERING	244	244	0
RURAL SYSTEMS TOOLS AND EQUIPMENT	2,139	2,232	93
INFORMATION SYSTEMS	1,585	1,585	0
TELECONTROL	1,737	1,737	(0)
TRANSPORTATION	7,473	7,473	0
ADMINISTRATIVE	996	996	0
ALLOWANCE FOR UNFORESEEN	1,000	1,738	738
SUPPLEMENTAL PROJECTS	8,343	8,343	0
PROJECTS APPROVED FOR LESS THAN $50,000	25	25	0
COVID-19 ADJUSTMENT	0	(28,570)	(28,570)
TOTAL CAPITAL BUDGET	**307,452**	**260,481**	**(46,971)**

2020 Capital Expenditures By Year
($000)

Summary										Actual Expenditure and Forecast										
	A				B	C	D (B+C)	E	F (A+C+E)	G				H	I	J	K (G+H+I+J)	K-F	H-D
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance
2020 Projects	-	-	-	-	-	55,564.6	55,564.6	37,611.7	93,176.3	-	-	-	12,528.5	10,498.4	52,470.9	37,611.7	113,109.5	19,933.20	7,404.7
2019 Projects	-	-	-	40,844.7	3,479.2	43,723.9	47,203.1	-	84,568.6	-	-	-	22,180.3	5,431.5	34,682.6	-	62,294.4	(22,274.2)	(7,089.0)
2018 Projects	-	-	31,552.5	35,844.9	13,021.0	3,715.0	16,736.0	-	71,112.4	-	-	13,941.1	24,720.8	4,982.6	12,128.3	-	55,772.7	(15,339.7)	374.9
2017 Projects	-	532.4	3,394.5	2,337.6	189.6	1,429.6	1,619.2	-	7,694.1	-	225.8	1,632.4	3,497.4	306.3	1,312.9	-	6,974.7	(719.4)	-
2016 Projects	6,969.1	10,808.7	15,408.6	6,597.3	2,220.5	11,116.8	13,337.3	-	50,900.5	5,599.5	8,877.8	15,184.2	7,901.7	1,542.2	11,795.1	-	50,900.5	(0.0)	-
COVID-19 Adj	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(28,570.4)	-	(28,570.4)	(28,570.4)	(28,570.4)
Grand Total	6,969.1	11,341.1	50,355.6	85,624.5	18,910.3	115,549.9	134,460.2	37,611.7	307,451.9	5,599.5	9,103.6	30,757.7	70,828.6	22,761.0	83,819.4	37,611.7	260,481.4	(46,970.5)	(27,879.8)

newfoundland labrador
hydro
a nalcor energy company

2020 Capital Expenditures By Category
($000)

Hydraulic Generation Projects	Capital Budget									Actual Expenditure and Forecast										
	A				B	C	D (B+C)	E	F (A+C+E)	G				H	I	J	K (G+H+I)	K-F	H-D	
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance	Notes
2020 Projects																				
Hydraulic In-Service Failures	-	-	-	-	-	1,250.0	1,250.0	-	1,250.0	-	-	-	-	176.6	1,073.4	-	1,250.0	-	-	
Hydraulic Generation Refurbishment and Modernization - Various Sites	-	-	-	-	-	6,580.2	6,580.2	10,249.8	16,830.0	-	-	-	-	1,000.7	5,673.7	10,249.8	16,924.2	94.2	94.2	
Purchase Tools and Equipment Less than $ 50,000	-	-	-	-	-	21.0	21.0	-	21.0	-	-	-	-	1.0	20.0	-	21.0	-	-	
2019 Projects																				
Hydraulic Generation Refurbishment and Modernization - Various Sites	-	-	-	10,313.6	1,875.8	5,486.4	7,362.2	-	15,800.0	-	-	-	8,893.9	857.1	6,505.1	-	16,256.1	456.1	-	
2018 Projects																				
Hydraulic Generation Refurbishment and Modernization - Various Sites	-	-	10,325.4	4,283.1	3,160.6	-	3,160.6	-	14,608.5	-	-	5,856.3	3,367.7	74.0	3,086.6	-	12,384.5	(2,224.0)	-	
2017 Projects																				
Refurbish Powerhouse Station Services - Bay d'Espoir	-	413.2	2,473.3	1,460.6	157.2	-	157.2	-	4,347.1	-	43.0	1,003.5	2,643.4	103.9	53.3	-	3,847.2	(499.9)	-	
Replace Exciter Controls Units 1 to 6 - Bay d'Espoir	-	119.2	921.2	877.0	32.4	1,429.6	1,462.0	-	3,347.0	-	182.7	628.9	853.9	202.4	1,259.6	-	3,127.6	(219.4)	-	
Total Hydraulic Generation Projects	-	532.4	13,719.9	16,934.3	5,226.0	14,767.2	19,993.2	10,249.8	56,203.6	-	225.8	7,488.7	15,758.9	2,415.7	17,671.7	10,249.8	53,810.6	(2,487.2)	-	

2020 Capital Expenditures By Category
($000)

Thermal Generation Projects	Capital Budget									Actual Expenditure and Forecast											
	A				B	C	D (B+C)	E	F (A+C+E)	G				H	I	J	K (G+H+I+J)	K-F	H-D	
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance	Notes
2020 Projects																				
Rewind Unit 3 Stator - Holyrood	-	-	-	-	-	1,281.4	1,281.40	5,664.2	6,945.6	-	-	-	-	44.9	1,236.5	5,664.2	6,945.6	-	-	
Upgrade Uninterruptible Power Supply 3 & 4 - Holyrood	-	-	-	-	-	348.7	348.70	-	348.7	-	-	-	-	48.4	300.3	-	348.7	-	-	
Thermal In-Service Failures	-	-	-	-	-	2,000.0	2,000.00	-	2,000.0	-	-	-	-	254.1	1,745.9	-	2,000.0	-	-	
Purchase Tools and Equipment Less than $ 50,000	-	-	-	-	-	41.7	41.70	-	41.7	-	-	-	-	-	41.7	-	41.7	-	-	
Total Thermal Generation Projects	-	-	-	-	-	3,671.8	3,671.8	5,664.2	9,336.0	-	-	-	-	347.4	3,324.4	5,664.2	9,336.0	-	-	

2020 Capital Expenditures By Category
($000)

Gas Turbine Generation Projects	Capital Budget									Actual Expenditure and Forecast										
	A				B	C	D (B+C)	E	F (A+C+E)	G				H	I	J	K (G+H+I+J)	K-F	H-D	
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance	Notes
2020 Projects																				
Perform Combustor Inspection - Holyrood Gas Turbine	-	-	-	-	-	546.1	546.1	4,927.4	5,473.5	-	-	-	-	28.3	517.8	4,927.4	5,473.5	-	-	
Install Partial Discharge Monitoring - Holyrood Gas Turbine	-	-	-	-	-	37.8	37.8	575.0	612.8	-	-	-	-	9.9	27.9	575.0	612.8	-	-	
Replace Fire Supression System - Happy Valley Gas Turbine	-	-	-	-	-	264.6	264.6	2,377.9	2,642.5	-	-	-	-	93.3	171.3	2,377.9	2,642.5	-	-	
Generator Assessment - Happy Valley Gas Turbine	-	-	-	-	-	1,097.6	1,097.6	-	1,097.6	-	-	-	-	59.8	1,037.8	-	1,097.6	-	-	
2019 Projects																				
Overhaul Olympus Gas Generator - Stephenville	-	-	-	1,666.8	316.9	-	316.9	-	1,666.8	-	-	-	1,245.1	351.7	(34.8)	-	1,562.0	(104.8)	-	
Upgrade Compressed Air System - Holyrood Gas Turbine	-	-	-	70.7	53.1	317.7	370.8	-	388.4	-	-	-	17.7	102.2	268.6	-	388.4	-	-	
Replace Main Fuel Valves - Hardwoods	-	-	-	404.2	72.8	-	72.8	-	404.2	-	-	-	168.0	39.7	33.1	-	240.8	(163.4)	-	
2018 Projects																				
Increase Fuel and Water Treatment System Capacity - Holyrood Gas Turbine	-	-	8,829.9	3,012.7	488.0	-	488.0	-	11,842.6	-	-	2,583.8	3,563.9	220.9	267.1	-	6,635.7	(5,206.9)	-	
Total Gas Turbine Generation Projects	-	-	8,829.9	5,154.4	930.8	2,263.8	3,194.6	7,880.3	24,128.4	-	-	2,583.8	4,994.7	905.8	2,288.8	7,880.3	18,653.3	(5,475.1)	-	

2020 Capital Expenditures By Category
($000)

Terminal Stations Projects	Capital Budget									Actual Expenditure and Forecast										
	A				B	C	D (B+C)	E	F (A+C+E)	G				H	I	J	K (G+H+I+J)	K-F	H-D	
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance	Notes
2020 Projects																				
Terminal Station In-Service Failures	-	-	-	-	-	1,500.0	1,500.0	-	1,500.0	-	-	-	-	142.4	1,357.6	-	1,500.0	-	-	
Replace Transformer T7 - Holyrood Terminal Station	-	-	-	-	-	2,678.1	2,678.1	-	2,678.1	-	-	-	-	82.2	2,595.9	-	2,678.1	-	-	
Purchase SF6 Multi Analyzer - Various	-	-	-	-	-	207.1	207.1	-	207.1	-	-	-	-	0.9	206.2	-	207.1	-	-	
Terminal Station Refurbishment and Modernization - Various Sites	-	-	-	-	-	3,712.0	3,712.0	6,067.8	9,779.8	-	-	-	-	377.7	3,334.3	6,067.8	9,779.8	-	-	
2019 Projects																				
Upgrade Terminal Station for Mobile Substation - St. Anthony	-	-	-	89.3	47.5	402.7	450.2	-	492.0	-	-	-	41.8	57.1	393.1	-	492.0	-	-	
Terminal Station Refurbishment and Modernization - Various Sites	-	-	-	10,891.1	1,199.2	19,061.8	20,261.0	-	29,952.9	-	-	-	5,891.3	2,135.2	18,125.8	-	26,152.3	(3,800.6)	-	
																	-			
2018 Projects																	-			
Implement Terminal Station Flood Mitigation - Springdale	-	-	186.2	787.8	1,047.6	-	1,047.6	-	974.0	-	-	135.8	87.0	95.8	951.8	-	1,270.4	296.4	-	
Terminal Station Refurbishment and Modernization - Various Sites	-	-	8,170.6	18,625.1	6,522.6	-	6,522.6	-	26,795.7	-	-	1,983.8	9,616.1	1,502.2	5,020.4	-	18,122.5	(8,673.2)	-	
																	-			
2016 Projects																	-			
Upgrade Circuit Breakers - Various Sites	6,969.1	10,808.7	15,408.6	6,597.3	2,220.5	11,116.8	13,337.3	-	50,900.5	5,599.5	8,877.8	15,184.2	7,901.7	1,542.2	11,795.1	-	50,900.5	-	-	
Total Terminal Stations Projects	6,969.1	10,808.7	23,765.4	36,990.6	11,037.4	38,678.5	49,715.9	6,067.8	123,280.1	5,599.5	8,877.8	17,303.8	23,537.8	5,935.7	43,780.2	6,067.8	111,102.5	(12,177.5)	0.0	

2020 Capital Expenditures by Category
($000)

Transmission Projects	A				B	C	D	E	F (A+C+E)	Actual Expenditure and Forecast G				H	I	J	K(G+H+I+J)	K-F	H-D	
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance	Notes
2020 Projects																				
Wood Pole Line Management Program - Various Sites	-	-	-	-	-	2,792.7	2,792.7	-	2,792.7	-	-	-	-	552.7	2,240.0	-	2,792.7	-	-	
2019 Projects																				
Muskrat Falls to Happy Valley Interconnection	-	-	-	12,586.4	57.9	7,392.1	7,450.0	-	19,978.5	-	-	-	12,528.5	1,236.7	6,213.3	-	19,978.5	-	-	
Total Transmission Projects	-	-	-	12,586.4	57.9	10,184.8	10,242.7	-	22,771.2	-	-	-	12,528.5	1,789.4	8,453.3	-	22,771.2	-	-	

2020 Capital Expenditures By Category
($000)

Distribution Projects										Actual Expenditure and Forecast										
	A				B	C	D (B+C)		F (A+C+E)	G				H	I	J	K (G+H+I+J)	K-F	H-D	
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance	Notes
2020 Projects																				
Provide Service Extenstions - All Areas	-	-	-	-	-	4,312.5	4,312.5	-	4,312.5	-	-	-	-	1,164.7	3,147.8	-	4,312.5	-	-	
Provide Service Extenstions - All Areas - CIAC	-	-	-	-	-	(196.5)	(196.5)	-	(196.5)	-	-	-	-	(576.2)	379.7	-	(196.5)	-	-	
Upgrade Disribution Systems - All Areas	-	-	-	-	-	3,456.4	3,456.4	-	3,456.4	-	-	-	-	1,311.6	2,144.8	-	3,456.4	-	-	
Upgrade Disribution Systems - All Areas - CIAC	-	-	-	-	-	(93.5)	(93.5)	-	(93.5)	-	-	-	-	(3.6)	(89.9)	-	(93.5)	-	-	
Distribution System Upgrades (2020-2021) - Various	-	-	-	-	-	102.7	102.7	3,154.4	3,257.1	-	-	-	-	44.7	58.0	3,154.4	3,257.1	-	-	
Install Recloser Remote Control (2020-2021) - Hampden and Upper Salmon	-	-	-	-	-	71.3	71.3	185.3	256.6	-	-	-	-	6.9	64.4	185.3	256.6	-	-	
Additions for Load - Distribution System - Makkovik and Hopedale	-	-	-	-	-	846.1	846.1	-	846.1	-	-	-	-	115.3	730.8	-	846.1	-	-	
2019 Projects																				
Distribution System Upgrades - Various Sites	-	-	-	390.8	(31.4)	5,490.1	5,458.7	-	5,880.9	-	-	-	422.2	1,035.6	4,423.1	-	5,880.9	-	-	
Install Recloser Remote Control (2019-2020) - Rocky Harbour	-	-	-	66.1	44.1	319.9	364.0	-	386.0	-	-	-	22.0	36.8	327.2	-	386.0	-	-	
Total Distribution Projects	-	-	-	456.9	12.7	14,309.0	14,321.7	3,339.7	18,105.6	-	-	-	444.2	3,135.8	11,185.9	3,339.7	18,105.6	-	-	

2020 Capital Expenditures By Category
($000)

Rural Generation Projects										Actual Expenditure and Forecast										
	A				B	C	D	E	F (A+C+E)	G				H	I	J	K (G+H+I+J)	K-F	H-D	
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance	Notes
2020 Projects																				
Overhaul Diesel Units - Various	-	-	-	-	-	2,310.9	2,310.9	-	2,310.9	-	-	-	-	929.3	1,381.6	-	2,310.9	-	-	
Diesel Plant Ventilation Upgrade - Nain	-	-	-	-	-	162.7	162.7	690.4	853.1	-	-	-	-	26.4	136.3	690.4	853.1	-	-	
Replace Automation Equipment - Rigolet	-	-	-	-	-	363.8	363.8	-	363.8	-	-	-	-	22.6	341.2	-	363.8	-	-	
Replace Sewage Lift System - Rigolet	-	-	-	-	-	127.9	127.9	-	127.9	-	-	-	-	29.9	98.0	-	127.9	-	-	
Upgrade Fuel Storage Tanks - Charlottetown	-	-	-	-	-	467.2	467.2	-	467.2	-	-	-	-	59.8	407.4	-	467.2	-	-	
Diesel Genset Replacements - Mary's Harbour	-	-	-	-	-	3,900.7	3,900.7	-	3,900.7	-	-	-	-	1,109.0	2,791.7	-	3,900.7	-	-	
Replace Powerhouse Roofing System - L'Anse Au Loup and St. Anthony	-	-	-	-	-	125.3	125.3	1,195.8	1,321.1	-	-	-	-	41.2	84.1	1,195.8	1,321.1	-	-	
2019 Projects																				
Additions for Load - Isolated Generation Systems	-	-	-	1,523.6	(682.0)	658.9	(23.1)	-	2,182.5	-	-	-	2,423.6	32.8	165.6	-	2,622.0	439.5	221.5	
Replace Human Machine Interface - Cartwright	-	-	-	306.9	154.0	-	154.0	-	306.9	-	-	-	152.9	72.0	82.0	-	306.9	-	-	
Diesel Genset Replacements (2019-2020)	-	-	-	525.6	385.4	3,421.8	3,807.2	-	3,947.4	-	-	-	140.2	142.8	3,664.4	-	3,947.4	-	-	
2018 Projects																				
Diesel Plant Engine Cooling System Upgrades - Various Sites	-	-	638.4	671.6	147.0	-	147.0	-	1,310.0	-	-	149.3	1,013.7	157.6	(10.6)	-	1,310.0	-	-	
Diesel Plant Fire Protection - Postville	-	-	505.6	336.4	296.8	-	296.8	-	842.0	-	-	37.2	508.0	293.2	3.6	-	842.0	-	-	
Diesel Genset Replacements - Makkovik	-	-	604.1	4,703.3	(452.0)	3,592.8	3,140.8	-	8,900.2	-	-	1,585.1	4,174.3	1,393.5	1,747.3	-	8,900.2	-	-	
Replace Automation Equipment - St. Anthony	-	-	307.4	1,565.9	(44.7)	-	(44.7)	-	1,873.3	-	-	127.2	1,790.8	152.7	177.5	-	2,248.2	374.9	374.9	
Total Rural Generation Projects	-	-	2,055.5	9,633.3	(195.5)	15,132.0	14,936.5	1,886.2	28,707.0	-	-	1,898.8	10,203.4	4,462.8	11,070.1	1,886.2	29,521.3	814.3	596.4	

2020 Capital Expenditures By Category
($000)

Properties Projects										Actual Expenditure and Forecast										
	A				B	C	D	E	F (A+C+E)	G				H	I	J	K (G+H+I+J)	K-F	H-D	
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance	Notes
2020 Projects																				
Upgrade Fire Suppression System - Bishop's Falls	-	-	-	-	-	91.6	91.6	292.6	384.2	-	-	-	-	86.8	4.8	292.6	384.2	-	-	
Upgrade Line Depots - Various	-	-	-	-	-	648.3	648.3	-	648.3	-	-	-	-	21.1	627.2	-	648.3	-	-	
2018 Projects																				
Install Energy Efficiency Lighting in Diesel Plants - Various	-	-	104.0	119.0	57.7	122.2	179.9	-	345.2	-	-	68.0	97.3	108.4	71.5	-	345.2	-	-	
Total Properties Projects	-	-	104.0	119.0	57.7	862.1	919.8	292.6	1,377.7	-	-	68.0	97.3	216.3	703.5	292.6	1,377.7	-	-	

2020 Capital Expenditures By Category
($000)

Metering Projects										Actual Expenditure and Forecast										
	A				B	C	D	E	F (A+C+E)	G				H	I	J	K (G+H+I+J)	K-F	H-D	
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance	Notes
2020 Projects																				
Purchase Meters and Metering Equipment - Various	-	-	-	-	-	244.2	244.2	-	244.2	-	-	-	-	6.2	238.0	-	244.2	-	-	
Purchase Meters and Metering Equipment - Various CIAC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total Metering Projects	-	-	-	-	-	244.2	244.2	-	244.2	-	-	-	-	6.2	238.0	-	244.2	-	-	

2020 Capital Expenditures By Category
($000)

Information Systems Projects	A				B	C	D	E	F (A+C+E)	Actual Expenditure and Forecast G				H	I	J	K (G+H+I+J)	K-F	H-D	
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance	Notes
2020 Projects																				
Replace Personal Computers - Hydro Place	-	-	-	-	-	673.3	673.3	-	673.3	-	-	-	-	9.8	663.5	-	673.3	-	-	
Replace Peripheral Infrastructure - Hydro Place	-	-	-	-	-	222.1	222.1	-	222.1	-	-	-	-	2.3	219.8	-	222.1	-	-	
Upgrade Core IT Infrastructure - Hydro Place	-	-	-	-	-	193.7	193.7	-	193.7	-	-	-	-	4.1	189.6	-	193.7	-	-	
Refresh Security Software - Hydro Place	-	-	-	-	-	110.2	110.2	-	110.2	-	-	-	-	22.5	87.7	-	110.2	-	-	
Perform Minor Enhancements - Hydro Place	-	-	-	-	-	49.0	49.0	-	49.0	-	-	-	-	2.0	47.0	-	49.0	-	-	
Upgrade Software Applications - Hydro Place	-	-	-	-	-	65.4	65.4	-	65.4	-	-	-	-	-	65.4	-	65.4	-	-	
2019 Projects																				
Upgrade Energy Management System - Hydro Place	-	-	-	271.7	162.8	-	162.8	-	271.7	-	-	-	108.9	100.9	61.9	-	271.7	-	-	
Total Information Systems Projects	-	-	-	271.7	162.8	1,313.7	1,476.5	-	1,585.4	-	-	-	108.9	141.6	1,334.9	-	1,585.4	-	-	

2020 Capital Expenditures By Category
($000)

Tools and Equipment										Actual Expenditure and Forecast										
	A				B	C	D	E	F (A+C+E)	G				H	I	J	K (G+H+I+J)	K-F	H-D	
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance	Notes
2020 Projects																				
Replace Light Duty Mobile Equipment - Various Sites	-	-	-	-	-	499.6	499.6	-	499.6	-	-	-	-	-	499.6		499.6	-	-	
Tools and Equipment Less than $ 50,000	-	-	-	-	-	439.4	439.4	-	439.4	-	-	-	-	5.6	433.8		439.4	-	-	
2018 Projects																				
Replace Off-Road Track Vehicles - Bishop's Falls and Bay d'Espoir	-	-	213.7	986.3	1,031.7	-	1,031.7	-	1,200.0	-	-	249.5	12.0	-	1,031.7	-	1,293.2	93.2	249.5	
Total Tools and Equipment	-	-	213.7	986.3	1,031.7	939.0	1,970.7	-	2,139.0	-	-	249.5	12.0	5.6	1,965.1	-	2,232.2	93.2	249.5	

2020 Capital Expenditures By Category
($000)

Telecontrol Projects										Actual Expenditure and Forecast										
	A				B	C	D	E	F (A+C+E)	G				H	I	J	K (G+H+I+J)	K-F	H-D	
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance	Notes
<u>2020 Projects</u>																				
Replace Network Communications Equipment - Various	-	-	-	-	-	186.8	186.8	-	186.8	-	-	-	-	117.4	69.4	-	186.8	-	-	
Upgrade Site Facilities - Various	-	-	-	-	-	45.5	45.5	-	45.5	-	-	-	-	23.9	21.6	-	45.5	-	-	
Replace Radomes - Various	-	-	-	-	-	384.5	384.5	-	384.5	-	-	-	-	14.5	370.0	-	384.5	-	-	
Upgrade Remote Terminal Units - Various	-	-	-	-	-	157.1	157.1	-	157.1	-	-	-	-	27.5	129.6	-	157.1	-	-	
Replace Battery Banks and Chargers - Various	-	-	-	-	-	195.9	195.9	-	195.9	-	-	-	-	69.9	126.0	-	195.9	-	-	
Purchase Tools and Equipment less than $50,000	-	-	-	-	-	93.4	93.4	-	93.4	-	-	-	-	40.1	53.3	-	93.4	-	-	
<u>2019 Projects</u>																				
Upgrade Telecontrol Facilities - Gull Pond Hill and Bay d'Espoir Hill	-	-	-	96.3	(1.5)	577.6	576.1	-	673.9	-	-	-	97.8	39.9	536.2	-	673.9	-	-	
Total Telecontrol Projects	-	-	-	96.3	(1.5)	1,640.8	1,639.3	-	1,737.1	-	-	-	97.8	333.2	1,306.1	-	1,737.1	-	-	

2020 Capital Expenditures By Category
($000)

Transportation											Actual Expenditure and Forecast										
	A				B	C	D	E	F (A+C+E)	G				H	I	J	K (G+H+I+J)	K-F	H-D	
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance	Notes
2020 Projects																				
Replace Light and Heavy Duty Vehicles (2020-2021) - Various	-	-	-	-	-	1,625.5	1,625.5	1,583.5	3,209.0	-	-	-	-	-	1,625.5	1,583.5	3,209.0	-	-	
2019 Projects																				
Replace Vehicles and Aerial Devices - Various Sites	-	-	-	1,248.1	(136.9)	594.9	458.0	-	1,843.0	-	-	-	1,385.0	288.2	169.8		1,843.0	-	-	
2018 Projects																				
Replace Vehicles and Aerial Devices - Various Sites	-	-	1,667.2	753.7	765.7	-	765.7	-	2,420.9	-	-	1,165.1	490.1	984.3	(218.6)		2,420.9	-	-	
Total Transportation	-	-	1,667.2	2,001.8	628.8	2,220.4	2,849.2	1,583.5	7,472.9	-	-	1,165.1	1,875.1	1,272.5	1,576.7	1,583.5	7,472.9	-	-	

Administrative										Actual Expenditure and Forecast										
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance	Notes
2020 Projects																				
Remove Safety Hazards - Various	-	-	-	-	-	198.6	198.6	-	198.6	-	-	-	-	56.7	141.9	-	198.6	-	-	
Purchase Office Equipment	-	-	-	-	-	60.9	60.9	-	60.9	-	-	-	-	0.0	60.9	-	60.9	-	-	
Replace Elevator Motors and Control Equipment - Hydro Place	-	-	-	-	-	89.1	89.1	647.6	736.7	-	-	-	-	29.8	59.3	647.6	736.7	-	-	
Total Administrative	-	-	-	-	-	348.6	348.6	647.6	996.2	-	-	-	-	86.5	262.1	647.6	996.2	-	-	

2020 Capital Expenditures By Category
($000)

Transportation										Actual Expenditure and Forecast									
	A				B	C	D	E	F (A+C+E)	G				H	I	J	K (G+H+I+J)	K-F	H-D	
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance	Notes
2020 Projects																				
Replace Light and Heavy Duty Vehicles (2020-2021) - Various	-	-	-	-	-	1,625.5	1,625.5	1,583.5	3,209.0	-	-	-	-	-	1,625.5	1,583.5	3,209.0	-	-	
2019 Projects																				
Replace Vehicles and Aerial Devices - Various Sites	-	-	-	1,248.1	(136.9)	594.9	458.0	-	1,843.0	-	-	-	1,385.0	288.2	169.8		1,843.0	-	-	
2018 Projects																				
Replace Vehicles and Aerial Devices - Various Sites	-	-	1,667.2	753.7	765.7	-	765.7	-	2,420.9	-	-	1,165.1	490.1	984.3	(218.6)		2,420.9	-	-	
Total Transportation	-	-	1,667.2	2,001.8	628.8	2,220.4	2,849.2	1,583.5	7,472.9	-	-	1,165.1	1,875.1	1,272.5	1,576.7	1,583.5	7,472.9	-	-	

Administrative										Actual Expenditure and Forecast									
	2016	2017	2018	2019	Carryover to 2020	Original 2020	Revised 2020	2021 and Beyond	Total	2016	2017	2018	2019	2020	Forecast Jul-Dec 2020	2021 and Beyond	Total	Project Variance	Annual Variance	Notes
2020 Projects																				
Remove Safety Hazards - Various	-	-	-	-	-	198.6	198.6	-	198.6	-	-	-	-	56.7	141.9	-	198.6	-	-	
Purchase Office Equipment	-	-	-	-	-	60.9	60.9	-	60.9	-	-	-	-	0.0	60.9	-	60.9	-	-	
Replace Elevator Motors and Control Equipment - Hydro Place	-	-	-	-	-	89.1	89.1	647.6	736.7	-	-	-	-	29.8	59.3	647.6	736.7	-	-	
Total Administrative	-	-	-	-	-	348.6	348.6	647.6	996.2	-	-	-	-	86.5	262.1	647.6	996.2	-	-	

2021 Capital Budget Application

Section I: 2017, 2018, and 2019 Average Rate Base

Table 1: 2017–2019 Average Rate Base ($000)

	2019	2018	2017
Capital Assets - Return 4	2,610,468	2,494,233	2,342,713
Work in Process[1]	37,417	31,655	33,556
	2,647,885	2,525,888	2,376,269
Deduct:			
Accumulated Depreciation - Return 6 [2]	449,739	367,808	308,470
Contributions in Aid of Construction - Return 7 [1]	45,593	43,071	32,477
Total Capital Assets	**2,152,552**	**2,115,009**	**2,035,322**
Deduct Items Excluded from Rate Base:			
Work in Process [1]	(37,417)	(31,655)	(33,556)
Asset Retirement Obligations (net of amortization)	(67)	185	789
Net Capital Assets	2,115,068	2,083,540	2,002,555
Net Capital Assets, Previous Year	2,083,540	2,002,555	1,699,168
Unadjusted Average Capital Assets	2,099,304	2,043,047	1,850,861
Deduct:			
Average Net Capital Assets Excluded from Rate Base	(9,679)	(12,208)	(21,141)
Average Capital Assets	2,089,625	2,030,839	1,829,720
Cash Working Capital Allowance - Return 8	1,299	2,640	6,405
Fuel Inventory - Return 10	57,611	56,041	43,617
Supplies Inventory - Return 10	37,701	37,021	34,719
Average Deferred Charges - Return 11	119,811	139,142	65,287
Average Rate Base at Year-End - Return 12	**2,306,047**	**2,265,683**	**1,979,748**

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[1] Contributions of $5.9 million (2018: $8.3 million, 2017: $15.1 million) that are related to capital assets that are in work in progress have been excluded from Contribution in Aid of Construction and included in work in progress.

[2] Accumulated amortization is net of the Retirement Asset Pool and Removal Provision. Please refer to Return 6 for further details.