

IN THE MATTER OF A Reference
from the Lieutenant Governor
in Council on the Muskrat Falls
Project pursuant to section 5
of the *Electrical Power Control Act*, 1994

Consumer Advocate's Submission March 2, 2012

To The Board of Commissioners of Public Utilities

Suite E210, Prince Charles Building
120 Torbay Road
P.O. Box 12040
St. John's, NL A1A 5B2

Attention: G. Cheryl Blundon
Director of Corporate Services & Board Secretary

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1 Overview

2
3
4 In June, 2011, the Lieutenant-Governor in Council of Newfoundland and
5 Labrador referred to the Board of Commissioners of Public Utilities (the Board) a
6 Reference Question and Terms of Reference relating thereto requesting the
7 Board review and report to Government on whether Nalcor Energy's (Nalcor)
8 proposed Muskrat Falls Generating Station and Labrador-Island Link HVdc
9 projects are the least cost option for the supply of power to the island's
10 customers as compared to the Isolated Island Option.

11
12 The Terms of Reference and Reference Question for the Board's review are
13 attached at Appendix "A". For the purposes of the review a Consumer Advocate
14 was appointed pursuant to section 117 of the Public Utilities Act RSN, 1990 c-P-
15 47.

16
17 The Reference Question stated:

18
19 **The Board shall review and report to Government on whether the**
20 **Projects represent the least-cost option for the supply of power to**
21 **Island Interconnected customers over the period of 2011-2067, as**
22 **compared to the Isolated Island Option, this being the 'Reference**
23 **Question'.**

24
25 The Reference Question identifies the two options to be compared over the
26 period 2011-2067:

- 27
28 1. Interconnected Option which includes the Muskrat Falls Generation
29 Station and Labrador-Island Link HVdc project; and
30
31 2. Isolated Island Option (consisting of a combination of small hydro on the
32 Island, along with wind power, refurbishment of Holyrood and other
33 thermal generation).

1 A more detailed description of the components of the two options is attached at
2 Appendix "B".

3

4 The examination of other island supply options, consideration of the export
5 market *via* the Maritime Link, the technical feasibility of the Maritime Link,
6 electricity requirements in Labrador as well as impact on island rates of each of
7 the options were not included in the review by the Terms of Reference.

8

9 The Consumer Advocate's mandate is to represent domestic and general service
10 customers during the review and to critically review the Nalcor Submission, and
11 any further submissions and reports relating to the Reference Question and to
12 attend any public hearing and make representations to the Board on behalf of
13 ratepayers in respect of the Reference Question. Since 2004, the Consumer
14 Advocate has represented domestic and general electricity customers in the
15 Province of Newfoundland and Labrador on a variety of regulatory matters before
16 the Board, including general rate applications, annual capital budget applications
17 and various applications pertaining to accounting and other regulatory matters
18 involving Newfoundland and Labrador Hydro and Newfoundland Power Inc. The
19 Consumer Advocate also retained the engineering and consulting firm of Knight
20 Piésold Consulting to assist the Consumer Advocate in connection with this
21 mandate. Knight Piésold Consulting is an independent, international consulting
22 company specializing in power supply developments. Knight Piésold Consulting
23 has provided consulting services for 90 years and has offices in 14 countries.

24

25 The Nalcor submissions of November, 2011 and the report of Manitoba Hydro
26 International Ltd. (MHI), the Board's independent consultants, are central to the
27 review and the Reference Question before the Board. These reports along with
28 a voluminous amount of documentation including exhibits (both public and
29 confidential), answers to requests for information, the presentations from Nalcor,
30 MHI and members of the public, together with letters of comment from interested
31 persons and parties form the record before the Board in relation to the Reference

1 Question. Pursuant to the Terms of Reference certain confidential information
2 which was designated as commercially sensitive by Nalcor was made available
3 only to the Board and its consultants.

4
5 As MHI's report noted, Nalcor is using a staged or phased decision gate process
6 to determine if, and how, the Interconnected Option should proceed. Phase 1 of
7 the Interconnected Option passed through a decision point termed as Decision
8 Gate 2 (DG2), in November, 2010. DG2 is considered to be approval of a
9 development scenario and allows for commencement of detailed design.
10 Following DG2 in November of 2010, engineering progresses to a level required
11 to support project approval or sanction, which is DG3.

12
13 Since DG2 and indeed while this review was ongoing, Nalcor and its consultants
14 were advancing with the engineering and design. Nalcor has adopted estimating
15 practices of the Association for the Advancement of Cost Engineering (AACE)
16 International for the Interconnected Option. DG2 capital cost estimates are
17 considered by Nalcor to be commensurate with an AACE Class 4 estimate which
18 has a range of accuracy of +50% to -30%, *i.e.* the cost estimates may be
19 understated by up to 50% or overstated by up to 30%. DG3 cost estimates are
20 considered by Nalcor to be a Class 3 estimate with a range of +30% to -20%.
21 The accuracy of cost estimates is in large measure a function of degree of
22 project definition achieved. Project definition at DG2 is less than 10%. Project
23 definition at DG3 is between 10% and 40% and Nalcor advised at the hearing
24 that it was aiming to achieve project definition at DG3 in the upper end of that
25 range. Nalcor's Project Director for the Lower Churchill Project indicated that
26 Nalcor is striving towards achieving having its information in place for its DG3
27 estimate by June, 2012. At that time, Nalcor will be updating all inputs to its
28 cumulative present worth analysis of the two Options.

29
30 For the purposes of the Board's review and as noted in MHI's report to the
31 Board, Nalcor did not generally provide information on the detailed engineering

1 or financial work completed after DG2. MHI's findings in its report therefore
2 relate to project components and costs as of DG2. Likewise, the Consumer
3 Advocate's submission relates to project components and costs as of DG2.

4
5 MHI provides consulting services to utilities, governments and private sector
6 clients worldwide. The Consumer Advocate and his consultants consider that
7 MHI is well qualified to review the matters pertaining to the Reference Question
8 referred for the Board's consideration and that MHI undertook their engagement
9 in an analytical, competent and independent manner. MHI approached their
10 investigation from two perspectives: a technical review of available studies and
11 related information from Nalcor was undertaken to determine if the degree of
12 skill, care and diligence required to meet utility best practices and procedures
13 were followed for the work done to date, and a financial review of the cumulative
14 present worth analysis used to select the least cost alternatives. From the first
15 perspective, MHI found that Nalcor's work and that of the consultants they
16 engaged is well-founded and generally in accordance with industry practices as
17 of DG2 with certain significant exceptions noted in their key findings. From the
18 second perspective, MHI stated that the detailed analysis performed by MHI
19 determined that Nalcor's cumulative present worth analysis was completed using
20 recognized best practices and the cumulative present worth for each option was
21 correct based on the inputs used by Nalcor. In respect of the inputs used by
22 Nalcor, MHI states, "[T]hese inputs were reviewed in the technical and financial
23 analyses conducted by MHI and were generally found to be appropriate."

24
25 MHI's report's conclusion (Vol. I, p. 91) states that its review of available
26 technical and financial documents was rigorous. MHI states that it has
27 undertaken an in-depth analysis. The Consumer Advocate agrees.

1 Of direct relevance to the Reference Question before the Board, MHI made the
2 following finding:

3
4 **MHI finds that the Muskrat Falls Generating Station and the**
5 **Labrador-Island Link HVdc projects represent the least-cost option**
6 **of the two alternatives, when considered together with the**
7 **underlying assumptions and inputs provided by Nalcor.**
8

9 Where MHI found gaps or concerns with the work carried out by Nalcor up to
10 DG2, MHI stated so quite plainly and directly in their report and reiterated the
11 same during their presentation before the Board. The most significant gaps or
12 concerns identified by MHI were in connection with aspects of power system
13 reliability and Nalcor's selected design loading criteria for the 1100 kilometre
14 HVdc transmission line. Nalcor was given an opportunity to address the areas of
15 concern raised by MHI during the presentation and questioning process before
16 the Board. The position of Nalcor was put to MHI for their comment during the
17 hearing. At the hearing, MHI confirmed its report's key findings and conclusions
18 including the concerns raised in their report. The Consumer Advocate concurs
19 with the concerns expressed by MHI.

20
21 The assessment as to the costs of each of the options presented in the
22 Reference must be evidence-based. Anything other than an evidence-based
23 assessment is injurious to the interests of consumers. Consumers will ultimately
24 bear the cost (rate) and service (reliability) risks associated with either of the
25 options that are being presented for assessment. Both options realistically, are
26 costly. Nalcor states that of these two options, the Muskrat Falls – Labrador
27 Island Link Project is the least costly way forward, stating that it has a 2.2 billion
28 (2010\$) dollar cumulative present worth (CPW) preference over the Isolated
29 Island Option over the term of the life of the Muskrat Falls generating and
30 Labrador Island link assets. In its report to the Board, MHI confirms that this
31 study period is appropriate and contains no bias in favour of one option over the
32 other. MHI also examined the capital and operating costs of each option for

1 reasonableness, with the composite costs of the integral parts of the two options
2 carried into the CPW analysis. These cost inputs were generally found to be
3 appropriate by MHI.

4
5 The question whether the Muskrat Falls – Labrador Island Link Option is least
6 cost compared to the Isolated Island Option inherently involves forecasts and
7 assumptions about future events and costs which, by nature, renders it
8 impossible to answer the question definitively. No one can predict the future so
9 as to be able to state definitively that one of these options will have a lower cost
10 in the long run than the other. In other words, there is risk involved in making
11 that assessment. There is a risk that forecast oil prices may be either lower or
12 higher than posited by Nalcor and its advisors in their Submission. There is a
13 risk that the Muskrat Falls generation and Labrador Island Link project could be
14 subject to cost overruns which could reduce or eliminate the preference for that
15 option. There is a risk that the assumptions made by Nalcor for load growth over
16 the very long period out to 2067, could be too high, or alternatively, too low
17 thereby either reducing or increasing the preference of the Interconnected Option
18 over the Isolated Island Option. Consumers in the Province therefore have a
19 vital interest in ensuring that the forecasts and various costs assumptions have
20 been developed using sound methodologies applicable to the circumstances. Put
21 simply, consumers need to know that the forecasts and assumptions relied upon
22 by Nalcor are reasonable.

23
24 At the hearing, MHI stated that:

25
26 **. . . Overall Nalcor’s inputs, for example the capital cost estimates,**
27 **fuel price forecasts and load forecasts into the CPW were developed**
28 **in accordance with the utility best practices. [Transcript, February**
29 **15, 2012, p. 163]**

30
31 The Consumer Advocate accepts and agrees with MHI’s judgment in this regard.

1 Beyond needing to know that the forecasts and assumptions relied upon by
2 Nalcor are reasonable, consumers need to know that the preferred option, based
3 on these assumptions and forecasts, can maintain its preference over the
4 Isolated Option once subjected to sensitivity testing.

5
6 With the Isolated Island Option, the key risks are world oil prices and
7 environmental costs associated with thermal electricity generation. Notably,
8 costs related to GHG emissions were not included in the CPW analysis. The
9 uncertainty around forecasting fuel prices is ever-present. If fuel prices decrease
10 by 44% below those used by Nalcor, the difference between the two CPW results
11 becomes neutral. Forecasts on the record in this review from Nalcor's oil price
12 forecaster, PIRA, as well as from respected sources such as the National Energy
13 Board and the U.S. Energy Information Administration all indicate that their
14 considered judgment is that oil prices will remain high for the foreseeable future.
15 However, risk works both ways. It is conceivable that oil prices will exceed those
16 reflected in the Reference Case, thereby increasing the preference for the
17 Interconnected Option. On the other hand, with the Interconnected Island Option
18 - the Muskrat – Labrador Island Link project - the major risk is construction
19 project risks. If capital costs estimates for both the Muskrat Falls Generating
20 Station and Labrador-Island Link were to be increased by 25%, the
21 Interconnected Option would still hold a \$1.2 billion dollar preference. If capital
22 costs for the Interconnected Option increased by 50% over DG2 estimates its
23 preference would be reduced from \$2.158 billion to \$200 million. However,
24 unlike oil price risk, construction risks can be potentially managed or mitigated
25 through prudent planning and "front end loading" the technical and engineering
26 effort prior to undertaking the project. These efforts were addressed in Nalcor's
27 Submission and at the hearing and are discussed later in this submission. To be
28 sure, the risks cannot be eliminated, however. In addition, there is risk
29 associated with the load forecast such that if there were to be any large changes
30 in load, it would have a significant impact on the cumulative present worth
31 analysis used to compare the two Options.

1 The sensitivity tests carried out by MHI in its report in relation to load forecasts,
2 fuel price forecasts and construction costs show that the Interconnected Option
3 continues to maintain a margin of preference over the Isolated Option.

4 At the hearing before the Board, Nalcor's President and CEO, Ed Martin, referred
5 to the fact that the Government of Newfoundland and Labrador has come to an
6 agreement with the Government of Canada whereby Canada has agreed to
7 provide a loan guarantee in relation to the Muskrat Falls-Labrador Island Link
8 project. This commitment was not in place at DG2 but its effect was analyzed in
9 Nalcor's CPW analysis in its Submission filed with the Board. The analysis
10 indicates that should the guarantee materialize, it would decrease the financing
11 costs of the project by approximately \$600 million in 2010 dollars. The
12 availability of the federal guarantee would increase the economic preference for
13 the interconnected option over the Isolated Island Option by 25% relative to the
14 Reference Case, bringing the margin of preference from \$2.2 billion to \$2.8
15 billion in 2010\$.

16

17 The recent closures of the paper mills in Stephenville and Grand Falls-Windsor
18 have allowed island customers to rely less on costly Holyrood- generated power
19 and energy over the past few years than would have otherwise been the case.
20 The closure of these mills also had the effect of delaying the need to bring on
21 additional generation to meet the island's demand and energy requirements.
22 The need was delayed, but not eliminated. It remains that by 2015 continued
23 growth of the island's utility demand, combined with the demand and energy
24 requirements for Vale's new nickel processing facility, will offset the decline
25 experienced in the island load due to the mill closures. Capacity deficits trigger
26 the need for the next generation source by 2015. Energy deficits are forecasted
27 in 2020.

28

29 Vale's forecasted annual energy consumption in three years time in 2015 of 585
30 GWhs translates into an additional 928,000 barrels of fuel consumed at
31 Holyrood. By 2016, when production further ramps up with Vale forecasted to

1 require 727 GWhs, the additional amount of oil burned at Holyrood is forecast to
2 be 1,154,000 barrels. (CA/KPL-Nalcor-106) If the Holyrood plant remains in
3 operation, in 20 years time Nalcor estimates that Holyrood will be burning an
4 average of about 3.6 million barrels of heavy fuel oil a year, at a projected cost of
5 about \$150 per barrel which is approximately \$550 million annually (Exhibit 99, p.
6 24 of 72).

7
8 The Isolated Option involves increasing dependence on thermal sources of
9 energy, despite bringing on small hydro developments at Island Pond, Portland
10 Creek and Round Pond over the next decade. It also involves a Government
11 mandate in the Energy Plan that costly environmental upgrades be undertaken at
12 Holyrood. Even if it were assumed that these upgrades and their associated
13 costs could somehow be avoided, the Interconnected Option still has a CPW
14 preference of \$1.816 billion (2010\$) over the Isolated Island Option. (CA/KPL-
15 Nalcor-74). In addition, it must be observed that the CPW analysis of Nalcor
16 does not reflect the potential environmental costs associated with thermal
17 electricity generation in the Isolated Island Option. MHI states in its report that
18 *“Greenhouse gas emission standards are likely to be set by the Federal*
19 *Government and as such pose a risk to the ongoing operation of HTGS*
20 *[Holyrood] as a generator.”* (Vol. II, p. 171). MHI stated further, *“It is also noted,*
21 *that while no consideration has been given to carbon pricing in either option, the*
22 *impact of any future value of carbon credits will be more significant on the*
23 *Isolated Island Option, which will lead to increasing the differential between the*
24 *two Options.”* (Vol. I, p. 87) In the Consumer Advocate’s assessment, these
25 risks cannot be ignored.

26
27 The Consumer Advocate accepts MHI’s determination that Nalcor’s cumulative
28 present worth analysis for the two Options was completed using recognized best
29 practices and that the cumulative present worth for each option was correct
30 based on the inputs used by Nalcor.

31

1 The Consumer Advocate accepts MHI's determination based upon its technical
2 and financial analysis that the inputs used by Nalcor were generally found to be
3 appropriate.

4 The Consumer Advocate agrees with MHI's finding that the Muskrat Falls
5 Generating Station and the Labrador Island Link HVdc projects represent the
6 least cost option of the two alternatives, when considered together with the
7 underlying assumptions and inputs provided by Nalcor.

1 Manitoba Hydro International

2
3 The Board of Commissioners of Public Utilities is an independent, expert tribunal
4 in the area of electrical utility regulation. Upon being referred the Reference
5 Question, the Board issued a Request for Proposals for expert consultants to
6 assist and advise the Board. The Request for Proposals in the judgment of the
7 Consumer Advocate was comprehensive and appropriate given the Reference
8 Question. The Board subsequently retained Manitoba Hydro International Inc.
9 (MHI) to act as the Board's independent consultants for the purpose of carrying
10 out the technical inquiries relevant to answering the Reference Question. The
11 Consumer Advocate is satisfied that MHI was possessed of the technical skill
12 and/or had access to the outside technical capabilities necessary to inquire into
13 and address the Reference Question in a competent manner.

14
15 MHI provides consulting services to power utilities, governments, and private
16 sector clients worldwide to assist them in the delivery of electricity efficiently,
17 effectively and in a sustainable manner. MHI has provided utility infrastructure
18 management, consulting, and training services to over 60 countries.

19
20 The Consumer Advocate is satisfied that the team of technical and financial
21 experts assembled by MHI to undertake the required reviews and analyses have
22 the expertise, training and experience to do so. The team members are
23 experienced in the design of hydroelectric plants, operation and maintenance of
24 HVdc systems, design and maintenance of thermal plants, transmission line
25 design, transmission system planning and operations, commercial utility
26 operations, load forecasting, and financial management and modeling. Outside
27 expertise was contracted to review the details of the engineering, construction,
28 and operation and maintenance of the Strait of Belle Isle crossing.

1 CPW Analysis

2
3 At the heart of the reference question before the Board is which of the two options
4 presented is least cost. Nalcor's least cost analysis is based on a Cumulative Present
5 Worth (CMW) methodology. In this case, CPW is the present value of all incremental
6 utility capital and operating costs incurred by Newfoundland and Labrador Hydro to
7 reliably meet a specific load forecast given a prescribed set of reliability criteria. Where
8 the cost of one alternative supply future for the grid has a lower CPW than another, the
9 option with the lower CPW will be recommended, consistent with the provision of
10 mandated least cost electricity service.

11
12 Using the CPW methodology, MHI states that the detailed analysis performed by MHI
13 determined that Nalcor's cumulative present worth analysis was completed using
14 recognized best practices and the cumulative present worth for each option was correct
15 based on the inputs used by Nalcor. Notably, in respect of the inputs used by Nalcor,
16 MHI states, ". . . *[T]hese inputs were reviewed in the technical and financial analysis*
17 *conducted by MHI and were generally found to be appropriate.*"

18
19 The Consumer Advocate has reviewed the cumulative present worth analysis
20 undertaken by MHI as described in its report at section 7 of Volume I and as elaborated
21 upon in Chapter 12 of Volume II. MHI first addresses whether the CPW methodology is
22 appropriate to be used in answering the question which of the Muskrat Falls (LIL) or the
23 Isolated Island Options is the least cost of the two options excluding the monetization of
24 the excess power from the Muskrat Falls generating facility. MHI states that this
25 methodology is generally accepted as a methodology for comparing mutually exclusive
26 alternatives, as long as there is a fixed output or an objective that is common to both
27 alternatives, noting that in this case the fixed objective is to meet the projected load
28 forecast, assuming the same level of service and reliability targets for each of the two
29 options. MHI is satisfied that the CPW approach used by Nalcor is reasonable for the
30 purpose intended.

31
32 MHI considers the use by Nalcor of a Power Purchase Agreement (PPA) in relation to
33 the Muskrat Falls generating facility (as opposed to Cost of Service) and whether this
34 has any bearing on the resulting impacts on the CPW for each of the two Options. MHI's

1 analysis (Volume II, Table 29) demonstrates that the CPW sensitivity to capital cost
2 methodology is not significant.

3
4 MHI reviews the appropriateness of Nalcor's choice of a discount rate to convert future
5 dollar costs to a present value. Nalcor used a discount rate that is equal to its weighted
6 average cost of capital (WACC), based on a target 75:25 debt/equity ratio. MHI's review
7 is appropriate given that the choice of an appropriate discount rate may impact the
8 results of the CPW analysis. MHI concludes that Nalcor's use of its 8% WACC as a
9 proxy for the discount rate is acceptable for the purposes of making a determination of
10 the comparable CPW for each of the two Options.

11
12 MHI considers the time horizon for the CPW analysis of 2010 to 2067 and concludes
13 that the time horizon is reasonable recognizing that the Muskrat Falls generating facility
14 and the Labrador-Island Link HVdc system are the dominant capital related investments
15 under review and their expected life spans are 60 and 50 years respectively from the
16 date of commissioning in 2017. At the hearing, MHI was asked whether the length of the
17 study period produces a mathematical bias in favour of one option over the other. MHI
18 confirmed that it did not, and emphasized the importance that the study period "*be*
19 *extended to the full life of the significant assets and those being Muskrat Falls and LIL.*"

20
21 MHI also reviews each of the Infeed and Isolated Options and states that the both the
22 Infeed and the Isolated Island Options represent the least cost-sequence of new
23 generation capacity from the two pre-defined sets of generation options for the island of
24 Newfoundland using standard Newfoundland and Labrador Hydro service parameters
25 and the current load forecast for the island. The generation facilities which come on-
26 stream for each of the two Options over the period to 2067 were itemized in Nalcor's
27 2010 PLF Strategist Generation Expansion Plan with sequencing determined by Nalcor
28 using Strategist system planning software. MHI states, "*The 'least cost' generation*
29 *expansion plan is the sequence selected by the software which results in the minimum*
30 *CPW, while still meeting all required service and load/energy constraints.*" (Vol. II, p.
31 190). MHI's report states, "*Nalcor has an exhaustive process for reviewing generation*
32 *options that is in keeping with leading North American Utilities. The Strategist software*
33 *used by Nalcor to evaluate and select a preferred generation development scheme is*
34 *appropriate.*" (Vol. I, p. 8).

1 As regards capital costs, MHI states that the actual cash costs for all new generation
2 and transmission capacity investments do not flow directly into the CPW analysis at the
3 time they are incurred. Muskrat Falls capital costs have been included in the CPW
4 through a PPA tariff while the remaining costs have been included in the CPW on a Cost
5 of Service basis. The construction and operating costs associated with the capacity
6 plans for each of the options are based on estimates that were developed by different
7 means and at different times. Considering the target level of accuracy for DG2
8 threshold, MHI reports that Nalcor has either taken cost estimates from past engineering
9 studies and escalated them to January 2010\$, or they have re-established a recent
10 estimate based on current costs as of January 2010\$. The base dollar values for all
11 monetary figures used in the CPW analysis are January 2010\$.

12

13 MHI's report states that the capital and operating costs of each option were examined for
14 reasonableness, recognizing, as noted above, that in some cases it was necessary to
15 escalate costs forward from previous years.

16

17 MHI's Cumulative Present Worth Analysis also considers the impacts of: fuel inventory,
18 asset life, depreciation expense, regulatory return on assets, insurance, thermal heat
19 rates, purchased power, operating costs, Upper Churchill power, fuel costs and HVdc
20 system losses.

21

22 The Consumer Advocate considers the analysis of MHI to be systematic and
23 appropriately thorough. The Consumer Advocate accepts MHI's findings that Nalcor's
24 cumulative present worth analysis was completed using recognized best practices and
25 the cumulative present worth for each option was correct based on the inputs used by
26 Nalcor. The inputs in the CPW analysis results in the Isolated Island Option having a
27 (2010\$) CPW of \$8.81 billion with the Interconnected Option at \$6.652 billion, giving rise
28 to a \$2.158 billion (2010\$) preference in favour of the Interconnected Option. The
29 Consumer Advocate also accepts MHI's findings that the inputs used by Nalcor were
30 reviewed and generally found to be appropriate.

31

32 The Consumer Advocate notes that MHI's report indicates that there are however other
33 considerations related to risks associated with the assumptions used for certain key
34 inputs such as load, fuel prices and cost estimates which may impact the cumulative

1 present worth analysis for the two options. These assumptions were tested by MHI with
 2 the use of several sensitivity analysis. The Consumer Advocate concurs with MHI that
 3 there are considerations related to risks associated with the assumptions used for these
 4 key inputs which may impact the cumulative present worth analysis for the two options.
 5 The table below is the CPW Sensitivity Analysis Summary found at page 87 in MHI's
 6 report:
 7

	Sensitivity Summary	Isolated Island Option	Infeed Option	Differenc e
1	Base case	\$8,810	\$6,652	\$2,158
2	Annual load decreased by 880 GWh	\$6,625	\$6,217	\$408
3	Fuel costs: PIRA's low price forecast	\$6,221	\$6,100	\$120
4	Fuel price reduced by 44% from base case	\$6,134	\$6,134	\$0
5	Labrador-Island Link capital cost increased by 25%	\$8,810	\$7,050	\$1,760
6	Muskrat Falls GS capital cost increased by 25%	\$8,810	\$7,229	\$1,581
7	Muskrat Falls GS and Labrador-Island HVdc Link capital cost increase by 25%	\$8,810	\$7,627	\$1,183
8	Labrador-Island HVdc Link and Muskrat Falls capital cost increased by 50%	\$8,810	\$8,616	\$194
9	Scenario with <ul style="list-style-type: none"> • Fuel cost decreased 20% • Annual load growth decreased of 20% • Capital cost increased for Muskrat Falls GS and Labrador-Island HVdc Link by 20% 	\$7,037	\$6,878	\$159
10	Scenario with <ul style="list-style-type: none"> • Annual load decreased by 880 GWh • Muskrat falls GS and Labrador-Island HVdc Link Capital cost increased by 10% 	\$6,625	\$6,598	\$27

8 The Consumer Advocate will address the key inputs of Load, Fuel Prices and Cost
 9 Estimates in the next sections.

Load Forecast

The load forecast predicts future electrical energy (GWh) and demand (MW) requirements, and is a critical factor in developing and evaluating future generation options.

In order to undertake a valid analysis comparing the two options on a CPW basis, it is necessary to examine the period to the end of the life of the assets associated with Muskrat Falls and the Labrador Island Link. Making forecasts as to load over an extended period of time is inherently an uncertain matter.

Nalcor's 2010 planning load forecast (as weather adjusted, i.e. to be representative of normal weather) covers the period 2010 to 2029. To support the CPW analysis, the load forecast was extended over the 2029-2067 period using an extrapolation of the last five forecast (2024-2029) years. The extrapolation was then reduced in five to ten year intervals to reflect the maturing market saturation for electric space heat. Whereas over the last 40 years, domestic energy growth per year averaged 78 GWh, and over the last 10 years averaged 62 GWh, over the period 2010-2029 domestic energy growth is expected to be considerably less at 38 GWhs annually. [MHI, Vol. II, Table 1]. As MHI noted, this is the result of lower electric space heat growth, higher marginal electricity prices and continued efficiency improvement. On a kWh per customer basis, domestic average use growth is forecast to reduce considerably from 106 kWh per customer per year over the last 10 years to 19 kWhs per customer per year over the 2010-2029 period. Housing starts are also expected to decline significantly over the period from 2010-2029 relative to the last 10 years and the last 40 years respectively.

MHI completed a comprehensive analysis of NLH's load forecasting methods, data sources, and data analysis. Results of the extrapolated forecast were reviewed only in the total island energy requirements and interconnected island

1 system peak. The load forecasting process was evaluated using criteria that
2 examined the reasonableness of the methodologies and assumptions used to
3 prepare the 2010 Planning Load Forecast. Past forecast performance was
4 measured by examining the accuracy of the last 10 forecasts prepared by NLH.

5
6 At section 3.1.4 of Vol. I, MHI made the following Load Forecast key findings:

7 8 **3.1.4 Load Forecast Key Findings**

9
10 **A detailed analysis of load forecasting practices, methodologies and**
11 **results has led to the following key findings:**

- 12
13 **1. The load forecasting process is conducted with due diligence,**
14 **skill and care and meets acceptable utility practices with the**
15 **exception that end-use modelling techniques for domestic**
16 **loads are not currently employed.**
- 17
18 **2. The load forecasting process has produced reasonable results**
19 **for the domestic and line loss sectors, excellent results for the**
20 **general service sector, and very poor results for the industrial**
21 **sector. The industrial sector has adversely affected the overall**
22 **energy and peak forecast results. In hindsight, if the pulp and**
23 **paper mill closures were accurately forecasted, the energy and**
24 **peak forecasts would have been excellent.**
- 25
26 **3. The domestic sector forecast consistently under predicts**
27 **future energy needs at a rate of 1% per future year. Although**
28 **the magnitude of the forecast error is acceptable, the**
29 **frequency of under predicting energy consumption is a**
30 **concern. The domestic forecasting process is inherently**
31 **biased towards under predicting energy consumption.**
- 32
33 **4. In the next ten years, the load forecast performance should**
34 **produce good results, if the remaining pulp and paper mill**
35 **remains operational. The forecast may slightly under predict**
36 **electricity requirements because of a relatively conservative**
37 **domestic forecast and an upward revision of 90 GWh for the**
38 **Vale expansion (not included in the forecast being reviewed).**

1 **Conversely, the load forecast will significantly over predict**
2 **electricity requirements, if the remaining pulp and paper mill**
3 **closes.**

- 4
- 5 **5. In the long term, if the remaining pulp and paper mill stays**
6 **operational, the load forecast is likely to under predict future**
7 **requirements because the domestic forecast is relatively**
8 **conservative and the industrial forecast does not include any**
9 **new loads for the study period.**

10

11 The matter of CDM in relation to the load forecast received attention at the
12 hearing, and was raised by some presenters. MHI observed (CA-KPL/MHI-03)
13 that conservation effects can be classified into two groups: naturally occurring
14 conservation and incentive based conservation. Naturally-occurring conservation
15 results from improved appliance energy-efficiency standards, improved building
16 standards, retrofit improvements and consumer behaviour changes. Incentive-
17 based conservation results from utility sponsored CDM Programs. As noted by
18 MHI, Newfoundland and Labrador Hydro and Newfoundland Power has had
19 limited success with CDM programs and to date the response to CDM program
20 and initiatives has been modest and lagging the utilities' targets (Exhibit 101, p.
21 42-43 of 79). MHI observes that Nalcor's load forecast assumes that the
22 technological change variable is expected to remain constant over the forecast
23 period meaning that naturally-occurring conservation will remain at a steady rate,
24 similar to the past. MHI has termed this assumption as being very conservative
25 and one that leads to a forecast that is lower for the domestic and general
26 service sectors for the reason that naturally occurring conservation may be more
27 difficult to achieve as the most cost-effective conservation practices have already
28 been adopted.

29

30 MHI also observes that while naturally occurring conservation should be included
31 in the load forecast, CDM program conservation should not be included in the
32 load forecast, as the energy savings associated with varying levels of CDM

1 investments should be included as a supply side option, so CDM investments
2 can be evaluated on an equivalent basis to other generation supply options.

3
4 In terms of the CPW analysis, MHI observes that varying levels of CDM
5 investment could have a significant cumulative effect on load, but “only a
6 marginal effect on the CPW analysis.” (CA/KPL-MHI-08) MHI references
7 Nalcor’s sensitivity analysis in Nalcor’s Submission that shows that moderate
8 conservation efforts leading to a reduction of 375 GWhs by 2031 would still
9 maintain a \$1.7 billion preference for the Interconnected Option, while
10 considerably more aggressive efforts leading to a reduction of 750 GWhs by
11 2031 would still maintain a \$1.3 billion preference for the Interconnected Option
12 over the Isolated Island Option.

13
14 Clearly, the longer the load forecast horizon, the more fraught with uncertainty is
15 the load forecast. There are legitimate questions around the aging nature of the
16 population and how that may impact energy demand in future decades of the
17 study period. There is certainly risk that the load forecast and extrapolation for
18 the period beyond 2029 could be too high.

19
20 One of the CPW sensitivity tests carried out by Nalcor tested for the sensitivity of
21 its CPW model for the parameter of the accuracy of the load forecast. The test
22 carried out essentially asked the question, what if Nalcor’s load growth
23 assumptions were too high and in fact load growth was just one-half of that
24 reflected in the Reference Case? The answer was that, all other things being
25 equal, such a loss in load would reduce but not eliminate the preference for
26 Muskrat. Muskrat would still have a preference of approximately three-quarters
27 of a billion dollars over the Isolated Island Option (Nalcor Submission, p. 126 of
28 158, Revision 1). This question and its answer are interesting because of its
29 illustrative value. It illustrates that if we experienced long-term load growth of just
30 50% of forecast for each and every year out to the year 2067, the Interconnected
31 Option still has a sizeable economic preference.

1 The aspect of the load forecast that MHI highlights quite clearly is the industrial
2 load forecast. MHI has noted that the industrial forecast is prepared on an
3 individual, case-by-case basis, with direct customer contact concerning future
4 operational plans. According to MHI, this methodology is reasonable considering
5 the small industrial customer base on the island, but in hindsight, the assumption
6 of continued operation of two pulp and paper mills was too optimistic. MHI
7 states, *“the assumption of continued operation of the one remaining pulp and*
8 *paper mill throughout the forecast horizon is optimistic and the assumption of no*
9 *new industrial load after 2015 is pessimistic. The amount of variability due to*
10 *potential load changes is high and could materially impact the results of the*
11 *cumulative present worth analysis.”* (MHI, Vol. I, p. 8).

12

13 To illustrate, if there were to be a loss of load of 880 GWhs commencing in 2013
14 and carrying forward, the preference for the Infeed Option, holding constant all
15 other parameters in the Reference Case, would be reduced to \$400,000,000 in
16 2010 dollars. The effect of such a loss of load in 2013 (and carried forward)
17 would mean that 880 GWhs of NLH’s marginal production could be met by
18 cheaper hydroelectric resources rather than expensive oil fired generation. This
19 particular sensitivity test scenario would see the CPW of the Isolated Island
20 Option decrease from \$8.8 billion to \$6.6 billion while the CPW of the
21 Interconnected Option would decrease from \$6.65 billion to \$6.2 billion. The
22 latter decrease reflects the fact that the Reference Case for the Interconnected
23 Island Option has the island burning oil at Holyrood through to 2017. [Reference:
24 Nalcor Submission, p. 128; Transcript – February 13, 2012].

25

26 Nalcor’s reply to PUB-51 indicates that accounting for capacity effects of the
27 annual decrease of 140 MW together with 880 GWhs of load would yield a
28 preference of \$545 million (\$2010) for the Infeed option over the Isolated Island
29 alternative. Nalcor states in the reply that the load decrease does not change the
30 annual power purchase payment for energy over the infeed and *that “Any*

1 *benefits derived through sales of excess energy have not been factored into the*
2 *result.*” This is in keeping with the Terms of Reference of this review.

3
4 At the hearing, Nalcor indicated that if the assumed loss of 880 GWhs of demand
5 were made specific to the situation of the Corner Brook mill, and it were assumed
6 that the mill’s generation source at Deer Lake were to be available to the grid, an
7 important consideration is that that power is not zero cost power and has to be
8 acquired and paid for, thereby increasing the preference for the infeed case.

9 [Transcript – February 13, 2012, p. 235].

10
11 A sudden loss of a 880 GWh in 2013 would give rise to a large gap created
12 between excess supply and demand. Assuming that the grid also had a capacity
13 of 125 MW would push out the next capacity defect to 2023 and the next energy
14 deficit to 2030 (Transcript, February 15, 2012, p. 99). MHI noted that a potential
15 method to improve the industrial forecast accuracy would be to assign a
16 probability of operation to the large industrial loads. The probability could
17 increase or decrease over time, depending on the likelihood of expansion or
18 contraction of business operations in the future. MHI notes however that this
19 may be *“difficult to implement given the limited size of the industrial customer*
20 *base.”* At the hearing, Nalcor’s Mr. Gilbert Bennett addressed the Corner Brook
21 mill in the context of the industrial load forecast as follows:

22
23 **I think that the facility is in operation, existing facility, they’re**
24 **continuing to run their business, so that’s one aspect, that’s one**
25 **aspect of the industrial forecast. The other forecast of the industrial**
26 **forecast is we did not forecast any additions to industrial demand in**
27 **the form of new customers, so with the information that’s available**
28 **to us, we have a customer who has signalled to us that they’re**
29 **continuing to operate their business, so I have difficulty forecasting**
30 **that that mill is going to disappear, I mean, that action of itself has**
31 **significant consequences and that’s something that we have no**
32 **basis to do. We have the customer there, they’re in operations and I**
33 **think the best way to address, you know, those kinds of potential**
34 **changes in demands is using the method that we did, through a**

1 **sensitivity analysis to test what would happen if in the long term any**
2 **of the forecasts were to vary, so as we can come at it that way from a**
3 **probabilistic perspective and just see what the impacts are, as**
4 **opposed to identifying, you know, the future of a particular individual**
5 **customer in our forecast. (Transcript, February 15, 2012, p. 226-7)**
6

7 MHI's Mr. Snyder commented on the assumption of there being no more
8 additional industrial demand in the form of new customers at the hearing. He
9 stated, "*I feel that 50 years into the future – no more major industrial, I can't*
10 *believe that.*" (Transcript, February 15, 2012, p. 221) The Consumer Advocate
11 shares the view that this assumption is conservative, if not pessimistic.
12

13 MHI stated at the hearing that if a utility believed that it is dealing with an
14 industrial customer that is reasonable and rational in their approach as to what
15 their load would be and they indicate that they are going to carry on operations,
16 the utility accepts that and assumes they are in fact going to be in operation.
17 [Transcript – February 15, 2012, pp. 223-224]. However, as there is risk around
18 load assumptions, the sensitivity testing is valuable.
19

20 If one were to assume a sensitivity scenario involving an annual load decrease of
21 880 GWhs commencing in 2013 and continuing onward, in combination with
22 capital cost increases of 10% on the Muskrat Falls and Labrador-Island Link, the
23 preference for the infeed option would be practically eliminated. [MHI, Vol. II,
24 Table 42]. If the loss of load were to happen in connection with cost over-runs
25 exceeding 10%, the Isolated Island option would be preferred. Given the
26 sensitivity of the load loss on the CPW, particularly in combination with potential
27 variations in fuel price and capital cost estimates, MHI stated that they
28 considered it imperative that Nalcor obtain as much understanding as possible
29 regarding the future prospects for the continued operation of its industrial
30 customers and in addition, develop contingency plans to address the implications
31 of restrictions in industrial loads. The Consumer Advocate would concur.

Fuel Price Forecasts

1
2
3 In order to undertake a valid analysis comparing the two Options on a CPW
4 basis, it is necessary to examine the period to the end of the life of the assets
5 associated with Muskrat Falls and the Labrador Island Link. However, there are
6 no oil price forecasts that extend for such a long period. Since 1999, Nalcor has
7 utilized the service of the PIRA Energy Group of New York for its fuel price
8 forecasts for No. 6 fuel oil and diesel fuel. PIRA is an international supplier of
9 energy market analysis and forecasts. PIRA energy Group's website
10 (www.pira.com) states:

11
12 **PIRA Energy Group, founded in 1976, is an international energy**
13 **consulting firm specializing in global energy market analysis and**
14 **intelligence. PIRA's Retainer Client Services are renowned for their**
15 **comprehensive research and commercial analysis of biofuels, coal,**
16 **electricity, emissions and freight markets. PIRA also offers multi-client**
17 **studies, training programs, and project consulting services that present**
18 **an unparalleled knowledge of markets and keen commercial insight.**
19 **This full range of services provides exceptional coverage of key U.S.**
20 **and global energy issues that impact the behavior and performance of**
21 **energy markets.**
22

23 PIRA's website states that it has 500 companies as clients from over 65
24 countries. Amongst the sectors represented in PIRA's client base are:

- 25
- 26 • Oil and gas companies of all sizes – small independents, national oil
 - 27 companies, and multi-national majors
 - 28 • Refiners
 - 29 • Trading companies
 - 30 • Pipeline companies
 - 31 • Utilities
 - 32 • Energy marketing and distribution companies
 - 33 • Government institutions
 - 34 • Chemical, ammonia and fertilizer companies
 - 35 • Other manufactures and industrial end-users of energy
 - 36 • Airlines
 - 37 • Investment banks

- 1 • Hedge funds
- 2 • Mutual funds
- 3 • Energy bankers and financiers
- 4 • Asset managers

5

6 PIRA has supplied a forecast dated January 2010 and extending out to 2025.
7 Beyond 2025, pricing is forecast at an annual inflation rate of 2%. At the hearing,
8 MHI stated that this was a reasonable approach (Transcript, February 15, 2012,
9 p. 211-2). Nalcor has indicated that for DG3 purposes, it expects to continue to
10 rely on PIRA's energy market analysis and related price forecasts (CA/KPL-
11 Nalcor-47). Nalcor has indicated that it plans to prepare a high and low thermal
12 price projection for Sensitivity Analysis based on the PIRA price forecast used for
13 the DG3 analysis.

14

15 Pursuant to Nalcor's license agreement for retainer services with PIRA Energy
16 Group, Nalcor is prohibited from releasing PIRA's proprietary content within the
17 public domain. However, pursuant to the Terms of Reference, the Board and
18 MHI had access on a confidential basis to the PIRA fuel price forecasts used by
19 Nalcor. Nalcor has provided a comparison of the PIRA, National Energy Board
20 (NEB) and the U.S. Energy Information Administration (EIA) forecasts to the
21 Board as Confidential Exhibits CE-69 (CA/KPL-Nalcor-53). The NEB and EIA
22 Forecasts are filed as Exhibits 118 and 117 respectively and confirm their
23 expectation that oil prices will remain high for the foreseeable future.

24

25 MHI conducted a sensitivity analysis on the potential fluctuation of fuel costs
26 beyond 2025. MHI reported that changing the long-term price inflator by + or -
27 1% relative to the 2% used by Nalcor has a minimal effect on the CPW, for the
28 reason that the escalation is so far into the future that discounting minimizes the
29 impact.

30

31 The Consumer Advocate agrees with MHI that there is uncertainty related to the
32 pricing of fuel for thermal-based power generation. Forecasts, as noted by MHI,

1 can have a short shelf life. There is evidence as well of retrospective studies that
2 demonstrate that there have been periods when certain forecasts were
3 dramatically too high for several years and then quite considerably too low for
4 several years (G.R.K. No. 6). The Consumer Advocate would observe that there
5 will be ample opportunity over a 50-plus year horizon for forecasts to be proven
6 in retrospect to have been either considerably too low or too high for prolonged
7 periods of time.

8
9 The future behaviour of world oil markets not only is a key risk, it is an
10 uncontrollable risk. It is the key driver of the difference between the CPWs of the
11 two options. In 2010 dollars the Reference Case puts the cost of fossil fuels
12 under the Isolated Island Option above 6 billion dollars (Submission, p. 108,
13 Table 23; p.124, Table 28). Of the overall \$8.8 billion (2010\$) CPW of the
14 Isolated Island Option, nearly 69% (or \$6 billion) of that cost is the cost of fossil
15 fuels. That is in spite of bringing on 25 MW of wind in 2014, 36 MW of hydro
16 from Island Pond in 2015, 23 MW of hydro from Portland Creek in 2018, and 18
17 MW of hydro from Round Pond in 2020. The development of indigenous
18 renewable resources on the island does not avoid a progressive dependence on
19 thermal energy for the island portion of the province. Indeed it is notable that
20 under the Interconnected Option, Nalcor's analysis indicates that some \$1.2
21 billion in 2010 dollars (Submission, p.124, Table 28) will be incurred for fossil fuel
22 purchases with these thermal fuel expenses being predominately incurred prior
23 to the full commissioning of Muskrat Falls in 2017.

24
25 As a mathematical matter, it is possible to construct scenarios involving changed
26 parameters that would tip the scales in favour of one scenario or the other. Such
27 mathematically constructed scenarios are useful for illustrative purposes, for
28 instance, to show the magnitude of change required in a variable in order to tip
29 the balance in favour of the other option. According to Nalcor's CPW Sensitivity
30 Analysis (Submission; p. 126, Table 1), the oil prices experienced over the study
31 period would have to approximate PIRA's low world oil forecast to eliminate the

1 preference for the Interconnected Option. If this were to occur, all other things
2 being as assumed in the Reference Case, the Interconnected Option would
3 retain just a 120 million dollar (2010\$) preference over the Isolated option.
4 According to Nalcor's reply to MHI in MHI-Nalcor-131, which cites PIRA Energy's
5 SPS Annual Guidebook 2011, the Reference Case forecast represents PIRA's
6 most likely view of how the energy markets will evolve with the Reference Case
7 being, according to PIRA, *'not just one of many plausible scenarios but one that*
8 *(PIRA) puts forward as a most likely basis for decision-making'*. MHI notes that it
9 would require fuel prices to decrease by 44% below those used by Nalcor in
10 order for the difference between the two cumulative present worth results
11 become neutral. (MHI, Vol.II, p. 208) It is certainly possible to conceive of oil
12 prices decreasing to the point and for such an extended duration, that the
13 preference for Muskrat could be eliminated and even reversed. The recent long-
14 term forecasts on the record in this proceeding including from PIRA, the IEA and
15 the National Energy Board, all say that their best judgment is that oil prices will
16 remain high for the foreseeable future. Of course, these entities' forecasts may
17 well not be proven correct over the long run but the report of MHI confirms that
18 when subjected to sensitivity tests in relation to oil price, the Interconnected
19 Option continues to maintain a margin of preference over a range of assumed oil
20 prices.

21
22 Certainly, risk works both ways. It is conceivable that oil prices will exceed those
23 that are reflected in the Reference Case. If PIRA's high world oil forecast were to
24 prevail, all other parameters being as assumed in the Reference Case, the
25 Interconnected Option's margin of preference would increase to nearly \$5.5
26 billion (2010\$) over the Isolated Option.

27
28 MHI is justified in observing:

29
30 **There remains significant uncertainty in fuel price forecasts. Global**
31 **disruptions in supply could drive the price of oil well above inflation.**
32 **However, new sources of supply, such as shale oil or downward**

1 **trends in natural gas pricing, may have the potential to minimize fuel**
2 **price decreases.**

3
4 At the presentations held on February 16, the Consumer Advocate asked MHI
5 whether there has ever been a time when the statement, *“there remains*
6 *significant uncertainty in fuel price forecasts”* has not been applicable. MHI
7 replied that there had never been such a time. If the absence of uncertainty in oil
8 price forecasts was required before advancing with capital spending, one would
9 observe little capital spending. The reality is that corporations have to make
10 investment decisions on the basis of less than certain information and upon
11 assumptions about the future grounded in the best available information. MHI
12 considers that Nalcor’s methodology of relying upon PIRA’s forecast out to 2025
13 and then assuming that 2025 price levels do not increase or decrease in real
14 terms thereafter to be a reasonable assumption as an input to the CPW analysis
15 (Transcript, February 16, p. 212). The Consumer Advocate concurs. It is also of
16 course true that the risks associated with oil price forecasts are magnified
17 considering the 50 plus year period used in the preparation of the cumulative
18 present worth analysis.

1 Capital Cost Estimates

2
3 To put the capital cost estimates utilized in this Review into perspective some
4 background is necessary.

5
6 Nalcor has employed a staged gate delivery process to determine if, and how,
7 the Lower Churchill Project should proceed. Nalcor's submission describes it as
8 follows:

9
10 **The Gateway Decision Process is a staged, or phased, decision gate**
11 **process used to guide the prudent planning and execution of a large**
12 **scale construction project for the identification of a business need**
13 **through to operations and eventually decommissioning.**
14

15 According to Nalcor, the Gateway Process has the following objectives:

- 16
- 17 • To provide a process to capture and utilize best value-adding potential;
 - 18 • To provide a mechanism for Nalcor Energy to verify readiness to move
19 from one phase to another in a systematic manner during the lifecycle of a
20 project;
 - 21 • To demonstrate that due diligence checks and balances are being applied
22 during the execution of the Project; and
 - 23 • To provide a means to pre-define "readiness" requirements for a project to
24 progress from one project phase to the next.
- 25

26 **Reference: Nalcor Submission, Vol. II, p. 32**

27
28 The Decision Gates contained with the Gateway Process are listed below:

- 29
- 30 • Decision Gate 1 – Approval to proceed with Concept Selection
 - 31 • Decision Gate 2 – Approval of Development Scenario and to Commence
32 Detailed Design

- 1 • Decision Gate 3 – Project Sanction
- 2 • Decision Gate 4 – Approval to Commence First Power Generation
- 3 • Decision Gate 5 – Approval to Commence Decommissioning

4

5 The owner of the Gateway Process is Nalcor’s CEO and President, Ed Martin.
 6 Implementation and stewardship of the process is delegated to the responsible Vice
 7 President, Gilbert Bennett. The Gatekeeper consults with Nalcor’s Board of Directors
 8 and seeks Shareholder (Government) alignment and approval.

9

10 The Nalcor Submission states,

11

12 **The use of formal Decision Gates facilitates decision-making by the**
 13 **Gatekeeper of the readiness of a project to move from one phase to the**
 14 **next, whereby the capital intensity of the phase increases. The Gatekeeper**
 15 **uses structured decision points, in consultation with Nalcor’s Board of**
 16 **Directors and in agreement with the Shareholder, to make appropriate**
 17 **decisions whether to:**

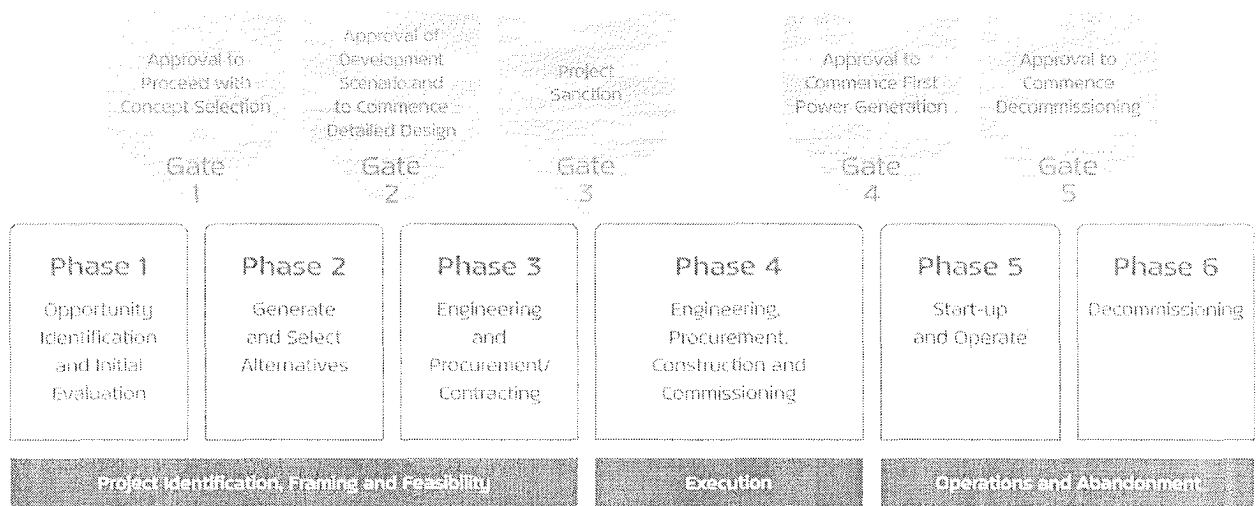
- 18 • **hold all activity pending receipt of some final clarifications or**
 19 **supporting information is received;**
- 20 • **move to the next sequential phase, or**
- 21 • **stop/terminate all activity to proceed to the next project phase.**

22

23 The following is an illustration from Nalcor’s Submission as regards the Decision Gate
 24 Process – Lower Churchill Project:

25 **Reference: Nalcor Submission, Vol. II, p. 35)**

Decision Gate Process - Lower Churchill Project



1 Nalcor describes the objective of Gateway Phase 2 – which culminated in the
2 DG2 decision in November, 2010, as follows:

3
4 **The objective of this Phase is to generate and evaluate a number of**
5 **development options from which a preferred option to develop the**
6 **business opportunity is selected. This Phase culminates at Decision**
7 **Gate 2, when approval is sought for the recommended development**
8 **option, the execution strategy, and initiation of detailed design. This**
9 **phase involves aboriginal negotiations, environmental assessment**
10 **processes, field work, power sales and access, financing strategy,**
11 **advanced engineering studies, early construction planning, and**
12 **economic analysis.**

13
14 In November of 2010, Nalcor determined the Muskrat Falls and the Labrador-
15 Island Transmission Link to be the least cost alternative to meeting the island's
16 long-term generation requirements. Nalcor states in its Submission:

17
18 **Decision Gate 2 was of strategic importance to the Project Team as it**
19 **signified that the development scenario, including phasing and**
20 **sequencing had been confirmed, and that the Project Team is ready**
21 **to move forward with further feasibility work, detailed engineering,**
22 **procurement and contracting to prepare to commence early**
23 **construction works following release from environmental**
24 **assessment.**

25
26 As at DG2 in November of 2010, the capital cost estimates that were used in the
27 CPW analysis were dated as August 13, 2010. The capital cost estimates will
28 evolve. MHI's report observes,

29
30 **Capital cost estimate evolve with improving accuracy as the level of**
31 **engineering progresses. Nalcor has adopted estimating practices of**
32 **the Association for the Advancement of Cost Engineering (AACE)**
33 **International for the Infeed Option. Nalcor considers the DG2 capital**
34 **cost estimate to be commensurate with an AACE Class 4 estimate**
35 **which is a feasibility estimate and has a range of accuracy of +50%**
36 **to -30%. The DG3 or project sanction capital cost estimate is**

1 **considered by Nalcor to be a Class 3 estimate with a range of**
2 **accuracy of +30% to -20%.**

3
4 **Reference: MHI Report, Vol. I, p. 7**

5
6 With the DG2 decision in November of 2010, the engineering and design work
7 ramped up. This marked the commencement of Phase 3 – Engineering,
8 Procurement and Contracting. The record indicates that Nalcor issued a request
9 for proposals and obtained bids from engineering contractors, undertook a
10 process of evaluation and selected SNC Lavalin as its Engineering, Procurement
11 and Construction Management consultant, culminating in the signing of a
12 contract with that firm in February of 2011. As at the time of the hearing before
13 the Board on February 13, 2012, Nalcor advised that SNC Lavalin has
14 approximately 220 persons in its St. John's office, while Nalcor has 130 persons
15 engaged in the project. The record indicates that significant technical work has
16 been ongoing since DG2. During the request for information process, Nalcor
17 indicated that between October 1 and December 31, 2011, it was estimating
18 expenditures on studies, analysis and reports including on the transmission link
19 to the island of \$33.7 million. [PUB-Nalcor-08, Rev. 1]. From August 1, 2011 to
20 DG3, Nalcor estimates that it will spend \$114 million over a spectrum of cost
21 categories.

22
23 At the hearing, Nalcor's Project Director for the Lower Churchill Project, Paul
24 Harrington, commented on the ongoing Phase 3 work:

25
26 **Phase 3, well we're working hard to get all of the information**
27 **together to be able to make that decision gate decision and within,**
28 **within this kind of phase, we're trying to get what is called a class 3**
29 **estimate and a class 3 estimate has a range of between 10 and 40**
30 **percent of project definition. So obviously the more project**
31 **definition you can get, the more accurate or narrower the range on**
32 **your accuracy for estimate that you will get. So currently all of those**

1 **folks are working towards to get all of the information together to be**
2 **able to come up with a capital cost estimate for DG3 of class 3.**

3
4 **Reference: Transcript – February 13, 2012, p. 97**

5
6 The accuracy range of cost estimates is largely a function of the degree of
7 project definition. As project definition increases, the range of accuracy of cost
8 estimates increases. During the hearing, Nalcor indicated that as at DG2, project
9 definition was in the range of 5% to 10% for the Muskrat Falls – Labrador Island
10 Link option and less than 5% for the Isolated Island option, noting that it was
11 more likely that capital costs associated with the Isolated Island Option would
12 increase, as opposed to decrease. Nalcor also stated that the normal project
13 definition range at DG3 is somewhere in the range of 10% to 40%. Nalcor's
14 Deputy Project Manager, Jason Kean, indicated that Nalcor's target is to be on
15 the *"upper side of the [project] definition [range] for a completion of a gateway*
16 *phase 3 work, such as to provide an estimate with the greatest accuracy as*
17 *possible."* (Transcript, February 13, 2012, pp. 101; February 14, 2012, pp. 130-
18 2)

19
20 MHI's report notes that the information provided by Nalcor and reviewed by MHI
21 was generally current as of the fall of 2010 and was used by Nalcor in making its
22 DG2 decision. MHI's report states,

23
24 **Nalcor did not generally provide information on the detailed**
25 **engineering or financial work completed after DG2. Thus the**
26 **findings in this Report related to project components and cost as of**
27 **DG2.**

28
29 At the hearing before the Board, the Consumer Advocate asked Nalcor to explain
30 why information post DG2 could not be made available to MHI for the purpose of
31 the review. Nalcor's Program Director, Mr. Harrington replied as follows:

1 **You know, we made every effort to respond to all of the information**
2 **requests to provide the information that we had available, but as you**
3 **can appreciate, you know, the large amount of work sometimes just**
4 **doesn't end up with a final report. There is ongoing activity where**
5 **multiple disciplines are involved as well, so we are not in a position,**
6 **even now, to actually provide you with a nice bound set of there are**
7 **some final reports. It's ongoing work and just an example of the**
8 **complexity of the estimate that's being put together, there are**
9 **approximately 50,000 line items with over 100,000 date (*sic*) points,**
10 **so all of that information is coming together. So, you know, we've**
11 **provided as much information as was available to us.**

12
13 **Reference: Transcript: February 13, 2012, p. 104**

14
15 Nalcor further indicated at the hearing that its current target date to have all of
16 the information in place for a DG3 decision is June of 2012.

17
18 As MHI has stated, its findings relative to project components and costs as of
19 DG2. Likewise, of course, the Consumer Advocate can only comment on project
20 components and costs as of DG2, the time at which approval was given to the
21 Muskrat Falls – Labrador Island Link development scenario and to proceed with
22 commencement of detailed design.

23
24 Pursuant to the Terms of Reference for the review, the Board and its advisors
25 had access to Nalcor's confidential information as regards project costing and
26 schedule that was deemed by Nalcor pursuant to the terms of the Energy
27 Corporation Act to be commercially sensitive and/or proprietary in nature. Such
28 confidential information was not released to the Consumer Advocate or his
29 advisors. Accordingly, the Consumer Advocate and his advisors were not able to
30 undertake a detailed review of Nalcor's capital cost estimates in the fashion
31 permitted of the Board and its advisors. This limitation practically means that the
32 Consumer Advocate must rely upon the Board's and its advisors' analyses of
33 Nalcor's detailed cost estimates as at DG2. The Consumer Advocate is satisfied

1 that MHI's methodology and approach to its review of Nalcor's cost estimates as
 2 outlined in its report are reasonable for the purposes of this review.
 3 The following (from Exhibit 101, p. 44 of 79) provides the DG2 Base Cost
 4 Estimates for the various components of the Muskrat Falls and Labrador-Island
 5 Transmission Link:

Component	DG2 Base Estimate (Direct 2010 US millions CAD)
Muskrat Falls	
Site Preparation, Access, Accommodations Complex, Site Services and Catering and Reservoir Clearing	\$373
Intake, Powerhouse, Turbines and Generators	\$923
Spillway Structure, RCC Dams (North & South), Cofferdams, and North Spur Stabilization	\$274
Switchyards and MF to CF Transmission Lines	\$261
Feasibility Studies, EA, Insurance, Engineering & Design, Project Management	\$375
Muskrat Falls Total	\$2,206
Labrador-Island Transmission Link	
Converter Stations, Electrodes and Switchyards	\$466
SOBI Cable Crossing, Land Sites and Transition Compounds	\$324
HVdc Overland Transmission	\$400
Island System Upgrades	\$194
Feasibility Studies, EA, Insurance, Engineering & Design, Project Management	\$232
Labrador-Island Transmission Link Total	\$1,616
Grand Total	\$3,822

1 To these base cost estimates, Nalcor adds a contingency allowance and
 2 escalation allowance. Table 2 from Nalcor’s Submission (Vol. II, p. 71 of 92)
 3 provides a summary of the Muskrat Falls and Labrador Island Link capital cost
 4 estimate, including an Estimate contingency and Escalation Allowance. For ease
 5 of reference it is set out below:

Project	Base Estimate	Historical Cost (pre 2010)	Adjusted Base Cost (Base Cost - Historical)	Estimate Contingency 15%	Escalation Allowance	Total Project Cost (excluding IDC)
Muskrat Falls Generating Facility	\$2,206	\$20	\$2,186	\$328	\$335	\$2,869
Labrador – Island Transmission Link (with Overload Capacity)	\$1,616	\$42	\$1,574	\$236	\$208	\$2,060
Total						\$4,929

6 Generally, MHI’s report found that Nalcor’s capital cost estimates to be within the
 7 accuracy range of an AACE class 4 estimate (+50%/-30%) which is
 8 representative of a feasibility level study. MHI’s report also points out that there
 9 were variations in the level of detail provided in relation to the components of the
 10 Muskrat Falls-Labrador Island Link project. MHI noted (Vol. I, p. 35),

11
 12 **Typically, in the early stages of a project’s development, a mix of**
 13 **cost estimate classes would be used, as evidenced by what MHI has**
 14 **seen in the case of Muskrat Falls Generating Station or the Strait of**
 15 **Belle Isle marine crossing, which were studied more extensively than**
 16 **other components.**

17
 18 MHI’s report indicates that most project documentation on the Labrador Island
 19 Link HVdc system was not available, such as the HVdc converter station single
 20 line diagram or a concept transition document, since the project definition

1 changed. MHI reports that the lack of detailed information hampered its review.
2 However, MHI reviewed Nalcor's cost estimates for the converter stations and
3 when compared against industry benchmarks were found to be reasonable.
4 Nalcor's cost estimate for system upgrades includes three 300 MVA
5 synchronous condensers plus the conversion of two units at Holyrood as well as
6 the addition of several high voltage breakers. MHI found these estimates to be
7 low but within the bands of cost variability and thus reasonable as inputs to the
8 DG2 screening process and CPW analysis. Nalcor's estimate for the overland
9 HVdc transmission line was stated at the hearing to be the result of a "bottom up"
10 approach (Transcript, February 13, 2012, p. 157-160). MHI's assessment of
11 Nalcor's estimate for the HVdc overland transmission line was that it was
12 reasonable, but at the low end of the range for this type of construction utilizing
13 industry benchmarks as a comparison. MHI also stated that Nalcor's proposed
14 1:50 year return period design was "*contrary to best practices carried out by*
15 *utilities in Canada*" and stated that a design based on a 150 – year return period
16 could be accommodated within the variability of an AACE Class 4 estimate at this
17 stage of development for the entire Labrador-Land Link HVdc project. The
18 incremental cost for the 1:150 year design was estimated at \$150,000,000.

19
20 Nalcor's reply to PUB-Nalcor-42 shed further light upon the degree of accuracy
21 that is attached to a Class 4 estimate. Nalcor states:

22
23 **According to AACE International recommended Practice No. 18R-97,**
24 **typical accuracy ranges for a Class 4 estimate can be -15% to -30%**
25 **on the low side to +20% to +50% on the high side, depending on the**
26 **technical complexity of the project, degree of project definition (i.e.**
27 **percentage of design complete), appropriate reference information,**
28 **and the inclusion of an appropriate contingency determination.**

29
30 **However these ranges are not absolute and are not industry or**
31 **project specific. AACE International Recommended Practice No.**
32 **18R-97 "Cost Estimate Classification System" states:**

1 **“In summary, estimate accuracy will generally be correlated**
2 **with estimate classification (and therefore the level of project**
3 **definition), all else being equal. However, specific accuracy**
4 **ranges will typically vary by industry. Also, the accuracy of**
5 **any given estimate is not fixed or determined by its**
6 **classification category. Significant variations in accuracy**
7 **from estimate to estimate are possible if any of the**
8 **determinants of accuracy such as technology, quality of**
9 **reference cost data, quality of the estimating process, and skill**
10 **and knowledge of the estimator vary. Accuracy is not**
11 **necessarily determined by the methodology used or the effort**
12 **expended. Estimate accuracy must be evaluated on an**
13 **estimate-by-estimate basis (emphasis added), usually in**
14 **conjunction with some form of risk analysis process.”**
15

16 There was discussion at the hearing before the Board as regards whether as at
17 DG2 – there may be more accuracy reasonably ascribed to the Class 4
18 estimates used at DG2 than might be indicated by the “textbook range” of -30%
19 to +50%. MHI’s Mr. Snyder stated MHI viewed the estimates on the Muskrat
20 Falls Generating Station and the Strait of Belle Isle marine crossing components
21 as being Class 4 estimates but with accuracy in the “tighter range”. Mr. Snyder
22 indicated that the range on these *components* “*would probably be at the lower*
23 *end in line with what Nalcor has suggested*”. Mr. Snyder stated that MHI did not
24 have sufficient information to make such an assessment in relation to the
25 converter station or transmission line. Mr. Snyder stated that on an overall basis
26 MHI believed that Nalcor’s estimate was a Class 4 estimate.
27

28 **Reference: Transcript, February 15, 2012, p. 167-170, p. 217-8**
29

30 Nalcor was asked by the Consumer Advocate to provide its assessment of the
31 accuracy of its DG2 estimates for the Muskrat Falls-Labrador Island Link. Mr.
32 Harrington stated that +50% and -30% are the extremes and added that he did
33 not think they would be there. He stated, “*I think we’ll be closer to the narrower*
34 *range, which is -15 to +20.*” Mr. Bennett added that the intent of industry best

1 practices is to “pull yourself from the extremes of the range closer in, and as we
2 progress with engineering definition, we reduce that certainly.” He added that it
3 was “not really appropriate for us to say, well, we think the range is this or that at
4 this point in time, but to continue with the process that we’re following and to
5 continue to define the project, with a view to minimize that range.” Mr. Bennett
6 stated however that Nalcor thinks that there’s a much higher probability of being
7 at the narrower range of -15 to +20 than being at the extreme edges using the
8 techniques they had identified and practices that are being followed.

9
10 **Reference: Transcript, February 13, 2012, p. 140-143**

11
12 Board counsel during the proceedings on February 14th re-visited this area in her
13 questioning. Mr. Harrington stated,

14
15 **Okay, I wish to clarify your question there. Within the standard that**
16 **you’ve quoted, AACE, there’s the wide range of +50 to -30, but they**
17 **also quote +20 to -15 range as well. So that’s the narrow band that**
18 **we’re talking about, and I think in my testimony yesterday, I indicated**
19 **I thought that we were closer to the narrower range. . .**

20
21 Mr. Kean, the Deputy Project Manager, stated that Nalcor as part of its overall
22 evaluation of the cost estimate undertook a risk analysis in June 2010 “*which*
23 *gave us much greater clarity on what the actual accuracy was.*” [Transcript,
24 February 14, 2012, p. 50].

25
26 While Nalcor could not state a definitive sub-range of accuracy for its DG2
27 estimate within the usual range of accuracy of Class 4 estimates, having regard
28 to the work left to be completed in Phase 3, there would appear to be reason to
29 believe that the outer bounds of the range are less likely, albeit, of course, still
30 possible. There does also appear to be greater confidence in the accuracy of the
31 estimate for the Muskrat Generating Station component and the SOBI. As noted,
32 Mr. Snyder stated that MHI believed that these components were probably in the

1 tighter range of a Class 4 estimate. The discussion around DG2 – Class 4
2 estimates' accuracy is of course relevant to the issue of the sensitivity of the
3 CPW preference for the Interconnected Option, as detailed in MHI's sensitivity
4 analysis.

5
6 Construction risks, being the key risk associated with the Muskrat Falls Labrador
7 Island Link project was addressed at the hearing. The Consumer Advocate
8 notes that Nalcor, as discussed at the hearing and as addressed in its
9 Presentation and Submission, has apparently invested a great deal of resources
10 and effort in attempting to mitigate the construction risks associated with the
11 Muskrat Falls-Labrador Island Link project.

12
13 The Consumer Advocate would refer specifically to Nalcor's benchmarking
14 exercises with other hydro developers in Canada, work on productivity and
15 performance, geotechnical investigations and labour assessment. Nalcor has an
16 internal team with significant project execution experience and an experienced
17 international LPCM Contractor, SNC Lavalin. Nalcor's stated approach is to use
18 proven practices and to employ the approach of "front end loading" in an effort to
19 improve cost and schedule predictability.

20
21 Customers want to know that Nalcor and its advisors are aware of how other
22 mega projects have "gone off the rails" in terms of cost over-runs and how Nalcor
23 plans to incorporate the lessons learned. Mr. Kean, the Deputy Project Manager,
24 referred to the importance of "front end loading". He stated,

25
26 **Yes, we are aware of this phenomena. It's actually an area that I've**
27 **published a couple papers on myself. Mega projects are**
28 **challenging, but as we indicated in our presentation, there are some**
29 **key things that one can do in planning a project of this size and**
30 **magnitude that can get things going well. A key aspect of that is**
31 **front end loading. Front end loading is the number one predictor of**
32 **success of a mega project. So many of the things that we've been**
33 **focused on throughout the last four years, four plus years, is to**

1 ensure we're well established in that regard. We've engaged
2 independent project analysts out of Virginia to come in and assess,
3 using their proprietary technology and proprietary methods, how
4 well defined our project is and are we on track in terms of being for
5 front end loading. They said we were- - at DG2, we were best in class
6 at that point and we were on track to being in very good shape for
7 DG3. Further, I guess the project has very well defined objectives.
8 We know what we need to do. We have a team that's been together
9 that is- - and we further have engaged a world class EPCM
10 consultant to work with us. The plans and targets are realistic.
11 They're based on well founded engineering and work that we've
12 undertaken extensively over the past few years and they're
13 achievable.

14

15 The Consumer Advocate asked Nalcor to comment upon what were the drivers
16 of cost over-runs on other recent large Canadian hydro projects. Mr.
17 Harrington's response is reproduced below:

18

19 Nalcor is part of the Canadian Electrical Utilities Project Management
20 Network. . . . we meet twice a year to go through lessons learned
21 from different projects and, you know, we take all of those lessons
22 learned under good advisement. We listen to what the other
23 challenges are on different projects and you made a reference to
24 [Site C] and the evolution of that project. Well, that project has
25 changed significantly from that which was originally contemplated.
26 So, those things have to be taken into account when you review how
27 a cost estimate changes over time. In addition, I mean, if you look at
28 [Site C] and compare it to the Muskrat Falls Project, just from a - -
29 just one metric, for example, how much material you have to move.
30 In [Site C], it's over 48 million metres cubed of material and of that,
31 over 20 million metres cubed of material that has to be moved off
32 site. Whereas Muskrat Falls is in the two, two and a half million
33 metres cubed of material. So from a scale perspective, we're dealing
34 with - - we're one of the best sites in North America that's never been
35 developed before, from a hydroelectric perspective, and that was a
36 NEB report. I can't remember exactly the year, but you know, it's still
37 a great project. So you know, we have certain physical conditions
38 that Mr. Bennett pointed out in one of his slides.

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...

These are the things that give me comfort, right, and should give us all comfort from the fact that we're dealing with a site that has competent bedrock. It doesn't have this massive amount of overburden or clay seams that we have to remove. We have this minimal overburden to remove and dispose of. We have conditions that have been validated by site investigations going over 20 years. We have constructability aspects which are beneficial. All of the materials that we've got are sourced from site excavation. So we're not dealing with massive amounts of trucks moving backwards and forwards to get the right type of material. We have this very good material balance, so we don't have to remove 20 odd million metres cubed of material off site, and we're dealing with basically conventional concrete methods. We go to the next slide, please. Thank you. We don't require a massive amount of additional dams and dikes. It's all in one place. If you look at Romaine or East Main projects, they required additional dams and dikes to be able to form the reservoir. Muskrat Falls does not require that. We also have the reliable hydrology aspect. So you know, that's another fantastic benefit for the project. We've got robust, conventional designs for all the structures. We're using conventional methods. We don't require underground. We don't require temporary diversion tunnels which also add costs. Some projects are dealing with one and a half kilometres of diversion tunnels. We've got conventional equipment. We're using the TG sets, the gates and the cranes that's been tried and tested and we're close to Happy Valley Goose Bay. We're, you know, within 20 minutes of a major facility with an airport and port. So all of these things give us a great comfort that we believe that we understand the risks of our project. We are not complacent with regards to other projects and other mega projects that have gone off the rails. We listen to what those other mega projects had to say and we've incorporated that in our project execution by embracing the concept of front end loading.

The Consumer Advocate regards these foregoing observations as relevant to gaining an appreciation for the construction risks associated with the Muskrat Falls project. Customers are well aware of the potential for the costs of large construction projects to exceed expectations. Given the CPW model's sensitivity

1 to capital cost overruns, consumers have a vital interest in Nalcor's efforts to
2 utilize best practices to mitigate construction risks and attendant cost overrun
3 potentials.

4
5 As noted by MHI and Nalcor, we can expect capital cost estimates for Muskrat
6 Falls-Labrador Island Link to evolve from DG2 to DG3. At DG3, project definition
7 will be much greater and the accuracy ranges for the cost estimates will be
8 narrower. At DG3, Nalcor will update its capital cost estimates and all other
9 inputs that feed into the CPW analysis. At DG3 there will be confirmation of the
10 project's scope, time and cost basis. In addition to updated capital costs, there
11 will be an updated schedule, operating costs, fuel prices, demand forecasts,
12 interest rate, exchange rates, escalation allowance, along with an updated risk
13 analysis and contingency (MHI-Nalcor-96).

14
15 Clearly not as much clarity exists as at DG2, as will exist at DG3 later this year.
16 It is Decision Gate 3 which acts as the final check and confirmation to verify the
17 financial viability established at Decision Gate 2. The Consumer Advocate
18 agrees with MHI that the Muskrat Falls Generating Station and the Labrador-
19 Island Link HVdc projects represent the least-cost option of the two alternatives,
20 when considered together with the underlying assumptions and inputs provided
21 by Nalcor. The Consumer Advocate accepts MHI's findings that the inputs
22 including the capital cost inputs which were reviewed by MHI were generally
23 found to be appropriate.

1 MHI's Areas of Concern

2
3 A. AC Integration Study

4
5 As noted in MHI's report, Nalcor did not complete system integration studies as
6 part of the project alternatives screening process. At the hearing, MHI explained
7 that integration studies are necessary to assess the impact of new facilities on
8 existing electrical power systems. MHI stated that Nalcor provided MHI studies
9 for a 1600 megawatt, three-terminal HVdc link between Gull Island to
10 Newfoundland and New Brunswick. However, significant changes were made to
11 the overall project definition with the proposed Muskrat Falls development, and
12 the deletion of the New Brunswick link. MHI noted that Nalcor had expected to
13 have the studies for the new project configuration completed in November, 2011
14 but advised subsequently that these studies would not be available until March,
15 2012. Accordingly, MHI did not have the opportunity to review the results of this
16 study. MHI's report states that good utility practice requires that these integration
17 studies be completed as part of the project screening process (DG2). MHI
18 considers this to be a "major gap" in Nalcor's work to date.

19
20 MHI states that as the full requirements for integration of the Labrador-Island Link
21 HVdc system are not known, *"there may be additional risk factors that may*
22 *impact the cumulative present worth of the Infeed Option."* At the hearing, MHI
23 stated that not having these studies completed has *"introduced an additional*
24 *design and operational risk or potential unknown capital costs in the generation*
25 *expansion plan."* For example, there may be a need for additional transmission
26 lines, additional AC equipment needed to regulate frequency or voltage and
27 back-up generation to cover operational limitations of the Labrador-Island link.
28 MHI stated that these integration studies must be completed prior to project
29 sanction DG3.

1 Nalcor's position as expressed during its presentation and through questioning
2 before the Board was that Nalcor was in agreement that it is important that the
3 system be modelled both in Labrador and on the island so that "we're confident
4 that the new DC link can be effectively integrated into the AC systems." Nalcor
5 stated that for DG2, it analyzed Teshmont's 1998 integration study which
6 evaluated an 800 megawatt point-to-point HVdc link from Gull Island to Soldier's
7 Pond. Nalcor states that it built upon the 1998 work with a 2007 study that
8 studied Gull Island and a 1600 Megawatt three-terminal HVdc system that
9 included terminations at Gull Island, Soldier's Pond and New Brunswick. Nalcor
10 stated at the hearing that the analysis determined that the point-to-point link will
11 have *"similar characteristics regardless of the change in generation source from*
12 *Gull Island to Muskrat Falls provided we have transmission capability between*
13 *the new generating site and the existing Churchill Falls facility, and as a result,*
14 *Nalcor did have sufficient input data to move through Decision Gate 2 on the*
15 *understanding and with the information that the full integration studies for the*
16 *HVdc system would be completed at Decision Gate 3."* Mr. Humphries,
17 Newfoundland and Labrador Hydro's Manager of System Planning, stated at the
18 hearing that Nalcor is of the opinion that the 1998 scheme is *"very similar to what*
19 *we are looking at today and further, we compared the results of the integration*
20 *study for '98 with the 2007 [study] and from the perspective of the integration*
21 *impacts into the island system, they're practically identical."*

22

23 At the hearing, the Consumer Advocate asked Nalcor to comment upon the
24 concern of MHI that in the absence of a completed system integration study that
25 there may be additional risk factors that may impact the cumulative present worth
26 of the Infeed Option. Nalcor was asked to comment on whether there may be a
27 "known unknown" or an "unknown unknown". Mr. Humphries stated that based
28 on Nalcor's understanding of the system and the previous studies, that the items
29 identified in these studies were *"representative of what we would be faced with*
30 *the integration of the Muskrat Falls scenario."* Mr. Humphries stated that while
31 the current studies are ongoing and not yet complete, his staff who have been

1 participating in the studies have not, based on work done thus far, identified any
2 further issues and did not expect to identify any further issues.

3
4 MHI was present during Nalcor's presentation and during its questioning
5 regarding the AC Integration studies. MHI's observation was not changed by
6 what it heard at the hearing. MHI was not persuaded that Nalcor's familiarity and
7 comfort level based on its two previous studies from 1998 and 2007 was
8 sufficient. MHI stated that they still considered this a significant gap.

9
10 The Consumer Advocate places considerable weight upon the judgment of MHI
11 on these issues and concurs with MHI. The Consumer Advocate notes Nalcor's
12 position is that it is not expecting to see cost ramifications significantly different
13 than they have already built into their DG2 estimates. The cost estimates in
14 relation to Island System Upgrades were \$194,000,000 plus contingency and
15 escalation. This estimate includes the Soldier's Pond converter station with three
16 MVAR synchronous condensers to support DC conversion and stabilize AC
17 performance and AC system upgrades at Holyrood involving the conversion of
18 units one and two to synchronous condenser units. In addition, a number of high
19 voltage breakers will need to be upgraded as a result of the higher fault currents.
20 MHI noted that there may be additional risk factors that may impact the
21 cumulative present worth of the infeed option. At the hearing, MHI stated that it
22 remains a possibility that what Nalcor has already incorporated into their estimate
23 at DG2 is sufficient (Transcript, February 15, 2012, p. 198). When asked if MHI
24 could provide some measure of the risk that may exist in the absence of these
25 integration studies, Mr. Snyder stated that he could not give a definitive number
26 in terms of value but noted that there may be things that Nalcor may choose to
27 incorporate because it makes better operation of the system. He stated, "It
28 makes the system more reliable and as a result, that might change the number of
29 dollars that are required." (Transcript, February 15, 2012, p. 198)

1 This gap notwithstanding, MHI's basic conclusion is that the Muskrat Falls
2 Generating Station and the Labrador-Island Link HVdc projects represent the
3 least-cost option of the two alternatives, when considered together with the
4 underlying assumptions and inputs provided by Nalcor.

5
6 B. HVdc Transmission Line

7
8 As noted in MHI's report, Nalcor has selected a 1:50 year reliability return period
9 (basis for design loading criteria). Nalcor has stated that it does not intend to re-
10 visit this issue prior to DG3.

11
12 MHI has stated that this selection is inconsistent with the recommended 1:500-
13 year reliability return period outlined in the International Standard CEI/IEC
14 60826:2003 with Canadian deviations in CSA Standard (CAN/CSA – C 22.3 No.
15 60826:06) for this class of line without an alternative supply. In its report and at
16 the hearing, MHI stated that the design choice of Nalcor was "*contrary to best*
17 *utility practice*". In the case where an alternative supply is available, the 1:150
18 year reliability return period is acceptable. In the latter scenario, MHI's report
19 states that Nalcor should also give consideration to an even higher reliability
20 period in the remote alpine regions, specifically in the Southeastern portion of
21 Labrador, two areas in the Long Range Mountains, and a small section in central
22 Newfoundland. This evidence at the hearing was that a 1:150 year design for
23 this extra line would cost an additional \$150,000,000. MHI stated that such a
24 design could be accommodated within the variability of an AACE Class 4
25 estimate.

26
27 Nalcor's position as expressed during its presentation is that its objective is to
28 ensure that reliability of the Interconnected Island System remains, at a
29 minimum, consistent with the island's historical experience and stated that it
30 would "*not advance an alternative that does not meet an acceptable level of*
31 *reliability.*" Nalcor takes the position that it complied with the CSA standard,

1 noting that suggested higher return periods set out in the applicable standard are
2 not mandatory, and that the reliability for a 1:50 year return period is consistent
3 with the current island system and the reliability of the HVdc line was tested for
4 compliance against its current generation and transmission planning criteria. Mr.
5 Bennett states that Nalcor's plan was to increase the loadings in the identified
6 Alpine areas, resulting in a *"much more robust structured design in those areas,
7 as well as the addition of additional anti-cascade structure to minimize the impact
8 of a failure, should it happen."* (Transcript, February 15, 2012, p. 957) The
9 costing for the additional beefing up was estimated to be in the order of 20 to 25
10 million dollars, which is not reflected in the DG2 estimate. (Transcript, February
11 15, 2012, p. 96)

12
13 Nalcor stated that it acknowledged that increasing the return period from 1:50 to
14 1:150 and beyond reduces the probability of a failure of that line, but once the
15 line fails the same number of customers will have unserved demand when it does
16 happen. Nalcor stated that in addition to considering the impact of increasing the
17 impact of increasing the return period (and hence lowering the probability of the
18 line failure), Nalcor stated that an important aspect in their thinking was *"to look
19 at the impact of the outage when it takes place."* Nalcor stated that involved
20 looking at ways to reduce the "impact" of the outage. Nalcor's view was that in
21 this case, *"reducing the impact of the outage would have a greater customer
22 benefit than reducing the probability of the outage in the first place."* Nalcor's
23 view was that if enhancements to the Island Interconnected System were
24 deemed to be necessary, *"a better cost benefit option for ratepayers is the
25 addition of standby generation."* Nalcor also stated that the reliability of the
26 system will improve with the construction of the new 230 KV line that it proposes
27 between Bay D'Espoir and Western Avalon, the line being required for either of
28 the alternative options under consideration in this Review.

29
30 Nalcor also stated *"that this addition of the Maritime link to the system further
31 enhances the system reliability, that with the availability of impact capability for*

1 *the Maritime Provinces, we reduce our depending on the transmission link from*
2 *Labrador.”* Nalcor states that the Island system has the ability to obtain power
3 from the Maritimes in the event of a structured failure.

4
5 The Consumer Advocate notes that the Terms of Reference for the review does
6 not contemplate an examination of the Maritime Link. For the purposes of this
7 review, we assume that the Maritime Link will not exist.

8
9 Nalcor has stated that it will proceed with the Muskrat Falls project without the
10 Maritime Link, noting that based on the analysis completed at DG2, there is \$2.2
11 billion (2010\$) CPW preference for the Interconnected Island Alternative over the
12 Isolated Island Alternative, this preference not being dependent on the
13 construction of the Maritime Link by Emera.

14
15 A reliable electrical system is, of course, of critical importance and value to
16 customers. As customers, we tend to take the reliability of our system for
17 granted until we are faced with a power outage and we find ourselves in
18 darkness. At that point, electrical reliability is at top of mind. Reliability must
19 always be top of mind for electrical utilities and system planners. In the case of
20 the proposed 1100 km HVdc transmission line, the line will be running through
21 areas with harsh meteorological conditions and through remote areas which
22 might well not be readily accessed by emergency response electrical crews. The
23 1998 ice storm in Quebec is a fresh memory for many customers, where
24 following this catastrophic event, transmission lines were re-built to a 1:500 year
25 standard. The MHI report constitutes evidence that generally accepted sound
26 public utility practice would be to select a greater than 1:50 reliability return
27 period for a line of this criticality even if an alternative supply is available.

28
29 The Consumer Advocate concurs with the judgment of MHI on this issue and
30 believes that its judgment is deserving of considerable weight. The Consumer
31 Advocate believes that whether the International Standard is mandatory or

1 recommendatory, deviation from it should require clear and compelling reasons
2 supported by ample analysis as to how such a deviation would impact reliability
3 for customers and whether those impacts were acceptable.

4
5 The Consumer Advocate considers that adding the incremental cost of the line
6 being designed to a 1:150 year return period to the cost of the Interconnected
7 Option does not significantly alter the preference for this Option. MHI states that
8 the cost of the 1:150 year design could be accommodated within the variability of
9 the AACE Class 4 estimate. Despite that, adding \$150,000,000 to the DG2
10 estimate for the HVdc transmission line would reduce the preference for the
11 Interconnected Option. According to the Sensitivity Test of MHI, if the *overall*
12 Labrador-Island Link capital cost increased by 25%, the Reference Case
13 preference for the Interconnected Option would decrease to 1.760 billion from
14 2.158 billion. By itself then, adding \$150,000,000 to Nalcor's estimate for the
15 HVdc line component only of the Labrador-Island Link, would not significantly
16 change the preference for the Interconnected Option.

17 18 C. System Reliability Studies

19
20 MHI's report states that Nalcor's choosing between the two options under review
21 without having carried out a probabilistic adequacy assessment is a gap in
22 Nalcor's work to date. MHI states that typically, these studies are completed at
23 DG2. MHI recommends that these probabilistic reliability assessment studies be
24 completed as soon as possible. MHI recommended that such studies become
25 part of Nalcor's process that would allow for comparison of the relative reliability
26 for further facilities.

27
28 MHI states that deterministic assessments such as those performed by Nalcor in
29 Exhibit 106, cannot quantify the true risks associated with a power system and
30 are unable to provide some of the important inputs for making sound engineering
31 decisions such as risk and associated costs, including the potential large societal

1 costs related to outages. MHI states that probabilistic assessment is an
2 invaluable means to assess system risk, reliability and associated cost of
3 benefits for various system improvement options. MHI states that various
4 Canadian utilities including Manitoba Hydro, BC Hydro, Hydro Quebec and Hydro
5 One in Ontario have adopted probabilistic methods for reliability studies for major
6 projects.

7
8 Nalcor stated at the hearing that it was not planning to undertake an assessment
9 of MHI's recommendation prior to DG3 (Transcript, February 14, 2012, p. 128).

10 Nalcor stated that starting to incorporate this kind of reliability analysis into its
11 traditional least cost decision making process would be a significant deviation
12 from the norm as experienced in this province over several decades. Mr.

13 Humphries stated:

14
15 **And it's our view that before taking on such a task, that we would**
16 **really need to assess, not only with ourselves, but also with**
17 **stakeholders, customers and the Board, the implications of including**
18 **such an analysis what impact it may have on the overall least cost**
19 **decisions.**

20
21 Mr. Wilson, on behalf of MHI, stated that Mr. Humphries' observations about the
22 need for stakeholder, regulator and customer involvement before embarking on
23 this initiative did not change MHI's recommendation. The Consumer Advocate
24 notes MHI's point that various Canadian utilities have adopted the probabilistic
25 method for major projects and that choosing between the two options is a gap in
26 Nalcor's work to date. The Consumer Advocate accepts this judgment.

DATED at St. John's, in the Province of Newfoundland and Labrador, this 2nd day of March, 2012.



Thomas Johnson, Consumer Advocate

323 Duckworth Street

P.O. Box 5955

St. John's, NL A1C 5X4

Telephone: (709)726-3524

Facsimile: (709)726-9600

Email: tjohnson@odeaearle.ca

Terms of Reference and Reference Question

In the Energy Plan, 2007, Government committed to the development of the Lower Churchill hydro resource. It has been determined that the least-cost option for the supply of power to the Island interconnected system over the period of 2011-2067 is the development of the Muskrat Falls generation facility and the Labrador-Island Link transmission line, as outlined in Schedule "A" attached hereto (the "Projects"), as compared to the isolated Island development scenario, as outlined in Schedule "B" attached hereto (the "Isolated Island Option"), both of which shall be outlined further in a submission made by Nalcor Energy ("Nalcor") to the Board of Commissioners of Public Utilities (the "Board"). It is contemplated that Newfoundland and Labrador Hydro ("NLH") would enter into a long-term power purchase agreement and transmission services agreement with Nalcor, or its subsidiaries, the costs of which would be included in NLH's regulated cost of service with the full cost of the Projects being recovered from NLH's Island interconnected system customers (the "Island Interconnected Customers").

Pursuant to section 5 of the *Electrical Power Control Act, 1994* (the "EPCA"), Government hereby refers the following matter to the Board:

The Reference Question

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 processes 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.

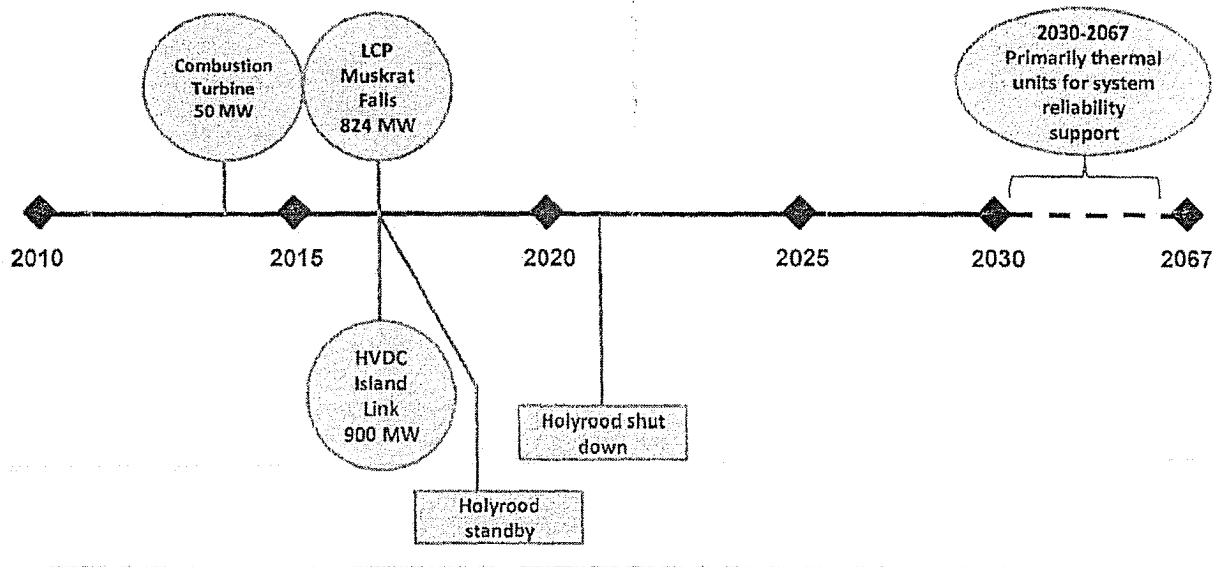
Where Nalcor or NLH determine that any information to be given to the Board for this review is commercially sensitive as defined in the *Energy Corporation Act*, it shall advise the Board, and the Board and its experts and consultants may use such information for this review but shall not release such information to any party.

For the purposes of this review, a consumer advocate shall be appointed pursuant to section 117 of the *Public Utilities Act*.

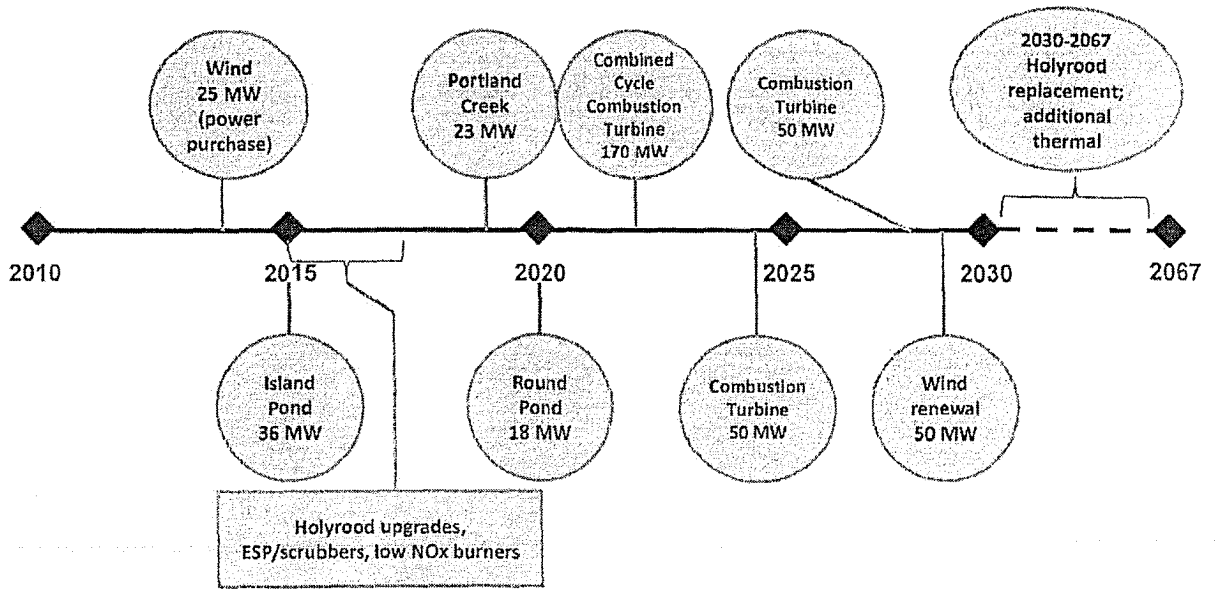
Any costs of the Board in respect of this review, including the costs of the consumer advocate, shall be paid by Nalcor.

The Board's report shall be provided to the Minister of Natural Resources by December 30, 2011. The Minister shall make this report public.

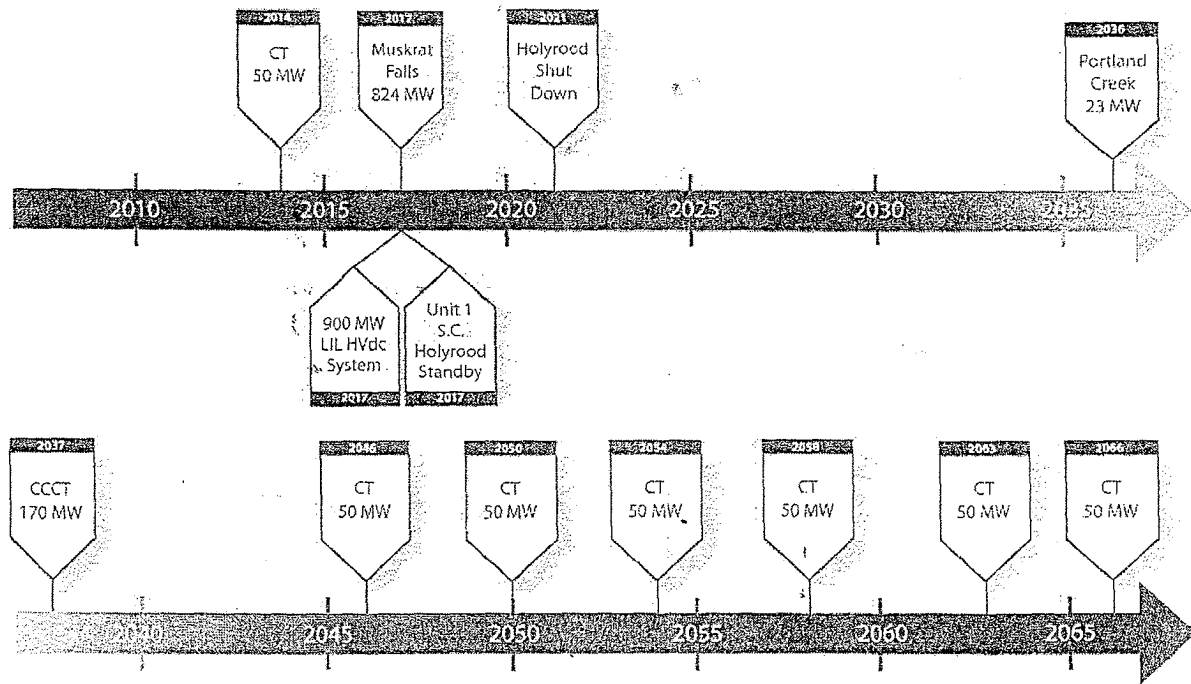
Schedule A – The Project



Schedule B - Isolated Island Option



1.6.1 Infeed Option



1.6.2 Isolated Island Option

