1 Introduction

In June 2011 the Government of Newfoundland and Labrador requested that the Board of Commissioners of Public Utilities of Newfoundland and Labrador (Board) review and report on whether Nalcor's proposed Muskrat Falls and Labrador-Island HVdc Link projects are the least cost option for the supply of power and energy to the Island of Newfoundland. The Government's request, in the form of a Reference Question, was stated as follows:

> *"The Board shall review and report to Government on whether the Projects represent the least-cost option for the supply of power to Island Interconnected Customers over the period of 2011-2067, as compared to the Isolated Island Option, this being the 'Reference Question'.*
>
> *In answering the Reference Question, the Board*
>
> - *shall consider and evaluate factors it considers relevant including NLH's and Nalcor 's forecasts and assumptions for the Island load, system planning assumptions, and the process for developing and comparing the estimated costs for the supply of power to Island Interconnected Customers; and*
>
> - *shall assume that any power from the Projects which is in excess of the needs of the Province is not monetized or utilized, and therefore the Board shall not include consideration of the options and decisions respecting the monetization of the excess power from the Muskrat Falls generation facility, including the Maritime Link Project."*

It should be noted that the investigation of alternative fuel types, other island supply options, consideration of the export market via the Maritime Link, the technical feasibility of the Maritime Link, electricity requirements in Labrador as well as potential impacts on island rates were not included in the review by the Terms of Reference.

The Board engaged Manitoba Hydro International Ltd. (MHI) as its independent expert to assist the Board in its review.

This section of the Report briefly describes MHI, the process of consultant selection, the MHI Team, Nalcor, and the two options that were to be compared. The balance of Volume I provides the high level summaries of the various detailed technical and financial analyses completed, with detailed reports contained in Volume 2: Studies.

1.1 Manitoba Hydro International

MHI is a wholly-owned subsidiary of Manitoba Hydro, one of the largest and oldest electric power utilities in Canada. MHI provides consulting services to power utilities, governments, and private sector clients worldwide to assist them in the delivery of electricity efficiently, effectively, and in a sustainable manner. In the execution of its projects, MHI has provided utility infrastructure management, consulting, and training services to over 60 countries worldwide.

MHI has established itself as an ethical, environmentally responsible provider of high-quality utility services to the international power sector for the past 25 years.

1.2 Board of Commissioners of Public Utilities, Newfoundland and Labrador

The Board is an independent, quasi-judicial tribunal constituted under the *Public Utilities Act*. It is responsible, among other things, for the regulation of and general supervision of public utilities in the Province of Newfoundland and Labrador. In regulating the utilities in the province, the Board ensures that the rates charged are just and reasonable, and that the service provided is safe and reliable.[14]

1.3 Request for Proposal, Response, and Contract Award

MHI was selected by the Board after a competitive request for proposal (RFP) process by invitation. The RFP and the proposal filed by MHI are available on the Board's public website. The Board awarded the contract to MHI on July 4, 2011.

1.4 The MHI Team

MHI established a team of technical and financial experts to undertake the required reviews and analyses. The team members are experienced in the design of hydroelectric plants and HVdc systems, project management, operation and maintenance of hydroelectric plants, operation and maintenance of HVdc systems, design and operation/maintenance of thermal plants, transmission line design, transmission system planning and operations, commercial utility operations, load forecasting, and financial management and modelling. An outside firm CESI, with expertise in submarine cables, was contracted to review the details of the engineering, construction, and operation and maintenance of the Strait of Belle Isle crossing. Additional subject matter experts from Manitoba Hydro, and some internal MHI support were also engaged when required. Key members of the team and their respective roles are shown in Figure 2.

[14] Board of Commissioners of Public Utilities of Newfoundland and Labrador, Mandate

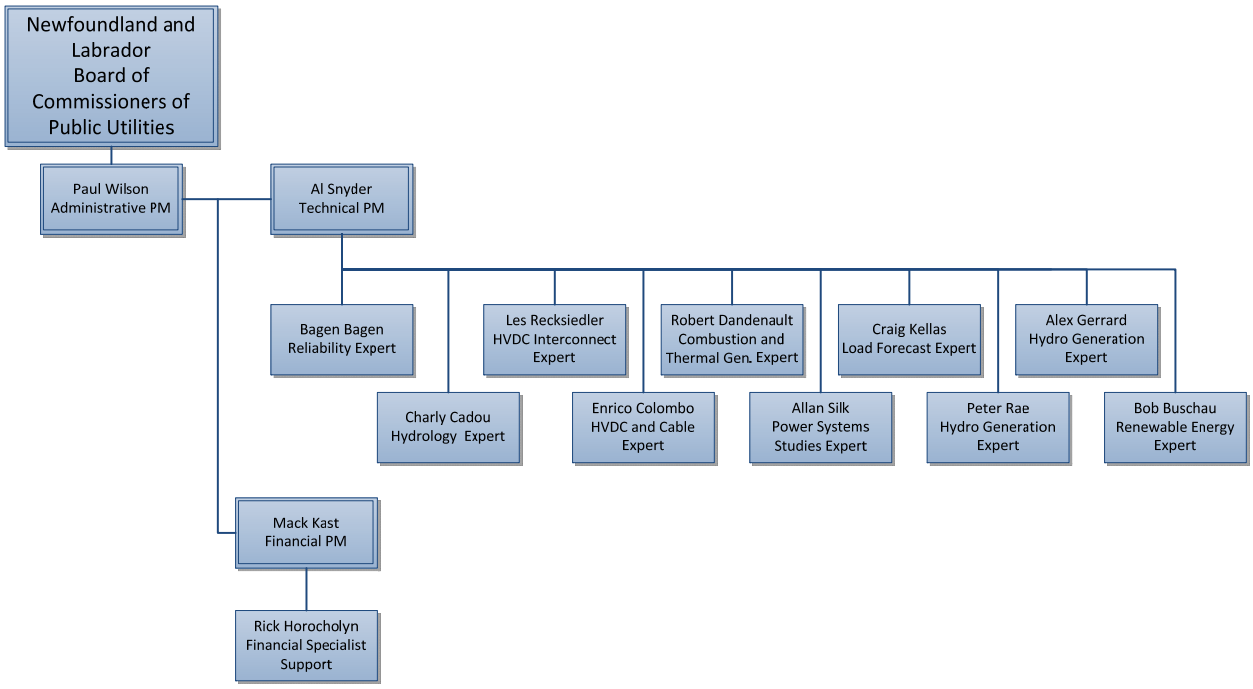

Figure 2: MHI Project Organization Chart

Team member biographies are available in Volume 2, Section 13 – Team and Qualifications.

1.5 Nalcor

Nalcor Energy (Nalcor) is a provincial Crown Corporation, enacted by legislation (*Energy Corporation Act*) and charged with managing, serving, utilizing, and commercializing the oil, gas, and electricity energy assets of the province of Newfoundland and Labrador.

Nalcor is organized into five lines of business, of which three are relevant to this review as shown in Figure 3.

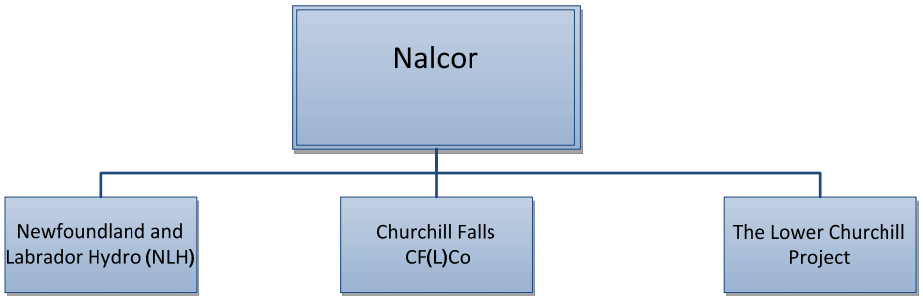

Figure 3: Nalcor Business Lines

1.5.1 Newfoundland and Labrador Hydro

Newfoundland and Labrador Hydro (NLH) is the principal generation and transmission operating company for Newfoundland and Labrador. It also operates distribution assets, primarily in rural areas of the province. Although NLH directly serves over 36,000 residential and commercial customers in approximately 180 communities across the province, it is primarily a bulk generation and transmission utility, with Newfoundland Power as its largest customer. NLH also operates 21 diesel systems to provide service to over 4,300 customers in isolated communities throughout coastal areas of Newfoundland and Labrador. Both utilities operate under the jurisdiction of the Board, which has regulatory authority over rates, policies, and capital expenditures.

Newfoundland Power is an investor-owned company operated by Fortis Inc. It serves approximately 243,000 customers in Newfoundland. Newfoundland Power also operates 140 MW of island generation as part of the energy mix available on the island, and purchases the remainder from NLH.

Figure 4 shows the current configuration of the provincial generation and transmission system.[15]

1.5.2 Churchill Falls – CF(L) Co

Nalcor controls 65.8% of the shares of Churchill Falls (Labrador) Corporation Limited, the owner of the 5,428 MW Churchill Falls Generating Station situated on the Upper Churchill River in Labrador. Hydro Quebec controls the remaining shares.

1.5.3 Lower Churchill Project

The Lower Churchill Project is intended to develop the approximately 35% of the Churchill River that has not already been developed by the Upper Churchill Falls Generating Station. The Lower Churchill Project is responsible for developing installations at Gull Island and Muskrat Falls.

[15] Exhibit 102, Nalcor, "Provincial Generation and Transmission Grid", January 2011.

Figure 4: Newfoundland and Labrador Generation and Transmission System Map

1.6 Options Reviewed

The province of Newfoundland and Labrador has extensive viable sources of energy that may be developed[16]. Newfoundland's electrical power system on the island presently has no interconnections to any other electrical system on the mainland. The planned Muskrat Falls Generating Station and Labrador-Island Link HVdc system would be the first mainland interconnection via Labrador.

The Reference Question defined the two options to be reviewed which are focused solely on the island of Newfoundland and its associated power system. These options represent Nalcor's assessment of the two most realistic alternatives available for the long-term supply of least cost power and energy to the Island of Newfoundland. The options, which utilize Nalcor's portfolio of potential generation assets and supply scenarios, are described as follows, with corresponding development time frames.

1.6.1 Infeed Option

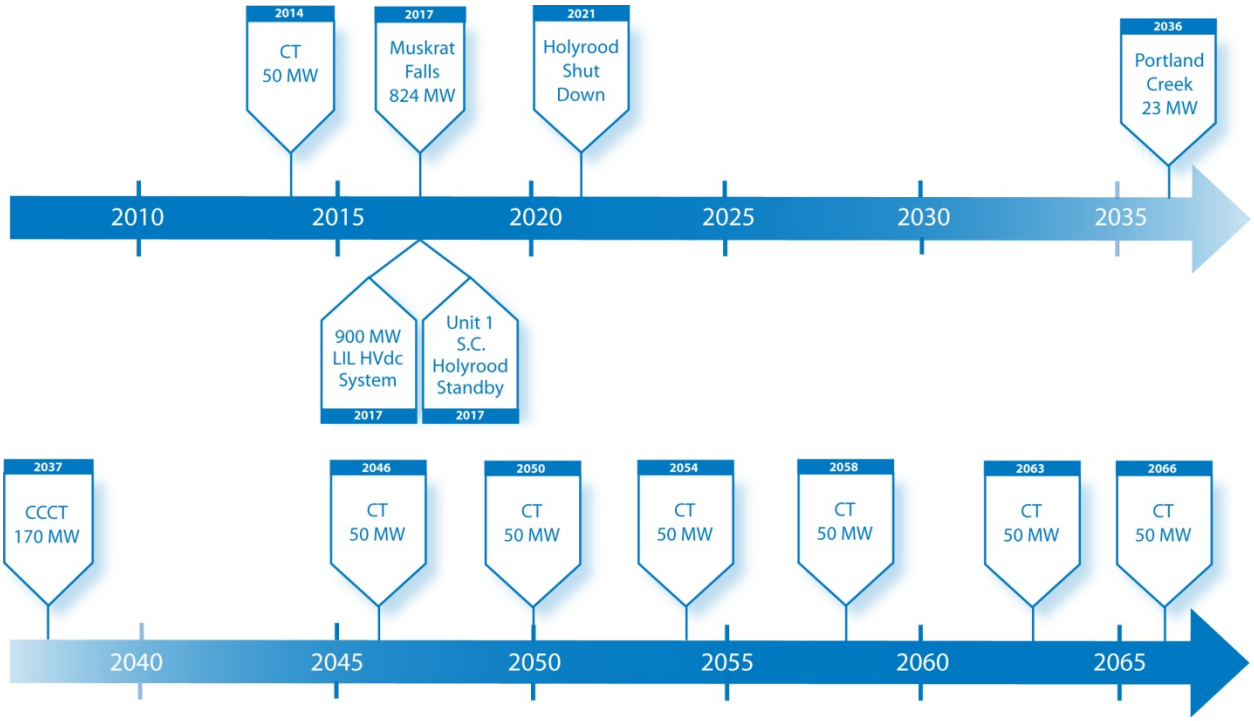

Figure 5: Project Timeline – Infeed Option

The timeline for the evaluation of the Options extends to 2067, which is 50 years past the in-service date of Muskrat Falls Generating Station and the Labrador-Island Link HVdc system[17]. From 2036 to 2067, new energy and capacity requirements will be met by adding the hydroelectric Portland Creek Generating Station (23MW), several 170 MW CCCTs, and 50 MW CT thermal energy sources.

[16] Government of Newfoundland and Labrador, "Focusing our Energy: Newfoundland and Labrador Energy Plan", 2007
[17] Exhibit 7, Nalcor, Service Life - Retirements.

Throughout this report, Muskrat Falls Generating Station and the Labrador-Island Link are also referred to as the "Infeed Option", or in the case of the HVdc system only, the "Labrador-Island Link HVdc system".

If the Infeed Option is developed, expenditures that result in a cumulative present worth (CPW) of more than $6.6 billion (2010$) will be required over the study period to 2067. Given the large output of Muskrat Falls Generating Station, averaging 4.9 TWh per year, excess energy will be available from the station for more than two decades. Any consideration of the monetization of this excess energy was excluded from the scope of this review by the Terms of Reference.

1.6.2 Isolated Island Option

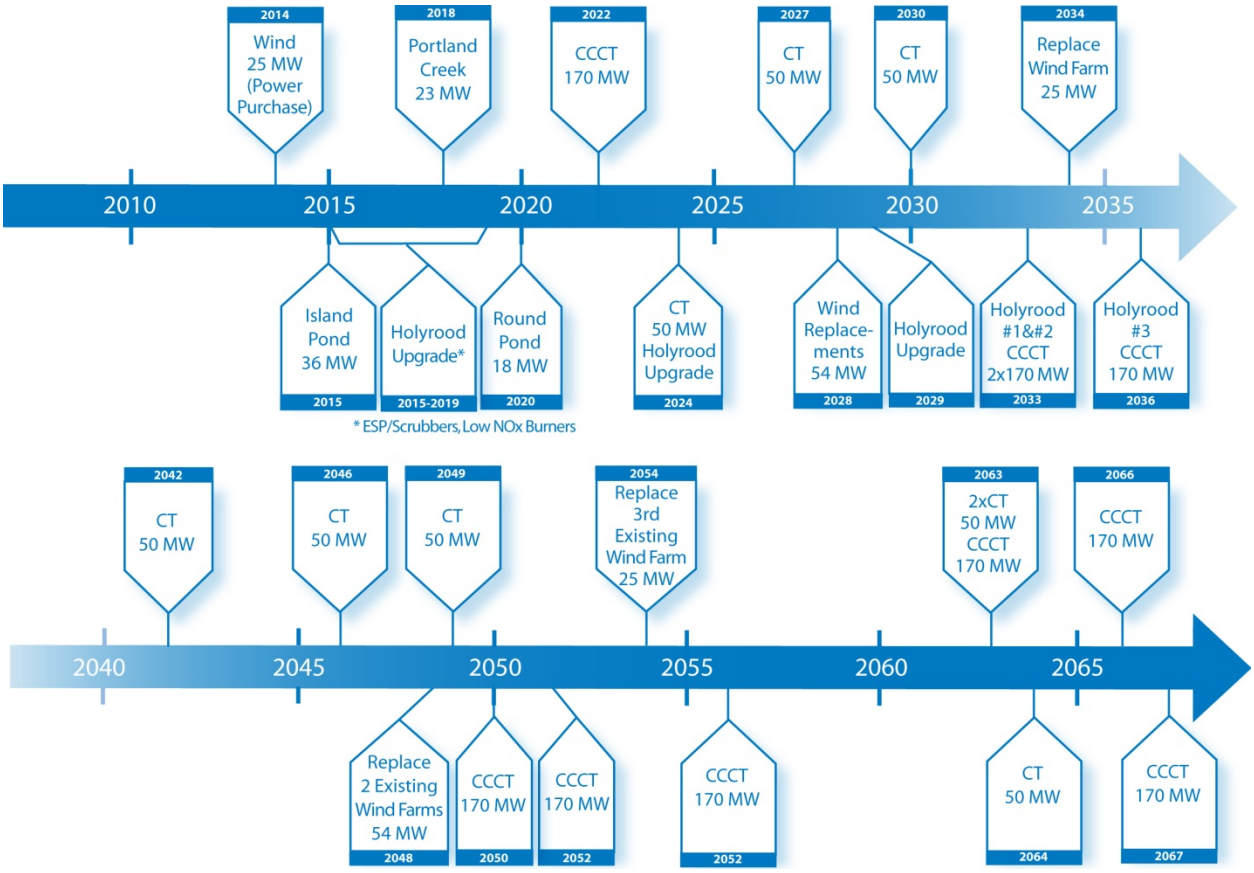

Figure 6: Project Timeline – Isolated Island Option

The Isolated Island Option has no future planned interconnections to the mainland. The salient points of the Isolated Island Option are as follows:

- Installation of environmental emissions controls at Holyrood Thermal Generating Station (electrostatic precipitators, scrubbers, and NOx burners).
- One new 25 MW wind farm in 2014, and replacement of wind farms after 20 years of operation.
- Three new hydroelectric developments at Island Pond, Portland Creek, and Round Pond, totalling 77 MW.

- New thermal generation totalling 1,640 MW, comprised of seven 170 MW CCCTs and nine 50 MW CTs.
- Replacement of the Holyrood Thermal Generating Station with three 170 MW CCCT generating units (two in 2033 and one in 2036).

If the Isolated Island Option is developed, expenditures that result in a CPW of more than $8.8 billion (2010$) will be required over the study period to 2067. Of the $8.8 billion, $6 billion will be for the cost of fuel.

1.7 Generation Resource Planning Process

Electric utility generation planning is based on the demand on the system (load forecast) which drives the supply of generation options to satisfy the load requirements. The load forecast is the first step in the planning process, as it establishes the future electricity requirements of customers. Information on future annual energy and peak demand requirements is needed to determine the timing and sizing of future generation sources. The load forecast may be a simple extrapolation of previous load growth, or it may involve large blocks of energy either added or deleted as part of industrial or commercial load start-ups or closures. Accurate load forecasts, together with an appropriate generation resource plan, minimize the risks that range between an inadequate supply and excess generating capacity.

Adding more generation assets requires significant amounts of capital and generally long lead times (particularly in the case of hydroelectric generation), so careful consideration needs to be given to the load forecast before any projects are undertaken. Market factors relating to price and the availability of a reliable electricity supply will have an impact on electricity demand. Load forecasts also depend on the price of energy; thus, each generation resource option may require its own load forecast to properly stage new generation.

The range of options available for generation vary from region to region, based on the supply of natural resources that can be economically harnessed to produce an adequate supply of firm energy and capacity. Firm energy is defined as having sufficient generating capability to meet annual load requirements; capacity is defined as having the ability to meet customers' peak demands. Utilities must plan and build systems to supply both firm energy and capacity.

Generation options include hydraulic river or tidal stations, with or without ponding or storage; thermal generating options fueled by oil, gas, coal, biomass or uranium (nuclear); and wind farms and/or solar farms. The objectives of the review of options are to eliminate those that are not feasible and then to select the most economic mix of generation facilities to match the projected load growth.

Screening supply options normally takes into account the security and reliability of the supply, the costs of energy to the customer, environmental and social considerations, risk and uncertainty, and the financial viability of non-regulated components. The process should consider a minimum 20-year planning horizon, and as a matter of course, re-evaluate options annually or as new information is made available on future load possibilities, new technologies, and planned plant retirements. All preferred supply options undergo a similar rigorous licencing process, which development planning must take into consideration to ensure that the supply is available when required.

Planned generating capacity must not be less than the forecasted firm annual peak energy, plus a reserve requirement determined partly by a resource adequacy study. A reserve requirement of 15 to 20% of forecasted firm loads is typical in North America when using a one day in ten loss of load expectation, and when there is no interconnection to an electrical grid[18]. The reserve requirement is normally 10 to 12% when the generation and transmission grid is strongly interconnected with other sources of supply as is the case with Manitoba Hydro.

Demand for energy should consider demand side management programs which are either in place or are contemplated in the near future. Demand side management is treated as if it were generation, as it represents a reduction from the base load forecast. The economics of demand side management programs should be evaluated to ensure that they make a positive contribution to the overall financial well-being of the province. The base load forecast also includes transmission losses associated with serving the domestic load.

Before selecting a generation plan, transmission requirements must be taken into consideration. Generally, the least-cost, technically viable option is selected to support the generation options being considered. Also, transmission facilities must be able to withstand various classifications of contingencies and meet reliability criteria.

All future costs are converted to present day costs through the use of a planning technique known as the CPW of the project. The CPW is the present value of all incremental utility capital and operating costs to reliably meet the load forecast, given a prescribed set of reliability criteria.

Once dependable and available supply options and their costs have been identified, a sophisticated software tool is used to optimize and select a preferred development scheme. The data required usually includes resource limitations, fuel prices, and capital and operating costs. The software tool produces a number of generation expansion plans, including a least cost scenario. In Nalcor's case, the software tool is *Strategist*®[19]. For other utilities, including Manitoba Hydro, custom in-house tools may be used to lay out various staged resource plans. Results are then reviewed in light of the security of supply required, regional economic and social needs, and environmental considerations, before a final decision is made.

Table 21 in Nalcor's Final Submission, identifies the range of options and eligible technologies considered by Nalcor. The two options reviewed in this report were defined by the Reference Question.

Once the eligible options or alternatives are identified to be included in the generation resource plan, the various feasibility studies, integration studies, cost estimates, schedules, reliability studies, environmental impact studies, and financial resource plans can be developed to define requirements, assess and quantify risks, and obtain approvals.

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[18] "Nalcor's Submission to the Board of Commissioners of Public Utilities with respect to the Reference from the Lieutenant-Governor in Council on the Muskrat Falls Project", November 2011, pg. 31
[19] CE-50 (Public), Ventyx, "*Strategist* Introduction"

1.7.1 Generation Resource Planning Key Finding

MHI reviewed Nalcor's generation resource planning process and found that it is consistent with that of leading North American utilities. The Strategist software used by Nalcor to evaluate and select a preferred generation development scheme is appropriate. It should be noted that the addition of a large industrial load on the island or in Labrador could result in a different generation expansion plan.