Interconnection Feasibility Study Report
GIP-042-FEAS-R1

Generator Interconnection Request # 42
100 MW Wind Generating Facility
Cape Breton county, NS

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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 69 kV (1S) Seaboard bus. The interconnection customer specified an alternative interconnection point via a new (to be constructed) 138 kV line that will connect this generating facility to the existing (2S) Victoria Junction 138 kV substation. The Interconnection Customer subsequently 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 69kV (1S) Seaboard substation has, for the most part been removed and, been reduced to a simple line tap. Adding this facility to the 69 kV system would require rebuilding of transmission lines and replacement of apparatus. The 69kV interconnection option was therefore excluded from further evaluation as it was expected to be more expensive than the 138 kV option. The generation site would be located in Cape Breton County approximately 19 km from the (2S) Victoria Junction 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 19 km from the (2S) Victoria Junction 138 kV substation and will be connected to via a new 138 kV line

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 – 30.5 MW - connected to L-5027 (in-service)
Wind – 14 MW – connected to L5573 (in-service)
Wind – 20 MW - distribution connected (in-service)
Wind – 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
#27 Wind – Cumberland L6513 100 MW – Feasibility Study complete

This project and projects 21 and 23 will interconnect with the Cape Breton 138 kV system and may both invoke upgrades to 138 kV facilities between (2C) Port Hastings, (85S) Wreck Cove and (2S) Victoria Junction.

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 require expansion of the east to west transmission system and increase reactive support requirements. Project 17, although ahead of this project in the Queue, does not share the same 138 kV 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 subsequent System Impact Study (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 project proponents 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 project in service	This project not in service
All transmission facilities in service		
(2S) Victoria Junction	2290	2070
138 kV Connection Pt (2)	1300	1050
2S-B64 Out of service		
(2S) Victoria Junction	1490	1260
138 kV Connection Pt	1040	800

(1) Classical fault study, flat voltage profile
(2) Connection Pt is 19 km from (2S) Victoria Junction

The maximum short-circuit level on the (2S) Victoria Junction 138 kV bus is presently 2000 MVA. 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% (bringing the short-circuit level to not more than 2300 MVA at Victoria Junction). Under contingency operation, with one of the two 138 kV buses out of service, the short-circuit level approaches 1100 MVA at Victoria Junction (138 kV) and 800 MVA at the 138 kV connection point.

The interrupting capability of 138 kV circuit breakers at Victoria Junction are 3500 MVA or higher which will not be exceeded by this development. The supply (infeed from 230 kV transformers) and tie breakers are rated 1200 A continuous and the remaining breakers rated 800A continuous. The bus and switchgear are rated 1200A The marginal increase in short-circuit level is not expected to cause any need for upgrading protection, circuit breakers or switchgear at this location.

7) Thermal Limits

The 138 kV VJ bus is rated 1200 with some of the connections and switches rated 800 A. Although the connected 138 kV circuits have lower ratings thermal overloads during normal operation (all transmission facilities in) are not anticipated. Connecting this facility to bus 2S-B65 (rather than bus 2S-B64) should be the least restrictive under first contingency operation.

This project will add generation to the 138 kV system in Cape Breton. We expect that the addition of this facility alone should not result in any overloads under system normal operating conditions. However, two other projects with higher Queue positions, will also add generation to this system. This project may contribute to the overloads and required upgrades/expansion.

This generating facility will require a curtailment scheme and high speed rejection scheme for integration with NSPI's Supervisory Control and Data Acquisition (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 ratio of short-circuit level to generating capacity ranges from 20 to 10 at Victoria Junction and is above 7 at the 138 kV connection point. These are reasonable ratios indicating that voltage variation should be acceptable at Victoria Junction and on the 138 kV system at the connection point. Problems with voltage control, deviation or voltage flicker should not occur provided that control equipment is correctly specified, set and maintained at this facility.

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 138 kV Point of Interconnection. The voltage controls must be responsive to voltage deviations at the Point of Interconnection, 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)

The NSPI transmission system has limited east to west transfer capability. Transmission corridors between Sydney and Halifax are often operated to security limits. Under system normal conditions generation rejection SPSs are utilized to increase system stability limits to maximize east to west power transfers. Therefore, the additional generating capacity, that this facility provides, cannot be integrated into the NSPI system, under all dispatch conditions, without system upgrades. System upgrades will be required to increase transmission capacity from the east end of NSPI's system to the load centers.

The extent of the facility additions/changes required to increase the east-west transmission capability will be determined by the SIS.

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 and in keeping with good utility practices.

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) 138 kV circuit breaker, switchgear and protection for line termination at Victoria Junction

ii) Approx 19 km 138 kV transmission 556 MCM ACSR (Victoria Junction to generating facility) with fiber optic link

iii) Control and Communications between Victoria Junction, generating facility & NSPI SCADA system (to be specified)

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

v) Changes to NSPI system/SPSs to permit higher east to west transfers under normal system conditions (all facilities in) without any additional generation constraints

Additions/Changes to be included at the generating facility

i) 138 kV Interconnection Substation. This will include 138 kV circuit breaker and protections as acceptable to NSPI, An RTU to interface with NSPI's 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 138 kV interconnection point 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 Remote Terminal Units (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 19 km 138 kV standard. transmission with fibre link	$4,600,000
ii) Victoria Junction, breaker, switches, protection	$1,000,000
iii) Control & Communications between NSPI and customer	$200,000
iv) Additions and changes to NSPI SPSs (NSPI costs only)	$100,000
v) Contingency (10%)	$600,000
Total of Determined Cost Items	$6,500,000

To Be Determined Cost Items	
vi) System additions to increase east-west transfer capability	TBD (SIS)
Total:	TBD

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

The above estimate includes the additions/changes to NSPI systems with the exception of item vi) which will not be known until the SIS is complete. All costs associated with facilities required at the Interconnection Customer's substation and generating facility are in addition to the above estimate. We estimate the time to construct the "Determined Cost Items" will be 14-18 months.

12) Issues to be addressed in the 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 associated with Cape Breton 138 kV system

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

(3) Cape Breton Export (Group 5 & 6 SPS)

(4) Lingan Total Gross generation

(5) Lingan overfrequency SPS

(6) L6538 Overload SPS

(7) Onslow South and reactive support requirements

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

(1) L7011

(2) L7012

(3) L7014

(4) L8004

(5) L8003

(6) L6503

(7) L6516

(8) L6537

(9) L6538

(10) L6539

(11) L6545

(12) L6549A, L6549B

(13) 88S-T71

(14) 88S-T72

(15) Operation with circuit breaker 2S-600 Open

(16) L8001 out (Import and Export Limits)

(17) 3C-T71

(18) 3C-T72

(19) 2C-B61

(20) 2C-B62

(21) Circuit breaker 2C-600 open

(22) Circuit breaker 1C-689 open

(23) Circuit Breaker 2S-600 open

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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