Interconnection Feasibility Study Report
GIP-027-FEAS-R1

System Interconnection Request # 27
100 MW Wind Generating Facility
Cumberland (L6513), NS

February 16, 2006

Control Centre Operations
Nova Scotia Power Inc.

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1) Introduction:

The Interconnection Customer submitted an Interconnection Request to NSPI for a proposed 100.5 MW wind generation facility interconnected to the NSPI system via a 138 kV line L6513 that runs between the (1N) Onslow and (74N) Springhill substation. 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 Study Agreement. The generation site would be located in Cumberland County, and connect to L-6513 approximately 32 km from (74N) Springhill, and at an accessible location just north of Sutherland Lake, via a newly constructed 138 kV line approximately 8 km in length (which connects the L6513 tap to the Interconnection Customer's substation).

2) Scope:

The Interconnection Feasibility Study 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; and

iii) preliminary description and non-bonding estimated cost of facilities required to interconnect the Generating Facility to the Transmission System, the time to construct such facilities, and to address the identified short circuit and power flow issues.

3) Assumptions:

The Point of Interconnection and configuration studied is as follows:

i) 100 MW wind farm comprised of 67 – 1.5 MW GE 1.5s wind turbines

ii) The wind generating facility is located approximately 8 km from L6513 (line tap location). The L6513 tap location is located approximately 30 km from (74N) Springhill.

iii) Transformer impedance assumed at 8% (on ONAN Base), rated 63/84//105 MVA

iv) This Feasibility Study is based on the assumption that projects that are ahead of this project in the Generation Interconnection Queue (Queue) will proceed.

4) Projects With Higher Queue Positions

As of 5 February 2007 the following projects can proceed ahead of this project, due to their position in the 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 MW – connected to L5573 (in-service)
- Wind Generation – 20 MW - distribution connected (in-service)
- Wind Generation – 40 MW – distribution connected (committed)

Generation projects with a higher Queue position, not yet committed
- #8 Wind – Guysborough L5527B 15 MW – Facilities Study complete
- #17 Wind – Lunenburg L6004 100 MW – Feasibility Study complete
- #21 Wind – Inverness L5579 30 MW – Feasibility Study complete
- #23 Wind – Inverness L6549 100 MW – Feasibility Study complete

This project and projects 8, 21 and 23 will increase east to west transmission loading and will also increase power transfers on Onslow South and therefore may increase reactive support requirements. Project 17, although ahead of this project in the Queue, does not share the same transmission facilities. All of the above projects can have a direct impact on this project for issues related to 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. Should any project that is ahead of this project be withdrawn, or changed, within the established procedures then this feasibility report and the SIS for this project must be updated accordingly, at the Interconnection Customer's expense.

5) Objective:

The objectives of the Feasibility Study are to identify the primary physical interconnection requirements. Specifically the short-circuit impacts on circuit breakers and any equipment overloads or voltage limits that may be exceeded under system normal (all transmission facilities in service). The Feasibility Study does not produce a binding estimate of all costs and changes that may be required to interconnect the facility. These costs are limited to facility additions/changes that are in the immediate vicinity of the proposed generating facility and any other system costs that are foreseen at the time this report is completed.

This assessment does not include any determination of facility changes/additions required to increase system transfer capabilities that may be required to meet the design and operating criteria established by the Northeast Power Coordinating Council (NPCC) and/or the North American Reliability Corporation (NERC) or required to maintain system stability. These requirements will be determined by the subsequent Interconnection System Impact Study (SIS).

6) Short-Circuit Duties

The maximum (future) expected short-circuit level on 138 kV systems is 5000MVA.

The short-circuit levels in the area before and after this development are provided in Table 5-1 below.

Table 5-1: Short-Circuit Levels. Three-phase MVA (1)		
Location	This generating facility in service	This generating facility not in service
All transmission facilities in service		
(74N) Springhill	1280	1190
L6513 Tap	1370	1130
138 kV Connection Pt (2)	1170	920
(1N) Onslow	2360	2239
L6513A (Springhill to Tap) Out		
(74N) Springhill		-------
L6513 Tap		700
138 kV Connection Pt		630
(1N) Onslow		990
L6513B (Onslow to Tap) Out		
(74N) Springhill		790
L6513 Tap		480
138 kV Connection Pt		440
(1N) Onslow		-------

(1) Classical fault study, flat voltage profile
(2) Connection Pt is at the 138 kV terminals of the interconnection substation

Although the actual increase in short-circuit levels will be dependent on the specific type of generator installed, the increase will not be more than 10% at (74N) Springhill and (1N) Onslow.

The short-circuit levels, following this development should be within the interrupting capability of circuit-breakers at (1N) Onslow and (74N) Springhill. The lowest rating of any circuit-breaker at these locations is 14.4 kA or 3400 MVA.

7) Thermal Limits

The ratings of L6513 are limited by ground clearance. The summer rating is 110 MVA. The rating of L6513 is a factor in the determination of NSPI's power import and export limits and in the setting and effectiveness of the import and export Special Protection Systems (SPSs).

While we do not expect the addition of this generating facility to, by itself, cause any overloads under system normal conditions (all transmission facilities in service) it may be overloaded following contingencies. This generation addition may require changes to the existing SPSs and, in order to maintain the existing transmission capability, require transmission upgrades between (1N) Onslow and (74N) Springhill. An assessment of the impact on the SPSs, the import and export capability, and any required transmission upgrades will be included in the SIS.

This generating facility will require a curtailment scheme and high speed rejection scheme for integration with NSPI SCADA controls and special protection schemes (SPSs) to maximize the capability of NSPI's transmission system, system security, and production of all generating facilities.

8) Voltage Control

The short-circuit level at the 138 kV tap, is 11.3 times generation capacity under system normal conditions. The ratio is 6.3 and 4.8 when operating with one end of L6513 open. While under system normal conditions voltage flicker and variation should not be a concern, it may be when operating with one end of the line open. Operation with one end of the line open is required to facilitate maintenance while permitting operation of this generating facility and also following operation of the Nova Scotia Import SPS. The SIS must determine the voltage flicker and variation that will occur for these three operating conditions and the facilities that must be employed to limit flicker and voltage variation to within acceptable limits.

The facilities included with this installation must be such that the facility is capable of providing both lagging and leading power factor of 0.95, measured at the 138 kV Point of Interconnection, when the facility is delivering 100 MW at the Point of Interconnection. A centralized controller will be required which adjusts individual generator real and reactive power output, in real time, and regulate the voltage at the Interconnection Customer's substation (Stevens Mountain). The voltage controls must be responsive to voltage deviations at the Interconnection Customer's substation, be equipped with a voltage set-point control, and also have facility that will slowly adjust the set-point over several minutes (5-10) to maintain reactive power just within the individual generators capabilities. The latter control may referred to as a slow-Q control. Details of the specific control features, control strategy and settings will be reviewed and addressed in the SIS.

NSPI must have manual and remote control of the voltage set-point, the slow-Q controls and reactive power output from this facility.

This facility must also have low-voltage ride-through capability. The SIS will verify this and state any specific options, controls and additional facilities that are required to achieve this.

9) System Limitations (System Security)

This addition of generation at this location will change the loading of transmission facilities between Truro, NS and Memramcook, NB. Limitations under system normal conditions were not noted in this assessment. However it is expected that this additional may cause post-contingency overloading of facilities following contingencies. The contingencies of concern are those which substantially change the loading of facilities between Nova Scotia and New Brunswick. Based on this assessment we expect that the SIS will determine that changes to the NS Import and Export SPSs are required. Changes to facilities (line ratings etc) may be required but are less likely.

This generating facility will increase loading on the Onslow South corridor (Truro to Halifax) by replacing generation south and west of (1N) Onslow. 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.

10) Expected Facilities Required for Interconnection

We expect the following facilities will be required assuming that the projects ahead of this project, in the queue, do not proceed.

Additions/Changes to NSPI systems

i) Tap L6513, installing three switches and a circuit switcher at the tap and grounding for live line operation

ii) Construct 8 km of 138 kV transmission from the L6513 tap to the generating facility

iii) Protection changes on L6513 at (74N) Springhill and (1N) Onslow. We expect this will entail replacing protection with a three-terminal protection scheme.

iv) Add communications for protection, controls, telemetry and SPSs between Springhill, Onslow, this generating facility and NSPI.

v) Modify existing NS Import and Export SPSs to cater to the operation of this facility

vi) Inclusion of generating facility into NSPI's generation rejection SPSs

Additions/Changes to be included at Stevens Mountain

i) 138 kV Interconnection substation. This will include 138 kV circuit breaker and protections as acceptable to NSPI, A Remote Terminal Unit (RTU) to interface with NSPI's Supervisory Control and Data Acquisition (SCADA) with telemetry and controls as required by NSPI.

ii) Facilities to provide 0.95 leading and lagging power factor when delivering rated output (100 MW) all at the Point of Interconnection when the voltage at that point is operating between 95 and 105 % of nominal.

iii) Centralized controls. These will provide centralized voltage set-point controls and slow-Q controls which acts to control the voltage on the 138 kV system and the reactive output of the machines. Responsive (fast-acting) controls are required. The controls will also include a curtailment scheme which will limit or reduce total output from the facility, upon receipt of a telemetered signal from NSPI's SCADA system. The controller will also limit the load ramp rate of the facility to within limits set by NSPI and/or telemetered from NSPI's SCADA system.

iv) NSPI to have control and monitoring of reactive output of this facility, via the centralized controller. This will permit the NSPI operator to raise or lower the voltage set-point and change the status of any slow-Q controls, remotely. NSPI will also have remote manual control of the load curtailment scheme.

v) Low voltage ride-through capability

vi) NSPI will require real-time monitoring (RTUs) of the interconnection substation

vii) Facilities for NSPI to execute high speed rejection of generation (transfer trip)

11) Magnitude of NSPI Interconnection Facilities Cost Estimate

Determined Cost Items	Estimate
i) Build 8 km 138 kV transmission in challenging terrain	$3,800,000
ii) Construct L6513 tap, three switches and circuit switcher	$350,000
iii) Protection changes Springhill and Onslow	$100,000
iv) Communications between Springhill, Onslow and generating facility	$500,000
v) Changes to Import/Export SPSs	$100,000
vi) Include generating facility in existing SPS schemes	$100,000
vii) Contingency (10%)	$450,000
Total of Determined Cost Item	$5,400,000
To Be Determined Cost Items	
viii) Transmission system changes to permit higher transfers	TBD (SIS)
Total	TBD

In this case the TBD costs may exceed the total of the determined costs. The TBD costs will be estimated following completion of the SIS. All costs associated with the Interconnection Customer's substation are not included in the above estimates. We estimate the time to construct the "Determined Cost Items" will be 18 months. The time to construct the TBD cost items will be estimated following completion of the SIS.

12) Issues to be addressed in subsequent SIS

The SIS must determine the facilities required to operate this facility at full capacity, withstand any first contingencies (as defined by NPCC/NERC) and identify any restrictions that must be placed on the system following a first contingency loss.

The assessment will consider but not be limited to the following.

i) The facility additions/changes required to increase 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 a follows.

   (1) All contingencies on 138 kV systems between Onslow and Memramcook

   (2) Onslow Import (Group 5 & 6 SPS)

   (3) Maritime Import & Export (SPS)

   (4) Strait Area SPSs

   (5) Onslow South and reactive support requirements

ii) First contingencies involving loss of, and operation following the loss of, the following.

   (1) L8001 out

   (2) L8003 out

   (3) L8002 out

   (4) Loss of L8002 & L8003

   (5) Loss of Hopewell (79N)

   (6) L6513 out

   (7) L6513A out

   (8) L6513B out

   (9) L6514 out

   (10) L6535 out

   (11) L6536 out

   (12) Memramcook transformer out

   (13) Loss of Load (272 MW)

   (14) Loss of generation (193 MW)

   (15) Two Unit generation loss (320 MW)

The changes to SPS schemes to permit 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 must be curtailed.

Control Centre Operations
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