11 Wind Farms

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In the Isolated Island Option, a new 25 MW wind farm is proposed and scheduled for in-service in 2014. This is in addition to those already in operation at St. Lawrence and Fermeuse rated at 27 MW each. The latter two wind farms have a twenty (20) year Power Purchase Agreement (PPA) with NLH which expire in 2028. Once the contract period ends, there is a build-own-operate-transfer (BOOT) clause that allows transfer of ownership of the wind farm assets to NLH at no cost.[221] For the CPW calculation, it is assumed that the wind farms have a twenty (20) year operating life[222], and after this period, the entire wind farm would be replaced by NLH. The replacement cost for each of the wind farms is factored into the CPW calculation.

11.1 Scope of Review

The scope of review for wind farms included the following objectives:

- Assess related planning and cost estimates for the wind farms and verify the estimates are reasonable.
- Examine related studies or assumptions such as wind surveys, annual capacity factors and assessment of allowable non-dispatchable wind capacity in the island grid.

The review is not intended to be exhaustive but is required to be sufficient to ensure that due diligence has been performed for the wind assessment.

11.2 Costs Estimate

The existing price structure used in the evaluation is based on NLH's current wind PPA structure as outlined in Exhibit 25[223]. The annual capacity factor at 40% is assumed for the new 25 MW wind farm to be erected in 2014 and is based on the average capacity factor between the two existing wind farms at Fermeuse (44.3% capacity factor) and St. Lawrence (35.7% capacity factor). There is no specific site and wind survey data collected for the proposed new wind farm to validate the 40% annual capacity factor. According to Nalcor, the proposed site for the new 25 MW wind farm would be selected through a wind RFP process.[224] Nalcor added that from previous 2005 and 2006 wind RFPs, submissions from other proponents (excluding Fermeuse and St. Lawrence wind proponents) the

[221] Exhibit 6a, Nalcor, "PPA Listing and Rates", July 2011
[222] Exhibit 7, Nalcor, "Service Life-Retirements", July 2011
[223] Exhibit 25, Nalcor, "Board Letter July 12th 2011: A report on the information and data collected for wind farms", July 2011
[224] Response to RFI MHI-Nalcor-87

indicated expected net annual capacity factors ranging from 35% to 43%. In our opinion, it appears to be a reasonable assumption that a 40% annual capacity factor be used for a planning level estimate.

The project cost to replace the new 25 MW wind farm and full replacement of existing Fermeuse and St. Lawrence wind farms after the end of their operating life is derived as shown in Exhibit 25. There are no detailed breakdown costs for material and labor for the wind turbines and the balance-of-plant. The Nalcor cost estimates for these wind farms are based on the 2007 Ontario Power Authority Integrated System Plan EB-2007-0707, Exhibit D, Tab 5 Schedule 1, Page 25, Table 14. The table gave a general capital cost per kW for the installed capacity, which excludes the transmission cost, the cost to develop the wind farm site and the operation and maintenance cost. Escalation and a percentage of the network and transmission cost is added to the general capital cost to bring the cost estimate in line to the base year (2010) at $2,323 per kW.

The calculated O&M cost is based on the annual energy production (i.e. the annual capacity factor) for each wind farm. The price per MWh used is perhaps on the low range for calculation of the CPW based on Nalcor's wind RFP information in comparison with the O&M cost presented in Table 14[225]. On a conservative side, a higher O&M cost would reflect various unknowns such as the wind farm site, wind turbine type and maintenance schedule, service centre location, land lease, insurance etc.

The capital and O&M cost estimate presented by Nalcor are in line with the average project installed cost as outlined in the International Energy Agency (IEA) Wind 2010 Annual Report[226]. This report provides an information update on wind related issues and projects across member countries (Canada is a member). In the report, the average installed cost per kW for a wind farm in Canada for the year 2010, range from $1,999-$2,499 per kW and the O&M cost is between $14.40 to $18.00 per MWh. As a reference project for comparison of total installed cost per kW, the IEA report stated that the recently commissioned St. Joseph wind farm in Manitoba, with an installed capacity of 138 MW, had an estimated total project cost of $345 million. This translates to an average installed cost of $2,500 per kW.

The cost estimates to replace the Fermeuse, St. Lawrence wind farms and add the new 25 MW 2014 wind farm were calculated by MHI based on Nalcor's Exhibit 25: Capital Cost @ $2,323 per kW (2010 $). These estimates are shown in Table 28.

Table 28: Wind Farm Capital and O&M Requirements

Plant	Capacity (MW)	Firm Energy (GWh)	Capital Cost (2010$ M)	Annual O&M (2010$ M)
Fermeuse	27	84	$ 62.72	$ 1.28
St. Lawrence	27	105	$ 62.72	$ 1.40
New Wind Farm	25	88	$ 58.10	$ 1.30
Total	**79**			

[225] Exhibit 25, Nalcor,"Board Letter July 12th 2011: A report on the information and data collected for wind farms", July 2011
[226] IEA Wind 2010 Annual Report, July 2011

11.3 Assessment of Non-Dispatchable Capacity

A review was performed to assess the additional amount of non-dispatchable (i.e. wind power) energy that could be integrated into the island grid to further offset the fuel cost and reduce emissions at Holyrood Thermal Generating Station. In 2004, Nalcor performed an assessment of the limitations for non-dispatchable generation[227] on the island grid in an effort to identify the upper limits of wind penetration into their system.

From the analysis Nalcor performed in 2004, the upper limit of 80MW is recommended by Nalcor for wind generation due to the following constraints:

1. Water Management: Additional wind generation would cause less generation from hydro facilities and therefore more water would be spilled from reservoirs. For example, adding 20 MW to the upper limit of 80 MW, the amount of spillage would double from 9 GWh to 19 GWh on an annual basis.
2. Transmission grid security: Non-dispatchable generation could displace the demand from the hydro generation and cause the transmission network to be lightly loaded in certain areas resulting in an overvoltage condition. A small disruption to the system could cause widespread system disturbances.
3. Regional transmission issue: A possible overvoltage condition due to limited voltage control provided by wind generation.

These limits identified in the 2004 study are still applicable today as the power system has not substantially changed[228]. As load grows, the Isolated Island system should be able to accommodate additional wind generation. In the response to RFI MHI-Nalcor-89, Nalcor states that the system could accommodate an additional 100 MW of wind in the 2025 timeframe and a further 100 MW around 2035. Nalcor has not studied this in detail but will undertake studies prior to DG3.

Nalcor has also stated that it has,

> *"not completed an analysis to establish the level of wind generation that could be sustained in the Muskrat Falls LIL HVdc option. However, given that this option will include at least one interconnection to the North American electrical grid and that there will be considerable hydroelectric capacity both in Labrador and on the Island to provide backup it would not be unreasonable to consider an additional 400 MW of wind generation on the Island. Nalcor will be analysing this as part of the analysis that will be completed prior to DG3."*

[227] Exhibit 61, Nalcor, "An Assessment of Limitations for Non-Dispatchable Generation on the Newfoundland Island System, Newfoundland Hydro, System Planning & System Operations", September 2011
[228] Response to RFI MHI-Nalcor-89

11.4 Conclusions and Key Findings

MHI's review of the wind farms focused on the planning and cost estimates for the Fermeuse and the St. Lawrence wind farms, and the proposed new wind farm to verify whether or not the estimates are reasonable. MHI examined the related studies and assumptions such as annual capacity factor, cost benchmark data, and assessment of allowable non-dispatchable wind capacity in the island grid.

MHI has determined the following key finding:

- The capacity factor of 40% used by Nalcor is reasonable for a planning study. The estimated capital and operating costs used in the analysis are appropriate. Nalcor's assessment of an 80 MW limit for wind generation under the Isolated Island Option is reasonable. Additional wind power could be installed beginning in the 2025 timeframe as the system capacity grows.