



**Interconnection Feasibility Study Report  
GIP-137-FEAS-R2**

**Generator Interconnection Request #137  
10MW Wind Generating Facility  
Richmond County, NS**

August 17, 2007  
Control Centre Operations  
Nova Scotia Power Inc.

### Executive Summary

The Interconnection Customer submitted an Interconnection Request to Nova Scotia Power Inc. (NSPI) for a proposed 10 MW wind Generation Facility interconnected to the NSPI system via the 25kV feeder 1C-411.

No adverse issues on the transmission system were determined for this project if no other generation higher in the Queue proceeds.

Assuming that the projects ahead of this project in the Generation Interconnection Queue do not proceed, required additions/changes to NSPI systems with a nonbinding estimated cost of \$310,000 are:

- Reconductor 2.5 km of feeder 1C-411 (from 1C-Point Tupper to Statia tap) to 336 AAC
- Control and communications between this Generating Facility and NSPI Supervisory Control and Data Acquisition (SCADA) system (to be specified)
- Contributed cost for portion of 1C-411

The Generation Facility requirements are listed in Section 10.

The potential requirement for system upgrades between the Sydney and Halifax areas will depend on the projects in the Interconnection Request Queue ahead of this project and will be determined in a subsequent System Impact Study.

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### 1 Introduction

The Interconnection Customer submitted an Interconnection Request (IR) to Nova Scotia Power Inc. (NSPI) for a proposed 10 MW wind Generation Facility interconnected to the NSPI system via the 25kV substation 1C-Point Tupper. The Interconnection Customer signed a Feasibility Study Agreement to study the connection of their proposed generation to the NSPI transmission system. This report is the result of that Agreement. The generation site would be located 2.5 km from 1C-Point Tupper and connect to 1C-Point Tupper via 25kV feeder 1C-411.

### 2 Scope

The Interconnection Feasibility Study (FEAS) report shall provide the following information:

- i. Preliminary identification of any circuit breaker short circuit capability limits exceeded as a result of the interconnection
- ii. Preliminary identification of any thermal overload or voltage limit violations resulting from the interconnection
- iii. Preliminary description and non-binding estimated cost of facilities required to interconnect the Generating Facility to the NSPI Transmission System, the time to construct such facilities, and to address any identified short circuit and power flow issues

The Scope of this FEAS includes modeling the power system in normal state (with all transmission elements in service) under anticipated load and generation dispatch conditions. The direct analysis performed for this FEAS considers transmission elements. A Distribution SIS will be required to perform analysis on distribution elements.

For Network Resources Integration Service (NRIS), the FEAS will identify any transmission upgrades required as the result of thermal overload, voltage violation, or equipment rating. The FEAS will attempt to provide high level cost estimates for such upgrades and direct interconnection costs.

A more detailed analysis of the technical implications of this development will be included in the System Impact Study (SIS) report. This may include system stability analysis, single or double contingencies, off-nominal frequency operation, off-nominal voltage operation, low voltage ride through, harmonic current distortion, harmonic voltage distortion, system protection, special protection systems (SPS), automatic general control (AGC) and islanded operation. The impacts on neighbouring power systems and the requirements set by reliability authorities such as Northeast Power Coordinating Council (NPCC), North American Electric Reliability Corporation (NERC), and NSPI

will be addressed at that time. The SIS may identify additional costs and upgrades that were not identified in this FEAS.

A separate Facilities Study will follow the SIS in order to ascertain the final cost estimate for the transmission upgrade requirements.

### 3 Assumptions

The Point of Interconnection and configuration studied is as follows:

- i. 10 MW wind farm comprised of twelve Enercon E48, 800kW, 400V, wind turbine generators and NRIS service type
- ii. The wind Generating Facility will be located approximately 2.5 km from the 1C-Point Tupper. 1C-Point Tupper is connected to the NSPI transmission system via the L-6517 to 2C-Port Hastings and L-6523 to 47C-Stora
- iii. Point of Interconnection will be at the 1C-Point Tupper 25kV feeder 1C-411
- iv. The results of the analysis in this FEAS are based on the assumption that IRs higher in the Generation Interconnection Queue (Queue) will not proceed, but the impacts of higher Queued IRs are reviewed qualitatively.

### 4 Projects with Higher Queue Positions

As of July 2007, the following IRs can proceed ahead of this project due to their position in the transmission Queue and have the status indicated.

#### In Service and committed generation projects

Wind Generation – 30.5 MW – connected to L-5027 (in-service)

Wind Generation – 14.0 MW – connected to L-5573 (in-service)

Wind Generation – 20.0 MW – distribution connected (in-service)

Wind Generation – 40.0 MW – distribution connected (committed)

#### Generation projects with a higher Queue position, not yet committed

IR 008 Wind – Guysborough, L-5527B, 15 MW – FAC Complete

IR 017 Wind – Lunenburg, L-6004, 100MW – SIS in Progress

IR 023 Wind – Inverness, L-6549, 100MW – SIS in Progress

IR 042 Wind – Cape Breton, New 138kV line, 100MW – SIS in Progress

IR 044 Wind – Colchester, L-6503, 35MW – FEAS in Progress

IR 045 Wind – Cumberland, L-6535, 35MW – SIS Complete

IR 046 Wind – Colchester, L-6513, 32MW – FEAS in Progress

IR 056 Wind – Cumberland, L-5058, 60MW – FEAS in Progress

IR 067 Wind – Annapolis, L-5026, 40MW – FEAS in Progress

IR 068 Wind – Digby, L-5533, 35MW – FEAS in Progress

IR 072 Wind – Guysborough, L-6515, 100MW – FEAS in Progress

IR 079 Wind – Antigonish, L-6515, 50MW – FEAS in Progress  
IR 080 Wind – Cumberland, L-5550, 30MW – FEAS in Progress  
IR 081 Wind – Shelburne, L-5027, 50MW – FEAS in Progress  
IR 082 Wind – Colchester, L-5040, 45MW – FEAS in Progress  
IR 083 Wind – Shelburne, L-6021, 150MW – FEAS in Progress  
IR 084 Wind – Pictou, L-7004, 50MW – FEAS in Progress  
IR 085 Wind – Pictou, L-6511, 50MW – FEAS in Progress  
IR 086 Wind – Pictou, L-7003, 50MW – FEAS in Progress  
IR 100 Wind – Yarmouth, New 69kV line, 52MW – FEAS in Progress  
IR 114 Wind – Pictou, L-6511, 60MW – FEAS in Progress  
IR 115 Wind – Pictou, L-7003, 120MW – FEAS in Progress  
IR 117 Wind – Shelburne, L-5027, 10MW – FEAS in Progress  
IR 126 Wind – Cumberland, L-6513, 70MW – IR valid  
IR 128 Wind – Cumberland, L-6536, 40.5MW – FEAS in Progress  
IR 130 Wind/Water pumped – Cape Breton, L-6516, 200MW – FEAS in Progress  
IR 131 Wind – Cape Breton, L-5580, 11.5MW – FEAS in Progress

All of the above projects can have a direct impact on this project for issues related to the management of the inter-provincial and inter-regional ties and on balancing the NSPI system.

The SIS will be based on the assumption that all projects that are ahead of this project in the Queue are in-service. In particular, IR 008, IR 023, IR 042, IR 044, IR 072, IR 079, IR 084, IR 085, IR 086, IR 114, IR 115, IR 130 and IR 131 affect the interface known as Onslow Import. Onslow Import is presently a congested interface from time to time. Until each project is confirmed or removed from the Queue, any portion of costs to upgrade the Onslow Import that are due to the addition of IR 137 cannot be estimated.

This IR #137 and IR #23, IR #42, IR#130, and IR #131 impact the interface known as Cape Breton Export, which is presently congested and managed by generation rejection Special Protection Systems. If any of the projects ahead of IR #137 proceed, the results of this FEAS must be revised.

Should any project ahead of this project in the Queue be withdrawn or changed, the System Impact Study for this project must be updated according to the Standard Generator Interconnection Procedures (GIP), at the Interconnection Customer's expense.

## 5 Flicker Levels

The Interconnection Customer is to ensure that the operation of the Generating Facility does not cause voltage variations on the Distribution System that result in objectionable lamp flicker to other connected customers. Flicker calculations indicate a  $P_{st99\%}=0.10$  at 1C-B41, which is acceptable and lower than NSPI's planning level of 0.35.

## 6 Short-Circuit Duties

The maximum (future) expected short-circuit levels on 25kV and 138kV systems are 350 MVA and 5,000 MVA respectively.

The short-circuit levels in the area before and after this development are provided in Table 6-1.

<b>Table 6-1: Short-Circuit Levels. Three-phase MVA <sup>(1)</sup></b>		
<b>Location</b>	<b>This Generating Facility in service</b>	<b>This Generating Facility not in service</b>
All transmission facilities in service		
1C-Point Tupper B61	2221	2183
1C-Point Tupper B41	238	192
Minimum Conditions (1C-GT2 Off )		
1C-Point Tupper B61	1750	1714
1C-Point Tupper B41	234	188

<sup>(1)</sup> Classical fault study

Although the actual increase in short-circuit levels will be dependent on the specific type of generator installed, the increase will be insignificant and not a cause for concern.

## 7 Thermal Limits

With all lines in service and for first contingency operation, there are no thermal limitations due to this project if projects higher in the Queue do not proceed. However, this generation project increases flow across the Cape Breton Export and Onslow Import interface. If any of the projects ahead of this project in the Queue proceed there may be upgrades required to add IR 137 to the NSPI system. The SIS will determine the costs of the upgrade due to IR 137 to the NSPI system in addition to all projects ahead of IR137 in the Queue at the time the SIS is performed.

## 8 Voltage Control

This project can be connected via 1C-411 provided the power factor is controlled on individual turbines to provide acceptable voltage levels for nearby customers. Initial modelling indicated the individual E48-WTGs would be set at .96 power factor, absorbing VARs. The SIS may further refine the required setting as it will be influenced by other projects in the distribution queue. In particular, the distribution project referenced in Report # 249-0307-IS25 will have 3 additional turbines at this location and the SIS will consider the impact it will have on IR 137.

The ratio of short-circuit level to generating capacity under normal system conditions is 19.2 (192/10) and is 18.8 (188/10) with local generation off. Such a high ratio is an indication of ease of integration. There should be no specific issues regarding voltage control and power quality due the addition of this facility alone.

This facility must also have low voltage ride-through capability as per FERC order 661A. The SIS will state specific options, controls and additional facilities that are required to achieve this.

### **9 System Limitations (System Security)**

The NSPI transmission system has limited east to west transfer capability. Transmission corridors between Sydney and Halifax are often operated to security limits. This project increases flow across the Cape Breton Export and Onslow Import interfaces. Generation rejection SPSs are utilized to increase system stability limits to maximum east to west power transfers. Depending on the impact of other generation additions ahead of this project in the Queue, transmission system upgrades may be required to integrate IR 137.

This Generating Facility will also increase loading on the Onslow South corridor (Truro to Halifax) by replacing generation south and west of Truro. This may require increased reactive support requirements in the Halifax area or invoke facility additions that can reduce the reactive support requirements. This will be evaluated in the SIS.

The SIS will determine the facility changes that are required to permit higher transmission loadings while maintaining compliance with NERC/NPCC standards for good utility practice.

### **10 Expected Facilities Required for Interconnection**

Based on the above discussion, this project is feasible at the requested capacity, subject to the SIS. It is expected that the following facilities will be required for operation under system normal conditions, assuming that the projects ahead of this project in the Queue do not proceed. This includes the assumption that the 2.4MW project proposed at the distribution level as per Report # 249-0307-IS25 is in service.

The following additions/changes to the Transmission Provider's Interconnection Facilities are required:



- i. Reconductor 2.5 km of feeder 1C-411 (from 1C-Point Tupper to Statia tap) to 336 AAC
- ii. Control and communications between this Generating Facility and NSPI Supervisory Control and Data Acquisition (SCADA) system (to be specified)
- iii. Contributed cost for portion of 1C-411

The Interconnection Customer’s Interconnection Facility is to include:

- i. WTGs to provide 0.95 leading and lagging power factor when delivering rated output (10 MW)
- ii. Low voltage ride-through capability
- iv. Real-time monitoring RTUs of the Interconnection
- iii. Facilities for NSPI to execute high speed rejection of generation (transfer trip)

## **11 Magnitude of NSPI Interconnection Facilities Cost Estimate**

Estimates for NSPI Interconnection Facilities are included in Table 11-1.

<b>Table 11-1: Cost Estimates</b>		
	<b>Determined Cost Items</b>	<b>Estimate</b>
i	Reconductor 2.5 km line to 336AAC	\$150,000
li	Contributed Cost on 1C-411	\$30,000
ii	Control and communications between NSPI and customer	\$100,000
iii	Contingency (10%)	\$28,000
	<b>Total of Determined Cost Items</b>	<b>\$308,000</b>
<b>To be Determined Costs</b>		
vi	System upgrades to improve east to west flows	TBD (SIS)

In this case, the TBD costs may exceed the total of the determined cost items.

The above estimate includes the additions/changes to NSPI systems only. All costs of associated facilities required at the Generating Facility are in addition to the above estimate. Items identified as TBD will be assessed in the SIS. The estimated time to construct the “Determined Cost Items” will be 12 to 24 months, provided:

- accessible and tree-cleared lands or Rights Of Way (ROW) acceptable to NSPI for design and construction of any required new transmission line or Transmission Provider's substation are provided.
- that no more than 2 to 3 projects per year go forward, and assuming all easements and permits are provided and complete.

## 12 Preliminary Scope of System Impact Study

The SIS must determine the facilities required to operate this facility at full capacity, withstand the contingencies as defined by NPCC/NERC and identify any restrictions that must be placed on the system, following a first contingency loss. The SIS will be conducted with the assumption that all projects higher Queued will proceed and the facilities associated with those projects are installed.

The assessment will consider but not be limited to the following: The facility additions/changes required increasing NSPI east to west transfers under system normal conditions (all transmission in) over the range of NSPI loads and with interruptible loads on or off.

Some of the interfaces that may be constrained and should be included in the assessment are as follows:

- i. Cape Breton Export
- ii. Onslow Import

Steady-state and post contingency analysis will have all elements within acceptable voltage and thermal limits under the following single contingencies, in accordance with NPCC/NERC criteria:

- i. L-8004
- ii. Hopewell transformer 79N-T81
- iii. L-8003
- iv. Loss of double Circuit tower line L-8004 and L-7005 at Hastings

System stability will be assessed for the following faults:

- i. Loss of any element without a fault
  - a. L-8004
  - b. Hopewell transformer 79N-T81
  - c. L-8003
  
- ii. Three-phase fault cleared in normal time
  - a. L-8003 at Onslow end
  - b. L-8003 at Hopewell end
  - c. L-8004 at Woodbine end
  - d. High Voltage side of 79N-T81
  
- iii. Single-phase to ground fault cleared in backup time (Breaker failure)
  - a. L-8003 at Onslow with failure of 67N-812 (lose L-8002)
  - b. L-7012 at Lingan end with failure of 88S-712 (lose L-7014)
  
- iv. Single-phase to ground fault on separated circuits of double circuit tower
  - a. L-8004 plus L-7005 at Canso Crossing
  - b. L-7003 plus section of L-7004 at Trenton

Any changes to SPS schemes required for operation of this Generating Facility, in addition to existing generation and facilities that can proceed before this project, will be determined by the SIS as well as any required additional transmission facilities. The determination will be based on NERC and NPCC criteria as well as NSPI guidelines and good utility practice. The SIS will also determine the contingencies for which this facility may be curtailed.

In addition, a Distribution analysis will need to be performed to verify various issues related to the use of distribution feeder 1C-411 to transport power to the 1C-Point Tupper Substation. Such issues shall include, but not be limited to voltage levels, protection coordination, and compatibility with operational methods.