Interconnection Feasibility Study Report

GIP-551-FEAS-R1

System Interconnection Request #551

50.4 MW Wind Generating Facility

Cumberland County (L-6535)

2017-03-31

Control Centre Operations
Nova Scotia Power Inc.

Executive Summary

The Interconnection Customer (IC) submitted an Interconnection Request (IR#551) for Network Resource Interconnection Service (NRIS) for a proposed 50.4 MW wind generation facility interconnected to the NSPI transmission system, with a Commercial Operation Date of 2022-12-31. The Point of Interconnection (POI) requested by the customer is on the 138 kV transmission line L-6535, at or near the existing substation 92N-Amherst Wind Farm. An alternate POI was proposed for a new substation intersecting L-6536 approximately 5 km south of the Nova Scotia – New Brunswick border.

The Generation Interconnection Procedures do not confer any rights to receive transmission service, which must follow the procedures of the NSPI Open Access Transmission Service. Preceding IR#551 is a long-term firm transmission service reservation in the amount of 330 MW from Nova Scotia to New Brunswick, as well as two transmission Interconnection Requests ahead of IR#551 which are considered in this study

NRIS service for IR#551 is expected to honour the long term firm reservation for delivery of 330 MW to the NS-NB border, plus delivery of between 172 MW and 220 MW of operating reserve to NB Power in accordance with reserve sharing agreements (Transmission Reservation Margin). This combination can result in a total transfer of 600 MW. This study examined transmission contingencies inside Nova Scotia to determine if thermal loading criteria would be violated for full NRIS operation with increased power export from Nova Scotia.

The assessment of the POI on the 138 kV line L-6535 indicated no upgrades would be necessary to interconnect 50.4 MW. A similar result was found for the alternate POI on L-6536.

No upgrades were found to be necessary to allow for increased export capability from Nova Scotia to New Brunswick beyond the long term firm reservation of 330 MW and the Transmission Reliability Margin to deliver up to 220 MW of reserve to NB Power,

Although normally outside the scope of a feasibility study for the NSPI system, a contingency in New Brunswick (loss of the 345kV line from Memramcook to Salisbury) was found to cause the Memramcook 345 kV transformer to reach 100% of its emergency rating in summer. This should be addressed by NB Power in the transmission service request studies under the NB Power OATT.

Data provided by the IC indicates that IR#551 should be able to meet this requirement without additional reactive support. Depending on the final design of the 34.5 kV collector circuits and the transformer impedances, supplementary reactive support may be needed in the form of capacitor banks at the low voltage terminals of the Interconnection Transformer, unless optional generator specifications are considered. This will be further investigated in the System Impact Study.

No concern regarding high short-circuit level or voltage flicker was found for this project on its own, provided that the project design meets NSPI requirements for low-voltage ride-through, reactive power range and voltage control system. Harmonics must meet the Total Harmonics Distortion provisions of IEEE 519. Short Circuit Ratio may be an issue for inverter-based

generation controls. The minimum short circuit level at the either the POI or the alternate POI is 1017 MVA with all lines in service, and 473 MVA with a line out of service. Short Circuit Ratio of between 9.4 and 20.2 should not be an issue for Type 4 generator control design.

Because of the proximity to the NS-NB border, IR#551 has a negligible loss factor.

IR#551 is not part of the Bulk Power System, and therefore protection systems do not need to meet NPCC BPS criteria.

The preliminary non-binding cost estimate for interconnecting 50.4 MW at L-6535 or the alternate POI on L-6536 would be $6,600,000 for NRIS. This cost estimates include a contingency of 10% and they will be further refined in the System Impact Study and the Facility Study. It may be feasible to interconnect IR#551 to the existing substation 92N-Ahmerst Wind Farm at a lower cost, but this will be determined in a subsequent Facility Study.

Table of Contents

Page

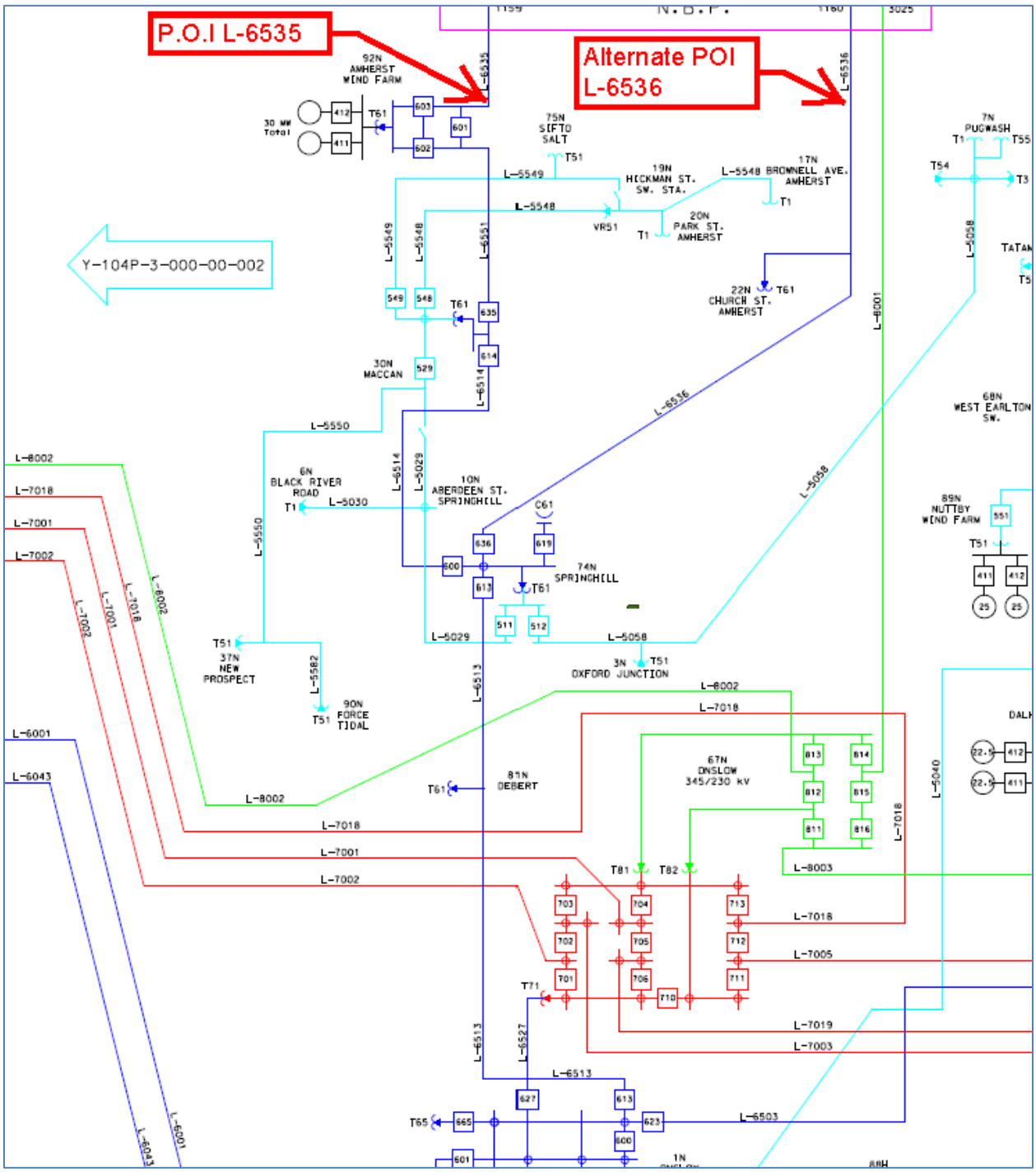
1 Introduction

The Interconnection Customer (IC) submitted an Interconnection Request (IR#551) for Network Resource Interconnection Service (NRIS) for a proposed 50.4 MW wind generation facility interconnected to the NSPI transmission system, with a Commercial Operation Date of 2022-12-31. The Point of Interconnection (POI) requested by the customer is on the 138 kV transmission line L-6535 at or near 92N-Amherst Wind Farm. An alternate POI was requested as a new substation connected to line L-6536 approximately 5 km south of the Nova Scotia – New Brunswick border. Figure 1 shows the proposed POI with the present configuration for L-6513 between 1N-Onslow and 74N-Springhill.

This configuration will change in 2018. A new high-capacity 138 kV transmission line designated L-6613 will replace L-6513 and will be connected into 1N-Onslow and 74N-Springhill using the existing switchgear.

The Interconnection Customer (IC) signed a Feasibility Study Agreement to study the connection of their proposed generating facility to the NSPI transmission system dated 2017-03-13, and this report is the result of that Study Agreement. This project is listed as Interconnection Request #551 in the NSPI Interconnection Request Queue, and will be referred to as IR#551 throughout this report.

Figure 1 Point of Interconnection (not to scale)



2 Scope

This Interconnection Feasibility Study (FEAS) consists of a power flow and short circuit analysis. Based on this scope, the FEAS report shall provide the following information:

1. Preliminary identification of any circuit breaker short circuit capability limits exceeded as a result of the interconnection;
2. Preliminary identification of any thermal overload or voltage limits violations resulting from the interconnection;
3. Preliminary description and high level non-bonding estimated cost of facilities required to interconnect the Generating Facility to the Transmission System and to address the 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.

In accordance with Section 3.2.2.2 of the Standard Generation Interconnection Procedures (SGIP), “the Interconnection Study for NR Interconnection Service shall assure that the Interconnection Customer's Generating Facility meets the requirements for NR Interconnection Service and as a general matter, that such Generating Facility's interconnection is also studied with the Transmission Provider’s Transmission System at peak load, under a variety of severely stressed conditions, to determine whether, with the Generating Facility at full output, the aggregate of generation in the local area can be delivered to the aggregate of load on the Transmission Provider’s Transmission System, consistent with the Transmission Provider’s reliability criteria and procedures”.

A more detailed analysis of the technical implications of this development will be included in the System Impact Study (SIS) report. The SIS includes system stability analysis, power flow analysis such as single contingencies (including contingencies with more than one common element), 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 generation 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 and will include an assessment of the status of the Interconnection Facility as a Bulk Power System element. The SIS may identify and provide a non-binding estimate of any additional interconnection facilities and/or network upgrades that were not identified in this FEAS.

An Interconnection Facilities Study follows the SIS in order to ascertain the final cost estimate to interconnect the generating facility.

In accordance with Section 2.4 of the SGIP, "Nothing in this GIP shall constitute a request for transmission service or confer upon an Interconnection Customer any right to receive transmission service". Transmission Service is subject to the requirements of the Nova Scotia Power Inc. Open Access Transmission Tariff (OATT).

This study does not examine the effects of increased wind generation on the overall operation and security of the NSPI power system. The most recent Integrated Resource Plan indicated that the maximum amount of wind generation which the NSPI system could accept without significant reinforcement of the ties with other systems was about 600 MW, which has currently been exceeded with the recent Community Feed-In Tariff (COMFIT) Program.

3 Assumptions

This FEAS is based on the technical information provided by the Interconnection Customer. The Point of Interconnection (POI) and configuration is studied as follows:

1. Network Resource Interconnection Service type per section 3.2 of the SGIP.

2. Commercial Operation date 2022-12-31.

3. The Interconnection Facility consists of 50.4 MW net generation with 12 units of 4.2 MW Enercon E-141 EP4-FT Wind Turbines on two collector circuits. These are classified as Type 4 Wind Energy Conversion Systems using full IGBT inverter technology.

4. The IC indicated that the POI is at the 138kV substation 92N-Amherst Wind Farm connected to L-6535 (north to the NS-NB Border) and L-6551 south to 30N-Maccan. An alternate POI is indicated at a new substation intersecting line L-6526 between 74N-Springhill and the NS-NB border, approximately 5 km from the border. This study will assume that the Interconnection Facility is adjacent to the existing transmission line L-6535 or L-6536 and there is negligible transmission circuitry from the POI to the wind farm transformer substation.

5. The generation technology used must meet NSPI requirement for reactive power capability of at least 0.95 capacitive to 0.95 inductive at the HV terminals of the IC Substation Step Up transformer. It is also required to have high-speed Automatic Voltage Regulation to maintain constant voltage at the designated voltage control point during and following system disturbances as determined in the subsequent System Impact Study. The designated voltage control point will either be the low voltage terminals of the wind farm transformer, or if the high voltage terminals are used, equipped with droop compensation controls. It is assumed that the generating units are not de-rated in their MW capability when delivering the required reactive power to the system.

6. Preliminary data was provided by the IC for the IC substation step-up transformers. Modeling for the primary interconnection point was conducted with a 138 kV-34.5 kV transformers rated 36/48/60 MVA. The Interconnection Facility transformer was modeled with a positive sequence impedance of 8.0% and an X/R ratio of 28. The IC indicated that this Interconnection Facility transformer has a grounded wye-delta winding configuration with +/-10% on-load tap changer and a separate grounding transformer; however NSPI indicated in the scoping meeting that the preferred winding arrangement is grounded wye – grounded wye with a delta tertiary and eliminate the need for the grounding transformer. The impedance of generator step-up transformers is assumed to be 6% on 4.8 MVA with an assumed X/R ratio of 7.5.

7. Collector circuit data was not provided, so typical data was assumed with the understanding that the net real and reactive power output of the plant will be impacted by losses through transformers and collector circuits.

8. The FEAS analysis is based on the assumption that IR's higher in the Generation Interconnection Queue and OATT Transmission Service Queue that have completed a System Impact Study, or that have a System Impact Study in progress will proceed, as listed in Section 4 below.

9. The IC indicated that the wind turbines are equipped with a "cold weather option" suitable for delivering full power under expected Nova Scotia winter environmental conditions. The data sheet supplied with the application provided a winter rating based on an ambient temperature of -30°C, which would be considered suitable for Nova Scotia.

10. The IC has indicated that this project is intended for export from Nova Scotia, and as such, there will be no adverse impact on Native Load Customers in the form of out-of-merit dispatch costs, compromised reliability, or any ancillary services outside the requirements of the NSPI OATT.

11. Planning criteria meeting NERC Standard TPL-001-4 *Transmission System Planning Performance Requirements* and NPCC Directory 1 *Design and Operation of the Bulk Power System* as approved for use in Nova Scotia by the Utility and Review Board, are used in evaluation of the impact of any facility on the Bulk Electric System.

12. All committed transmission upgrades associated with the Maritime Link have been completed.

4 Projects with Higher Queue Positions

All in-service generation is included in the FEAS.

As of 2017-03-31 the following projects are higher queued in the Interconnection Request Queue and OATT Transmission Service Queue, and have the status indicated.

Interconnection Requests -Included in FEAS

- All distribution connected generation qualified under the COMFIT program
- IR #426 GIA Executed, in-service
- IR #507 GIA Executed
- IR #516 GIA Executed
- IR #540 GIA in Progress
- IR #542 SIS in Progress

Interconnection Requests –Not Included in FEAS

- IR #514 FEAS complete
- IR #543 Load FAC in progress
- IR #549 FEAS in progress
- IR #550 FEAS in progress

OATT Transmission Service Queue– Included in FEAS

- TSR-400 Long Term Firm Point to Point, under construction

OATT Transmission Service Queue– Not included in FEAS

- TSR-401 Point to Point Application Complete
- TSR-402 Network, Application Complete
- TSR-403 Point to Point, Application Complete
- TSR-404 Network, Application Complete
- TSR-405 Network, Application Complete
- TSR-406 Network, Application Complete

Only Transmission Service Request TSR-400 and Interconnection Requests IR#516 and IR#542 are expected to have an impact on IR#551.

If any of the higher-queued projects included in this FEAS are subsequently withdrawn from the Queue, the results of this SIS may require updating or a re-study may be necessary. The re-study cost incurred as a result of the withdrawal of the higher-queued project shall be the responsibility of the Interconnection Customer that withdraws the higher queued project.

5 Objective

The objective of this FEAS is to provide a preliminary evaluation of the system impact and the high-level non-binding cost estimate of interconnecting the 50.4 MW generating facility to the NSPI transmission system at the designated location(s). The assessment will identify potential impacts on the loading of transmission elements, which must remain within their thermal limits. Any potential violations of voltage criteria will be identified and addressed. If the proposed new generation increases the short-circuit duty of any circuit breakers beyond their rated capacity, the circuit breakers must be upgraded. Single contingency criteria[1] are applied for both NRIS and ERIS assessments.

This FEAS is based on a power flow and short circuit analysis and does not include a complete determination of facility changes/additions required to increase system transfer capabilities that may be required to the Bulk Power System to meet the design and operating criteria established by NPCC and NERC or required to maintain system stability. These requirements will be determined by the subsequent interconnection System Impact Study (SIS).

Although this FEAS is not meant to constitute a System Impact Study for Transmission Service under the OATT, it is acknowledged that this project is intended for export from Nova Scotia and will be studied in two ways; the first will assume that the output from IR#551 will not displace any firm transactions and will be incremental to established transfer levels, the second will assume that the anticipated transfer limit between Nova Scotia and New Brunswick in 2022 is honoured.

[1] A Single Contingency is defined by NPCC as "A single event, which may result in the loss of one or more elements".

6 Short-Circuit Duty / Short Circuit Ratio

The maximum (design) expected short-circuit level is 5000 MVA on 138 kV systems. The short-circuit levels in the area before and after this development at either of the POI are provided below in Table 6-1. Because the generator type for IR#551 is Type 4, the fault characteristics are given as only slightly greater than full load current, or X'd = 1.0 per unit.

Table 6-1: Short-Circuit Levels. IR551 on L-6535 or L-6536 Three-phase MVA [(1)]

Location	Without IR #551	With IR #551
All transmission facilities in service		
Point of Interconnection	1126	1167
30N-Maccan 138 kV	1050	1074
Minimum Conditions		
Point of Interconnection	473 line out	1017 lines in

(1) Classical fault study, flat voltage profile

The maximum short-circuit level at the POI on L-6535 (92N-Amherst Wind) with IR#551 off-line will be 1126 MVA in 2021. With IR #551 on-line the short-circuit level will increase to 1167 MVA at the POI. Similarly, under minimum generation conditions, the short circuit level will be 1017 MVA with all lines in-service, and 473 MVA with the line from the POI to Memramcook NB out of service. This translates into minimum Short Circuit Ratio of between 9.4 and 20.2, which would generally be considered acceptable for Type 4 generator controls.

IR#551 does not add appreciable fault duty to local circuit breakers.

7 Voltage Flicker and Harmonics

Due to the lack of flicker coefficient information on the Enercon E-141 Wind Turbines, this study assumes the same flicker data as for the Enercon E-82 machine. Type 4 wind turbines are not expected to result in appreciable voltage flicker at minimum generation conditions. Therefore voltage flicker should not be a concern for this project.

The generator is expected to meet IEEE Standard 519-1992 limiting voltage Total Harmonic Distortion (all frequencies) to a maximum of 1.5%, with no individual harmonic exceeding 1.5% on 138 kV.

8 Thermal Limits

This facility is requested to be interconnected via a new substation connected to the existing 138 kV transmission line L-6535 near 92N-Amherst Wind Substation as shown in Figure 1. The transmission lines connected to this POI are designed, insulated and operated at 138 kV (insulator strings, phase spacing, conductor height). An alternate POI was identified as a new substation intersecting line L-6536, approximately 5 km south of the NS-NB border. Transmission lines in the vicinity are built to the specifications shown in Table 8.1

Table 8.1 Local Transmission Element Limits

Line	Conductor	Design Temperature	Limiting Element	Summer Rating Normal/Emergency	Winter Rating Normal/Emergency
L-6535	556.5 Dove	100°C	Conductor	214/234	242/266
L-6536	556.5 Dove	100°C	Metering	173/190	173/190
L-6514	556.5 Dove	60°C	Conductor/Switch	140/154	143/157
L-6613	1113 Beaumont	100°C	Switchgear	287/316	287/316
L-6513	556.5 Dove	50°C	Conductor	110/121	165/181
L-6551	556.5 Dove	100°C	Switch	143/157	143/157
L-1159	NB Power Equipment 80°C /100°C			175/213	215/222
L-1160	NB Power Equipment 80°C /100°C			175/213	215/246

IR#551 would feed into the Nova Scotia – New Brunswick Interface and has the potential to impact NS export and import limits. It must be assumed that when IR#551 is operating at full rated power, then all other wind power generation sources in the local area are also operating at full rated power. Because this Interconnection Request is requested to be NRIS, then IR#551 will be incremental to economically dispatched generation serving native load and committed firm transmission reservations.

There is a long-term firm transmission reservation between Nova Scotia and New Brunswick (Transmission Service Request TSR-400) of 330 MW. Transmission upgrades are underway to permit the NS-NB transfer of 330 MW plus the delivery of between 172 MW and 220 MW of shared Operating Reserve in accordance with the NS-NB Interconnection Agreement for a total capability of between 502 MW and 552 MW.

As NRIS, IR#551 adds 50.4 MW to the flow across the Nova Scotia - New Brunswick border, resulting in a total export of between 550 MW and 600 MW, including the firm transmission reservation of 330 MW and the delivery of shared operating reserve to New Brunswick. While exporting high amounts of power from NS, the Export Power Monitor SPS (NPCC Type III) must be armed to quickly reject/runback up to 330 MW of generation in Nova Scotia to avoid overload of the parallel 138kV transmission, maintain synchronism between the NS and NB power systems, and avoid excess over-frequency operation of the NS power system. Loss of L-8001 (designated L-3025 on the New Brunswick side of the border) will activate this SPS for the following contingencies:

- Loss of L-8001/L-3025 for any reason
- Breaker failure of 67N-814 (L-8001, 67N-T81)
- Breaker failure at Memramcook NB (L-3006, L-8001/L-3025, ME-T3)

No contingency conditions were found to result in thermal limits being exceeded with IR#551 on-line at either 550 MW of NS export (i.e. with 172 MW of reserve delivered to NB Power) or 600 MW of NS export (i.e. with 220 MW of reserve delivered to NB Power). A contingency in New Brunswick, loss of the 345kV line L-3006, resulted in the Memramcook 345kV transformer reaching 101% of its summer emergency rating. Such a condition would be addressed by NB Power in the course of SIS for transmission service through their system.

Because IR#551 is located between Onslow and the NB Border, the impact of the project on import from NB must be considered. Importing more than 100 MW from NB is possible with the Import Power Monitor SPS, which provides a controlled separation of Nova Scotia from New Brunswick if line L-3006 and/or L-8001 is lost. It was found that, after the building of line L-6613, there would be no impact of IR#551 on the Import Power Monitor setting of 100 MW. It would be possible to set the Import Power Monitor SPS arming at higher import values, up to the point where voltage collapse would be experienced for the simultaneous loss of L-8001 and L-3006 (as would be the case for a breaker failure at Memramcook 345kV). The Import Power Monitor setting of 150 MW can be used if IR#551 is installed.

There was no difference in results found for winter or for the alternate POI on L-6536.

9 Voltage Limits

This project, like all new generating facilities must be capable of providing both lagging and leading power factor of 0.95, measured at the HV terminals of the IC Substation Step Up Transformer, at all production levels up to the full rated load of 50.4 MW. This translates into a reactive delivery of 15.6 Mvar leading and lagging.

Data provided by the IC indicates that IR#551 should be able to meet this requirement without additional reactive support. The data sheet indicated that the Enercon E-141 4.2 MW WECS would be used, with a rated power factor (pf) is 0.90, total of 26.6 Mvar, at the machine terminals. Depending on the characteristics of the collector circuits and given the impedances of the transformers, supplementary reactive support may be needed in the form of capacitor banks at the low voltage terminals of the Interconnection Transformer. Another alternative would be a mixture of WECS with better pf ratings (FT and FTQ models). This will be further investigated in the System Impact Study.

A centralized controller will be required which continuously adjusts individual generator reactive power output within the plant capability limits and regulates the voltage at the 34.5 kV bus voltage. The voltage controls must be responsive to voltage deviations at the terminals of the Interconnection Facility substation, be equipped with a voltage set-point control, and also have the ability to slowly adjust the set-point over several (5-10) minutes to maintain reactive power within the individual generators capabilities. The details of the specific control features, control strategy and settings will be reviewed and addressed in the SIS, as will the dynamic performance of the generator and its excitation. Line drop compensation, voltage droop, control of separate switched capacitor banks must be provided.

The NSPI System Operator must have manual and remote control of the voltage set-point and the reactive set-point of this facility to coordinate reactive power dispatch requirements.

This facility must also have low voltage ride-through capability as per Appendix G of the Standard Generator Interconnection and Operating Agreement (GIA). The SIS will state specific options, controls and additional facilities that are required to achieve this.

Enercon offers an optional STATCOM feature which provides reactive power and voltage control down to zero real power operation (low wind). It is recommended that the IC obtain an optional quote for this feature, as it may help to support system voltage and stability during high power transfer levels. The need for this feature will be further examined in the SIS.

10 System Security / Bulk Power Analysis

As noted in Section 8, the transmission capacity between Nova Scotia and New Brunswick is limited to the long term firm transmission reservation associated with the Maritime Link, including the transmission capacity necessary to deliver reserve to NB Power under the Interconnection Agreement. This study has confirmed that, due to the specific POI for IR#551, there is enough incremental capacity available to support this NRIS application at the locations identified.

It is important to note that export capability above about 100 MW is dependent on the availability of sufficient generation in Nova Scotia to be rejected or run-back by SPS action. This means that for NS export up to 330 MW, the Maritime Link must be operating in import mode in excess of 330 MW or two thermal units at Pt. Aconi/Lingan must be operating at full load to provide the required run-back capability.

The SIS will determine if any facility changes are required to permit the proposed higher transmission loadings while maintaining compliance with NERC/NPCC standards and in keeping with good utility practice.

The POI on either L-6535 or L-6536 is not considered Bulk Power System (BPS), and therefore the Interconnection Substation does not need to be designed to meet the requirements of NPCC Directory 4 *System Protection Criteria*.

11 Expected Facilities Required for Interconnection

The following facility changes are required to interconnect IR #551 at the proposed POI:

Additions/Changes for POI on the 138 kV circuit L-6535:

1. A three-breaker ring bus development adjacent to the right-of-way of L-6535, designed for 138 kV, non-BPS. There is a potential for modification of the existing 92N-Amherst Wind Farm to create a new node for IR#551, but this engineering detail will be examined in the subsequent Facility Study. If IR#551 is interconnected north of 92N, interprovincial intertie metering must be moved to that site.
2. Modification of NSPI protection systems,
3. Control and communications between the wind farm and NSPI SCADA system (to be specified).

The following additional network upgrades are required to provide NRIS service for export:

4. No additional transmission upgrades were identified to support NRIS.

Additions/Changes for Alternate POI on the 138 kV circuit L-6536:

1. A three-breaker ring bus development adjacent to the right-of-way of L-6536, designed for 138 kV, non-BPS.
2. Modification of NSPI protection systems,
3. Control and communications between the wind farm and NSPI SCADA system (to be specified).

The following additional network upgrades are required to provide NRIS service for export:

4. No additional transmission upgrades were identified to support NRIS.

Requirements for the Generating Facility

1. It is assumed that the Interconnection Substation is located at the POI. If not, a radial branch line to a new Interconnection Substation would be required. The branch line would be designed for 138 kV and would be shielded for at least 1 km out of the Interconnection Substation. The Interconnection Substation would require circuit breakers at high side of each of the customer power transformer and protection as

acceptable to NSPI. A Remote Terminal Unit (RTU) to interface with NSPI's SCADA, with telemetry and controls as required by NSPI.

2. Facilities to provide 0.95 leading and lagging power factor when delivering rated output at the HV terminals of the IC Substation Step Up Transformer when the voltage at that point is operating between 95 and 105 % of nominal. The functionality of Enercon STATCOM mode should be considered.
3. Centralized controls. These will provide centralized voltage set-point controls and are known as Farm Control Units (FCU). The FCU will control the 34.5 kV bus voltage 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.
4. 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 remotely.
5. Low voltage ride-through capability as per Appendix G to the Standard Generator Interconnection and Operating Agreement (GIA).
6. Real-time monitoring (including an RTU) of the interconnection facilities. Local wind speed and direction, MW and Mvar, as well as bus voltages are required.
7. Facilities for NSPI to execute high speed rejection of generation (transfer trip) if determined in SIS. The plant may be incorporated into SPS run-back schemes.
8. Synthesized inertial response similar to the features of Enercon IE controls.
9. Automatic Generation Control to assist with tie-line regulation.
10. Operation at ambient temperature of -30°C

12 NSPI Interconnection Facilities and Network Upgrades Cost Estimate

Estimates for NSPI Interconnections Facilities and Network Upgrades for interconnecting 50.4 MW wind energy onto the preferred POI on the 138 kV line L-6535 or the alternate POI on L-6536 are included in Table 12-1.

Table 12-1: Cost Estimates identified from FEAS scope Primary or Alternate POI

	Determined Cost Items	Estimate
NSPI Interconnection Facilities		
i	Site preparation for new substation at POI on L6535	$1,000,000
ii	138 kV 3-breaker ring bus primary equipment and control building	$4,000,000
iii	Protection, control	$300,000
vi	Protection modifications for remote sites	$200,000
vii	Communications	$500,000
viii	Subtotal without increased export capability	$6,000,000
ix	Contingency (10%)	$600,000
x	Total	$6,600,000
Network Upgrades for NRIS		
xi	None	$600,000
Totals		
xii	Contingency (10%)	$600,00
xiii	Total of Determined Cost Items	$6,600,000
	To be Determined Costs	
xiv	System additions to address potential stability limits	TBD (SIS)
xv	Memramcook transformer loading issue	TBD (NB Power SIS)

The preliminary non-binding cost estimate for interconnecting 50.4 MW at the POI on L-6535 or the alternant POI on L-6536 would be $6,600,000 including a contingency of 10%. Because the location of the POI and the alternate POI demonstrated that there is transmission capability to support increased export from NS to NB, NRIS is provided without incremental transmission upgrade costs.

12 Loss Factor

Injection of 50.4 MW of power at the POI, for delivery to NB border will be incremental to transmission system losses serving native load. To assist in the evaluation of the impact of the location of the POI and alternate POI, loss factors from the POI to the NS-NB border were calculated. This calculation does not include any losses from the generators to the POI (generator transformer, collector circuits, Interconnection Substation equipment, or any radial circuit from the Interconnection Substation to the POI):

- POI on L-6535, Loss Factor - negligible
- Alternate POI on L-6536 - negligible

This means, for example, if output of IR#551 was raised from 0 MW to 50 MW at the POI, the incremental amount of power received at the NS-NB border would be 50 MW.

13 Issues to be addressed in SIS

The following provides a preliminary scope of work for the subsequent SIS for IR#551. The SIS will include a more comprehensive assessment of the technical issues and requirements to interconnect generation as requested. It will include contingency analysis, system stability and ride through and operation following a contingency (N-1 operation). The SIS must determine the facilities required to operate this facility at full capacity, withstand any contingencies (as defined by the criteria appropriate to the location) and identify any restrictions that must be placed on the system following a first contingency loss. The SIS will confirm the options and ancillary equipment that the customer must install to control flicker, voltage and ensure that the facility has the required ride-through capability. The SIS will be conducted in accordance with the GIP with the assumption that all appropriate higher-queued projects will proceed and the facilities associated with those projects are installed.

The following outline provides the minimum scope that must be complete in order to assess the impacts. It is recognized the actual scope may deviate, to achieve the primary objectives.

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

i. Facilities that the customer must install to meet the requirements of the GIP
ii. The minimum transmission additions/upgrades that are necessary to permit operation of this Generating Facility, under all dispatch conditions, catering to the first contingencies listed.
iii. Guidelines and restrictions applicable to first contingency operation (curtailments etc.)
iv. Under-frequency load shedding impacts

To complete this assessment the following first contingencies, as a minimum, will be assessed:

- L-8001/3025
- L-3006
- Memramcook 345/138 kV transformer
- L-6535
- L-6514
- L-6535/L-1159
- L-6535/L-1160
- L-8001 & 67N-T81 (common circuit breaker)
- L-8002 & 67N-T81 (common circuit breaker)
- L-3006 & L-3025 & Memramcook 345/138 kV Tx (common breaker)
- L-3006 & L3017 (common breaker)
- L-1108/1190 Common 138 kV structure

- Loss of 180 MW of load under peak load conditions
- Loss of largest generation source in NS
- Loss of Maritime Link

To complete this assessment the dynamics of the following first contingencies, as a minimum, will be assessed:

- 3 phase fault L-8001/3025 at 67N-Onslow, NS Import SPS operation (islanding)
- 3 phase fault L-8001/3025 at 67N-Onslow, NS Export SPS operation
- 3 phase fault L-3006 at Memramcook, NB SPS/UVLS operation (islanding)
- 3 phase fault L-3006 at Memramcook, NB Export SPS
- 3 phase fault L-3006 at Salisbury, NB SPS/UVLS operation (islanding)
- 3 phase fault L-8003 at 67N-Onslow
- 3 phase fault L-8002 at 67N-Onslow
- SLG L-3017, drops L-3017&L-3006 (common CB), NB SPS/UVLS operation,
- SLG Memramcook T3, drops L-3006 (common CB), NB SPS/UVLS operation
- SLG L-8003 at Onslow, drops 67N-T82, 345kV SPS Operation
- 3 phase fault at 79N-Hopewell, drops L-8003, 8004, bus, SPS operation

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[2] and NPCC[3] criteria as well as NSPI guidelines and good utility practice. The SIS will also determine the contingencies for which this facility must be curtailed.

Nova Scotia Power
Transmission System Operations
2017-03-31

[2] NPCC criteria are set forth in its Reliability Reference Directory #1 *Design and Operation of the Bulk Power System*
[3] NERC transmission criteria are set forth in *NERC Reliability Standards TPL-001, TPL-002, TPL-003*