Interconnection Feasibility Study Report
GIP-IR801-FEAS-R0

Generator Interconnection Request 801
7 MW Solar Generating Facility
Cumberland County, NS

2025-02-13

Control Centre Operations
Nova Scotia Power Inc.

Executive Summary

The Interconnection Customer (IC) submitted a Network Resource Interconnection Service (NRIS) Interconnection Request for a proposed 7 MW solar generation facility interconnected to the NSPI distribution system, with a Commercial Operation Date of 2026-05-01. The Point of Interconnection (POI) requested by the customer is the NSPI 12.5 kV distribution circuit 6N-301, approximately 2.7 km from 6N-Black River Rd.

Preliminary Assessment on IR801 indicated that NSPI must upgrade existing distribution facilities to accommodate this solar generation facility at the requested location. This feasibility study (FEAS) is to provide a preliminary evaluation of transmission system impacts from interconnecting the proposed generation facility to the NSPI system.

There are nineteen Transmission Interconnection Requests and twenty-one Distribution Interconnection Requests in the Advanced Stage Queue that are higher queued than IR801. In addition, there is a long-term firm Transmission Service Reservation *(TSR)* that must be accounted for: 550 MW from New Brunswick to Nova Scotia *(TSR411)*.

TSR411 is expected to be in service in 2028 and a system study is currently underway to determine the associated upgrades to the Nova Scotia transmission system. These upgrades are expected to materially alter the configuration of the transmission system in Nova Scotia. As a result, the following notice was posted to the OASIS site at https://www.nspower.ca/oasis/generation-interconnection-procedures:

> *Due to ongoing development discussions and engineering studies, the Transmission System Network Upgrades identified as part of Transmission Service Request #411 will not be included in the System Impact Study (SIS) Analysis for Generator Interconnection Procedures (GIP) Study Groups #32 to #35. GIP Study Group #32 to #35 analysis will be limited to the 2024 Transmission System configuration plus any material Network Upgrades identified in higher queued projects.*

This study assumes that the addition of generation from IR801 will displace coal-fired generation in eastern Nova Scotia for NRIS.

Interconnection with NSPI 12.5 kV distribution circuit 6N-301 will not require any new transmission interconnection facility to the generation facilities. IR801 generator is not considered as a NERC Bulk Electric System (BES) element, or part of Nova Scotia Bulk Power System (BPS).

No violations of thermal or voltage criteria for transmission facilities were found for IR801. The addition of IR801 7MW solar generation will cause reverse flow into the transmission system through the substation transformer 6N-T51 and 74N-T61. The NSPI protection and control systems should be modified accordingly. It should be noted that the 6N station feeder circuits may be converted from 12.5 to 25kV in the future. Therefore, a dual-rated GSU transformer should be considered for IR801.

Data provided by the IC indicated that IR801 will be utilizing Sungrow SG350HX string inverter. Based on the provided impedances of the transformers, existing collector circuit length and typical collector circuit impedances, IR801 would be able to meet the net power factor of +0.95 to -0.95

at the generator step-up transformer 12.5 kV bus. As specific details of the collector circuits become available, the adequacy of reactive power supply will be further investigated in the System Impact Study. It is required that the proposed Sungrow SG350HX string inverter models should meet the requirement to produce full Mvar capability down to zero MW output.

IR801 was not found to adversely impact the short-circuit capabilities of existing circuit breakers. It is assumed that the project design meets NSPI requirements for low-voltage ride-through and voltage control. Harmonics must meet the Total Harmonics Distortion provisions of IEEE 519. Voltage flicker will be further examined when data for the machine is made available. The minimum short circuit level at the 12.5 kV of generator step-up transformer (POI) is 50 MVA with all lines in service which corresponds to a short-circuit ratio of 7.1.

The preliminary value for the unit loss factor is calculated as 5.7% at the POI on 6N-301.

The preliminary non-binding transmission cost estimate for interconnecting 7 MW to the POI at 6N-301, including the cost of the protection upgrades at 6N substation is $891,000. In this estimate, $550,000 of the amount represents Network Upgrade costs which are funded by the Interconnection Customer, but which are eligible for refund under the terms of the GIP. The remainder of the costs are fully funded by the Interconnection Customer. These estimates do not include costs associated with distribution systems or IC's Interconnection Facilities.

Table of Contents

1 Introduction

The Interconnection Customer (IC) submitted a Network Resource Interconnection Service (NRIS) Interconnection Request for a proposed 7 MW solar generation facility interconnected to the NSPI distribution system, with a Commercial Operation Date of 2026-05-01. The Point of Interconnection (POI) requested by the customer is the NSPI 12.47 kV distribution circuit 6N-301, approximately 2.7 km from 6N-Black River Rd.

The IC signed a Feasibility Study Agreement to study the connection of their proposed generating facility to the NSPI system dated 2024-07-15, and this report is the result of that Study Agreement. This project is listed as Interconnection Request 801 (previously as IR770), in the NSPI Interconnection Request Queue and will be referred to as IR801 throughout this report.

Figure 1 shows the proposed geographic location of IR801 in relation to the NSPI transmission system.

Figure 1 IR#801 Site Location

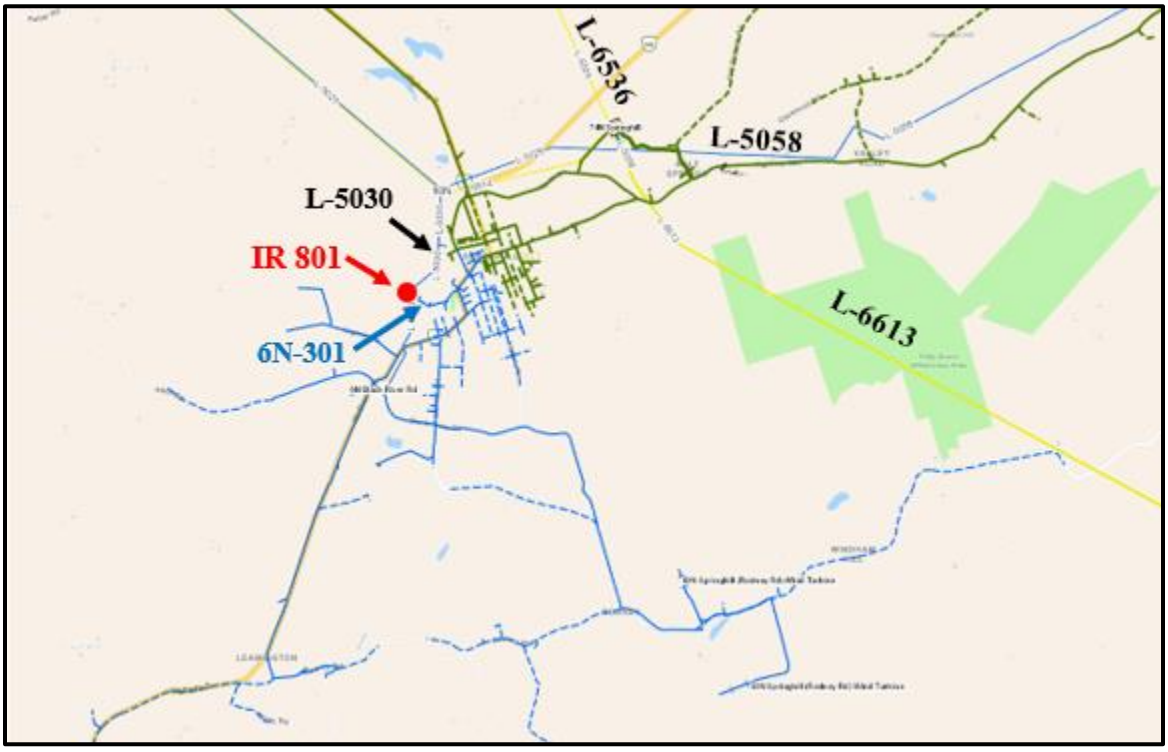


Figure 2 shows the circuit breaker configuration of transmission lines in the vicinity of the POI. Figure 3 shows the distribution circuit and proposed generator site.

Figure 2 Circuit Breaer Configuration near POI

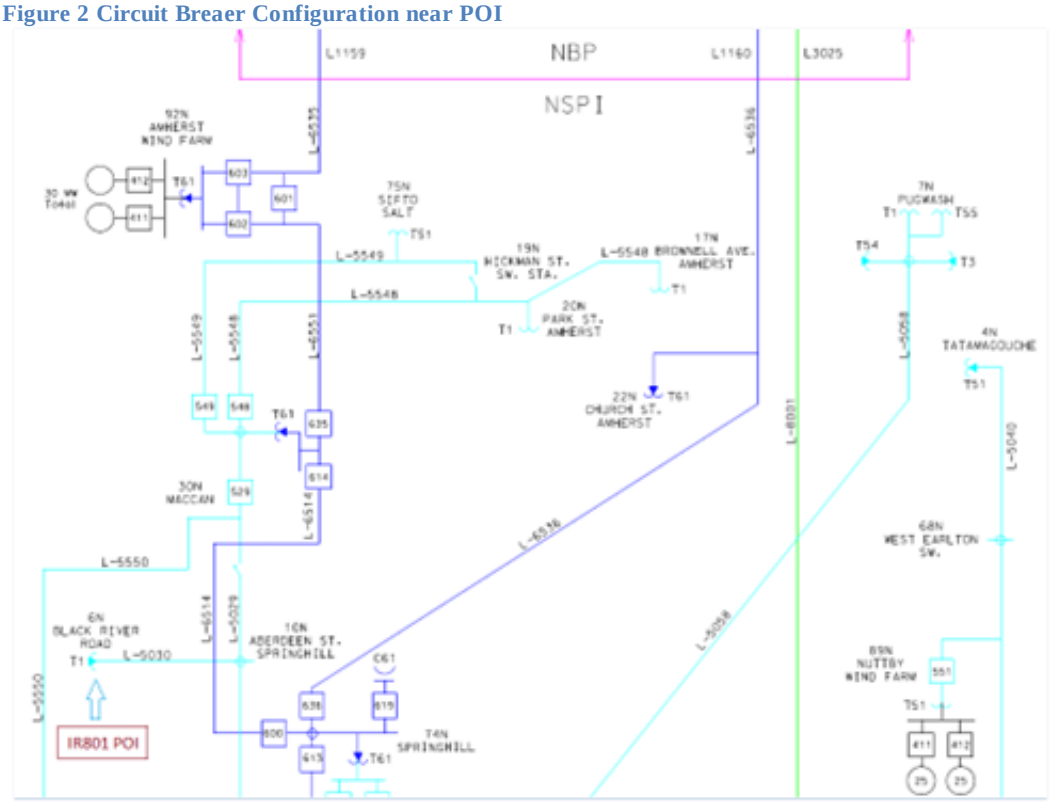
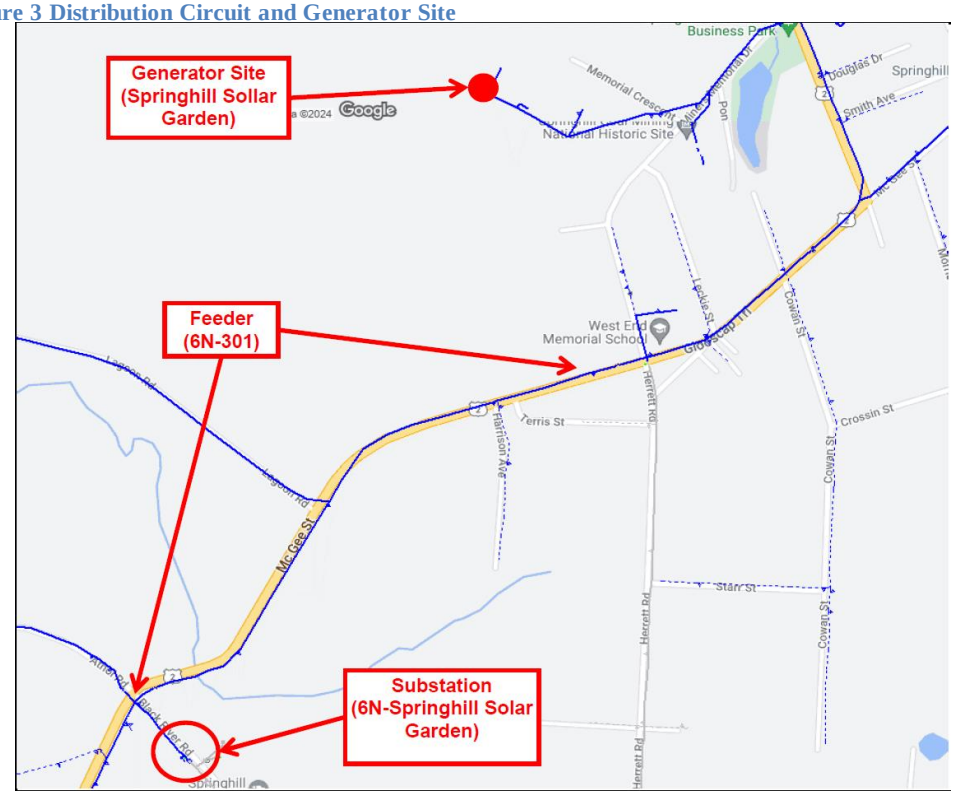


Figure 3 Distribution Circuit and Generator Site



2 Scope

The objective of this Interconnection Feasibility Study (FEAS) is to provide a preliminary evaluation of transmission system impacts from interconnecting the proposed generation facility to the NSPI distribution system at the requested location. The assessment will identify potential impacts on transmission element loading, which must remain within their thermal limits. Any potential violations of voltage criteria will be identified and addressed. If the proposed generation increases the short-circuit duty of any existing circuit breakers beyond their rated capacity, the circuit breakers must be upgraded. Single contingency criteria are applied.

The scope of the FEAS includes the modelling of the power system in normal state (with all transmission elements in service) under anticipated load and generation dispatch conditions. A power flow and short circuit analysis will be performed to provide the following information:

- Preliminary identification of any circuit breaker short circuit capability limits exceeded as a result of the interconnection, and any network upgrades necessary to address the short circuit issues associated with the IR. Expected minimum short circuit capability will also be identified for the purposes of Short Circuit Ratio analysis.

- Preliminary identification of any thermal overload or voltage limit violations resulting from the interconnection and identification of the necessary network upgrades to allow full output of the proposed facility. Thermal limits are applied to the seasonal (summer/winter) emergency ratings of transmission elements. Voltage violations occur when the post-contingency transmission bus voltage is outside the range of +/-10% of nominal voltage.

- Preliminary analysis of the ability of the proposed Interconnection Facility to meet the reactive power, power quality and cold-weather capability requirements.

- Preliminary description and high-level non-binding estimated cost and time to construct the transmission facilities required to interconnect the generating facility to the NSPI system.

- For comparative purposes, the impact of IR801 on incremental system losses under standardized operating conditions is examined.

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 the system transfer capabilities that may be required to meet the design and operating criteria established by NSPI, the Northeast Power Coordinating Council (NPCC), and the North American Electric Reliability Corporation (NERC). These requirements will be determined by a more detailed analysis in the subsequent interconnection System Impact Study (SIS).

An Interconnection Facilities Study (FAC) follows the SIS to ascertain the final cost estimate to interconnect the generating facility.

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. NRIS as per section 3.2 of the Generator Interconnection procedures (GIP).

2. Commercial Operation date 2026-05-01.

3. The Interconnection Customer Interconnection Facility (ICIF) consists of up to 28 Sungrow SG350HX string inverters, each rated at 0.32 MVA; Each inverter connects to 24 strings of solar PV modules. Maximum output is capped at a total of 7 MW, connected to collector circuits operating at a voltage of 12.47 kV.

4. The Point of Interconnection (POI) is identified on distribution circuit 6N-301 therefore no new transmission interconnection facilities are required to connect IR801 to the NSPI system. It should be noted that the 6N station feeder circuits may be converted from 12.5 to 25kV in the future. Therefore, a dual-rated GSU transformer should be considered for IR801.

5. The generation technology used must meet NSPI requirements for reactive power capability of at least 0.95 capacitive to 0.95 inductive at the HV terminals of the generator 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 solar 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 interconnection facility. The positive-sequence impedance of three 12.47/0.8kV generator step-up (GSU) transformers are each rated at 5.5% on 3.2 MVA with an assumed X/R ratio of 8. These GSUs have a delta (HV) -wye (LV) winding configuration with +/-2x2.5% tap changer.

7. Preliminary assessment indicated that IR801 requires 0.65 km reconductor of 1/0 aluminum line section of 6N-301. With the network upgrade 6N-301 impedance is explicitly modeled as 0.3584+j0.6890 p.u. (R+jX) with 0.000018 p.u. charging (B) on system base 100 MVA.

8. The existing transformer 6N-T51 is rated at 7.5/10/12.5 MVA and modeled with a positive-sequence impedance of 6.97% on 7.5 MVA with an assumed X/R ratio of 20.

6N-T51 has a delta (HV)- grounded wye (LV) winding configuration with +/-10% on-load tap changer with 33 steps.

9. There is existing wind generation of 2.1 MW on distribution circuit 6N-302. This wind generation substation is 83N and it is modelled with the following parameters:

   - Two types of Wind Turbine Generators (WTG) are modeled: Vensys V62 rated at 1.2 MW and AWE 900 rated at 0.9 MW;

   - GSU for Vensys V62 is rated at 6% on 1.25 MVA with an assumed X/R ratio of 8. This GSU has a grounded wye (HV) - grounded wye (LV) winding configuration with +/-2x2.5% tap changer; GSU for Vensys V62 is rated at 8% on 1.0 MVA with an assumed X/R ratio of 8. This GSU has a grounded wye (HV) -delta (LV) winding configuration with +/-2x2.5% tap changer.

   - Distribution circuit from 6N to 83N is modelled with impedance of 1.71536+j1.7490 p.u. (R+jX) with 0.000039 p.u. charging (B) on system base 100 MVA; Collector circuit from 83N to WTG site 1 is modeled with impedance of 0.142+j1.042 p.u. (R+jX) with 0.000003 p.u. charging (B); and collector circuit from 83N to WTG site 2 is modeled with impedance of 0.568+j0.568 p.u. (R+jX) with 0.000012 p.u. charging (B).

10. It is assumed that IR801 generation meets IEEE Standard 519 limiting total harmonic distortion (all frequencies) to a maximum of 5% with no individual harmonic exceeding 3% for 69 kV.

11. Generation in a higher queue position, except for the interconnection requests that are electrically remote from IR801, are modeled in the base cases.

12. Planning criteria meeting NERC Standard TPL-001-5 *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.

13. The rating of transmission facilities in the vicinity of IR801 are shown in Table 1 and Table 2.

Table 1 Local Transmission Element Ratings

Line	Conductor	Design Temp	Limiting Element	Summer Rating Normal/Emergency	Winter Rating Normal/Emergency
L-6613	1113 Beaumont	100°C	Switch	287/316 MVA	287/316 MVA
L-6514	556.5 Dove	60°C	Conductor/ Switch	140/154 MVA	140/154 MVA
L-6535	556.5 Dove	100°C	Conductor	215/237 MVA	242/266 MVA
L-6536	556.5 Dove	100°C	Conductor	215/237 MVA	242/266 MVA
L-5030	4/0 Penquin	50°C	Conductor	31/34.1 MVA	45/49.5 MVA

Table 2: Rating of Transformers		
Transformer	Normal Rating / Max. Loading	
	Summer MVA	Winter MVA
6N-T51	12.5/ 13.75	12.5/ 16.6
74N-T61	56/56	56/56

4 Projects with Higher Queue Positions

All in-service generation is included in the FEAS, except for Lingan Unit 2, which is assumed to be retired.

As of 2025/01/29, the following projects are higher queued in the Advanced Stage Interconnection Request Queue and are committed to the study base cases:

- IR516: GIA Executed
- IR542: GIA Executed
- IR574: GIA Executed
- IR598: GIA Executed
- IR597: GIA Executed
- IR664: GIA Executed
- IR662: GIA Executed
- IR670: FAC Complete
- IR671: FAC in Progress
- IR669: GIA Executed
- IR668: GIA Executed
- IR618: GIA Executed
- IR673: GIA Executed
- IR675: FAC Complete
- IR677: GIA in Progress
- IR697: SIS in Progress
- IR686: SIS in Progress
- IR739: SIS in Progress
- IR742: SIS in Progress

In addition, there is a long-term firm Transmission Service Reservation (TSR) that must be accounted for: 800 MW from New Brunswick to Nova Scotia (TSR-411). TSR411 is expected to be in service in 2028 and a system study is currently underway to determine the associated upgrades to the Nova Scotia transmission system. These upgrades are expected to materially alter the configuration of the transmission system in Nova Scotia. As a result, the following notice was posted to the OASIS site at https://www.nspower.ca/oasis/generation-interconnection-procedures:

Due to ongoing development discussions and engineering studies, the Transmission System Network Upgrades identified as part of Transmission Service Request #411 will not be included in the System Impact Study (SIS) Analysis for Generator Interconnection Procedures (GIP) Study Groups #32 to #35. GIP Study Group #32 to #35 analysis will be limited to the 2024 Transmission System configuration plus any material Network Upgrades identified in higher queued projects.

5 Short-Circuit Duty / Short Circuit Ratio

The maximum expected (design) short-circuit level is 5,000 MVA (21 kA) on 138kV systems and 3,500 MVA (31.5 kA) on 69 kV system. The fault current characteristic for this Sungrow String Inverter SG350HX is assumed as 1.1 times rated current, or X'd = 0.9091 per unit on machine base MVA.

Short circuit analysis was performed using PSS®E for a classical fault study, 3LG and flat voltage profile at 1.0 p.u. V. The short-circuit levels in the area before and after this development are provided below in Table 3.

Table 3: Short-Circuit Levels. IR801 on 6N-301 Three-phase MVA (1)

Location	Without IR801	With IR801
All transmission facilities in service		
POI on 6N-301 (12.47kV)	53 (2)	62 (2)
6N- Black River Rd (12.47kV)	84 (2)	92 (2)
6N- Black River Rd (69kV)	334	343
74N-SpringHill (69kV)	419	428
74N-SpringHill (138kV)	1334	1342
Minimum Conditions (PA, LG1, ML In-Service)		
6N- Black River Rd (69kV), all lines in-service	312	320
POI on 6N-301 (12.47kV), all lines in-service	50	59
6N- Black River Rd (69kV), L-6514 open at 74N	291	299
POI on 6N-301 (12.47kV), L-6514 open at 74N	50	59
6N- Black River Rd (69kV), L-6555 open at 74N	276	284
POI on 6N-301 (12.47kV), L-6555 open at 74N	49	58

(1) Classical fault study, flat voltage profile
(2) The maximum current produced by the existing wind generation on 6N-302 is assumed approximately 2.1MVA based on its Distribution SIS report.

The interrupting capability is at least 5000 MVA for the 138 kV circuit breakers and 3500 MVA for 69 kV circuit breakers at 74N-Springhill. As such, the interrupting rating at these substations will not be exceeded by this development on its own.

Inverter-based generation installations often have a minimum Short Circuit Ratio (SCR) for proper operation of converters and control circuits. Based on the calculated short circuit

levels, the short circuit ratio would be 7.1 at the 12.5kV Interconnection Facility of the IR801 substation with all lines in service and IR801 offline. This is about 7.1 with L-6555 or L-6514 open at 74N-Springhill.

6 Voltage Flicker and Harmonics

Flicker coefficient information was not provided for the Sungrow SG350HX string inverter machine. Voltage flicker will be further examined when data for the machine is made available.

The generating facility is expected to meet IEEE Standard 519-2014 limiting voltage Total Harmonic Distortion (all frequencies) to a maximum of 5%, with no individual harmonic exceeding 3% on 69 kV.

7 Load Flow Analysis

The load flow analysis was completed for generation dispatches under system summer peak, spring light load and winter peak load conditions which are expected to stress the NS-NB border corridor. Winter peak load conditions was scaled to 92% of system peak winter load to correlate with solar generation peak output during winter, as the peak solar output will occur in early afternoon, rather than at system peak at 7pm. Generation dispatch was also chosen to represent import and export scenarios that consider the NS-NB import and export levels at current limits.

The major transmission interfaces/corridors relating to the IR801 are shown in Figure 4. The nominal interface thermal limits are summarized in Table 4.

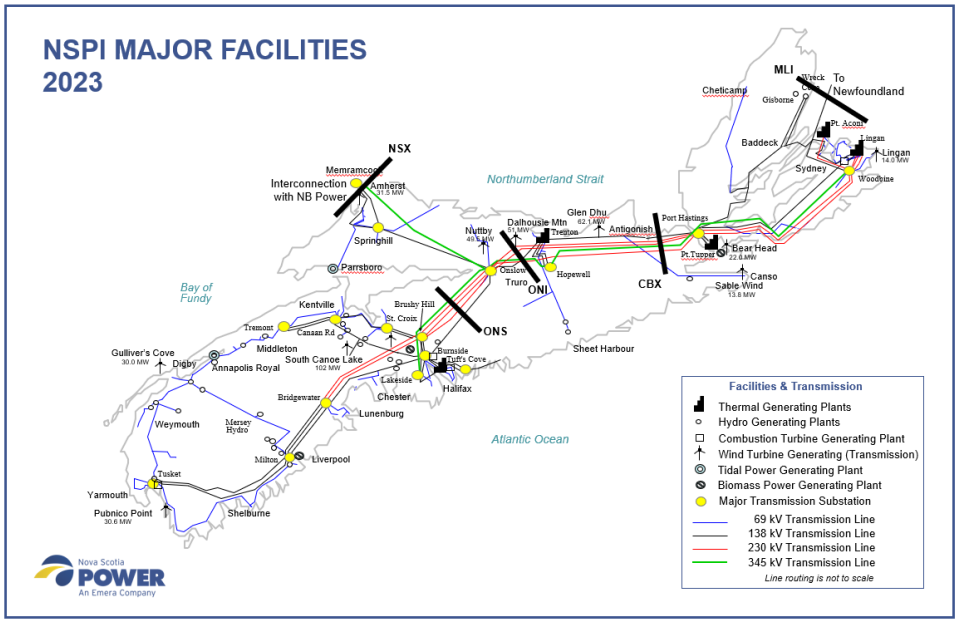


Figure 4: Major Transmission Interfaces

Table 4: Transmission Interface Limits						
Interface	MLI (*1)	NSX (*2)	NSI (*3)	CBX (*4)	ONI	ONS (*5)
Summer	475	500	Up to 300	875-1075	1075-1275	600-850
Winter	475	500	Up to 300	950-1150	1275	600-975

(1) MLI is limited by simultaneous New Brunswick Import
(2) NS Export to NB (NSX) is dependant on Maritime Link runback RAS
(3) NS import from NB (NSI) is dependant on conditions in NB and PEI, capped at 38% of NS load.
(4) Dependant on generation at Trenton and Point Tupper
(5) Dependant on dynamic reactive power reserve in Metro

For these cases, transmission connected wind generation facilities were dispatched between 19% and 100% of their rated capability. All interface limits were respected for base cases.

Two scenarios were examined for each of the Light Load (*SML*), Summer Peak *(SP)*, and Winter Peak (*WP*) cases:

- Pre-IR801 cases ending with "-1": IR801 off.
- Post-IR801 cases ending with "-2": IR801 dispatched at 7 MW under NRIS designation.

Table 5: PSSE Case Descriptions											
Case	NS Basic Load	6N Load	NSX	ML	CBX	ONS	ONI	Total Wind	Total Hydro	PHP	BESS
SML_01A-1	550	1.6	150	-170	-238	285	125	927	48	-211	-135
SML_01A-2	550	1.6	150	-170	-245	285	118	927	48	-211	-135
SML_01B-1	550	1.6	1	-170	-269	351	41	860	8	-211	-150
SML_01B-2	550	1.6	1	-170	-276	351	34	860	8	-211	-150
SML_01C-1	550	1.6	-149	-170	-270	351	-109	704	8	-211	-150
SML_01C-2	550	1.6	-149	-170	-276	351	-115	704	8	-211	-150
SML_01D-1	550	1.6	151	-170	-24	351	37	759	8	-211	-150
SML_01D-2	550	1.6	151	-170	-30	351	31	759	8	-211	-150
SML_02A-1	561	1.6	329	-170	13	285	151	759	9	-178	-150
SML_02A-2	561	1.6	329	-170	13	285	144	759	9	-178	-150
SML_03A-1	561	1.6	330	-170	-233	169	189	909	63	-178	-100
SML_03A-2	561	1.6	330	-170	-233	176	189	909	63	-178	-100
SP_01A-1	1372	3.7	150	-330	-116	413	337	1449	20	-209	-150
SP_01A-2	1372	3.7	150	-330	-116	413	331	1449	20	-209	-150
SP_01B-1	1376	3.7	-150	-330	-116	680	305	1094	20	-209	-150
SP_01B-2	1376	3.7	-150	-330	-116	680	298	1094	20	-209	-150
SP_02B-1	1372	3.7	-151	-140	-69	881	352	1157	34	-209	-150
SP_02B-2	1372	3.7	-151	-140	-69	881	345	1157	34	-209	-150
SP_03B-1	1372	3.7	329	-475	400	847	798	1125	23	-209	-90
SP_03B-2	1372	3.7	329	-475	400	847	791	1125	23	-209	-90

SP_04B-1	1372	3.7	498	-475	380	726	849	1161	31	-146	0
SP_04B-2	1372	3.7	498	-475	380	726	842	1161	31	-146	0
WP_02A-1	2095	5.1	-151	-170	20	703	420	1418	83	-15	0
WP_02A-2	2095	5.1	-151	-170	14	703	413	1418	83	-15	0
WP_02B-1	2095	5.1	-150	-170	25	869	410	1486	92	-221	0
WP_02B-2	2095	5.1	-150	-170	25	869	403	1486	92	-221	0
WP_04A-1	2152	5.1	348	-330	990	718	1179	294	149	-15	0
WP_04A-2	2152	5.1	348	-330	990	718	1172	294	149	-15	0

For NRIS analysis, this FEAS added IR801 and displaced coal-fired generation in Cape Breton, reducing Cape Breton Export (CBX) transfers and Onslow Import (ONI) transfers. Single contingencies were applied at the 230 kV, 138 kV and 69 kV voltage levels for the above system conditions with IR801 interconnected to the POI at 6N-301. Automated analysis searched for violations of emergency thermal ratings and emergency voltage limits for each contingency. Contingencies studied are listed in Table 6.

Table 6: PSSE Contingency List

Transmission Line	Transformer/ Bus/Generator	Circuit Breaker Failure	Double Circuit Tower
L-7014, L-7021, L-7022	88S: T71, T72	88S: 710, 711, 713, 721, 722, 723*	L-5039 + L-6033, L-6011 + L-6010, L-6010 + L-6005, L-6005 + L-6016 L-6033 + L-6035, L-6033 + L-6035 L-6534 + L-7021, L-7003 + L-7004*, L-7024 + L-7004*, L-7008 + L-7009, L-7009 + L-8002
L-7011*, L-7012*, L-7015, L-8004*	101S: T81, T82	101S: 701, 702, 703, 704, 705, 706, 711, 712, 713, 811, 812*, 813*, 814, 816	
L-7004, L-7024, L-7027*	3C: T71, T72	3C: 710*, 711, 712*, 713*, 714, 715*, 716	
L-7001, L-7002, L-7018, L-7019, L-8001*,L-8011, L-8002, L-8006	67N: T71, T81, T82	67N: 701, 702, 703, 704, 705, 706, 711*, 712, 713, 811*,813, 814*, 817*	
L-6001, L-6503, L-6613	1N: B61, B62, C61, T1, T4, T65	1N: 600, 601, 613	
L-6507, L-6508, L-8003*	79N: T81*	IR686: 801, 802, 803 (1)	
	91N: B71, B72	91N: 701, 702, 703, 704	
L-6005, L-6010, L-6011, L-6016, L-6051, L-7008, L-7009	120H: SVC, T71, T72	120H: 621, 622, 623, 624, 626, 627, 628, 629, 710, 711, 712, 713, 714, 715, 716, 720	
L-6008, L-6033, L-6038	103H: B61, B62, T61, T63, T81	103H: 600, 608, 691	
L-5012, L-5041, L-5049	91H: G3, G4, G5, G6, T62, T11	91H: 511, 516, 521, 523	
L-7025	125C: B71	125C: 701	
L-7003	127C: B71	127C: 701	
L-7005	102N: B71	102N: 701	
L-7555	100N: B71	100N: 701	
	99W: T71, T72	99W: 708, 709	
L-6545 L-6054	110W: T62 89S: G1 104W: G1 1C: G2 48C: G1 50N: G5, G6	2S: 513 104H: 600 132H: 602, 603, 605, 606 101V: 601	

Table 6: PSSE Contingency List			
Transmission Line	Transformer/ Bus/Generator	Circuit Breaker Failure	Double Circuit Tower
99W: BESS, 43V: BESS, 132H: BESS			

*Indicates contingency was studied with/without RAS action
(1) This study assumes that IR686 is interconnected onto L-8001 with a ring bus configuration and a dedicated 345 kV line connected to 67N-Onslow.

The study shows no violation of transmission thermal or voltage limit criteria that are attributed to IR801.

The load supplied by 6N substation is studied at 1.6-5.6 MW during periods of light to peak load including an existing 2.1 MW wind generation facility on 6N-302 distribution circuit. With the addition of IR801 7MW solar generation, reverse flow into the transmission system through the substation transformer 6N-T51 and 74N-T61 is anticipated. The protection and control systems should be modified accordingly.

8 Reactive Power and Voltage Control

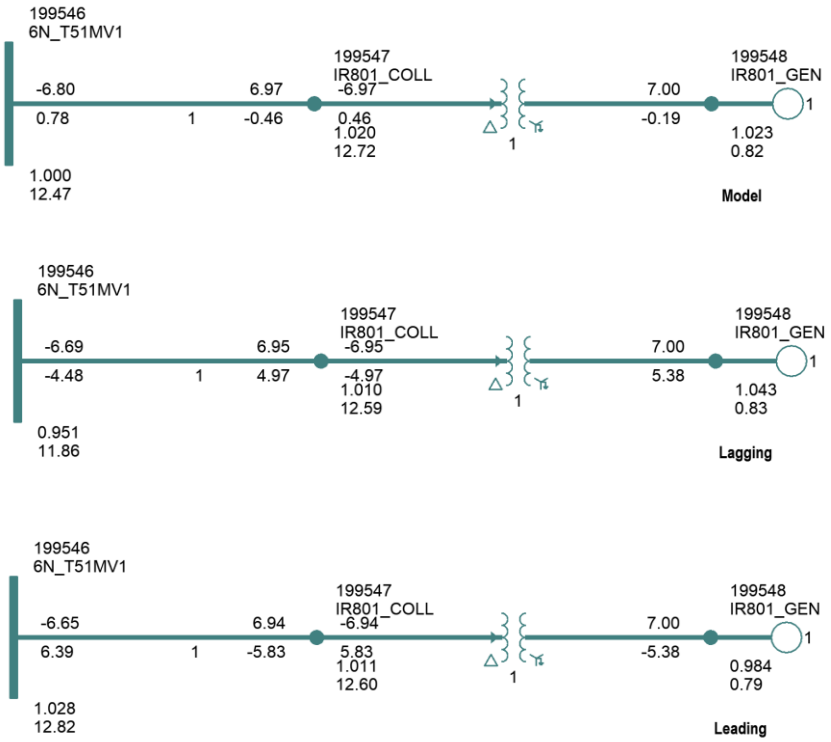
In accordance with the *Transmission System Interconnection Requirements* Section 7.6.2, IR801 must be capable of delivering reactive power at a net power factor of at least +/- 0.95 of rated capacity to the high side of the generator pad mount transformer(s). It also requires that rated reactive power shall be available through the full range of real power output of the Generating Facility, from zero to full power.

There was no detailed manufacture technical data provided for Sungrow String SG350HX Inverter. The information provided by IC (Appendix 1 to GIP) indicated that the Sungrow SG350HX string inverter has a rated MVA of 0.32 with a power factor of 0.80 lagging and leading (+/- 0.192 Mvar per inverter).

The analysis shown in Figure 5 indicates that IR801 would be able to meet the full-load reactive power requirement. The model shows that with 28 SG350HX Inverter units operating at a total 7 MW and 5.376 Mvar (maximum), the delivered power to the high side of the generator step-up transformer is 6.95 MW and 4.97 Mvar, or a power factor of 0.81 with inverter terminal voltage at 1.04 p.u.

This configuration would be able to meet the leading power factor requirement of -0.95 at the high side of generator step-up transformer while the inverters are operating at a total of 7 MW and -5.38 Mvar at a terminal voltage of 0.98 p.u.

Figure 5: Power Factor Analysis



Because this analysis is based on preliminary transformer data and assumed collector circuit models, reactive capability will be confirmed in the SIS.

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 12.5 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 or voltage droop must be provided if applicable.

In accordance with the *Distribution Interconnection Requirements for Generating Facilities Greater than 100 kW* Section 6.17, IR 801 must be capable of controlling voltage and operating at a fixed, preset power factor. The controller's voltage set-point shall be adjustable throughout the range of 95-105% of rated terminal voltage. IR801 shall be capable of providing dynamic reactive power compensation (dynamic Volt/VAr operation), it shall be able to consume reactive power in response to an increase in line voltage and produce reactive power in response to a decrease in line voltage.

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.

Settings for the 6N-T61 on-load tap-changer must be coordinated with plant voltage controller for long-term reactive power and voltage management at the POI.

9 System Security / Bulk Power Analysis

IR801 is requested to connect into the 12.5 kV distribution systems, therefore it will not be categorized as part of the Nova Scotia Bulk Power System (BPS) or NERC Bulk Electric System (BES).

10 Expected Facilities Required for Interconnection

The following transmission facility changes will be required to connect IR801 to the NSPI distribution system at a POI on 6N-301 under NRIS:

a. Required Network Upgrades

- Modification of NSPI protection systems at 6N-Black River Rd and 74N-Springhill.

b. Required Transmission Provider's Interconnection Facilities (TPIF):

- Add control and communications between the solar plant and NSPI SCADA system (to be specified).

c. Required Interconnection Customer's Interconnection Facilities (ICIF)

- 6N station may be converted from 12.5 to 25kV in the future. Dual-rated GSU transformer should be considered for IR801.
- Facilities to provide 0.95 leading and lagging power factor when delivering rated output at the HV terminals of the IC generator step-up transformer when the voltage at that point is operating between 95 and 105 % of nominal. This study shows that Sungrow String SG350HX Inverter is able to meet this requirement.

It's also required that it meets the requirement that rated reactive power be delivered from zero to full rated real power.

- Centralized controls: These will provide centralized voltage set-point controls and are known as Farm Control Units (FCU). The FCU will control the 12.5 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.
- NSPI will 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.
- Facility capable of controlling voltage and operating at a fixed, preset power factor. The controller's voltage set-point shall be adjustable throughout the range of 95- 105% of rated terminal voltage.
- Facility capable of providing dynamic reactive power compensation (dynamic Volt/VAr operation), it shall be able to consume reactive power in response to an increase in line voltage and produce reactive power in response to a decrease in line voltage.
- Low voltage ride-through capability as per Section 7.4.1 of the Nova Scotia Power Transmission System Interconnection Requirements (TSIR).
- Facilities for NSPI to execute high speed rejection of generation (transfer trip) if determined in SIS. The plant may be incorporated into RAS run-back schemes.
- Operation at ambient temperature of -30°C.

11 NSPI Interconnection Facilities and Network Upgrades Cost Estimate

Estimates for NSPI Transmission Interconnections Facilities and Network Upgrades for interconnecting 7 MW solar energy at the 12.5 kV POI on 6N-301 are included in Table 7.

Table 7 Transmission System Cost Estimate NRIS @ POI 6N-301

Item	Network Upgrades	Estimate
1	Modification of protection systems to 6N-Black River Rd	$500,000
	Sub-total for Network Upgrades	$500,000
Item	**TPIF Upgrades**	**Estimate**
2	NSPI P&C relaying equipment	$100,000
3	NSPI supplied RTU	$60,000

4	Tele-protection and SCADA communications	$150,000
	Sub-total for TPIF Upgrades	$310,000
	Total Upgrades	**Estimate**
	Network Upgrades + TPIF Upgrades	$810,000
	Contingency (10%)	$81,000
	Total (Incl. 10% contingency and Excl. HST)	$891,000

The preliminary non-binding transmission cost estimate for interconnecting 7 MW at the POI at 6N-301 under NRIS is $891,000 including a contingency of 10%. In this estimate, $500,000 (plus 10% contingency) of the amount represents Network Upgrade costs which are funded by the Interconnection Customer, but which are eligible for refund under the terms of the GIP.

These estimates do not include costs associated with distribution system or the IC's interconnection facilities. These estimates do not include costs to address any stability issues that may be identified at later stage.

The estimated time to construct the Network Upgrades and Transmission Providers Interconnection Facilities is 18-24 months after receipt of funds.

12 Loss Factor

Loss factor is calculated by running the winter peak load flow case with and without the new facility in service while keeping 91H-Tufts Cove as the Nova Scotia Area Interchange bus. This methodology reflects the load centre in and around Metro.

Without IR801 in service, losses in the winter peak case total 94.1 MW. With IR801 in service at the POI of 6N-301, displacing generation at 91H, the system losses total 94.5 MW – an increase of 0.4 MW. The power delivered to the 6N-301 is 6.97 MW, therefore the loss factor is calculated as 0.4/6.97 = 5.7%.

13 Issues to be addressed in SIS

The following provides a preliminary scope of work for the subsequent SIS for IR801.

The SIS will include a more comprehensive assessment of the technical issues and requirements to interconnect generation as requested. 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, frequency response, active power 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 proceed, and the facilities associated with those projects are installed.

The following outline provides the minimum scope that must be complete 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 and the *Transmission System Interconnection Requirements*.

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 accomplish the SIS, the following statement posted on the NSPI OASIS Generation Interconnection site[1] clarifies the SIS model requirements:

> *To be eligible for inclusion in the Interconnection System Impact Study stage, and thereby advance the Interconnection Request's initial Queue Position, the Interconnection Customer must meet the progression milestone requirements of Section 7.2 of the GIP at least ten (10) Business Days prior to the Interconnection System Impact Study commencement date. For clarity, item 7.2 (i) – provision of a detailed stability model for the generator(s) shall mean:*
> *Provision of PSSE and PSCAD models in compliance with documents NSPI-TPR-015-2: PSSE and PSCAD Model Requirements, and*
> *Provision of test data demonstrating model testing in compliance with NERC, NPCC and NSPI criteria. NSPI-TPR-014-1: Model Quality Testing lists the minimum requirements that will be performed by NSPI. Additional testing may be performed to assess compliance with all applicable criteria. Any test not meeting the minimum NSPI requirements will be documented in the MQT report to the IC. NSPI-TPR-015-2: PSSE and PSCAD Model Requirements and NSPI-TPR-014-1: Model Quality Testing will undergo revision as the grid evolves and performance criteria changes. The most up to date version will be provided as they become available.*

[1] https://www.nspower.ca/oasis/generation-interconnection-procedures

Any changes to RAS 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.

A thorough assessment will be provided to ensure that the facilities will meet applicable NSPI, NPCC and NERC transmission design criteria.

In addition, the SIS will include a distribution system impact study (DSIS) to determine the distribution interconnection requirements and upgrades associated with IR801.

Nova Scotia Power
Transmission System Operations
2025-02-13

[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 Standard TPL-001-5*