MHI Wind Analysis – Terms of Reference

Manitoba HYDRO INTERNATIONAL

Scope of Services

1.0 Introduction

This proposal is in response to an enquiry from the Government of Newfoundland and Labrador, Department of Natural Resources to carry out the goals listed below in the scope of work.

Manitoba Hydro International (MHI) possesses a roster of well-qualified personnel to draw upon for this assignment. In particular MHI staff have been engaged in generation planning projects in several countries throughout the world and can count on the support of Manitoba Hydro's 6000 plus employees. Our human resources capabilities are available to cover all disciplines and tasks required for the successful completion of this project. We are proposing various experts to meet the requirements of this important work, all of which have worked extensively in their relevant fields. Staff CVs are available on request.

2.0 Objective

A number of non-government organizations and private citizens have questioned the need to build the Muskrat Falls Generating Station and the associated HVdc transmission system as the next option for the Isolated Island of Newfoundland. These groups have promoted a wind power solution as replacement for 824 MW Muskrat Falls Generating Station and ultimately the 500 MW Holyrood Thermal Generating Station as a viable alternative.

The basic question is "Can sufficient wind generation be installed on the Island to replace the Holyrood Thermal Generating Station and provide a firm supply of electricity to Island customers over the long term?" The Island of Newfoundland is large with varying wind resources available across the Island. At this time, the probability of the entire island becalming is unknown. The transmission system has limited power transfer capability west-east to the Avalon Peninsula and would likely require upgrades. Cost is an important consideration to customers.

Nalcor has engaged Hatch to complete a study entitled "Wind Integration Study – Isolated Island Newfoundland." The Hatch study will, among other things, will determine the amount of wind generation that can be economically and reliably integrated into the Isolated Island system, including the shutdown of Holyrood, over the study period. Hatch will also provide an independent review of Nalcor's stability and voltage regulation analysis to determine if it is appropriate and to reasonably assess the technical limits of the system to reliably accept this variable generation resource.

The purpose of the MHI study is to provide a learned opinion and commentary on the reasonableness of the report recently completed by Hatch and the information provided by Nalcor in support of the Hatch Study.

Study Goals:

1. Complete a due diligence review of both the Hatch study and the information provided by Nalcor to determine if the study goals set out for Hatch have been met.

2. Utilizing the Hatch Study, and other literature as appropriate, provide a narrative that addresses the following question: "In an isolated island scenario, can sufficient wind be developed to replace the Holyrood thermal generating station and meet future demand?" Is this a technically feasible and economic alternative to Muskrat Falls?

This assessment could be structured as follows:

1. Wind as replacement for thermal generation (Introduction);
2. Overview of reliability standards and firm capacity;
3. Limitations of energy storage on the Island of Newfoundland;
4. Capacity value of wind;
5. Wind installation base required to provide adequate capacity on the Island;
6. Costs of over-building wind;
7. Technical issues associated with over-building wind;
8. Summary of findings.

The Consultant will also provide such advice and other services as may be required from time to time by the Client.

3.0 Proposed Team

Paul Wilson – Managing Director, MHI
Role: Project Director

Danny Northcott, P.Eng. – Power System Simulation and Project Engineer, MHI
Role: Project Manager

Dr. David Jacobson, P.Eng. – Interconnections & Grid Supply Planning, Manitoba Hydro
Role: AC Integration and Industry Trends

Tom Molinski, P.Eng. – Emerging Energy Systems Section Head, Manitoba Hydro,
Role: Wind Turbine Technologies, Cold Weather Operation

Additional engineering resources from MHI will assist the technical leads when required. Individuals from the design services team will be used for the final report publication.

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4.0 Proposed Services

The Services which the Consultant shall perform or cause to be performed include the following:

1. Task 1: Review of Hatch 2012 Wind Study.

   Undertake a review to determine the reasonableness of the Hatch 2012 Wind Study.

Task 1.1:	Review the 2012 Hatch wind report and provide an assessment of its reasonableness in terms of results, inputs, methods, and use of industry know-how.	David Jacobson Tom Molinski
Task 1.2:	In consultation with Nalcor, review and document the Nalcor's important considerations for a high level of wind power penetration on the Island of Newfoundland.	David Jacobson Tom Molinski
Task 1.3:	Review Nalcor's 2012 Wind report for critical assumptions and parameters relevant for the wind capacity credit and wind/hydroelectric generation resource plan study.	David Jacobson
Task 1.4:	Draft assessment report for the Hatch 2012 wind study	David Jacobson Tom Molinski

2. Task 2: Wind Application Assessment for Newfoundland

   This task will involve a desktop exercise to review existing literature, working group papers, technical resources, and industry know-how to describe the technology used in the industry, identify existing wind farm applications in isolated networks, identify the key issues in their application, document known metrics with these wind farm applications.

Task 2.1:	Review and report on Industry Trends in Isolated Island scenarios (CIGRE, IEEE, IEE, IEC, etc.)	David Jacobson
Task 2.2:	Review and report on Wind Turbine Technologies applied to Isolated Island scenarios (examine other Isolated power systems: Ireland, UK, Tasmania, Hawaii, Spain-Canary Islands, or others as applicable).	David Jacobson Tom Molinski
Task 2.3:	Review and report on Wind Turbine Technologies applied in Isolated Island power systems, turbine technology matches, and applications in extreme cold weather climates.	Tom Molinski

Task 2.4:	Review and report on best practices and existing metrics by region for Wind Capacity Credit assessment. Review IEEE/NERC documents and summarize findings.	David Jacobson
Task 2.5:	Identify key factors in integration issues for a high penetration of variable generation (wind turbines). This will include grid planning, real time control, reliability assessment, turbine maintenance and operations KPIs.	Tom Molinski
Task 2.6:	Develop a technology compliance matrix for wind farms applied to the Island of Newfoundland and identify critical gaps in the technologies.	Tom Molinski

3. Task 3: Report Development

Task 3.1:	Draft a report on study and findings. Preparation of a final report is anticipated to include the outline noted above and also: • An executive summary; • A description of the methodology used to complete the Services; • A discussion of the results of the study, including a discussion any observations and recommendations. • This report will be formatted for public use. • Present the report to the Client	Danny Northcott Paul Wilson Design Team

4. Provide support on this subject to the Client until the project closes.

Schedule Item Scheduled Completion Date

- Draft Report: August 30th, 2012
- Final Report: September 7th, 2012
- Presentation: TBD
- Completion of Services: September 30th, 2012

JD