Nova Scotia Utility and Review Board

IN THE MATTER OF *The Public Utilities Act,* R.S.N.S. 1989, c.380, as amended

Nova Scotia Power
10-Year System Outlook

2018 Report

REVISED

Date Revised: July 12, 2018

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1.0 INTRODUCTION

In accordance with the 3.4.2.1[1] Market Rule requirements this report provides NS Power's 10-Year System Outlook on behalf of the NS Power System Operator (NSPSO) for 2018.

The 2018 10-Year System Outlook report contains the following information:

- A summary of the NS Power load forecast and update on the Demand Side Management (DSM) forecast in Section 2.
- A summary of generation expansion anticipated for facilities owned by NS Power and others in Sections 3 through 5, including an updated Unit Utilization and Investment Strategy in Section 3.3.
- A summary of environmental and emissions regulatory requirements, as well as forecast compliance in Section 6. This section also includes projections of the level of renewable energy available.
- A Resource Adequacy Assessment in Section 7, including an update regarding the annual wind capacity value study in Section 8 and evaluation of the contribution of Energy Resource Interconnection Service connected resources in Appendix B.
- A discussion of transmission planning considerations in Section 8.

[1] The NSPSO system plan will address: (a) transmission investment planning; (b) DSM programs operated by EfficiencyOne or others; (c) NS Power generation planning for existing Facilities, including retirements as well as investments in upgrades, refurbishment or life extension; (d) new Generating Facilities committed in accordance with previous approved NSPSO system plans; (e) new Generating Facilities planned by Market Participants or Connection Applicants other than NS Power; and (f) requirements for additional DSM programs and / or generating capability (for energy or ancillary services).

- Identification of transmission related capital projects currently in the Transmission Development Plan in Sections 9 and 10.

- IRP Action Plan Update Table in **Appendix A**.

2.0 LOAD FORECAST

The NS Power load forecast provides an outlook on the energy and peak demand requirements of in-province customers. The load forecast forms the basis for fuel supply planning, investment planning, and overall operating activities of NS Power. The figures presented in this report are the same as those filed with the UARB in the 2018 Load Forecast Report on April 30, 2018 and were developed using NS Power's Statistically Adjusted End-Use (SAE) model to forecast the residential and commercial rate classes. The residential and commercial SAE models are combined with an econometric based industrial forecast and customer specific forecasts for NS Power's large customers to develop an energy forecast for the province, also referred to as a Net System Requirement (NSR).

Figure 1 shows historical and forecasted net system requirements (NSR) which includes in-province energy sales plus system losses. Anticipated growth in energy sales is expected to be offset by Demand Side Management (DSM) initiatives and energy efficiency improvements outside of structured DSM programs. For the 2018 forecast, distributed solar generation was also included in the forecast, further reducing future energy sales growth. The result of these inputs is an average annual decline in NSR of 0.3 percent.

Figure 1: Net System Requirement with Future DSM Program Effects

Year	NSR (GWh)	Growth (%)
2008	12,539	-0.8%
2009	12,073	-3.7%
2010	12,158	0.7%
2011	11,907	-2.1%
2012	10,475	-12.0%
2013	11,194	6.9%
2014	11,037	-1.4%
2015	11,098	0.5%
2016	10,809	-2.6%
2017	10,873	0.6%

Year	NSR (GWh)	Growth (%)
2018*	10,960	0.8%
2019*	11,000	0.4%
2020*	11,003	0.0%
2021*	10,916	-0.8%
2022*	10,881	-0.3%
2023*	10,835	-0.4%
2024*	10,802	-0.3%
2025*	10,740	-0.6%
2026*	10,705	-0.3%
2027*	10,670	-0.3%
2028*	10,659	-0.1%

***Forecasted value**

NS Power also forecasts the peak hourly demand for future years. The total system peak is defined as the highest single hourly average demand experienced in a year. It includes both firm and interruptible loads. Due to the weather-sensitive load component in Nova Scotia, the total system peak occurs in the period from December through February.

The peak demand forecast is developed using end-use energy forecasts combined with peak-day weather conditions to generate monthly peak demand forecasts through an estimated monthly peak demand regression model. The peak contribution from large customer classes is calculated from historical coincident load factors for each of the rate classes. After accounting for the effects of DSM savings, system peak is expected to increase 0.2 percent on average annually over the forecast period, and is being driven by increasing firm peak requirements.

Figure 2 shows the historical and forecast net system peak.

Figure 2: Coincident Peak Demand with Future DSM Program Effects

Year	Interruptible Contribution to Peak (MW)	Firm Contribution to Peak (MW)	System Peak (MW)	Growth (%)
2008	352	1,840	2,192	1.7%
2009	268	1,824	2,092	-4.5%
2010	295	1,820	2,114	1.0%
2011	265	1,903	2,168	2.5%
2012	141	1,740	1,882	-13.2%
2013	136	1,897	2,033	8.0%
2014	83	2,036	2,118	4.2%
2015	141	1,874	2,015	-4.9%
2016	98	2,013	2,111	4.8%
2017	67	1,951	2,018	-4.4%
2018*	154	1,985	2,139	6.0%
2019*	156	2,001	2,157	0.9%
2020*	158	2,015	2,172	0.7%
2021*	157	2,016	2,174	0.1%
2022*	157	2,021	2,178	0.2%
2023*	157	2,028	2,184	0.3%
2024*	156	2,034	2,191	0.3%
2025*	156	2,030	2,187	-0.2%
2026*	156	2,027	2,183	-0.2%
2027*	156	2,022	2,177	-0.3%
2028*	155	2,017	2,172	-0.2%

***Forecasted value**

3.0 GENERATION RESOURCES

3.1 Existing Generation Resources

Nova Scotia's generation portfolio is composed of a mix of fuel and technology types that includes coal, petroleum coke, light and heavy oil, natural gas, biomass, wind, tidal and hydro. In addition, NS Power purchases energy from Independent Power Producers (IPPs) located in the province and imports power across the NS Power/NB Power intertie and the Maritime Link. Since the implementation of the Renewable Electricity Standard (RES) discussed in Section 6.1, an increased percentage of total energy is produced by variable renewable resources such as wind. However, due to their intermittent nature, variable resources provide less firm capacity than conventional generation resources. Therefore, the majority of the system requirement for firm capacity is met with NS Power's conventional units (e.g. coal, gas) while their energy output is being displaced by renewable resources when they are producing energy. This is discussed further in Section 3.3.

Figure 3 lists NS Power's and IPPs' verified and forecasted firm generating capability for generating stations/systems along with their fuel types. It has been updated to include changes and additions to the IPPs and renewables effective up to the filing date of this report.

1 **Figure 3: 2018 Firm Generating Capability for NS Power and IPPs**

Facility	Fuel Type	Winter Net Capacity (MW)
Avon	Hydro	6.8
Black River	Hydro	22.5
Lequille System	Hydro	24.2
Bear River System	Hydro	37.4
Roseway[2]	Hydro	0.0
Tusket	Hydro	2.4
Mersey System	Hydro	42.5
St. Margaret's Bay	Hydro	10.8
Sheet Harbour	Hydro	10.8
Dickie Brook	Hydro	3.8
Wreck Cove	Hydro	212.0
Annapolis Tidal[3]	Hydro	3.5
Fall River	Hydro	0.5
Total Hydro		**377.1**
Tufts Cove 1, 2 & 3	Heavy Fuel Oil/Natural Gas	318
Trenton	Coal/Pet Coke/Heavy Fuel Oil	304
Point Tupper	Coal/Pet Coke/Heavy Fuel Oil	150
Lingan	Coal/Pet Coke/Heavy Fuel Oil	612
Point Aconi	Coal/Pet Coke & Limestone Sorbent (CFB)	168
Total Steam		**1552**
Tufts Cove Units 4,5 & 6	Natural Gas	144
Total Combined Cycle		**144**
Burnside Units 1, 2 & 3[4]	Light Fuel Oil	99
Tusket	Light Fuel Oil	33
Victoria Junction	Light Fuel Oil	66

[2]This asset is not used and useful in accordance with recent direction of the UARB. NS Power is assessing the requirements for decommissioning of these assets.
[3] The firm capacity of the Annapolis Tidal unit is based on average performance level at peak time. Nameplate capacity (achieved at low tide) is 19.5 MW.
[4] Burnside Unit #4 (winter capacity of 33 MW) is presently unavailable but is planned to be returned to service by the end of Q2 2018 – please refer to Section 4.2.1.

Facility	Fuel Type	Winter Net Capacity (MW)
Total Combustion Turbine		**198**
Pre-2001 Renewables	Independent Power Producers (IPPs)	25.8
Post-2001Renewables (firm)[5]	IPPs	64.0
NS Power wind (firm)[5]	Wind	13.7
Community-Feed-in-Tariff (firm)[5]	IPPs	30.5
Total IPPs & Renewables		**133.9**
Total Capacity		**2405**

3.1.1 Maximum Unit Capacity Rating Adjustments

As a member of the Maritimes Area of the Northeast Power Coordinating Council (NPCC), NS Power meets the requirement for generator capacity verification as outlined in *NPCC Regional Reliability Reference Directory #9, Generator Real Power Verification.*[6] These Criteria are reviewed and adjusted periodically by NPCC and subject to approval by the UARB.

The Net Operating Capacity of the thermal units and large hydro units covered by the NPCC criteria do not require adjustments at this point in time. NS Power will continue to refresh unit maximum capacities in the 10-Year System Outlook each year as operational conditions change.

3.2 Changes in Capacity

Figure 4 provides the firm Supply and DSM capacity changes in accordance with the assumption set developed for the 2017-2019 Base Cost of Fuel forecast and the 2018 Load Forecast.

[5] Energy Resource Interconnection Service (ERIS) and Network Resource Interconnection Service (NRIS) wind projects are assumed to have a firm capacity contribution of 17% as detailed in Section 8.3.1.
[6] https://www.npcc.org/Standards/Directories/Forms/Public%20List.aspx

Figure 4: Firm Capacity Changes & DSM

New Resources 2018-2027	Net MW
DSM firm peak reduction[7]	179
Total Demand Side MW Change Projected Over Planning Period	**179**
Community and Tidal Feed-in Tariffs (Firm capacity)	18
Biomass[8]	43
Maritime Link Import - Base Block	153
Burnside #4 (return to service)	33
Assumed Unit Retirements/Lay-ups[9]	-153
Total Firm Supply MW Change Projected Over Planning Period	**94**

3.2.1 Burnside Combustion Turbine Unit #4

Burnside Unit #4 is a 33 MW combustion turbine located in the Burnside Industrial Park in Dartmouth that provides black start capability, 10-minute reserve, dynamic reactive reserve, reactive power support and firm capacity to the NS Power electrical system. Unit #4 was originally commissioned in 1972 but has been out of service since 2008.

NS Power is currently forecasting an expected full return to service for Burnside Unit #4 by the end of Q2, 2018.

3.2.2 Mersey Hydro

NS Power is in the final stages of assessing options to address current concerns on the Mersey Hydro System. Degradation of the powerhouse and water control structures after

[7] DSM Firm Peak Reduction is calculated from the 2018 NS Power 10 Year Energy and Demand Forecast, M08670, Exhibit N-1, Table A-3 and A-4, April 30, 2018.
[8] The transmission upgrades being completed for the Maritime Link will allow 45MW of the PH Biomass unit to be counted as firm; however, tests for operating capacity completed have resulted in 43MW of available firm capacity able to be credited.
[9] Retirement of Lingan 2 unit once Maritime Link Base Block provides firm capacity service.

nearly a century of service for some hydro assets has necessitated the need for significant redevelopment work. The Mersey Hydro System is an important part of NS Power's hydro assets and is responsible for approximately 25 percent of annual hydroelectric production. The Company is preparing the Mersey Redevelopment Project Application for filing with the UARB.

3.2.3 Firm Capacity of Distributed Generation

A portion of distributed generation has been denoted as firm – these sources are listed in **Figure 3** and **Figure 4** above. Ongoing evaluation of the firm capacity contribution of these facilities continues in order to further understand the impact and reliability of this designation. Existing and future solar installations are not included as firm generating capacity as they will not contribute generation during system peak, which occurs in winter after sunset.

3.3 Unit Utilization & Investment Strategy

The following sub-sections provide an updated Unit Utilization and Investment Strategy (UUIS). The Company forecasts 10 years of utilization and investment projections in this report. These projections are based on NS Power's currently available assumptions; forecasts will continuously change as assumptions are adjusted based on regulatory or policy changes, operational experience and market information. The upcoming policy changes discussed in Section 6.3, such as the implementation of a Nova Scotia Cap and Trade program and an Equivalency Agreement regarding the federal Coal-Fired Generation of Electricity Regulations, could potentially trigger a significant shift in the utilization forecast.

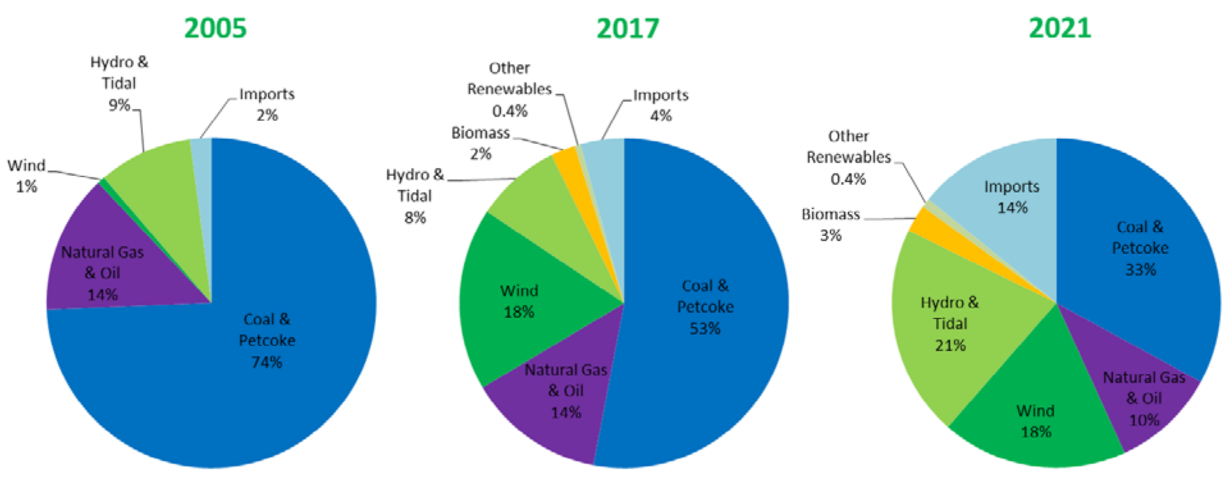
This UUIS is a product of generation planning and engineering integrating the latest in Asset Management methodology and Generation Planning techniques in the service of a complex generation operation. It provides an outlook for how NS Power will operate and invest in generation assets recognizing the trend towards lower utilization along with demands for flexible operation arising from renewables integration, and will continue to be updated annually in the 10-Year System Outlook Report.

3.3.1 Evolution of the Energy Mix In Nova Scotia

NS Power's energy production mix has undergone significant changes over the last decade. Since the implementation of the Renewable Electricity Standard (RES), an increased percentage of energy sales is produced by variable renewable resources such as wind. However, due to their intermittent nature, variable resources provide less firm capacity than conventional generation resources. Therefore, the majority of the system requirement for firm capacity and other ancillary services is met with NS Power's conventional units (e.g. coal, gas) as shown in Sections 3.1 and 3.2, while the energy output of conventional units is being displaced by renewable resources.

Figure 5 below illustrates this change with the actual energy mix from 2005 and 2017 and the forecasted energy mix for 2021.

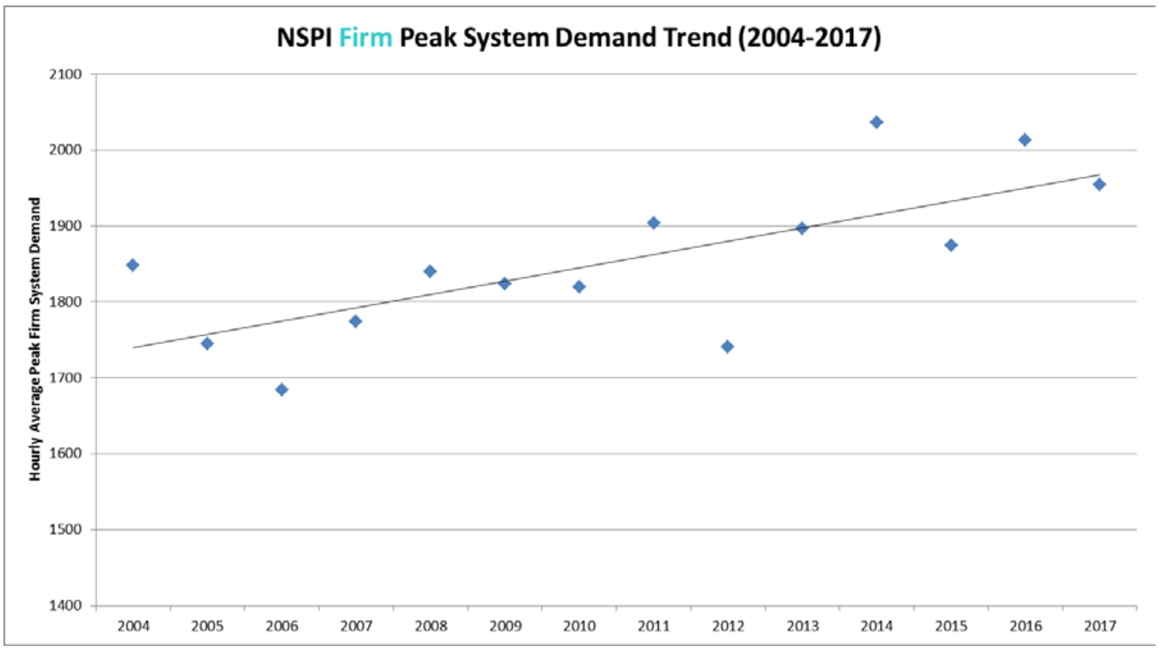
Figure 5[10]: 2005, 2017 Actual, 2021 Forecasted Energy Mix



[10] Consistent with the provisions of the Renewable Electricity Regulations, in 2021 the category of Imports includes ML Surplus energy while the category of Hydro includes ML NS Base Block and Supplemental Energy from the Muskrat Falls hydro project.

As illustrated in **Figure** 6 below, NS Power's firm peak demand has been increasing at a trend of approximately one percent per year. While energy is increasingly being produced by new renewable sources, the capacity required to serve system demand will continue to be served by dispatchable conventional resources together with imports. The steam units also provide other critical services to the system such as load-following.

Figure 6: Peak System Demand Trend



3.3.2 Projections of Unit Utilization

NS Power prepares a 10 year forecast of projected unit utilization parameters annually in in this report using the Plexos modeling tool and the current assumptions regarding fuel and market prices, load forecast, system constraints, and generating parameters; these assumptions change year-over-year and the Company adjusts its utilization strategy accordingly. As the Plexos model optimizes dispatch against this set of input assumptions, the forecasted utilization of the generating units can be expected to vary as inputs such as fuel pricing shift.

Figure 7 below provides the current forecasted unit utilization of NS Power's steam fleet. The Company notes that the outcome of the carbon policy changes discussed in Section 6.3 could alter the near term of this utilization forecast, particularly if carbon emission limits change due to a Cap and Trade program. As policy outcomes become clear the forecast model will be updated and the updated results will be provided in future 10 Year System Outlook reports.

Figure 7: NS Power Steam Fleet Unit Utilization Forecast

Unit	Metric	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Lingan 1	Capacity Factor (%)	32	24	30	30	26	29	25	27	32	28
	Unit Cycles (Ranges)	10 - 25	< 10	10 - 25	10 - 25	10 - 25	10 - 25	10 - 25	10 - 25	10 - 25	10 - 25
	Service Hours	4048	2851	4147	3914	3421	4029	3622	3722	4451	4065
Lingan 2	Capacity Factor (%)	30	63	0	0	0	0	0	0	0	0
	Unit Cycles (Ranges)	< 10	< 10	0	0	0	0	0	0	0	0
	Service Hours	3533	4362	0	0	0	0	0	0	0	0
Lingan 3	Capacity Factor (%)	48	37	47	45	46	41	37	28	29	39
	Unit Cycles (Ranges)	25 - 50	25 - 50	25 - 50	10 - 25	10 - 25	25 - 50	25 - 50	10 - 25	10 - 25	25 - 50
	Service Hours	6320	5089	6976	6813	7099	6285	5747	3922	4223	5682
Lingan 4	Capacity Factor (%)	42	27	37	33	34	34	32	31	33	25
	Unit Cycles (Ranges)	10 - 25	10 - 25	10 - 25	10 - 25	10 - 25	25 - 50	10 - 25	10 - 25	10 - 25	10 - 25
	Service Hours	5513	3565	5252	4655	4705	4736	4869	4738	4793	3381
Point Aconi	Capacity Factor (%)	83	83	73	81	81	81	70	76	71	73
	Unit Cycles (Ranges)	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
	Service Hours	7634	7731	6869	7666	7666	7690	6848	7437	6906	7144
Point Tupper	Capacity Factor (%)	66	35	27	27	30	29	18	29	26	28
	Unit Cycles (Ranges)	< 10	10 - 25	10 - 25	10 - 25	10 - 25	25 - 50	10 - 25	10 - 25	10 - 25	10 - 25
	Service Hours	6424	4494	3556	3504	3986	4284	2588	3626	3220	3739
Trenton 5	Capacity Factor (%)	53	29	34	41	47	43	33	19	29	30
	Unit Cycles (Ranges)	< 10	< 10	< 10	10 - 25	< 10	10 - 25	10 - 25	10 - 25	10 - 25	10 - 25
	Service Hours	5580	4071	4971	6189	6970	6634	5152	2852	4537	4613
Trenton 6	Capacity Factor (%)	60	39	30	23	18	19	24	39	28	27
	Unit Cycles (Ranges)	10 - 25	< 10	< 10	< 10	< 10	< 10	< 10	10 - 25	10 - 25	10 - 25
	Service Hours	6177	5700	4509	3214	2484	2750	3898	6039	4411	4360
Tufts Cove 1	Capacity Factor (%)	28	50	15	12	11	16	22	18	21	19
	Unit Cycles (Ranges)	10 - 25	10 - 25	25 - 50	10 - 25	10 - 25	10 - 25	10 - 25	10 - 25	25 - 50	25 - 50
	Service Hours	2668	4833	1717	1413	1267	1787	2338	1787	2195	1962
Tufts Cove 2	Capacity Factor (%)	24	41	10	9	9	10	16	14	13	14
	Unit Cycles (Ranges)	10 - 25	10 - 25	10 - 25	25 - 50	10 - 25	10 - 25	10 - 25	10 - 25	10 - 25	10 - 25
	Service Hours	2662	4603	1400	1318	1298	1363	1764	1558	1413	1697
Tufts Cove 3	Capacity Factor (%)	45	67	33	32	25	25	48	31	30	27
	Unit Cycles (Ranges)	10 - 25	25 - 50	50 - 100	50 - 100	25 - 50	25 - 50	25 - 50	25 - 50	25 - 50	25 - 50
	Service Hours	4760	6850	4399	4316	3177	3111	5595	3536	3378	3157
Tufts Cove 4	Capacity Factor (%)	64	71	51	52	54	52	61	60	57	58
	Unit Cycles (Ranges)	50 - 100	50 - 100	> 100	> 100	> 100	> 100	50 - 100	50 - 100	> 100	50 - 100
	Service Hours	5995	6851	5371	5485	5512	5322	6170	5709	5533	5522
Tufts Cove 5	Capacity Factor (%)	62	67	52	52	51	50	59	62	58	59
	Unit Cycles (Ranges)	50 - 100	25 - 50	> 100	> 100	> 100	> 100	50 - 100	50 - 100	50 - 100	50 - 100
	Service Hours	5802	6450	5456	5436	5217	5117	5963	5940	5544	5633
Tufts Cove 6	Capacity Factor (%)	43	49	28	31	32	29	39	37	36	35
	Unit Cycles (Ranges)	25 - 50	25 - 50	50 - 100	50 - 100	> 100	50 - 100	50 - 100	50 - 100	50 - 100	50 - 100
	Service Hours	5178	5729	4180	4612	4377	4092	4965	5026	4714	4581

3.3.3 Projections of Unit Sustaining Investment

Unit utilization and reliability objectives have long been the drivers for generator investment planning. Traditionally, in a predominantly base loaded generation fleet, it was sufficient to consider capacity factor as the source for utilization forecasts for any given unit. This is no longer the case; integration of variable renewable resources on the NS Power system has imposed revised operating and flexibility demands to integrate wind generation on previously base-loaded steam units. Therefore, it is necessary to also consider the effects of unit starts, operating hours, flexible operating modes (e.g. ramping and two-shifting) and the latest understanding of asset health along with the forecasted unit capacity factors.

NS Power has created the concept of utilization factor (UF) for the purpose of communicating the operation strategy for a particular generator. The essence of this approach is to better express the demands placed upon NS Power's generating units given the planned utilization. The UF for each unit is evaluated by considering the forecasted capacity factor, annual operating hours, unit starts, expected two-shifting, and a qualitative evaluation of asset health. By accounting for these operational capabilities, the value brought to the power system by these units is more clearly reflected. Refer to **Figure 8** below.

Figure 8: Utilization Factor

The UF parameters are assessed to more completely describe the operational outlook for the steam fleet and direct investment planning, and include:

- Capacity factor reflects the energy production contribution of a generating unit and is a necessary constituent of unit utilization. It is a part of the utilization factor determination rather than the only consideration as it would have been in the past.

- Service hours have become a more important factor to consider with increased penetration of variable-intermittent generation, as units are frequently running below their full capacity while providing load following and other essential reliability services for wind integration. For example, if a unit operates at 50 percent of its capacity for every hour of the year, then the capacity factor would be 50 percent. In a traditional model, this would suggest a reduced level of investment required, commensurate with decreased capacity factor. However, many failure mechanisms are a function of operating hours (e.g. turbines, some boiler failure mechanisms, and high energy piping) and the number of service hours (which in this example is every hour of the year) is not reflected by the unit's capacity factor. Additionally, some failure mechanisms can actually be exacerbated by reducing load operation (e.g. valves, some pumps, throttling devices).

- Unit cycles (downward and upward ramping of generating units) can stress many components (e.g. turbines, motors, breakers, and fatigue in high energy piping systems) and accelerate failure mechanisms; therefore, these must also be considered to properly estimate the service interval and appropriate maintenance strategies.

- Asset health is a critical operating parameter to keep at the forefront of all asset management decisions. For example, asset health may determine if a unit is capable of two-shifting (unit shut down during low load overnight and restart to serve load the next day). Although it does not necessarily play directly into the UF function, it can be a dominant determinant in allowing a mode of operation; therefore, it influences the UF function.

While the UF rating provides a directional understanding of the future use of each generating unit, the practice of applying it has another layer of sophistication as system parameters change. NS Power utilizes the Plexos dispatch optimization model to derive utilization forecasts and qualitatively assess the UF of each unit by evaluating the components described above.

Figure 10 and **Figure 11** below provide the projected sustaining investments based on the anticipated utilization forecast in **Section 3.3.2**. Estimates of unit sustaining investment are forecast by applying the UF, related life consumption and known failure mechanisms. NS Power does not include unplanned failures in sustaining capital estimates. These estimates are evaluated at the asset class level; some asset class projections are prorated by the UF and others have additional overriding factors. For example, the use of many instrument and electrical systems is a function of calendar years, as they operate whether a unit is running or not. Investments for coal and ash systems are a direct function of capacity factor, as they typically have material volume based failure mechanisms. In contrast, the UF is directly applicable to the investment associated with turbines, boilers and high energy piping. Major assets are regularly re-assessed in terms of their condition and intended service as NS Power's operational data, utilization plan, asset health information, and forecasts are updated.

The overarching investment philosophy is to cost effectively maintain unit reliability while minimizing undepreciated capital. Mitigating risks by using less intensive investment strategies is a tactic executed throughout the thermal fleet. Major outage intervals are extended where possible to reduce large investments in the thermal fleet.

Major changes in the asset management plan from the 2018 10-Year System Outlook include:

- Increased cycling (output ramping or two shifting) of the thermal fleet can sustain the unit utilization factors even as the capacity factors decline. For example, a unit that is heavily cycled can require more sustaining investment than a base loaded machine. **Figure 9** shows the projected unit utilization factors.

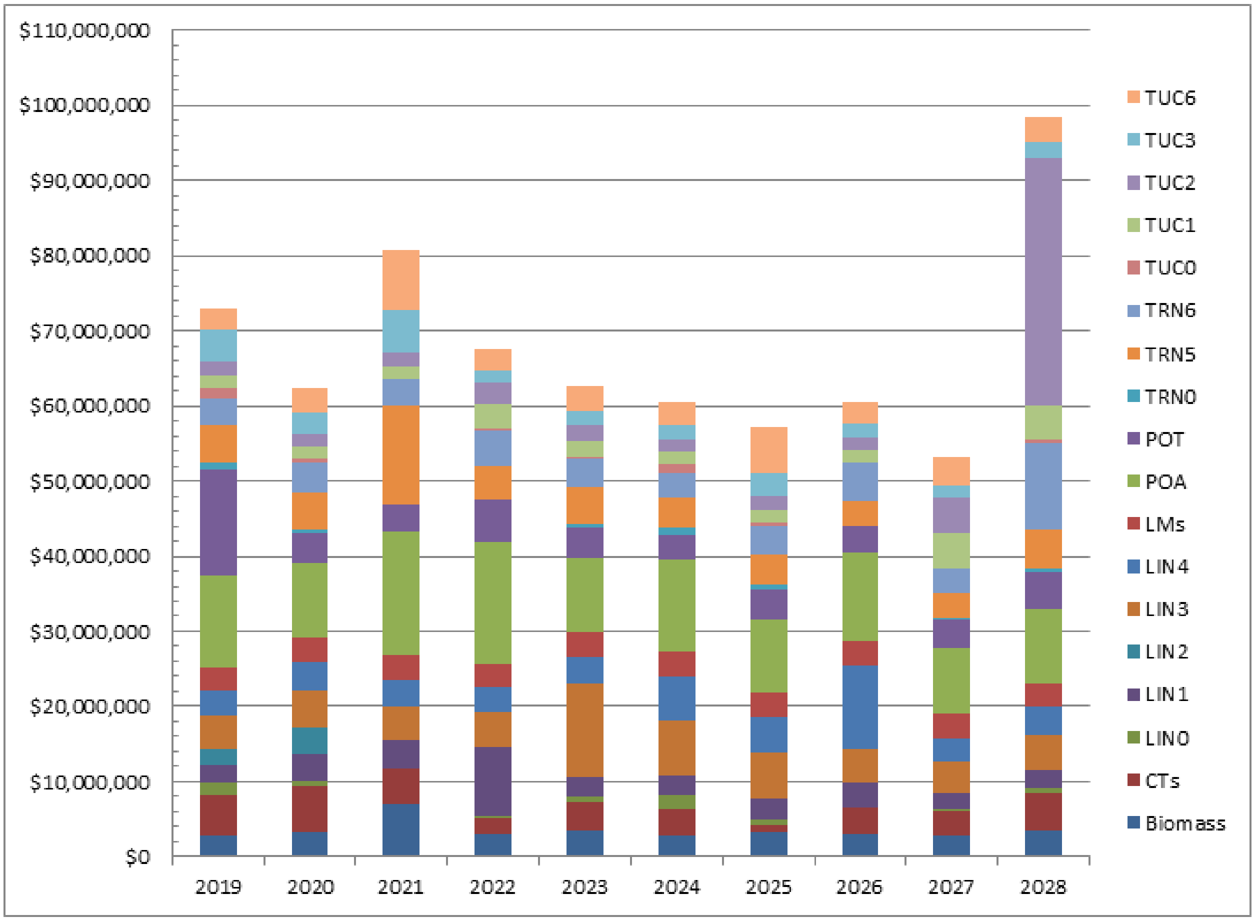
- Lower forecasted utilization of Tuft's Cove Unit 2 drives the major turbine refurbishment interval out to 2028.

- Higher utilization forecasts for Trenton Unit #5 advances the need for a major outage into the 10-year planning window.

Figure 9: Unit Utilization Factors

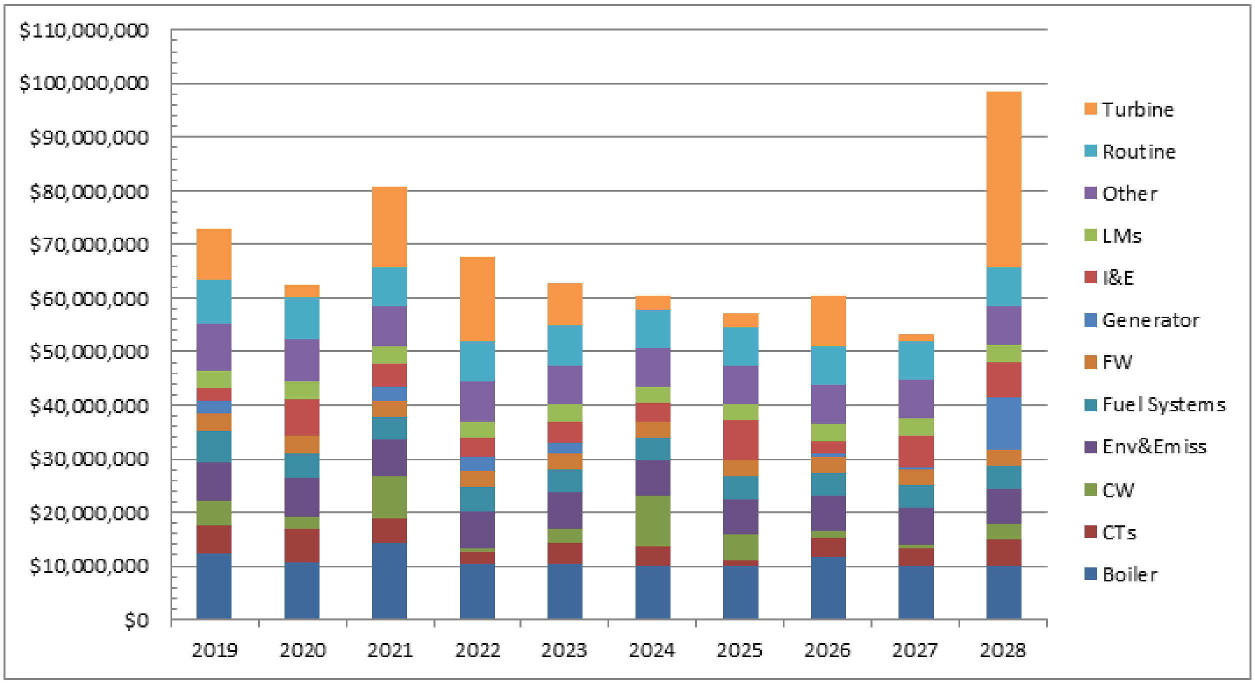
Unit	UF(2019-2023)	UF (2024-2028)
PH Biomass	High	High
Lingan Unit 1	Low	Low
Lingan Unit 2	Low/Off	Off
Lingan Unit 3	High	Med
Lingan Unit 4	Med	Med
Pt. Aconi	High	High
Pt. Tupper	Med	Med
Trenton 5	High	High
Trenton 6	Med	Med
Tuft's Cove 1	Low	Low
Tuft's Cove 2	Low	Low
Tuft's Cove 3	Med	Med
Tuft's Cove 6	High	High
LM 6000	High	High
CT's	Low	Low

Figure 10: Forecasted Annual Investment (in 2018$) by Unit



Note: Figure does not include escalation as it is used for asset planning.

Figure 11: Forecasted Annual Investment (in 2018$) by Asset Class



Note: Figure does not include escalation as it is used for asset planning. Forecast investments are subject to change arising from asset health and actual utilization. Changes in currency value can also have significant effect on actual cost.

NS Power notes the large sustaining capital investment projection for the year 2028 for Tufts Cove Unit #2. Consistent with Synapse's recommendation #7 in its Generation Utilization & Optimization study, to determine the capacity and unit commitment requirements to assess possible Tufts Cove unit economic retirement, as part of the next IRP, NS Power plans to assess replacement options for this unit as an alternative to the sustaining capital investment.

3.3.4 Steam Fleet Retirement Outlook

As stated in NS Power's submission to the UARB dated June 7, 2018[11] in regard to Synapse Energy Economic Inc.'s (Synapse) Generation Utilization and Optimization report (M08059) filed on May 1, 2018:

> Synapse's results provide a direct answer to the Board's question posed through the approved objective in the Terms of Reference for this work; it is cost-effective for rate payers is the retention of the coal fleet through 2030, and possibly beyond. Synapse confirmed this interpretation of the results at the Technical Conference on March 28, 2018.
>
> NS Power understands this is not a final determination as to the long-term utilization of these generation units and recognizes that uncertainty remains with respect to a major resource planning factor, the carbon regime to be implemented in Nova Scotia over the next decade and beyond. A long-term view of the useful lives of these plants will not be firmly established until this regime is established and understood. The Company currently expects this will be resolved by the end of 2018, likely enabling the undertaking of an Integrated Resource Planning (IRP) exercise in 2019, subject to clarity surrounding federal and provincial carbon policy.[12]

As set out in Section 6.3, the details of the amendments to the Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations[13] and a related potential equivalency agreement are under discussion between the Province and the Government of Canada, and NS Power is providing input to that process as required. The

[11] M008059 NS Power comments on Synapse Final Report (May 1, 2018) June 7, 2018, 2018.
[12] Ibid at page 4 of 8.
[13] Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations, SOR/2012/167, made under the Canadian Environmental Protection Act, 1999, SOR/2012/167, s.7.3

potential outcomes of these discussions include a range of unit retention or retirement possibilities.

NS Power will develop an updated retirement schedule as part of the next IRP following the conclusions of these negotiations based on their outcome, the finalization of the Federal Coal-fired Generation of Electricity Regulations, and the forecasted major investment intervals for the units. In the interim, Lingan Unit 2 is planned for retirement upon the commencement of the delivery of the Nova Scotia Block of energy and related firm capacity from the Muskrat Falls, currently anticipated in 2020.

4.0 NEW SUPPLY SIDE FACILITIES

4.1 Potential New Facilities

As of May 17, 2018, NS Power has four Active Transmission Connected Interconnection Requests (70.1MW) and eight Active Distribution Connected Interconnection Requests (17.3MW) at various stages of interconnection study.

Proponents of the transmission projects have requested Network Resource Interconnection Service (NRIS) or Energy Resource Interconnection Service (ERIS). Distribution projects do not receive an NRIS or ERIS designation. NRIS refers to a firm transmission interconnection request with the potential requirement for transmission reinforcement upon completion of the System Impact Study (SIS). ERIS refers to an interconnection request for firm service only to the point where transmission reinforcement would be required. Results of the interconnection studies will be incorporated into future transmission plans.

5.0 QUEUED SYSTEM IMPACT STUDIES

Figure 12 below provides the current combined Transmission and Distribution Advanced Stage Interconnection Queue.

Figure 12: Combined Transmission & Distribution Advanced Stage Interconnection Queue of June 29, 2018

Combined T/D Advanced Stage Interconnection Request Queue
Publish Date: Wednesday, May 16, 2018

Queue Order	IR#	Request Date DD-MMM-YY	County	MW Summer	MW Winter	Interconnection Point	Type	In-service date DD-MMM-YY	Status	Service Type
1-T	426	27-Jul-12	Richmond	45.0	45.0	47C	Biomass	01-Jan-17	GIA Executed	NRIS
2-D	442	21-Dec-12	Hants	0.5	0.5	82V-423	Biogas	29-Dec-15	GIA Executed	N/A
3-D	498	23-Apr-14	Antigonish	0.5	0.5	4C-441	Biogas	15-Jan-15	GIA Executed	N/A
4-T	516	5-Dec-14	Cumberland	5.0	5.0	37N	Tidal	01-Jul-16	GIA Executed	NRIS
5-D	518	16-Dec-14	Halifax	2.0	2.0	139H-411	Biomass	1-Oct-16	GIA Executed	N/A
6-T	540	28-Jul-16	Hants	14.1	14.1	17V	Wind	01-Jan-18	GIA Executed	NRIS
7-D	545	24-Jan-17	Halifax	1.3	1.3	82V-401	Battery	1-Dec-17	SIS Complete	N/A
8-T	542	26-Sep-16	Cumberland	6.0	6.0	37N	Tidal	01-Jan-19	FAC in Progress	NRIS
9-D	553	24-Feb-17	Digby	0.9	0.9	509V-301	Tidal	31-Dec-18	SIS Complete	N/A
10-D	557	19-Apr-17	Halifax	5.6	5.6		CHP	01-Sep-18	SIS Complete	N/A
11-D	565	26-Jan-18	Lunenburg	0.5	0.5	84W-301	Biogas	25-Feb-19	SIS in Progress	N/A
12-D	548	31-Jan-17	Kings	6	6	36V-302	Tidal	01-Oct-17	SIS in Progress	N/A

Active transmission and distribution requests not appearing in the Combined Transmission & Distribution Advanced Stage Interconnection Request Queue are considered to be at the initial queue stage, as they have not yet proceeded to the SIS stage of the Generator Interconnection Procedures (GIP). **Figure 13** indicates the location and size of the generating facilities currently in the Combined T/D Advanced Stage Interconnection Request Queue.

Figure 13: Generation Projects Currently in the Combined T/D Advanced Stage Interconnection Request Queue

Company/Location	Nameplate Capacity (MW)
IR #426 NRIS Version of existing 64MW (IR 219, which was ERIS) Biomass	N/A
IR #516 Tidal in Cumberland County	5.0
IR #540 Wind in Hants County	14.1
IR #542 Tidal in Cumberland County	6.0
IR #545 Battery in Halifax	1.3
IR #557 CHP in Halifax	5.6
COMFIT Distribution Interconnection Request	10.4
Total	**42.4**

Port Hawkesbury Biomass, 63.8 MW gross / 45 MW net output, generating unit is presently an ERIS classified resource which will be converted to NRIS following the system upgrades associated with Transmission Service Request 400, which are expected to be completed in 2018.

5.1 OATT Transmission Service Queue

There is presently one request in the OATT Transmission Queue, as shown in **Figure 14.**

Figure 14: Requests in the OATT Transmission Queue

Number	Project	Date & Time of Service Request	Project Type	Project Location	Requested In-Service Date	Project size (MW)	Status
4	TSR 400	July 22, 2011	Point to Point	NS-NB	May 31, 2018	330	Waiting for transmission construction completion expected later this year. L6613 construction and reconfiguration of CB causeway

6.0 ENVIRONMENTAL AND EMISSIONS REGULATORY REQUIREMENTS

6.1 Renewable Electricity Requirements

The Nova Scotia Renewable Electricity Standard (RES) includes a renewable energy requirement for NS Power of 25 percent of energy sales in 2015, and 40 percent in 2020.

In addition to these requirements, Nova Scotia has a Community Feed-in-Tariff (COMFIT) for projects which include community ownership that are connected to the distribution system and Net Metering legislation for renewable projects.[14] The current Net Metering program was initiated in July 2011, and implementation of the COMFIT program occurred in September 2011.

On April 8, 2016, the Province amended the Renewable Electricity Regulations to allow NS Power to include COMFIT projects in its RES compliance planning. It also amended the Regulations to remove the "must-run" requirement of the Port Hawkesbury biomass generating facility.[15] NS Power continues to have contractual obligations associated with operation and maintenance of this biomass co-generation facility.

NS Power has complied with the renewable electricity requirement in all applicable years. From 2015 through to 2017 the Company served 26.6 percent, 28 percent and 29 percent of sales, respectively, using qualifying renewable energy sources. NS Power's production tracking and forecast for the current year indicate that renewable electricity compliance will also be achieved for the year 2018.

[14] Effective December 18, 2015, the Electricity Act reduced the maximum nameplate capacity for Net Metering from 1,000 kW to 100 kW. Net metering applications submitted on or after December 18, 2015 are subject to the new 100 kW limit. The legislation also closed the COMFIT to new applications.

[15] Renewable Electricity Regulations, made under Section 5 of the Electricity Act S.N.S. 2004, c. 25 O.I.C. 2010-381 (effective October 12, 2010), N.S. Reg. 155/2010 as amended to O.I.C. 2018-133 (effective May 8, 2018), N.S. Reg. 83/2018s. 5 2A.

The total annual RES-eligible energy from the Maritime Link will amount to 1.2 TWh, which includes both the Nova Scotia Block and Supplemental Block (for the first five years of operation). Surplus energy purchases from the Maritime Link are not RES compliant in the Renewable Electricity Regulations. RES compliant electricity that will be delivered on the Maritime Link in 2020 may vary depending on the start date of the flow of the Nova Scotia Block and Supplemental Block. The Company has included a RES forecast for 2020 assuming a full year of Nova Scotia and Supplemental Block flow for simplicity and to illustrate the expected renewable energy in a year with normal Maritime Link operation, as well as a second forecast with a start date of July 1, 2020 to reflect the current outlook for 2020.

The RES Compliance Forecast in

Figure 15 below illustrates the full amount of RES-eligible energy forecasted to be available to the Company if the Nova Scotia Block and Supplemental Block energy flow begins on January 1, 2020 (1154 GWh), and the biomass unit is fully dispatched (290 GWh when Port Hawkesbury Paper (PHP) load is being supplied and 341 GWh when PHP load is not being supplied).

Figure 15: RES 2019 and 2020 Compliance Forecast (Full Year Maritime Link)

RES 2019 and 2020 Compliance Forecast			
	2019	**2020 with PHP**	**2020 no PHP[16]**
Energy Requirements (GWh) [17]			
NSR including DSM effects	11,000	11,003	9,923
Losses	767	755	755
Sales	10,233	10,248	9,168
RES (%) Requirement	25%	40%	40%

[16] Port Hawkesbury Paper LP (PHP) is approved to operate under the Load Retention Tariff until the end of 2019. As such, the compliance forecast figures are shown both inclusive and exclusive of the PHP customer load.

[17] NSR and Losses are from the 2018 NS Power 10 Year Energy and Demand Forecast, M08670, Exhibit N-1, Table A-1, April 30, 2018.[18] The reduction in Hydro Generation in 2020 is as a result of required maintenance currently scheduled in 2020.

RES 2019 and 2020 Compliance Forecast			
	2019	**2020 with PHP**	**2020 no PHP**[16]
RES Requirement (GWh)	**2,558**	**4,099**	**3,667**
Renewable Energy Sources (GWh)			
NS Power Wind	260	260	260
Post 2001 IPPs	753	755	755
PH Biomass	290	290	341
COMFIT Wind Energy	503	503	503
COMFIT Non-Wind Energy	84	86	86
Eligible Pre 2001 IPPs	80	85	85
Eligible NSPI Legacy Hydro[18]	940	914	914
REA procurement (South Canoe/Sable)	355	355	355
Maritime Link	0	1,154	1,154
Forecasted Renewable Energy (GWh)	**3,265**	**4,402**	**4,453**
Forecasted Surplus or Deficit (GWh)	**707**	**302**	**785**
Forecasted RES Percentage of Sales	**31.9%**	**43.0%**	**48.6%**

The RES Compliance Forecast in **Figure 16** below illustrates the amount of RES-eligible energy currently forecasted to be available to the Company assuming a start date of July 1, 2020 for Nova Scotia Block and Supplemental Block energy flow (612 GWh), as well as a fully dispatched biomass unit. This version of the RES forecast shows a potential shortfall of renewable energy if PHP is operating, while without PHP there is a renewable energy surplus. This is within the reasonable range of compliance planning as the potential shortfall could be made up with the purchase of renewable imports.

[18] The reduction in Hydro Generation in 2020 is as a result of required maintenance currently scheduled in 2020.

Figure 16: RES 2019 and 2020 Compliance Forecast (Part Year Maritime Link)

RES 2019 and 2020 Compliance Forecast			
	2019	**2020 with PHP**	**2020 no PHP**[19]
Energy Requirements (GWh) [20]			
NSR including DSM effects	11,000	11,003	9,923
Losses	767	755	755
Sales	10,233	10,248	9,168
RES (%) Requirement	25%	40%	40%
RES Requirement (GWh)	**2,558**	**4,099**	**3,667**
Renewable Energy Sources (GWh)			
NS Power Wind	260	260	260
Post 2001 IPPs	753	755	755
PH Biomass	290	290	341
COMFIT Wind Energy	503	503	503
COMFIT Non-Wind Energy	84	86	86
Eligible Pre 2001 IPPs	80	85	85
Eligible NSPI Legacy Hydro[21]	940	914	914
REA procurement (South Canoe/Sable)	355	355	355
Maritime Link	0	612	612
Forecasted Renewable Energy (GWh)	**3,265**	**3,860**	**3,911**
Forecasted Surplus or Deficit (GWh)	**707**	**-239**	**244**
Forecasted RES Percentage of Sales	**31.9%**	**37.7%**	**42.7%**

6.2 Environmental Regulatory Requirements

The Nova Scotia Greenhouse Gas Emissions Regulations[22] specify emission caps for 2010 – 2030, as outlined in

[19] Port Hawkesbury Paper LP (PHP) is approved to operate under the Load Retention Tariff until the end of 2019. As such, the compliance forecast figures are shown both inclusive and exclusive of the PHP customer load.

[20] NSR and Losses are from the 2018 NS Power 10 Year Energy and Demand Forecast, M08670, Exhibit N-1, Table A-1, April 30, 2018.[21] The reduction in Hydro Generation in 2020 is as a result of required maintenance currently scheduled in 2020.

[21] The reduction in Hydro Generation in 2020 is as a result of required maintenance currently scheduled in 2020.

Figure 17. The net result is a hard cap reduction from 10.0 to 4.5 million tonnes over that 20-year period, which represents a 55 percent reduction in CO_2 release over 20 years. Carbon emissions in Nova Scotia from the production of electricity in 2030 will have decreased by 58 percent from 2005 levels. The primary means of meeting the caps is a reduction in thermal generation from the existing coal-fired generating units, replaced by renewable energy.

Figure 17: Compliance CO_2 Emission Caps

Compliance Period	Calendar Years	Emission Cap for All Facilities (million tonnes CO_{2eq})
1	2010, 2011	19.22
2	2012, 2013	18.50
3	2014, 2015, 2016	26.32
4	2017, 2018, 2019	24.06
5	2020	7.50
6	2021, 2022, 2023, 2024	27.50
7	2025	6.0
8	2026, 2027, 2028, 2029	21.50
9	2030	4.50

The Nova Scotia Air Quality Regulations[23] specify emission caps for sulphur dioxide (SO_2), nitrogen oxides (NO_X), and mercury (Hg). These regulations were subsequently amended to extend from 2020 to 2030, effective January 1, 2015. The amended regulations replaced annual limits with multi-year caps for the emissions targets for SO_2 and NO_X as outlined in **Figure 18.** The regulations also provide local annual maximums, as well as limits on individual coal units for SO_2, as provided in **Figure 19** and **Figure 20** respectively. The mercury emission caps are outlined in

[22] Greenhouse Gas Emissions Regulations made under subsection 28(6) and Section 112 of the Environment Act S.N.S. 1994-95, c. 1, O.I.C. 2009-341 (August 14, 2009), N.S. Reg. 260/2009 as amended to O.I.C. 2013-332 (September 10, 2013), N.S. Reg. 305/2013.

[23] Air Quality Regulations made under Sections 25 and 112 of the Environment Act S.N.S. 1994-95, c. 1 O.I.C. 2005-87 (February 25, 2005, effective March 1, 2005), N.S. Reg. 28/2005 as amended to O.I.C. 2017-255 (October 12, 2017), N.S. Reg. 150/2017.

Figure 21.

Figure 18: Emissions Multi-Year Caps (SO_2, NO_X)

Multi-Year Caps Period	SO_2 (t)	NO_X (t)
2015 – 2019 (equal outcome)	304,500	96,140
2020	36,250	14,955
2021 – 2024	136,000	56,000
2025	28,000	11,500
2026 – 2029	104,000	44,000
2030	20,000	8,800

Figure 19: Emissions Annual Maximums (SO_2, NO_X)[24]

Year	SO_2 Annual Maximum (t)	NO_X Annual Maximum (t)
2015 – 2019	72,500	21,365
2021 – 2024	36,250	14,955
2026 – 2029	28,000	11,500

Figure 20: Individual Unit Limits (SO_2)

Year	SO_2 Individual Unit Limit (t)
2015 – 2019	42,775
2020 – 2024	17,760
2025 – 2029	13,720
2030	9,800

[24] Annual maximums apply to the multi-year ranges from **Figure 19** only. Please refer to **Figure 20** for the caps on years that are not contained within the multi-year cap ranges.

Figure 21: Mercury Emissions Caps

Year	Hg Emission Cap (kg)
2010	110
2011	100
2013	85
2014	65
2020	35
2030	30

By 2030, emissions of sulphur dioxide from generating electricity will have been reduced by 80 percent from 2005 levels. Nitrogen oxides emissions will have decreased by 73 percent and mercury emissions will have decreased 71 percent from 2005 levels.

SO_2 reductions are being addressed mainly by reduced thermal generation and changes to fuel blends. NO_X reductions are being addressed through reductions in thermal generation and the previous installation of Low NO_X Combustion Firing Systems. Mercury reductions are being accomplished through reduced thermal generation, changed fuel blends and the use of Powder Activated Carbon systems.

The amendments to the Nova Scotia Air Quality Regulations[25] also provide an optional program until the end of 2020, through which NS Power can obtain credits to be used to make up deferred mercury emission requirements from earlier in the decade as well as for compliance from 2020 through to 2029. NS Power offers a mercury recovery program, such as recycling light bulbs or other mercury-containing consumer products, which reduces the amount of mercury going into the environment through landfills. NS Power, through its contracted service provider, Efficiency One, has collected mercury credits of 2.3 kg in 2015 and 19.2 kg in 2016, and 44.8 kg in 2017 as a result of this program and

[25] Air Quality Regulations made under Sections 25 and 112 of the Environment Act S.N.S. 1994-95, c. 1 O.I.C. 2005-87 (February 25, 2005, effective March 1, 2005), N.S. Reg. 28/2005 as amended to O.I.C. 2017-255 (October 12, 2017), N.S. Reg. 150/2017

these can be used to compensate for the deferred mercury emissions by 2020 as well as for compliance from 2020 to 2029. NS Power continues to offer the program in 2018.

6.3 Upcoming Policy Changes

Until the recent federal coal phase-out policy changes announced in the fall of 2016, [26] NS Power's operation of and planning for its coal-fired generation units has been proceeding consistent with the provisions of the Agreement on Equivalency of Federal and Nova Scotia Regulations for the Control of Greenhouse Gas Emissions from Electricity Producers in Nova Scotia (the Equivalency Agreement). The Equivalency Agreement was finalized in May 2014, and effective starting July 1, 2015 contemporaneous with the effective date for the current federal Reduction of Carbon Dioxide Emissions from Coal-Fired Generation of Electricity Regulations.

In November 2016, the Province of Nova Scotia announced an agreement-in-principle had been reached with the Government of Canada to develop a new equivalency agreement that will enable the province to move directly from fossil fuels to clean energy sources but enable Nova Scotia's coal-fired plants to operate at some capacity beyond 2030. The need for this new agreement was driven by amendments proposed by the Federal Government to the Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations.[27] The amendments to the Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations and potential for a related equivalency agreement are under discussion between the Province and the Government of Canada, and NS Power is providing input to that process as required.

In addition to the amendments to the Reduction of Carbon Dioxide Emissions from Coal-fired Generation of Electricity Regulations, the Government of Canada announced a

[26] https://www.canada.ca/en/environment-climate-change/news/2017/11/taking_action_tophase-outcoalpower.html
[27] Vol. 152, No. 7 Canada Gazette Part I Ottawa, Saturday, February 17, 2018.

"Pan-Canadian Approach to Pricing Carbon Pollution"[28] in October 2016. This program includes the requirement for each province to implement a carbon price by 2018 through either an explicit carbon tax or a cap and trade program. In November 2016, the Province of Nova Scotia announced that it would comply with the Federal requirement using a cap-and-trade program. Amendments to the Environment Act[29] were passed in October 2017 and the first set of regulations,[30] which provide for emission reporting which is now in effect. The details of the cap and trade program and a related second set of regulations remain under development, with an expected program initiation in January 2019.

[28]https://www.canada.ca/en/environment-climate-change/news/2016/10/canadian-approach-pricing-carbon-pollution.html
[29] Bill No. 15, as passed, Environment Act (amended), R.S.N.S. c. 10, 2017.
[30] Quantification, Reporting and Verification Regulations made under Section 112Q of the Environment Act S.N.S. 1994-95, c. 1 O.I.C. 2018-43 (effective February 15, 2018), N.S. Reg. 29/2018.

7.0 RESOURCE ADEQUACY

7.1 Operating Reserve Criteria

Operating Reserves are generating resources which can be called upon by system operators on short notice to respond to the unplanned loss of generation or imports. These assets are essential to the reliability of the power system.

As a member of the Maritimes Area of NPCC, NS Power meets the operating reserve requirements as outlined in *NPCC Regional Reliability Reference Directory #5, Reserve.* These Criteria are reviewed and adjusted periodically by NPCC and subject to approval by the UARB. The Criteria require that:

> Each Balancing Authority shall have ten-minute reserve available that is at least equal to its first contingency loss…and,
> Each Balancing Authority shall have thirty-minute reserve available that is at least equal to one half its second contingency loss.[31]

In the *Interconnection Agreement between Nova Scotia Power Incorporated and New Brunswick System Operator (NBSO),*[32] NS Power and New Brunswick Power (NB Power) have agreed to share the reserve requirement for the Maritimes Area on the following basis:

> The Ten-Minute Reserve Responsibility, for contingencies within the Maritimes Area, will be shared between the two Parties based on a 12CP [coincident peak] Load-Ratio Share… Notwithstanding the Load-Ratio Share the maximum that either Party will be responsible for is 100 percent of its greatest, on-line, net single contingency, and, NSPI shall be responsible for 50 MW of Thirty-Minute Reserve.

[31] https://www.npcc.org/Standards/Directories/Forms/Public%20List.aspx

[32] New Brunswick's new Electricity Act (the Act) was proclaimed on October 1, 2013. Among other things, the Act establishes the amalgamation of the New Brunswick System Operator (NBSO) with New Brunswick Power Corporation ("NB Power").

The Ten-Minute Reserve Responsibility formula results in a reserve share of approximately 40 percent of the largest loss-of-source contingency in the Maritimes Area (limited to 10 percent of Maritimes Area coincident peak load). This yields a reserve share requirement for NS Power of approximately 40 percent of 550 MW, or 220 MW, capped at the largest on-line unit in Nova Scotia. When Point Aconi is online, NS Power maintains a ten-minute operating reserve of 168 MW (equivalent to Point Aconi net output), of which approximately 33 MW is held as spinning reserve on the system. Additional regulating reserve is maintained to manage the variability of customer load and generation. The reserve sharing requirement with Maritime Link as the largest source in Nova Scotia will depend on the amount of Maritime Link power used in Nova Scotia.

7.2 Planning Reserve Criteria

The Planning Reserve Margin (PRM) intends to maintain sufficient resources to serve firm customers. Unit forced outages, higher than forecasted demand, and lower than forecasted wind generation are all conditions that could individually or collectively contribute to a shortfall of dispatchable capacity resources to meet customer demand.

NS Power is required to comply with the NPCC reliability criteria that have been approved by the UARB. These criteria are outlined in *NPCC Regional Reliability Reference Directory #1 – Design and Operation of the Bulk Power System*[33] and states that:

> Each Planning Coordinator or Resource Planner shall probabilistically evaluate resource adequacy of its Planning Coordinator Area portion of the bulk power system to demonstrate that the loss of load expectation (LOLE) of disconnecting firm load due to resource deficiencies is, on average, no more than 0.1 days per year. [This evaluation shall] make due allowances for demand uncertainty, scheduled outages and deratings, forced outages and deratings, assistance over interconnections with

[33] https://www.npcc.org/Standards/Directories/Forms/Public%20List.aspx

neighboring Planning Coordinator Areas, transmission transfer capabilities, and capacity and/or load relief from available operating procedures.

The 2014 IRP Loss of Load Expectation (LOLE) study confirmed that the 20 percent planning reserve margin applied by NS Power is required to meet the NPCC reliability criteria. The PRM is a long-term planning assumption that is typically updated as part of an IRP process; each year in the 10 Year System Outlook Report the Company verifies that the established PRM remains in compliance with the NPCC reliability criteria. NS Power is in the process of initiating an updated LOLE study to establish the planning reserve margin for the next cycle of long-term planning.

The planning reserve margin provides a basis for the minimum required firm generation NS Power must maintain to comply with NPCC reliability criteria; it does not represent the optimal or maximum required capacity to serve other system requirements such as load-following (ramping capability) and emissions compliance. The optimal capacity requirement is determined through a long-term planning exercise such as an IRP, as discussed in Section 7.4.

7.3 Capacity Contribution of Renewable Resources in Nova Scotia

7.3.1 Wind Capacity Contribution

NS Power continues to evaluate the coincidence of wind generation with peak load on an annual basis to better understand the Effective Load Carrying Capability (ELCC) or capacity value of wind assets on the NS Power system by completing studies using available data. The capacity value determines the amount of firm capacity contribution that can be credited to wind installed on the system. This is a dynamic value that changes as the wind penetration level changes; it is unique to each electricity system as the capabilities of the other system generating units and the load shape influence its result.

In previous 10 Year System Outlook reports, NS Power provided calculations for the capacity value of wind using both the LOLE and Cumulative Frequency methodologies. The LOLE methodology is a long standing utility industry standard for planning reserve margin assessment, which can be adapted to assess the capacity value of wind. Cumulative Frequency is a statistical technique of analyzing a set of historical data points to determine the minimum capacity factor of wind predicted to be available on the system during peak hours, with corresponding certainty. As discussed in the 2017 10 Year System Outlook Report, LOLE is the more robust methodology for calculating wind capacity value; the Company has used the Cumulative Frequency Analysis as a supplementary study to the LOLE. As the industry standard for assessment of the capacity value of wind generation is the LOLE methodology, NS Power no longer plans to continue completing Cumulative Frequency assessments of the ELCC of wind generation.

The advantages of the LOLE methodology over others are that the calculation practices are well-established and the computation considers not just the coincidence of peak load and wind generation, but also the impact of the amount of wind generation proportional to the system (exhibiting declining capacity factor with higher penetration levels of wind). The main disadvantage of the LOLE approach is that the results can vary significantly year over year. As discussed in the 2017 10-Year System Outlook, the International Energy Agency (IEA) Wind Task 25 Final Report[34] recommends that between 10 and 30 years of wind and load data is required to establish a reliable ELCC of wind generation using LOLE calculations.

To date, the LOLE calculation has been completed each year using the Probabilistic Assessment of System Adequacy (PASA) module of Plexos. The model has taken into account hourly actual wind, hourly actual load, generator capacities, and forced outage rates. In conjunction with the continued update of long-term planning assumptions in

[34] IEA Wind Task 25 Final Report - http://www.ieawind.org/AnnexXXV/PDF/Final%20Report%20Task%2025%202008/T2493.pdf

preparation for the next IRP, NS Power has been conducting a revised LOLE study to evaluate the capacity value of wind, as well as the duration requirements for storage technologies discussed in Section 8.3.2, for the NS Power system using a more comprehensive modeling approach. NS Power is in the process of finalizing this study and will bring forward the results as part of the long-term planning assumptions vetting conducted through the next IRP. NS Power has used the 17 percent capacity value of wind historically applied in Nova Scotia for the purposes of this year's Report. Please also refer to Section 7.3.1.1 regarding the inclusion of Energy Resource Interconnection Service wind resources.

For future long-term planning exercises, the marginal capacity value of any incremental wind generation decreases due to saturation effects and the increase of variable generation affecting the ability to serve load during peak demand. The results of the study will provide the appropriate capacity values to be used in modeling new wind resources considered in long term resource planning exercises.

Some municipal load is served from one independent wind farm supply. This generation is not included in NS Power's sourced wind generation but contributes to operational considerations of the total amount of wind generation.

7.3.1.1 Energy Resource Interconnection Service Connected Resources

In the 2017 10 Year System Outlook Report, NS Power advised it was conducting a study to determine the potential capacity contribution of ERIS facilities based on current system configuration and conditions. The study has been completed and is attached as **Appendix B**.

The study has concluded that all existing ERIS facilities can operate as though they are NRIS facilities and therefore can contribute to system capacity for the purposes of resource planning at this time without the requirement for additional system upgrades. The transmission system upgrades undertaken to enable the transmission of Maritime

Link energy across Nova Scotia contributed to the change to ERIS facility capacity treatment.

Consistent with this and for the purposes of reflecting this potential additional capacity in this report, NS Power has applied a capacity value of 17 percent to all existing wind resources, both ERIS and NRIS, in this report. This change results in an additional 28 MW of capacity.

The Company notes that this represents a material change to the treatment of these facilities and a significant increase to the Company's reported capacity. However, the addition of large-scale wind to the system and the interplay of this with firm and curtailable transmission resources remains a new area for resource planning and remains subject to change.

Until these matters are better understood it remains premature to make longer-term resource planning decisions based on this capacity addition. The Company will continue to monitor this resource planning input and will refine the capacity estimates as required. Changes, if necessary, will be incorporated within future 10 Year System Outlook Reports.

7.3.2 Storage Capacity Contribution

As part of the LOLE study being conducted to evaluate the capacity contribution of wind, NS Power is also evaluating the ability for storage to provide system capacity; most importantly, what duration of energy storage technologies will be required for Nova Scotia at varying levels of storage penetration. The results of this work will be provided with the other LOLE study results in preparation for the next IRP.

7.4 Load and Resources Review

The ten year Load and Resources Outlook in **Figure 22** and **Figure 23** below are based on the capacity changes and DSM forecast from **Figure 4** above, and provides details regarding NS Power's required minimum forecasted planning reserve margin equal to 20 percent of the firm peak load.

Figure 22 is intended to provide a medium-term outlook of the capacity resources available to the Company compared to expected customer demand, given the most recent assumptions to date. As noted in Section 8.2, the planning reserve margin provides a basis for the minimum required firm generation NS Power must maintain to comply with NPCC reliability criteria; it does not necessarily represent the optimal or maximum required capacity to serve other system requirements such as wind-following (ramping capability) and emissions compliance. In its final report submitted to the UARB in the Generation Utilization and Optimization proceeding,[35] Synapse stated:

> The PRMs provide one high-level measure of the amount of generation capacity relative to the NPCC 20 percent planning reserve margin requirement. PRM is defined as the amount of firm capacity available over the planning peak load. Notably, the NPCC constraint is not the only constraint that dictates how much capacity might be required on the system. Plexos' ability to model hourly dispatch requirements means that any ramping requirements must be met with adequate capacity. Also, the presence of annual emissions constraints combined with the multi-fossil-fuel environment in which the thermal fleet operates (coal, oil, gas) leads to capacity requirements that could exceed thresholds needed to meet either NPCC reserve or ramping requirements. The integrated aspect of the model (long-term planning and short-term dispatch) is intended to allow capture of all these moving parts when optimizing retirement and build decisions.[36]

[35] Synapse Energy Economic Inc., Nova Scotia Power Inc. Thermal Generation Utilization and Optimization Economic Analysis of Retention of Fossil-Fueled Thermal Fleet To and Beyond 2030 – M08059, filed on May 1, 2018

[36] Ibid at section 3.1,

As stated by Synapse, other considerations may dictate the most economic generating capacity for the system; therefore, any surplus capacity in this outlook does not necessarily suggest that any full or partial unit retirement would be possible or optimal, as these units may provide other additional value. The optimal capacity requirement, and the appropriateness of any unit retirements, is determined through a long-term planning exercise such as an IRP.

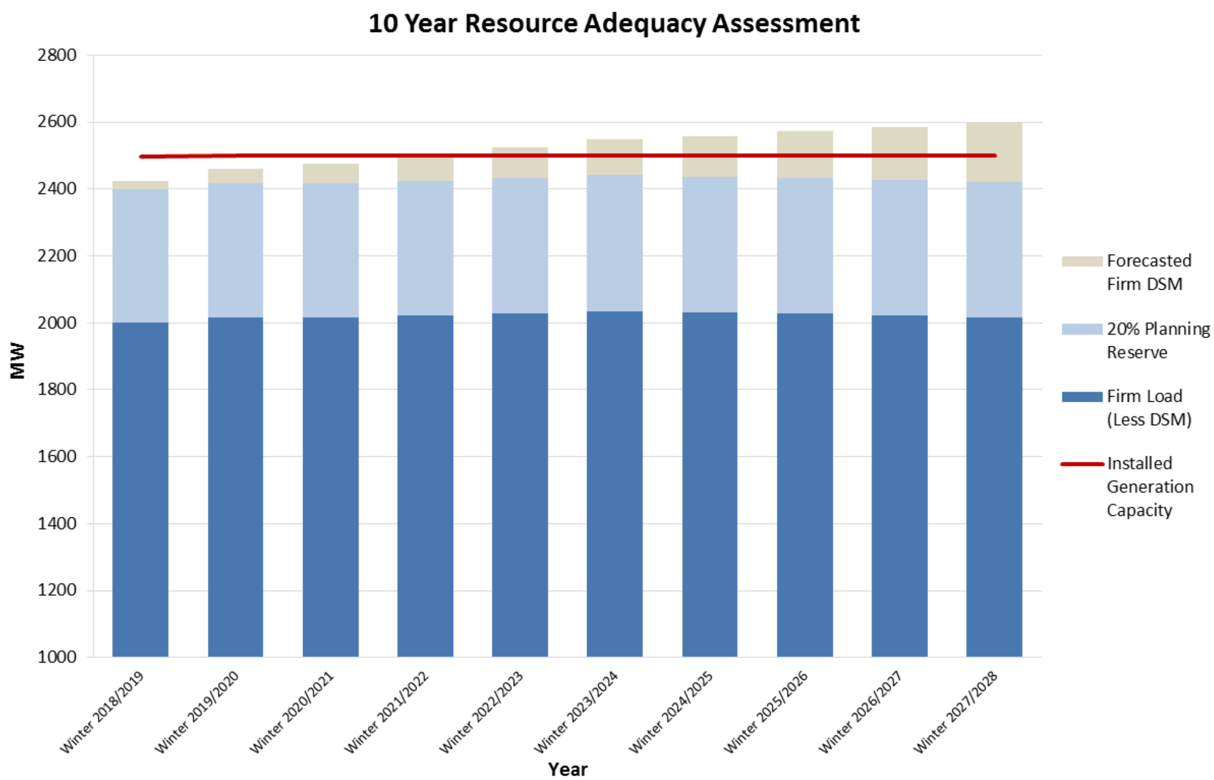
1 **Figure 22: NS Power 10 Year Load and Resources Outlook**

	Load and Resources Outlook for NSPI - Winter 2018/2019 to 2027/2028 (All values in MW except as noted)										
		2018/2019	2019/2020	2020/2021	2021/2022	2022/2023	2023/2024	2024/2025	2025/2026	2026/2027	2027/2028
A	Firm Peak Load Forecast	2,025	2,056	2,074	2,095	2,118	2,141	2,154	2,168	2,181	2,197
B	DSM Firm[37]	24	41	58	74	90	107	123	141	159	179
C	Firm Peak Less DSM (A - B)	2,001	2,015	2,016	2,021	2,028	2,034	2,030	2,027	2,022	2,017
D	Required Reserve (C x 20%)	400	403	403	404	406	407	406	405	404	403
E	Required Capacity (C + D)	2,401	2,418	2,420	2,425	2,433	2,441	2,436	2,433	2,426	2,421
F	Existing Resources	2405	2405	2405	2405	2405	2405	2405	2405	2405	2405
	Firm Resource Additions:										
G	Thermal Additions [38]	33		-153							
H	Biomass [39]	43									
I	Community Feed-in-Tariff [40]	13.8	2.5								
J	Tidal Feed-in-Tariff [41]	0.8	0.5								
K	Maritime Link Import			153							
L	Total Annual Firm Additions (G + H + I + J + K)	91	3	0	0	0	0	0	0	0	0
M	Total Cumulative Firm Additions (L + M of the previous year)	91	94	94	94	94	94	94	94	94	94
N	Total Firm Capacity (F + M)	2496	2499	2499	2499	2499	2499	2499	2499	2499	2499
	+ Surplus / - Deficit (N - E)	94	81	79	73	66	58	62	66	72	78
	Reserve Margin % [(N - C)/C]	25%	24%	24%	24%	23%	23%	23%	23%	24%	24%

[37] Cumulative estimated Firm Peak reduction based on DSM forecast
[38] Thermal includes Burnside #4 (winter capacity 33 MW) which is assumed to be returned to service by the end of Q2 2018. Also includes assumed Lingan 2 retirement once Maritime Link Base Block provides firm capacity service.
[39] 43 MW from the PH Biomass plant which will be able to provide firm service following the transmission upgrades required for the Maritime Link.
[40] The Community Feed-in-Tariff represents distribution-connected renewable energy projects, totalling 179.1 MW installed by beginning of 2020 (156.6 wind, 22.5 MW non-wind).
[41] Tidal Feed-in-Tariff - Tidal projects assume 6.5 MW by 2020

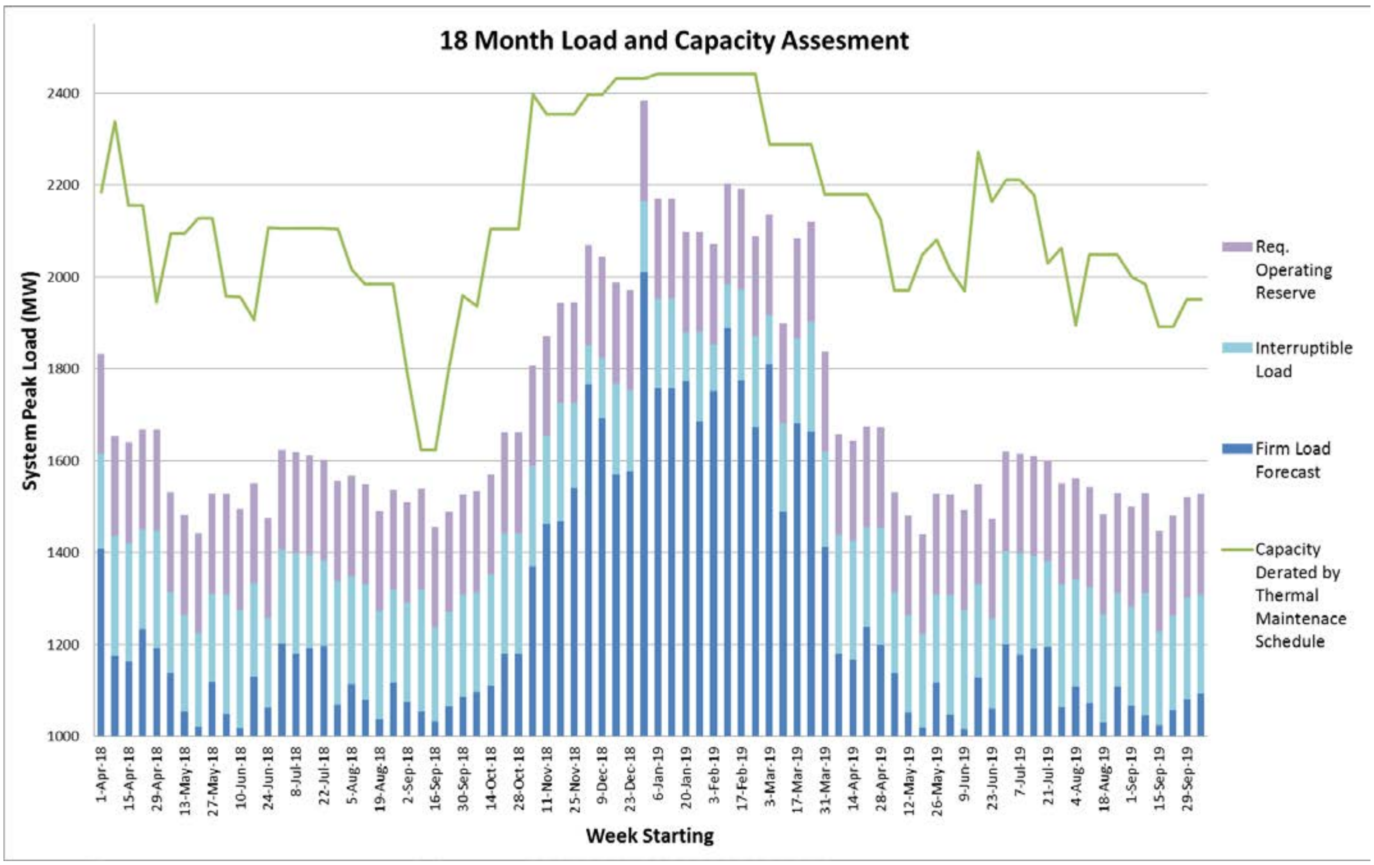
Figure 23 is a graphical representation of the assessment completed in **Figure 22** above. It provides a breakdown of the forecasted system demand and planning reserve margin and how this will be served by the system capacity.

Figure 23: Firm Capacity and Peak Demand Analysis



NS Power performs an assessment of operational resource adequacy covering an 18-month period twice a year (in April and October proceeding the summer and winter peak capacity periods) in compliance with NERC standards and in association with NPCC working groups. These reports of system capacity and adequacy are posted on the NSPSO's OASIS site in the Forecast and Assessments Section. **Figure 24** shows a graphical representation of NS Power's most recent 18 month assessment.

Figure 24: 18 Month Load and Capacity Assessment

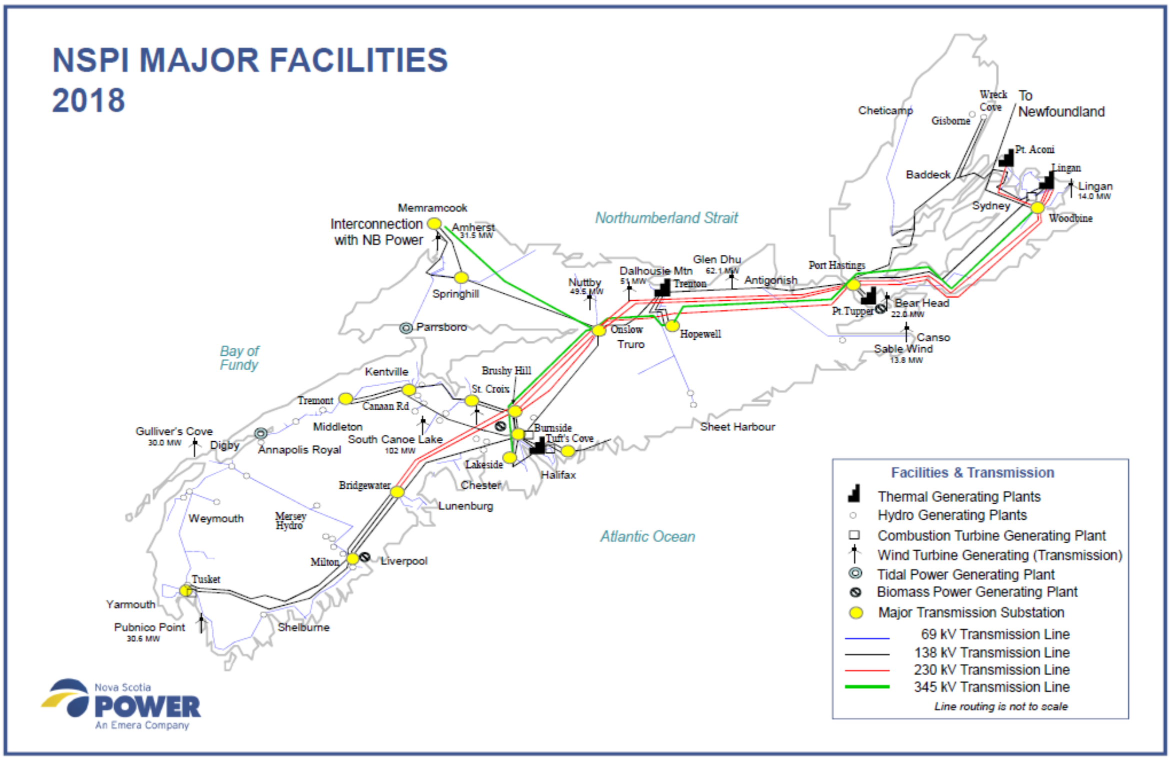


8.0 TRANSMISSION PLANNING

8.1 System Description

The existing transmission system has approximately 5,220 km of transmission lines at voltages at the 69 kV, 138 kV, 230 kV and 345 kV levels. The configuration of the NS Power transmission system and major facilities is shown in **Figure 25**.

Figure 25: NS Power Major Facilities in Service 2018



The 345 kV transmission system is approximately 468 km in length and is comprised of 372 km of steel tower lines and 96 km of wood pole lines.

The 230 kV transmission system is approximately 1271 km in length and is comprised of 47 km of steel/laminated structures and 1224 km of wood pole lines.

The 138 kV transmission system is approximately 1871 km in length and is comprised of 303 km of steel structures and 1568 km of wood pole lines.

The 69 kV transmission system is approximately 1560 km in length and is comprised of 12 km of steel/concrete structures and 1548 km of wood pole lines.

Nova Scotia is interconnected with the New Brunswick electric system through one 345 kV and two 138 kV lines providing up to 350 MW of transfer capability to New Brunswick and up to 300 MW of transfer capability from New Brunswick, depending on system conditions. As the New Brunswick system is interconnected with the province of Quebec and the state of Maine, Nova Scotia is integrated into the NPCC bulk power system.

Nova Scotia is also interconnected with Newfoundland via a 500MW, +/-200kV DC Maritime Link tie that was placed into service on January 15, 2018 in preparation for the receipt of capacity and energy from the Muskrat Falls Hydro project and the Labrador Island Link DC tie between Labrador and Newfoundland.

8.2 Transmission Design Criteria

NS Power, consistent with good utility practice, utilizes a set of deterministic criteria for its interconnected transmission system that combines protection performance specifications with system dynamics and steady state performance requirements.

The approach used has involved the subdivision of the transmission system into various classifications each of which is governed by the NS Power System Design Criteria. The criteria require the overall adequacy and security of the interconnected power system to be maintained following a fault on and disconnection of any single system component.

8.2.1 Bulk Power System (BPS)

The NS Power bulk transmission system is planned, designed and operated in accordance with North American Electric Reliability Corporation (NERC) Standards and NPCC criteria. NS Power is a member of the NPCC, therefore, those portions of NS Power's bulk transmission network where single contingencies can potentially adversely affect the interconnected NPCC system are designed and operated in accordance with the NPCC Regional Reliability Directory 1: Design and Operation of the Bulk Power System, and are defined as Bulk Power System (BPS).

8.2.2 Bulk Electric System (BES)

On July 1, 2014, the NERC Bulk Electricity System (BES) definition took effect in the United States. The BES definition encompasses any transmission system element at or above 100 kV with prescriptive Inclusions and Exclusions that further define BES. System Elements that are identified as BES elements are required to comply with all relevant NERC reliability standards.

NS Power has adopted the NERC definition of the BES and an NS Exception Procedure for elements of the NS transmission system that are operated at 100 kV or higher for which contingency testing has demonstrated no significant adverse impacts outside of the local area. The NS Exception Procedure is used in conjunction with the NERC BES definition to determine the accepted NS BES elements and is equivalent to Appendix 5C of the NERC Rules of Procedure.

The BES Definition and NS Exception Procedure were approved by Order of the Board dated April 6, 2017.

Under the BES definition and NS Exception Procedure approved by the Board, elements classified as NS BES elements are required to adhere to all relevant NERC standards that have been approved by the Board for use in Nova Scotia.

8.2.3 Special Protection Systems (SPS)

NS Power also makes use of Special Protection Systems (SPS) in conjunction with the Supervisory Control and Data Acquisition (SCADA) system to enhance the utilization of transmission assets. These systems act to maintain system stability and remove equipment overloads, post contingency, by rejecting generation and/or shedding load. The NS Power system has several transmission corridors that are regularly operated at limits without incident due to these SPS.

8.2.4 NPCC A-10 Standard Update

The NPCC Task Force on Coordination of Planning (TFCP) is in the process of reviewing Document A-10 and its application, in consultation with the Task Force on Coordination of Operation (TFCO), Task Force on System Protection (TFSP), and Task Force on System Studies (TFSS). Currently, Document A-10 provides a methodology to identify Bulk Power System (BPS) elements in the interconnected NPCC Region. At present, all NPCC criteria apply to BPS facilities; however, there are questions as to whether this application produces the appropriate level of reliability in NPCC.

The objectives of the review are as follows:

(1) Consider existing and alternative methodologies to:
- Identify critical facilities for the applicability of NPCC Directories;
- Simplify the existing methodology to make it less labor-intensive;
- Improve consistency across Areas in application and outcomes of the methodology.

(2) Consider conforming changes to NPCC documents to implement any necessary improvements as a result of the review.

NS Power has representation on the A-10 Working group that is performing the review for TFCP. Throughout 2017, Webex meetings have been held twice per week with in-person meetings including representatives from all NPCC areas occurring two days of every month. The working group is now actively testing the first two of the following three methodologies that were submitted to TFCP in the interim report entitled CP-11, A-10 Review Phase 1 Final Report dated Nov 17, 2017:

1. Proposal #1: Revised A-10 Methodology
   the working group, in accordance with the TFCP Scope of Work, seeks to maintain the framework of the existing A-10 performance-based test, improve the clarity and consistency of the testing procedure as well as direct the applicability of Directory #1 to where it is technically justified.

2. Proposal #2: Performance Based Methodology
   Methodology #2 is a hybrid methodology combining both bright-line filtering and performance-based analysis to develop a list of critical facilities that should be designed and operated according to NPCC's more stringent criteria. This methodology has two performance-based tests – one for Directory #1 and one for Directory #4 which clearly identify which elements are required to be classified as BPS due to their impact on system performance.

3. Proposal #3: Connectivity Based Methodology
   Methodology #3 is a hybrid methodology combining both bright-line determination and connectivity analysis to develop a list of facilities to be designed and operated according to NPCC's more stringent criteria. The objective of this methodology is to pursue a non-performance based method to identify critical facilities to which NPCC Directory #1 and Directory #4 may be applied.

Testing of Methodology #3 is presently on hold. The working group anticipates the testing phase will be completed by the end of Q3, 2018.

Changes to the existing A-10 methodology could have a material financial impact on NS Power if the new methodology greatly increases the number of BPS elements on NS Power's transmission system.

8.3 Transmission Life Extension

NS Power has in place a comprehensive maintenance program on the transmission system focused on maintaining reliability and extending the useful life of transmission assets. The program is centered on detailed transmission asset inspections and associated prioritization of asset replacement (for example, conductor, poles, cross-arms, guywires, and hardware replacement).

Transmission line inspections consist of the following actions:

- Visual inspection of every line once per year via helicopter, or via ground patrol in locations not practical for helicopter patrols.
- Foot patrol of each non-BPS (Bulk Power System) line on a three year cycle. Where a Lidar survey is requested for a non-BPS line, the survey will replace the foot patrol in that year.
- For BPS lines, Lidar surveys every two years out of three, with a foot patrol scheduled for the third year.

The aforementioned inspections identify asset deficiencies or damage, and confirm the height above ground level of the conductor span while recording ambient temperature. This enables the NSPSO to confirm the rating of each line is appropriate.

8.4 Transmission Project Approval

The transmission plan presented in this document provides a summary of the planned reinforcement of the NS Power transmission system. The proposed investments are required to maintain system reliability and security and comply with System Design Criteria and other standards. NS Power has sought to upgrade existing transmission lines and utilize existing plant capacity, system configurations, and existing rights-of-way and substation sites where economic.

Major projects included in the plan have been included on the basis of a preliminary assessment of need. The projects will be subjected to further technical studies, internal approval at NS Power, and approval by the UARB. Projects listed in this plan may change because of final technical studies, changes in the load forecast, changes in customer requirements or other matters determined by NS Power, NPCC/NERC Reliability Standards, or the UARB.

In 2008, the Maine and Atlantic Technical Planning Committee (MATPC) was established to review intra-area plans for regional resource integration and transmission reliability. The MATPC forms the core resource for coordinating input to studies conducted by each member organization and presenting study results, such as evaluation of transmission congestion levels in regards to the total transfer capabilities on the utility interfaces. This information is used as part of assessments of potential upgrades or expansions of the interties. The MATPC has transmission planning representation from NS Power, Maritime Electric Company Ltd., Emera Newfoundland and Labrador, Northern Maine Independent System Administrator (which includes Emera Maine Northern Operating Region and Eastern Maine Electric Cooperative), Newfoundland and Labrador Hydro, and New Brunswick Power (NB Power). NS Power and NB Power jointly conduct annual Area Transmission Reviews for NPCC.

9.0 REGIONAL DEVELOPMENT

9.1 Maritime Link

The Maritime Link (ML) is a bipolar connection between 101S Woodbine and Bottom Brook terminal station (BBK) in Newfoundland that is based on Voltage-Source Converter (VSC) technology. Each pole is configured as an asymmetric monopole VSC rated for 200kV and 250MW on the DC side of the converter. The bipole configuration allows for redundancy of half of the total rated transfer capability.

The ML is a combination of cable and overhead line: approximately 171km of subsea cable and 142 + 46 km of overhead line on the NL and NS sides respectively. The AC yard for each pole at each converter station has a converter transformer with high-side tap changer and a pre-insertion resistor, along with filtering, protection, and measuring apparatus. The DC side has a smoothing filter, DC line disconnector, and high speed switch for fast discharge of the DC line. The active and reactive power levels can be constant, gently ramped, or nearly instantly changed (e.g. during use as SPS).

The ML was placed into service on January 15, 2018. Commercial energy transactions over the ML between NS Power and Nalcor Energy Marketing began on February 19, 2018 upon approval of the Newfoundland Open Access Transmission Tariff (OATT). These transactions, in conjunction with the increased reliability and ancillary benefits have created value for customers in both Nova Scotia and Newfoundland. NS Power will continue to work with Nalcor to maximize the value of the Maritime Link on behalf of customers.

In April 2018, Nalcor reaffirmed the schedule for commissioning the Muskrat Falls Generating Station, with first power still expected in late 2019. It is anticipated that the delivery of the Nova Scotia Block of energy and Surplus Energy pursuant to the Energy Access Agreement will begin in mid-2020.

9.2 Nova Scotia – New Brunswick Intertie Overview

The power systems of Nova Scotia and New Brunswick are interconnected via three overhead transmission lines; one 345 kV line from Onslow, Nova Scotia to Memramcook, New Brunswick, and two 138 kV lines from Springhill, Nova Scotia to Memramcook, New Brunswick. Since there is only a single 138 kV line between Springhill and Onslow in Nova Scotia, the intertie can be considered to be comprised of a single 345 kV circuit in parallel with a single 138 kV circuit. The primary function of the intertie is to support system reliability.

Access to the Nova Scotia - New Brunswick intertie is controlled by the terms of the respective OATTs of NS Power and NB Power. As noted in Section 6.1.1, **Figure 14**, there is currently one active Transmission Service request for Long-Term Firm Point-to-Point Transmission Service across the NB-NS intertie, and no active Network Integration Transmission Service requests for network service within NS.

Power systems are designed to accommodate a single contingency loss (i.e. loss of any single element and certain multiple elements) and since the 345 kV line carries the majority of the power flow (between NS and NB), loss of a 345 kV line becomes the limiting factor. Power flow on the 138 kV lines is also influenced by the loads in Prince Edward Island; Sackville, New Brunswick; as well as Amherst, Springhill and Debert, Nova Scotia. Wind and planned tidal generation in the Amherst/Parrsboro area can also impact 138 kV line loading.

Import and export limits (both firm and non-firm) on the intertie have been established to allow the Nova Scotia and the New Brunswick system to withstand a single contingency loss. The limits are currently set at up to 350 MW export and up to 300 MW import. These figures represent limits under pre-defined system conditions, and differ for Firm versus Non-Firm Transmission Service. Conditions which determine the actual limit of the interconnection are shown in **Figure 26**.

In 2018, line L-6513 between Onslow and Springhill will be rebuilt and re-named as L-6613. This work will impact the current import and export levels with New Brunswick.

Figure 26: Conditions Determining Limits

Export	Import
Amount of generation in Nova Scotia that can be rejected or run-back via SPS action	Nova Scotia system load level (Import must be less than 22% of total system load)
Reactive Power Support level in the Metro Area	Percentage of synchronous generation in Nova Scotia (providing inertia and frequency response)
Arming status of SPS New Brunswick	New Brunswick export level to Prince Edward Island and/or New England
Real time line ratings (climatological conditions in northern Nova Scotia)	Seasonal line ratings (climatological conditions in northern Nova Scotia)
Net Northern Nova Scotia System load level	Load level in Moncton area plus flow to Prince Edward Island
Largest single loss of load contingency in Nova Scotia	Largest generation/source contingency in Nova Scotia
Generation in the Amherst/Parrsboro area	Generation in Amherst/Parrsboro area
Internal transmission limitations in Nova Scotia (Cape Breton Export, Onslow Import)	Status of generation and transmission lines in New Brunswick
	Status of the intertie between New Brunswick and Quebec
	Conditions on intertie between New Brunswick and New England

If the 345 kV Nova Scotia - New Brunswick intertie trips while exporting, the parallel 138 kV lines can be severely overloaded and potentially trip, causing Nova Scotia to separate from New Brunswick. If this happens, the Nova Scotia system frequency (measured in Hertz) will rise, risking unstable generation plant operation and possible equipment damage. To address this, NS Power uses a fast-acting SPS to reject or run back sufficient generation to prevent separation.

If the NS Power system becomes separated from the North American interconnected power system during heavy import, Nova Scotia system frequency will drop. Depending on the system configuration at the time of separation and the magnitude of the import electricity flow that was interrupted, the system will respond and re-balance. The system does this by automatically rejecting firm and non-firm load through under-frequency load shedding (UFLS) protection systems as required by NPCC Standard PRC-006-NPCC-1 Automatic Under-frequency Load Shedding. The degree of load shedding will be impacted by the amount of in-province generation supplied by non-synchronous power sources, such as wind energy conversion systems, photovoltaic (solar), or tidal power due to the technical characteristics of those sources. NPCC is currently conducting a study of the effects of decreased synchronous generation sources and interaction with the UFLS. High penetration levels of non-synchronous generation in Nova Scotia reduce the total inertia of the NS Power system, thereby increasing the rate at which the Nova Scotia system frequency declines, resulting in the potential for higher levels of load shedding through UFLS.

The loss of the 345 kV line between Onslow, Nova Scotia and Memramcook, New Brunswick is not the only contingency that can result in Nova Scotia becoming separated from the New Brunswick Power system while importing power. All power imported to Nova Scotia flows through the Moncton/Salisbury area of New Brunswick. Since there is no generation in the Moncton/Salisbury area, and only a limited amount of generation in Prince Edward Island (PEI), power flowing into Nova Scotia is added and shares transmission capacity with the entire load of Moncton, Memramcook, and PEI. In 2016, firm transmission capacity from NB to PEI was increased to 300MW.

NB Power restricts power export to Nova Scotia to a level such that any single contingency does not cause adverse impacts on New Brunswick, PEI, or the intertie with New England. Any transmission reinforcement proposed to improve reliability, increase import and export power capacity or prevent the activation of UFLS in Nova Scotia must also consider the reinforcement of the southeast area of the New Brunswick transmission system.

Although joint studies have been conducted, at this time the timing and configuration of an expansion to the provincial intertie has yet to be determined. The remaining transmission project associated with the Maritime Link will reinforce the 138 kV portion of the intertie and will significantly increase the firm export capability from Nova Scotia. When construction of this new circuit between Onslow and Springhill is completed in 2018, it will reduce the exposure to UFLS, potentially increase import capacity, and improve transmission capacity for generation projects in the Amherst/Parrsboro area. However, import capacity will still be limited by transmission congestion in southeast New Brunswick. Given the dynamic nature of the provincial and regional electricity markets it is likely that further upgrades may be required over the next decade. To this end, NS Power has secured a large portion of a right-of-way to support a second 345 kV line between Onslow and the New Brunswick border.

9.3 Co-operative Dispatch

NS Power and NB Power continue to operate under the Cooperative Dispatch Agreement executed December 20, 2016, following the successful pilot. The Parties continue to enter in energy and reserve transactions, when economic, to create saving for customers of both utilities. NS Power expects to continue operating under this agreement with no material amendments presently expected.

10.0 TRANSMISSION DEVELOPMENT 2017 TO 2026

10.1 Transmission Development Plans

Transmission development plans are summarized below. As highlighted earlier, these projects are subject to change. For 2018, the majority of the projects listed are included in the 2018 Annual Capital Expenditure Plan.

2018

- Separating L-8004 and L-7005 at the Canso Causeway crossing to increase the Cape Breton export limit. This upgrade is associated with the Maritime Link project. (CI 43678)
- Completion of Spider Lake substation in the metro area to relieve Halifax generation constraints. (CI 48022)
- 2C Port Hastings 138kV substation will be uprated to meet NPCC BPS standards.
- L-6513 transmission line re-build to increase the line rating. This upgrade is associated with the Maritime Link project. (CI 43324)
- In accordance with a directive from NPCC, Bulk Power System (BPS) elements which previously fell within the "grandfather clause" of NPCC Directory 04 System Protection Criteria must have duplicate high-speed protection systems and duplicate station batteries. Lingan 230 kV will be uprated in 2018. (CI 46757)
- Replacement of Lingan 230 kV Westinghouse Gas insulated Switchgear (GIS) equipment to mitigate the potential failure and increase reliability. (CI 46591)
- 88S Lingan 138kV will be uprated to meet NPCC BPS standards.
- 6S Terrace Street 69 kV substation will be retired once the existing 4 kV distribution load is converted to 12 kV.
- New 12MVA Mount Hope 69kV-25kV substation in Dartmouth
- Replacement of 15/20/25MVA Penhorn 69-12.5kV Transformer 48H-T1

- Replacement of 7.5/10//11.2 MVA Halliburton 69-25kV Transformer 56N-T1 with new 15/20/25MVA unit due to load growth and voltage conversions from 4kV to 25kV. CI:52328
- Capacitor Bank Breaker replacement at 103H-Lakeside (3 breakers). These are high duty cycle units critical to the operation of the transmission system.
- 2018 Transmission Right of Way Widening 69kV (CI: 51969) to reduce the occurrence of edge and off right of way tree contacts (Year 3 of 8)
- Purchase of new 25MVA mobile transformer to replace 5P (2018 – 2019)
- L-5330B (73), L-5549 (21), L-6020 (49), L-6531 (8) structure replacement (2018-2019): CI 49948

2019

- 2019 Transmission Right of Way Widening 69kV (CI: 51969) to reduce the occurrence of edge and off right of way tree contacts (Year 4 of 8)
- Purchase of new 25MVA mobile transformer to replace 5P (2018 – 2019)
- Replacement of 73W-T1 transformer at Auburndale with a new 138/69-25 kV transformer rated at 15/20/25 MVA.

2020

- 2020 Transmission Right of Way Widening 69kV (CI: 51969) to reduce the occurrence of edge and off right of way tree contacts (Year 5 of 8)
- Replace existing 12.5/14MVA Milton transformer with 15/20/25MVA unit supplied at either 69kV or 138kV.
- Replace existing 5/5.6MVA Central Argyle 7.5/10/12.5MVA unit.
- Replace existing 4.5/10/12.5//14MVA Barrington Passage transformer with 15/20/25MVA unit and add additional feeder circuit.
- Replace existing 3/4//4.48MVA Lower East Pubnico transformer with 7.5/10/12.5MVA unit.
- Replace existing 138kV Harbour Crossing (L6014): A transmission planning study is currently underway to determine the most practical means of replacing

the L-6014 capacity that will be displaced with the removal of the Harbour Crossing. The new infrastructure will need to be in service in 2020.

2021

- 2021 Transmission Right of Way Widening 69kV (CI: 51969) to reduce the occurrence of edge and off right of way tree contacts (Year 6 of 8).

2022

- 2022 Transmission Right of Way Widening 69kV (CI: 51969) to reduce the occurrence of edge and off right of way tree contacts (Year 7 of 8)
- Install New 138kV Supply to 50V-Klondike and replace existing 69-25kV transformer with new 15/20/25 MVA unit.

2023

- 2020 Transmission Right of Way Widening 69kV (CI: 51969) to reduce the occurrence of edge and off right of way tree contacts (Year 8 of 8).

10.2 Bulk Electricity System

The following compliance gaps were identified concerning the implementation of the BES definition in Nova Scotia Power:

1. The SVC at the 120H Brushy Hill substation was been classified as a BES element. A project is underway to refurbish the SVC at 120H and this capital item should cover any BES disturbance monitoring requirements on the SVC.

Update: The refurbishment of the SVC at 120H was completed in 2017. As part of this work, disturbance monitoring was added at the site that can be accessed locally.

The 85S Wreck Cove substation is not classed as BES but the generator transformers and the generators are classed as BES. A sequence of events recorder exists at the 85S Wreck Cove substation to record breaker positions, protection operations and teleprotection status. The monitoring of the generators and generator transformers that reside in the plant are the responsibility of generation services as protective relaying and other monitoring equipment also resides there.

Update: The assessment will be scheduled for 2018.

2. The 14H – Burnside and 83S – Victoria Junction generators have been classified as BES elements. An assessment is required by generation services for sequence of events and fault recorder capabilities.

Update: The assessment will be scheduled for 2018.

3. At 1N Onslow and 103H Lakeside there are deficiencies in the monitoring capabilities for the shunt devices and modifications are required to bring these substations into compliance.

Update: An assessment of the Onslow and Lakeside monitoring capabilities will be scheduled in 2018. The estimated cost to correct deficiencies in the monitoring capabilities of the shunt devices at 1N-Onslow and 103H-Lakeside is $150,000 per site.

4. The 101S Woodbine substation has a project underway to expand the substation and the disturbance monitoring capabilities for this substation will be covered under this expansion project.

Update: In 2017, the work to expand the 101S-Woodbine substation was completed. Disturbance monitoring was added as required and event trigger setpoints have been applied.

Compliance work for newly identified BES elements shall be completed within five years from the date of this Order.

10.3 Western Valley Transmission System – Phase II Study

A study was initiated in late 2017 to determine the system upgrades needed to address transmission line capacity, clearance, and age issues in the Western Valley over a 15 year transmission planning horizon. In particular, the following 69 kV lines were targeted:

L-5531 (13V-Gulch to 15V-Sissiboo)
L-5532 (13V-Gulch to 3W-Big Falls)
L-5535 (15V-Sissiboo to 9W-Tusket)
L-5541 (3W-Big Falls to 50W-Milton)

These lines were targeted as a result of Lidar studies that were performed in 2015 to determine if the existing line to ground clearances were consistent with those required for NS Power's default 50°C line temperature rating of each line. Results of these studies indicated that there were numerous clearance violations with respect to clearance to buildings, water, distribution line crossings, and the ground.

In addition, three of the four 69kV lines noted above were built in the 1950's using single pole delta wood pole construction. These are now between 60-70 years old and at their end of life. There is also a thermal capacity issue in the Valley and Western NS regions. The transmission system was designed and built to serve load in these areas, which it remains capable of doing. However, over the past 10-15 years, new generation resources have been installed that have significantly changed the flows on these lines. Large scale wind generation facilities and distributed (COMFIT) generation have been added to existing hydro facilities and have reversed typical line flows during periods of light load and high generation such that there is no remaining capacity for additional generation resources between Kingston and Yarmouth.

Scope

The scope of the study is to assess four options for dealing with the clearance, age, and capacity issues on Lines L-5531 (13V-Gulch to 15V-Sissiboo), L-5532 (13V-Gulch to 3W-Big Falls), L-5535 (15V-Sissiboo to 9W-Tusket), and L-5541 (3W-Big Falls to 50W-Milton):

Option #1 - Restore L-5531, L-5532, L-5535, and L-5541 to 50°C Temperature Rating

Option #2 - Upgrade L-5531, L-5532, L-5535, and L-5541 to 80°C Temperature Rating

Option #3 - Rebuild L-5531, L-5532, L-5535, and L-5541 with 336 ACSR Linnet and 100°C Temperature rating

Option #4 - Rebuild L-5531, L-5532, L-5535, and L-5541 with 556 ACSR Dove and 100°C Temperature rating (Operate at 69kV)

A brief description of each option is as follows:

Option #1 – Restore L-5531, L-5532, L-5535, and L-5541 to design temperature of 50°C:

This option would upgrade the structures so that line would be capable of operating up to 50°C while maintaining sufficient ground clearance (including 0.8m snow buffer).

Option #2 – Upgrade L-5531, L-5532, L-5535, and L-5541 to design temperature of 80°C:

This option would upgrade the structures so that lines would be capable of operating up to 80°C but existing conductors would remain unchanged. Essentially this would consist of re-tensioning the existing transmission lines and replacing poles where required with higher ones to increase ground clearance.

Option #3 – Rebuild L-5531, L-5532, L-5535, and L-5541 with ACSR 336.4 Linnet to design temperature of 100°C:

This option would rebuild the lines with higher rated conductor (ACSR 336.4 Linnet) designed to operate up to 100°C at 69 kV. Existing transmission Structures would be replaced.

Option #4 – Rebuild the lines to 138 kV standards with ACSR 556.5 Dove at 100°C but operate at 69 kV :

This option would rebuild the lines to 138 kV standards using 556 ACSR (Dove) conductor designed to operate up to 100°C. The lines would continue to be operated at 69kV but would be ready for future conversion to 138kV. This would enable an easier upgrade for the transmission system from 51V-Tremont to 9W-Tusket and 50W-Milton from 69 kV to 138 kV. Note that the existing lines L-5025 (51V-Tremont to 11V-Paradise) and L-5026 (11V-Paradise to 13V-Gulch) were built for 138 kV standards but currently operated at 69 kV.

Option 4 would also allow for the future conversion of Lines L-5025, L-5026, L-5531, L-5532, L-5535, and L-5541 to 138 kV. However, conversion to 138kV would also require the conversion of numerous line taps; generator interconnection substations; and distribution substations supplied via the principle lines under study.

Status: The initial draft of the Western Valley Transmission System – Phase II Study is expected to be complete by July 6, 2018.

11.0 CONCLUSION

Customers count on NS Power for energy to power every moment of every day, and for solutions to power a sustainable tomorrow. Environmental legislation in Canada and Nova Scotia continues to drive a transformation of the NS Power electric power system. Within the 10-year window considered in this Report, NS Power will experience further reductions in hard caps for CO_2, SO_2, NO_X and mercury, and will be required to serve 40 percent of sales with renewable electricity from qualifying sources. The outcomes of other ongoing federal and provincial policy changes discussed in Section 6.3 remain uncertain, and could affect the Company's outlook within this 10-year period.

This transformation has driven a shift towards renewable electricity generation and a reduction in conventional coal fired electricity production. The integration of variable renewable resources on the NS Power system has imposed revised operating and flexibility demands on previously base-loaded steam units, which continue to bring essential reliability services to the system.

NS Power is participating in the Board's Generation Utilization and Optimization process. On June 7, 2018, the Company submitted comments to the UARB and stakeholders indicating its general support of the recommendations included in Synapse's *Thermal Generation Utilization and Optimization Economic Analysis of Retention of Fossil Fueled Thermal Fleet to and Beyond 2030* Final Report. As noted in NS Power's comments, uncertainty remains with respect to the design and implementation of the carbon policy regime for the province. In its letter, the Company submitted that the issues and recommendations discussed in Synapse's report would be best examined through an Integrated Resource Planning exercise in 2019 after the Board, stakeholders and the Company have more certainty around federal and provincial carbon policy.

From the resource planning perspective, this Report is intended to provide a medium term outlook of the capacity resources available to the Company compared to expected customer demand, given the most recent assumptions to date. NS Power continues to review and refine the main drivers of resource planning requirements, such as the end-use forecasting methodology for forecasting firm peak load, the studies used to evaluate the firm capacity contribution of wind and ERIS resources, and the planning reserve margin requirement.

As noted in Section 7.4, the capacity assessment in this report provides a basis for the minimum required firm generation NS Power must maintain to comply with NPCC reliability criteria; it does not necessarily represent the optimal or maximum required capacity to serve other system requirements (such as ramping capability to follow wind and load patterns). The optimal capacity requirement, and the appropriateness of any unit retirements or additions, is determined through a long-term planning exercise such as an IRP. The Company will continue to analyze and adjust its outlook accordingly as load forecasting methodology matures, planning assumptions are updated and the outcomes of policy changes regarding carbon emissions and coal unit retention become clear.

The key inputs for Transmission Planning in the ten-year window of this Report include transmission of energy to be delivered over the Maritime Link, continued compliance with Reliability Standards, and opportunities for regional cooperation.

2018 10 Year System Outlook Report
Status of 2014 IRP Action Items

2014 IRP Action Item	IRP Reference	2018 10YSO Report Reference	Status
Continue to develop an understanding of the operational challenges associated with the planned increasing levels of variable generation integration and report to the UARB as part of the 10 Year System Outlook Report.	IRP Final Report, page 69, Section 6.2.2	2018 10YSO Report: Section 8.3	**Annual Update:** Item to be addressed annually in 10 Year System Outlook reports.
Report to the UARB on the status of the need for flexible resources to integrate additional variable generation in the 10 Year System Outlook Report.	IRP Final Report, page 69, Section 6.2.2	2018 10YSO Report: Section 8.3	**Annual Update:** Item to be addressed annually in 10 Year System Outlook reports.
During 2015-2020, conduct additional system studies to evaluate operations with increased levels of renewable resources that are expected over the next few years. Include investigation of system requirements with fewer steam units providing real power operations. • Report on the status of such efforts each year in the 10 Year System Outlook Report. • Use Plexos to continue to assess hourly patterns of system need and resources with respect to operation under higher levels of wind resources expected over the next few years.	IRP Final Report, pages 73 – 74, Section 6.2.5	2018 10YSO Report: Section 4.3.1 – Impact of increased levels of renewables included in Utilization Factor calculation and projections of steam unit operations.	**Annual Update:** Item to be addressed in annual 10 Year System Outlook reports.
During 2015-2016, continue to evaluate the coincidence of wind generation with peak load to better understand the capacity value of wind assets on the NS Power system.	IRP Final Report, page 68, Section 6.2.2	2018 10YSO Report: Analysis updated in Section 8.3.1.	**Item Complete:** LOLE and Cumulative Frequency Analyses conducted in 2015 and 2016, and reported in respective 10 Year System Outlook Reports. **Annual Update:** Update of wind capacity value analysis to be continued in future 10YSO reports.
Report on the ongoing evaluation of the planning reserve margin for the power system in the 10 Year System Outlook	IRP Final Report, page 75, Section	2018 10YSO Report: Section 8.2	**Annual Update:** Item to be discussed annually in annual 10

2018 10 Year System Outlook Report
Status of 2014 IRP Action Items

2014 IRP Action Item	IRP Reference	2018 10YSO Report Reference	Status
Report.	6.2.7		Year System Outlook reports. Comprehensive study of Planning Reserve Margin requirements to be conducted as input to next Integrated Resource Plan.
ERIS connected wind resources will be evaluated for firm capacity contribution. During 2015, NS Power will determine the extent to which ERIS resources can count as capacity towards resource adequacy during winter peak.	IRP Final Report, page 75, Section 6.2.6	2018 10YSO Report: Section 8.3.1.1	**Item Complete:** NS Power completed study to evaluate potential capacity contribution level of ERIS Resources. Study confirmed ERIS resources are able to deliver capacity on transmission system; ERIS resources have been included as contributing to firm capacity in the 2018 10YSO report.
Continue the thermal generation asset analysis work from the IRP process. By the end of June 2015, file an initial thermal asset management plan striving to optimize the level of sustaining capital expenditures required for the fleet of coal/oil/gas plant. Update this plan each year in the 10 Year System Outlook Report. The plan will include the following: • Recognition of uncertainty of many elements involved in this form of analysis. • Recognition of/adherence to planning reserve margin requirement and level of planning reserve surplus associated with different net firm peak load trajectories based on then-anticipated DSM peak reductions and associated net firm peak load forecast.	IRP Final Report, pages 71 – 72, Section 6.2.4	2018 10YSO Report: Section 4.3	**Item Complete:** Unit Utilization & Investment Strategy included in 2015 10 Year System Outlook Report, and all subsequent 10YSO Reports. The Generation Utilization & Optimization Synapse Report filed with the UARB provided additional context on some of these issues. NS Power expects the next IRP will also inform any outstanding issues.

2018 10 Year System Outlook Report
Status of 2014 IRP Action Items

2014 IRP Action Item	IRP Reference	2018 10YSO Report Reference	Status
• Projections of possible retirement paths for the thermal fleet. • Prioritization of units or plans for retention given system constraints. • Consideration of locational value of Tufts Cove plant, and flexible operating characteristics of gas and oil-fired steam units compared to coal-fired units. There may be locational or system considerations that could give preference to sustaining capital or life extension expenditures at the Tufts Cove location compared to other plants. • Consideration of location of other system resources, either NS Power-owned or IPP-owned, and their capacity value. • Consideration of unit utilization forecasts and the significant driver that operating hours is for maintenance investment.			
Monitor ongoing developments of tidal energy and report to the UARB as part of the 10 Year System Outlook Report filed annually in June.	IRP Final Report, page 68, Section 6.2.2	2018 10YSO Report: Section 4.2 (current tidal forecasted capacity additions)	**Annual Update:** Updates provided in 10YSO on known tidal developments, when applicable.
File Renewable to Retail Tariff Application by September 1, 2015.	IRP Final Report, page 69, Section 6.2.2	N/A	**Item Complete**
Complete the integration of the Maritime Link.	IRP Final Report, page 68, Section	2018 10YSO Report: Section 10.1	**Item Complete**

2018 10 Year System Outlook Report
Status of 2014 IRP Action Items

2014 IRP Action Item	IRP Reference	2018 10YSO Report Reference	Status
	6.2.2		
Execute the Maritime Link transmission investments.	IRP Final Report, page 73, Section 6.2.5	2018 10YSO Report: Section 10.1	Item to be completed in 2018.
Monitor cost-effective market opportunities (imports and exports) as well as enhancements in regional balancing and interconnection and report on developments in the 10 Year System Outlook Report.	IRP Final Report, page 70, Section 6.2.3	2018 10YSO Report: Section 10.2 and 10.3	**Annual Update:** Item to be continually addressed in annual 10 Year System Outlook reports.
During 2015, continue discussions with Newfoundland (NALCOR) and New Brunswick (New Brunswick Power) on greater regional electric system coordination: • Provide an annual update to the UARB. • Discuss need, impacts, and cost allocation associated with a second 345 kV line to New Brunswick. • Explore mechanisms to advance efficient regional unit commitment, dispatch, and operating reserve sharing policies.	IRP Final Report, page 70, Section 6.2.3	2018 10YSO Report: Section 10.1, 10.2 & 10.3	**Annual Update:** Item to be continually addressed in annual 10 Year System Outlook reports.

2017 NRIS Wind Study
Report 062-2017TSMG-R0

Principal Investigator
John Charlton, P. Eng.

December, 2017

Transmission Planning
Nova Scotia Power Inc.

Executive Summary

This study was initiated to determine if the *Effective Load Carrying Capability (ELCC)* of existing *Energy Resource Interconnection Service (ERIS)* wind generating facilities within Nova Scotia can be counted toward resource adequacy following the construction of the system Network Upgrades associated with the Maritime Link project.

This report presents the results of the study with the objective of assessing the impact of Maritime Link Network Upgrades on existing ERIS wind generation facilities connected to the Nova Scotia transmission system. The scope of the study was limited to short circuit analysis, steady state analysis, and stability analysis, and also included a provision to estimate the cost of any additional network upgrades required to enable the existing ERIS facilities to operate in a similar fashion to NRIS facilities.

The results of the analysis demonstrate the following:

- There are no thermal, voltage, or stability violations on the transmission system resulting from receipt of full output of all existing ERIS wind generation facilities connected to the NSPI transmission system under normal and first contingency conditions with the Maritime Link (ML) upgrades in service. Analysis cases included winter peak, summer peak, and light load scenarios with maximum levels of wind on the NSPI backbone system.

- Short circuit levels at all NSPI and wind generation facility substations (≥ 69 kV) were satisfactory and were confirmed to be below NSPI design criteria levels.

- All NS transmission and distribution connected wind can be included in the ELCC calculations from the perspective of transmission system capacity. Note that this study did not attempt to define what the ELCC contribution from wind generation facilities should be, as NSPI is currently studying methodologies based on *Loss of Load Expectation (LOLE)*, and on *Cumulative Frequency Analysis (CFA)* to determine the appropriate ELCC value for Nova Scotia. At present, CFA analysis shows that an overall ELCC of 8% could be obtained with a confidence level of 90%. This would result in an ELCC contribution of 48.8MW based on existing wind resources of approximately 610MW.

- No additional facilities are required in order to operate existing ERIS designated facilities in the same manner as existing NRIS facilities.

- Analysis of wind generation includes all facilities under the jurisdiction of the NSPI System Operator, not just facilities with a power purchase agreement with NSPI.

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List of Tables and Figures

1.0 Introduction

This study was initiated to determine if the *Effective Load Carrying Capability (ELCC)* of existing *Energy Resource Interconnection Service (ERIS)* wind generating facilities within Nova Scotia can be counted toward resource adequacy following the construction of the system Network Upgrades associated with the Maritime Link project. The objective was not to determine how a facility can be reclassified from *Energy Resource Interconnection Service (ERIS)* to *Network Resource Interconnection Service (NRIS)*, but rather to determine if its ELCC can be included in resource adequacy calculations.

1.1 Scope

This report presents the results of the study with the objective of assessing the impact of Maritime Link Network Upgrades on existing ERIS wind generation facilities connected to the Nova Scotia transmission system. In particular, the study evaluates whether or not the ERIS facilities could essentially operate as NRIS facilities as a result of the ML improvements to the transmission system.

The scope of the study is limited to the following:

- Short circuit analysis
- Steady state analysis to determine any thermal overload of transmission elements or voltage criteria violation
- Stability analysis to demonstrate that the interconnected power system is stable for various fault contingencies

The scope of this report also provides for a high-level non-binding cost estimate of any remaining upgrades needed to permit existing ERIS facilities to operate in a similar manner as NRIS facilities.

1.2 Existing Transmission System

The existing NSPI transmission system has approximately 5,150 km of transmission lines at voltages 69 kV, 138 kV, 230 kV and 345 kV, and is interconnected to New Brunswick Power via one 345kV and two 138kV transmission lines. It has concentrated generation in the eastern portion of the province, and flows from the east are typically towards Onslow in the centre of the province. From Onslow there is a transmission corridor to the Nova Scotia border with New Brunswick in addition to a corridor towards the load centre in Halifax.

The corridors of the BPS system which are monitored and have associated stability limits are:

- Cape Breton Export (CBX), a corridor with high flows from the high generation zone in the east towards the centre of the province.
- Onslow Import (ONI), a corridor of lines coming into Onslow from the east with flows typically towards Onslow.

- Nova Scotia Import/Export (NSX), the tie lines with NB Power.
- Onslow South (ONS), the corridor south from Onslow with flows typically out of Onslow. This corridor supplies additional generation to the Halifax load centre and the western portion of the province.

CBX and ONI have been identified as having Interconnection Reliability Operating Limits (IROLs) to the Maritimes Area Reliability Coordinator.

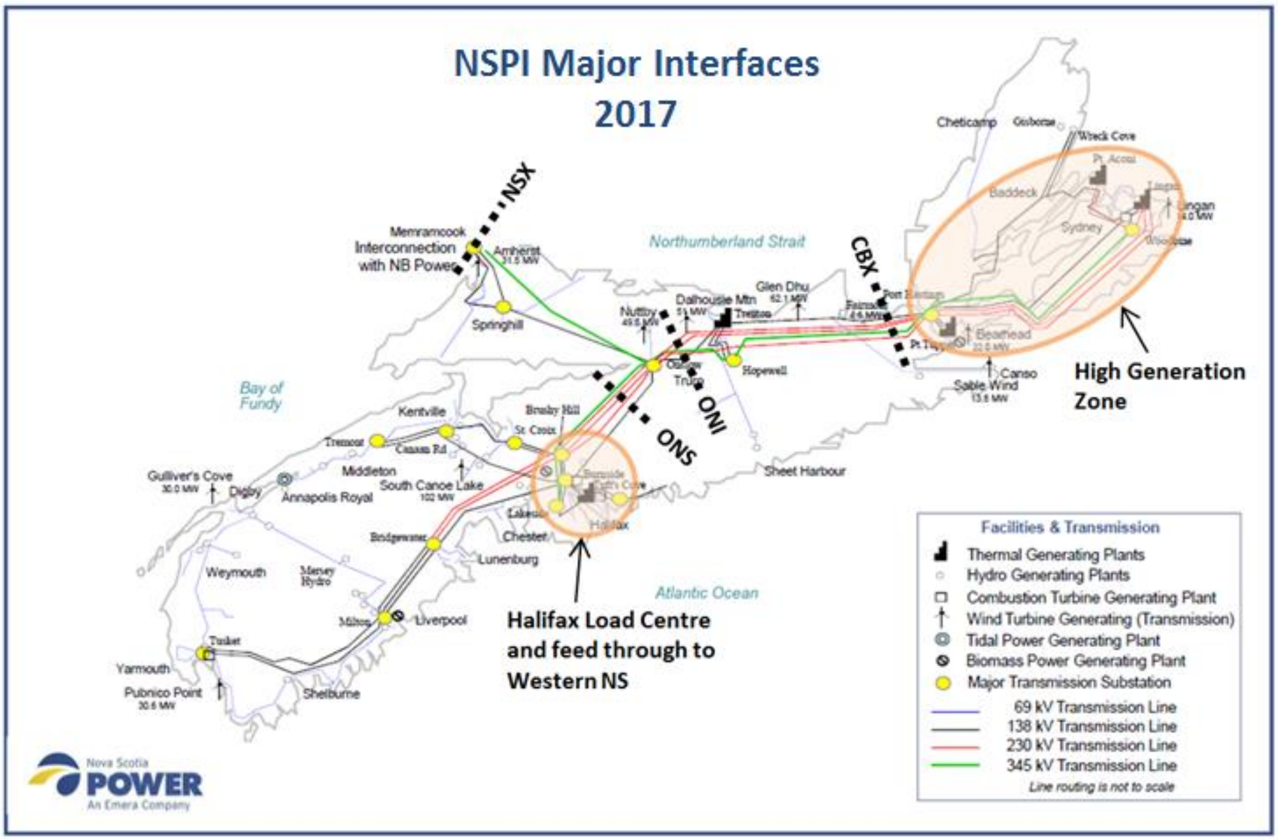


Figure 1: NS Interfaces

Transmission Connected Wind Generation:
There are currently 11 wind generation facilities located in Nova Scotia that are considered to be connected to NSPI's transmission system. These facilities are identified below in Figure 2 and Table 1. Single line diagrams for each facility are included in Appendix A of this report.

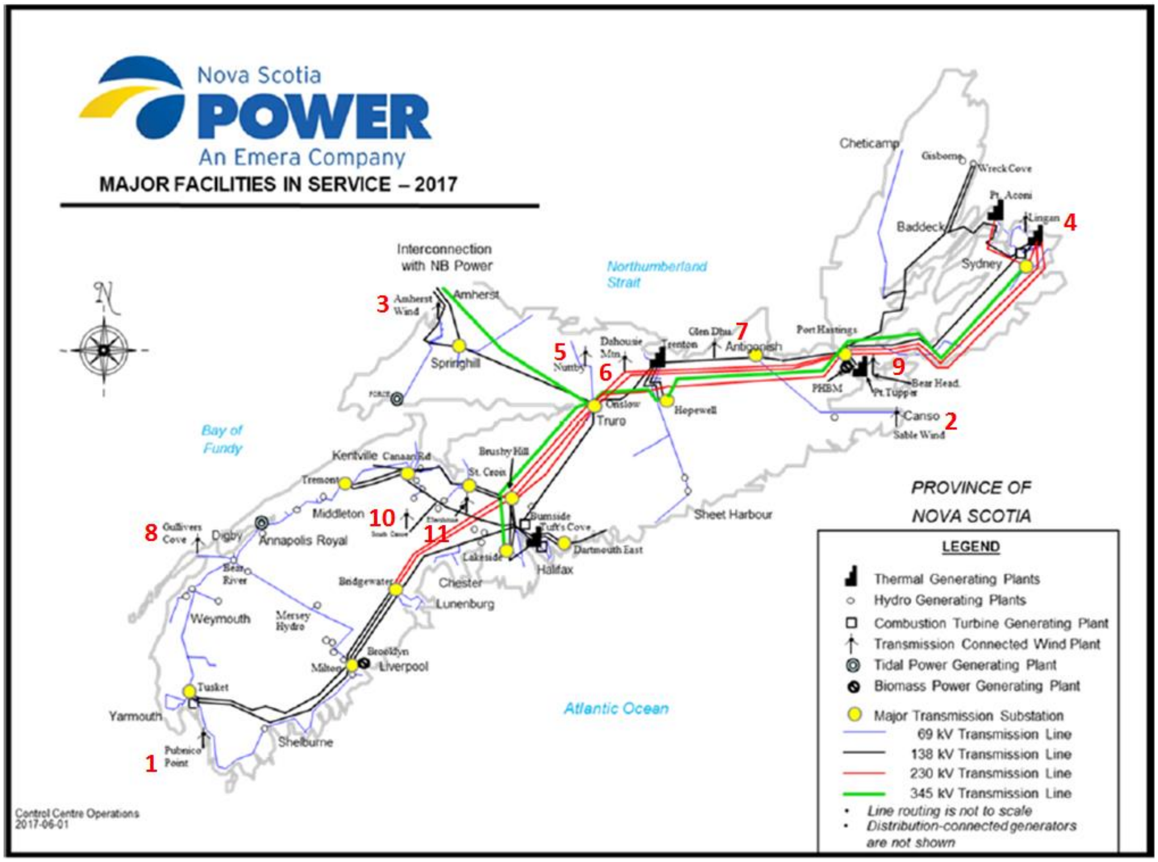


Figure 2: Transmission Connected Wind Generation Facilities

Transmission Connected Wind Farms in Nova Scotia					
#	I.D.	Wind Farm	MW	IR #	Service
1	106W	Pubnico Point	30	5	N/A
2	19C	Sable	13.8	8	NRIS
3	92N	Amherst	31.5	45	N/A
4	109S	Lingan	14	48	N/A
5	89N	Nuttby	49.5	82	ERIS
6	91N	Dalhousie Mountain	50	84	ERIS
7	93N	Glendhu	62.1	114	ERIS
8	98V	Gullivers Cove	30	141	NRIS
9	120C	Bear Head	23	150	NRIS
10	110W	South Canoe I	24	372	NRIS
		South Canoe II	78	379	NRIS
11	102V	St Croix. (Ellershouse)	16.5 *	461	NRIS

** - An additional 14.1 MW is under development at 102V*

Table 1: Transmission Connected Wind Farms

In order to connect to the transmission system, the majority of these facilities were studied under the Standard Generator Interconnection Procedures (GIP), as approved by the Nova Scotia Utility and Review Board. However, a few facilities were proposed prior to the effective date of the GIP. While the studies for these early projects were similar to those used after the GIP came into effect, their service designation was not defined and appears as 'N/A' in Table 1. Projects with this designation essentially operate as NRIS generation. Projects that proceeded after the GIP came into effect were classified as either ERIS or NRIS.

It should be noted that the three ERIS projects in Table 1 are all located on the backbone of the Nova Scotia (NS) transmission system, either between Cape Breton and Onslow, or between Onslow and New Brunswick (NB). These are the portions of the transmission system most impacted by upgrades associated with the Maritime Link project, which will enable firm export of 150MW to NB between December 1 and March 31 of each year, and 330MW of firm exports to NB between April 1 and November 31 of each year.

1.3 Maritime Link Project

The Maritime Link (ML) is a bi-directional Voltage-Source Converter High Voltage Direct Current interconnection between NS and the island of Newfoundland. The nominal rating of the converters is 500 MW, but with cable and inverter losses, the delivered power at the 101S-Woodbine terminal is expected to be approximately 475 MW. The ML is configured for two poles of 250 MW (net 237.5 MW) each.

The following Network upgrades were identified as required for the Maritime Link to proceed. The last of these upgrades is scheduled for completion in 2018:

1. 67N-Onslow 345kV bus re-configuration to eliminate L-8002 + L-8003 common breaker contingency by swapping the 345kV Termination nodes for L-8001 (Memramcook – NB L-3025) and L-8003 (79N-Hopewell).
2. 101S-Woodbine 345 kV bus development per 1-Line (Appendix A) including a second 556 MVA 345kV/230kV transformer.
3. Lines L-7011 and L-7012 termination at 101S-Woodbine per 1-Line (Appendix A)
4. Line protection upgrade for L-7011, L-7012, L-7021, L-7022, and SPS modification to include run-back of HVDC
5. New tower crossing at Canso Causeway to eliminate shared tower crossing for lines L-7005 and L-8004
6. Uprating of Line L-7019 from 60^{o}C operating temperature to 70^{o}C (273/345 MVA),
7. Uprating of Line L-6511 from 50^{o}C operating temperature to 60^{o}C (140/184 MVA),
8. Rebuild of Line L-6513 with operating temperature of 100^{o}C (287/287 MVA – limited to 287 MVA by breaker ratings)

1.4 Expected Generation Facilities

All in-service transmission connected generation facilities are included in the study. As of November 2017, NSPI's Advanced Stage Generation Interconnection Request queue included four transmission generation projects at various stages of interconnection study. The following new generation projects are expected to proceed prior to 2021:

- 14.1 MW wind generation (1 project)
- 13 MW tidal generation (3 projects: 2MW, 5MW, 6MW)

1.5 Expected Generation Retirements

The 150MW 87S-Lingan generator G2 is scheduled for retirement in conjunction with the commissioning of the Maritime Link and the flow of the NS block of energy (firm capacity) from the Muskrat Falls hydro facility in Labrador. As such, the Lingan Unit G2 was not included in the base case models.

1.6 Expected Export Transmission Service Facilities

The transmission service request TSR-400 for firm Point to Point Service between NS and NB was included in base case scenario models. TSR-400 calls for Firm export capacity of 330MW between April 1 and November 30 of each year, and for 150MW of Firm export capacity between December 1 and March 31 of each year. Firm transfers between NS and NB are scheduled to begin with the completion of the Maritime Link project and the start of commercial operation of the Muskrat Falls Hydro facility in Labrador. While the Maritime Link is scheduled to go into service in late 2017, the Muskrat Falls generating station is scheduled to provide first power in 2019, with full power becoming available in 2020.

1.7 Base Case Development

The system representation used in the base cases for this study was developed jointly with NBP for the Maritimes area from the update of MMWG 2014 Series MMWG 2020 base cases. The projects planned for installation between 2017 and 2021 that are listed below, were included:

1. Network Upgrades associated with the Maritime Link per Section 1.3
2. Dual high-speed protection systems installed at 1N-Onslow 138 kV, 103H-Lakeside 138kV, 120H-Brushy Hill 138kV, 120H-brushy Hill 345kV, and 3C-Port Hastings 230kV.
3. 120H Brushy Hill SVC controls replacement
4. Addition of 50MVAR Capacitor Bank at 103H-Lakeside
5. Addition of 50MVAR Capacitor Bank at 90H-Sackville
6. Replacement of Lingan 230 kV Westinghouse Gas insulated Switchgear (GIS)
7. Installation of dual high-speed protection systems at 88S-Lingan 230kV substation during GIS replacement project.
8. Installation of new 138kV Spider Lake substation in Dartmouth.
9. Thermal uprating of L-7003 from 60°C to 70°C operating temperature.

1.8 Assumptions

The study was performed using the following assumptions:

1. NSPI's transmission line ratings as posted on NSPI's Intranet, including any projected line upgrades for the periods under study.
2. Committed generation as listed in Section 1.4 is modeled in the base cases.
3. All transmission elements are in-service, including capacitor banks and the Static Var Compensator.
4. All transmission upgrades associated with Maritime Link have been completed
5. Remedial Action Schemes (SPS's) are armed to reject or run-back the Maritime Link HVDC facility up to 330 MW for contingencies.
6. COMFIT generation is not dynamically modelled, but is treated as negative load netted at the appropriate substation bus. Wind generation currently connected to the NSPI distribution system totals 185MW.

2.0 Technical Model

For the steady state analysis, the seven transmission wind facilities interconnected along the backbone of the NS electrical system were operated at nameplate capacity for each of the Winter Peak (2021WIN), Summer Peak (2021SUM), and Light Load (2021LL) cases. These facilities include the three existing ERIS facilities: IR#82 - Nuttby Mountain, IR#84 - Dalhousie mountain, and IR#114 - Glen Dhu, and also the two facilities having 'N/A' designations: IR #45 - Amherst and IR #48 - Lingan. The remaining four transmission wind facilities that do not interconnect with the backbone system were dispatched at 30% of their nameplate capacity in all cases except for one light load case where they were dispatched to 0MW. The PSS®E model for load flow is shown in Figure 3.

As noted in Section 1.8, the 185MW of distribution system connected wind generation was not explicitly modelled. Instead, it was treated as negative load, meaning that connected load at each distribution substation bus was netted out with the generation connected to feeders originating from that bus. For the case of this NRIS study, it was assumed that all distribution connected wind was operating at 70% nameplate rating. The tables of load adjustments made to each of the 2021WIN, 2021SUM, and 2021LL PSS®E cases are included in Appendix C of this report.

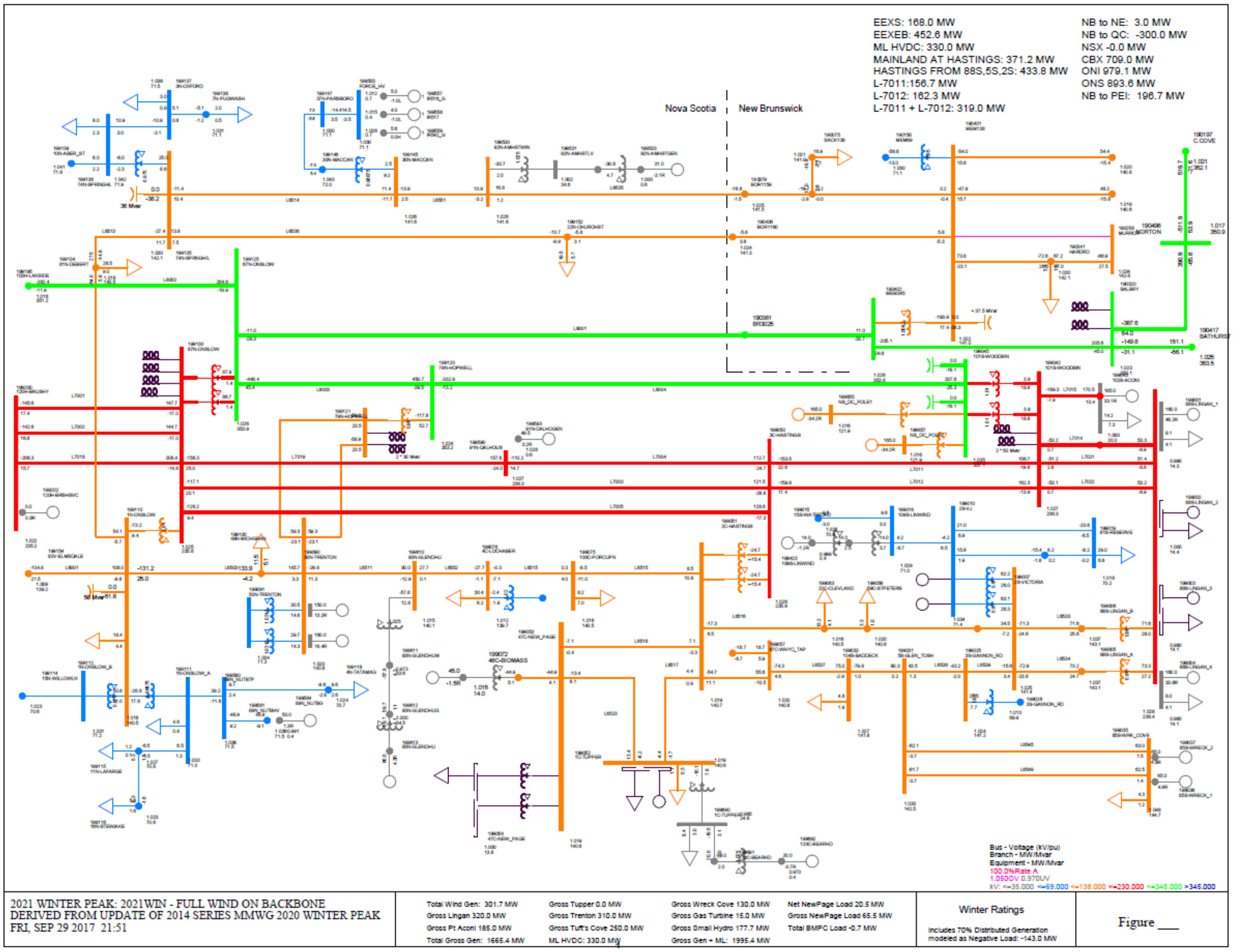


Figure 3: PSS®E model

2.1 System Load

NSPI has a winter peaking system with a large Non-Firm component. The forecast for system "Peak Total" includes Non-Firm load as the system is planned to accommodate both Firm and Non-Firm Load. However, the Non-Firm load has highly variable production schedules and can be curtailed by the System Operator if needed for system control, and typically responds to real-time marginal pricing to self-curtail coincident with system peak demand.

In 2012, a large industrial customer retired part of their infrastructure, lowering their interruptible load by approximately 65MW. In addition, they migrated a portion of their interruptible load to a real time pricing rate. While this load remained interruptible under the new rate, customer production schedules were adjusted resulting in lower customer interruptible load during peak periods.

The 2021 Coincident Peak Demand for NSPI, including Demand Side Management effects, is provided in Table 2. The summer and light load forecast are scaled from the firm winter peak load forecast based on historic load patterns. The Non-Firm load has a wide variability and can be on maximum or minimum at any time of the year. However, with the real time pricing component, the non-firm load will most likely be off during system peak.

Coincident Peak Demand - 2017 NSPI Forecast for 2021			
Year	**Peak Total (MW)**	**Non-Firm (MW)**	**Firm (MW)**
Peak	2193	155	2038
Summer Peak	1477	155	1322
Light Load	696	62	634

Table 2: Coincident Peak Demand

2.2 System Model and Methodology

Testing and analysis was conducted using the following criteria, software packages and/or modelling data.

Short Circuit

NSPI system sequence models are kept current for the Aspen OneLiner program. The base cases for the 2017 year were updated with the planned facilities described in Section 1. Short circuit analysis was then performed to compare post Maritime Link fault levels at each of the transmission wind generation sites with NSPI's design criteria to confirm that fault levels remain within design limits.

The methodology used to determine the short circuit level at each of the wind farm HV buses was as follows:

- With all lines in service and all generators on-line, a classical fault analysis for all buses was performed using ASPEN OneLiner. Classical fault analysis assumes a uniform pre-fault voltage profile of magnitude of 1.0 p.u. at 0 degrees.
- The results of the short circuit analysis are shown in Table 3 for Transmission Connected wind farms. Results for all provincial buses are shown in Appendix B.

Steady State

Analysis was carried out using Python scripts within PSS®E software version 33.7. The scripts simulate base case and a wide range of single contingencies, with the output reports summarizing bus voltages or branch flows that exceed established limits.

System modifications and additions up to 2021 were modeled and contingencies that would best provide a measure of system reliability were tested in accordance with NSPI and NPCC design criteria. The Study year 2021 was selected to accommodate the completion and full operation of the Maritime Link project. Details on the contingencies studied are provided in Section 3.2.2.

Steady State analysis was run for the contingencies on each of the bases cases listed in Section 3.2.1.

Stability
Analysis was carried out using PSS®E software version 33.7. Stability analysis was performed for the 2021 study year and system configuration. Winter Peak, Summer Peak and Light Load cases were studied for a wide range of contingencies to provide an overall measure of the impacts of operating ERIS generation as NRIS generation on system reliability. Details on the contingencies studied are provided in Section 3.2.2.

3.0 Technical Analysis

3.1 Short Circuit

The NSPI design criteria for maximum system fault capacity (three phase, symmetrical) is 5,000 MVA on 138kV and 3,500 MVA on 69kV.

Short circuit analysis was performed using Aspen OneLiner V11.8, classical fault study, 3LG and flat voltage profile at 1 per unit voltage**.** The short-circuit level at each of the transmission interconnected wind farm buses within Nova Scotia was determined to demonstrate that the Network Upgrades associated with the Maritime Link project did not raise the short circuit levels above equipment design criteria.

Wind Generation Site Short Circuit Level (at POI)					
Bus #	**Stn**	**Name**	**MW**	**kV**	**2021 MVA**
199275	106W	Pubnico Point	30	69	231
199080	19C	Sable	13.8	69	104
199530	92N	Amherst	31.5	138	1125
199016	109S	Lingan	14	69	527
199581	89N	Nuttby	49.5	69	272
199590	91N	Dalhousie Mountain	50	230	2306
199610	93N	Glendhu	62.1	138	1222
199710	98V	Gullivers Cove	30	69	153
199052	120C (At 1C)	Bear Head (at 1C HV)	23	138	2284
199501	110W	South Canoe I	24	138	889
		South Canoe II	78		
199635	102V	St Croix. (Ellershouse)	16.5	69	805

Table 3: Short Circuit Levels

Short circuit levels do not change significantly as a result of the Network upgrades associated with the Maritime Link project. The wind generation sites that are remote to the backbone system saw little or no change in fault level at their Point of Interconnection. Wind sites connected to the backbone of the system saw marginal increases in short circuit level at their Point of Interconnection, but remained well within the design criteria ratings.

3.2 Steady State Analysis

3.2.1 Base Cases

Table #4 shows the complete list of base cases used within this study. Base cases included Winter Peak, Summer Peak, and Light Load scenario's under a variety of import and export conditions. 1-line diagrams for each steady state base case are presented in Appendix D.

Base Case Models												
Case	Condition	ML MW NL/NS	NB/HQ MW	NB/NE MW	NB/PEI MW	NS/NB MW	ONI MW	CBX MW	ONS	Wind MW	GEN MW	Load MW
2021WIN	Normal WP	330	-300	0	200	0	979	709	893	302	1720	2050
2021WIN-1	WP, NSX: 150MW	330	-300	0	200	150	1113	845	876	302	1878	2058
2021WIN-1a	WP, NSX: 150MW Pt Tupper off	330	-300	0	200	150	1123	856	887	302	1884	2064
2021WIN-2	WP, NSX: -100MW	330	-300	0	200	-100	896	622	911	302	1613	2043
2021WIN-3	WP, NSX: -100MW	-100	-300	0	200	-100	878	604	893	302	2046	2046
2021SUM	Normal SP	475	-300	800	160	0	603	469	590	304	1012	1487
2021SUM-1	SP, NSX: 330MW	475	-300	800	160	330	952	680	609	304	1217	1362
2021SUM-2	SP, NSX: -100MW	475	-300	800	160	-100	525	430	612	304	766	1341
2021SUM-3	SP, NSX: -100MW ML: -100MW	-100	-300	800	160	-100	528	213	616	304	1340	1340
2021SUM-3a	SP, NSX: -100MW ML: -100MW, Metro	-100	-300	800	160	-100	203	72	291	304	1326	1326
2021LL	Normal LL	70	600	800	80	0	233	99	263	207	505	575
2021LL-1	NSX: 330MW ML: 475MW	410	600	800	80	330	564	436	263	207	504	584
2021LL-2	NSX: -100MW ML: -100MW	-100	600	800	80	-100	134	-11	263	207	575	575

Table 4: Base Case Models

- These cases demonstrate the behaviour of the system with maximum amounts of wind generation on the backbone system, under conditions of maximum export and import.
- In each case, distributed generation is modelled at 70% nameplate rating.

3.2.2 Steady-State Contingencies

The steady state analysis included the contingencies listed in Table 5.

BES/BPS Elements								Load Flow Contingencies	
Station	Bkr	line	Bus	Xfmr	Var	Gen	Element	Load Flow	SPS
88S 230kV	x						710	88S, 88S-710	-
	x						711	88S, 88S-711	-
	x						712	88S, 88S-712	-
	x						713	88S, 88S-713	-
	x						720	88S, 88S-720	-
	x						721	88S, 88S-721	-
	x						722	88S, 88S-722	-
	x						723	88S, 88S-723, G0	-
								88S, 88S-723, G8	G8 BBU
		x					L7014	88S, L-7014	-
		x					L7021	88S, L-7021, G0	-
		x					L7022	88S, L-7022, G0	-
				x			88S-T71	88S, 88S-T71	-
101S 230kV	x						701	101S, 101S-701, G0	-
	x						702	101S, 101S-702, G0	-
	x						703	101S, 101S-703	-
	x						704	101S, 101S-704, G0	-
	x						705	101S, 101S-705, G0	-
	x						706	101S, 101S-706, G0	-
	x						711	101S, 101S-711, G0	-
	x						712	101S, 101S-712	-
	x						713	101S, 101S-713	-
		x					L7011	101S, L-7011, G0	-
		x					L7012	101S, L-7012, G0	-
		x					L7015	101S, L-7015	-
101S 345kV	x						811	101S, 101S-811	-
	x						812	101S, 101S-812, G0	-
								101S, 101S-812, G5	G5 CBX Lo
								101S, 101S-812, G6	G6 CBX Hi
	x						813	101S, 101S-813, G0	-
								101S, 101S-813, G5	G5 CBX Lo
								101S, 101S-813, G6	G6 CBX Hi
	x						814	101S, 101S-814	-
	x						816	101S, 101S-816	-
		x					L8006 P1	101S, ML-POLE1	-
		x					2 poles	101S, ML-BIPOLE	-
		x					L8004	101S, L-8004, G0	-
								101S, L-8004, G5	G5 CBX Lo
								101S, L-8004, G6	G6 CBX Hi
				x	x		101S-T81	101S, 101S-T81	-

BES/BPS Elements								Load Flow Contingencies	
Station	Bkr	line	Bus	Xfmr	Var	Gen	Element	Load Flow	SPS
2C 138kV		x					L6515	2C, L-6515	-
		x					L6516	2C, L-6516	-
		x					L6517	2C, L-6517	-
		x					L6518	2C, L-6518	-
		x					L6537	2C, L-6537, G0	-
								2C, L-6537, G20	WC L6538 o/l
			x				2C-B61	2C, 2C-B61, G0	-
								2C, 2C-B61, G20	WC L6538 o/l
			x				2C-B62	2C, 2C-B62	-
3C 230kV	x						710	3C, 3C-710, G0	-
	x						711	3C, 3C-711, G0	-
	x						712	3C, 3C-712, G0	-
	x						713	3C, 3C-713, G0	-
	x						714	3C, 3C-714, G0	-
	x						715	3C, 3C-715, G0	-
	x						716	3C, 3C-716, G0	-
	x						720	3C, 3C-720, G0	-
		x					L7003	3C, L-7003, G0	-
		x					L7004	3C, L-7004, G0	-
		x					L7005	3C, L-7005, G0	-
				x			3C-T71	3C, 3C-T71	-
1N 138kV	x						600	1N, 1N-600	-
	x						601	1N, 1N-601	-
	x						613	1N, 1N-613	-
		x					L6001	1N, L-6001	-
		x					L6503	1N, L-6503	-
		x					L6513	1N, L-6513	-
			x				1N-B61	1N, 1N-B61	-
			x				1N-B62	1N, 1N-B62	-
67N 230kV	x						701	67N, 67N-701, G0	-
	x						702	67N, 67N-702, G0	-
	x						703	67N, 67N-703, G0	-
	x						704	67N, 67N-704, G0	-
	x						705	67N, 67N-705, G0	-
	x						706	67N, 67N-706, G0	-
	x						710	67N, 67N-710, G0	-
	x						711	67N, 67N-711, G0	-
	x						712	67N, 67N-712, G0	-
	x						713	67N, 67N-713, G0	-
		x					L7001	67N, L-7001	-
		x					L7002	67N, L-7002	-
		x					L7018	67N, L-7018	-
		x					L7019	67N, L-7019	-
				x			67N-T71	67N, 67N-T71	-

BES/BPS Elements								Load Flow Contingencies	
Station	**Bkr**	**line**	**Bus**	**Xfmr**	**Var**	**Gen**	**Element**	**Load Flow**	**SPS**
67N 345kV	x						811	67N, 67N-811, G0	-
								67N, 67N-811, G5	G5 ONI Lo
								67N, 67N-811, G6	G5 ONI Hi
	x						812	67N, 67N-812	-
	x						813	67N, 67N-813	-
	x						814	67N, 67N-814, G0	-
								67N, 67N-814, NSX1	G9 NSX Lo
								67N, 67N-814, NSX2	G9 NSX Hi
	x						815	67N, 67N-815, G0	-
								67N, 67N-815, NSX1	G9 NSX Lo
								67N, 67N-815, NSX2	G9 NSX Hi
	x						816	67N, 67N-816, G0	-
								67N, 67N-816, G5	G5 ONI Lo
								67N, 67N-816, G6	G6 ONI Hi
		x					L8001	67N, L-8001, G0	-
								67N, L-8001, G5	G9 NSX Lo
								67N, L-8001, G6	G9 NSX Hi
		x					L8002	67N, L-8002	-
				x	x		67N-T81	67N, 67N-T81	-
79N 138kV	x						601	79N, 79N-601	-
								79N, 79N-601, G5	G5 CBX Lo
								79N, 79N-601, G6	G6 CBX Hi
	x						606	79N, 79N-606	-
								79N, 79N-606, G5	G5 CBX Lo
								79N, 79N-606, G6	G6 CBX Hi
		x					L6507	79N, L-6507	-
		x					L6508	79N, L-6508	-
79N 345kV	x						803	79N, 79N-803, G0	-
								79N, 79N-803, G5	G5 CBX Lo
								79N, 79N-803, G6	G6 CBX Hi
	x						810	79N, 79N-810, G0	-
								79N, 79N-810, G5	G5 CBX Lo
								79N, 79N-810, G6	G6 CBX Hi
		x					L8003	79N, L-8003, G0	-
								79N, L-8003, G5	G5 ONI Lo
								79N, L-8003, G6	G6 ONI Hi
				x	x		79N-T81	79N, 79N-T81, G0	-
								79N, 79N-T81, G5	G5 CBX Lo
								79N, 79N-T81, G6	G6 CBX Hi
91N 230kV	x						701	91N, 91N-701	-
	x						702	91N, 91N-702	-
	x						703	91N, 91N-703	-
			x				91N-B71	91N, 91N-B71	-

BES/BPS Elements								Load Flow Contingencies	
Station	Bkr	line	Bus	Xfmr	Var	Gen	Element	Load Flow	SPS
DCT		x					L6507_L6508	DCT, L-6507][L-6508	-
		x					L6534_L7021	DCT, L-6534][L-7021	-
		x					L7003_L7004	DCT, L-7003][L-7004, G0	-
								DCT, L-7003][L-7004, G3	G4 BBU 1
		x					L7008_L7009	DCT, L-7008][L-7009	-
		x					L7009_L8002	DCT, L-7009][L-8002	-

Table 5: Steady State Contingencies

3.2.3 Steady-State Evaluation

The Network Upgrades associated with the Maritime Link are sufficient to permit the existing ERIS designated transmission connected wind farms to operate in a similar manner to NRIS facilities. None of the contingencies listed in Table 3 resulted in thermal or voltage violations. As such, no additional upgrades are required to accept their full output under normal and first contingency conditions once the ML facilities are installed.

3.3 Stability Analysis

Design criteria require the system to be stable and well damped in all modes of oscillations. The peak values of any mode of oscillation must decay to a value that is 60% less than the original amplitude over any 10 second period.

3.3.1 Stability Base Cases

Each of the cases identified in Section 3.2.1 in Table 4 for Steady State analysis were also analysed for stability using contingencies that provide the best measure of system reliability.

3.3.2 Stability Contingencies

The stability analysis included the contingencies listed in Table 6.

Elements								2021 Dynamics Contingencies	
Station	Bkr	line	Bus	Xfmr	Var	Gen	Element	Dynamics	SPS
88S 230kV	x						713	88S BBU 88S-713	-
	x						720	88S BBU 88S-720	-
	x						721	88S BBU 88S-721	-
	x						722	88S BBU 88S-722	-
	x						723	88S BBU 88S-723 G0	-
		x					L7014	88S L7014 3PH Fault	-
		x					L7021	88S L7021 3PH Fault	-
		x					L7022	88S L7022 3PH Fault	-
101S 230kV	x						701	101S BBU 101S-701 G0	-
	x						702	101S BBU 101S-702 G0	-
	x						706	101S BBU 101S-706	-
	x						712	101S BBU 101S-712	-
		x					L7011	101S L7011 3PH Fault G0	-
		x					L7012	101S L7012 3PH Fault G0	-
		x					L7014	101S L7014 3PH Fault	-
		x					L7021	101S L7021 3PH Fault	-
		x					L7022	101S L7022 3PH Fault	-
101S 345kV	x						811	101S BBU 101S-811	-
	x						812	101S BBU 101S-812 G0	-
								101S BBU 101S-812 G5	G5 CBX Lo
								101S BBU 101S-812 G6	G6 CBX Hi
	x						813	101S BBU 101S-813 G0	-
								101S BBU 101S-813 G5	G5 CBX Lo
								101S BBU 101S-813 G6	G6 CBX Hi
					x		2 poles	101S, MLBIPOLE	-
		x					L8004	101S L8004 3PH Fault G0	-
								101S L8004 3PH Fault G5	G5 CBX Lo
								101S L8004 3PH Fault G6	G6 CBX Hi
2C 138kV			x				2C-B62	2C BUS 2C-B62 3PH Fault	-
3C 230kV	x						711	3C BBU 3C-711 G0	-
	x						715	3C BBU 3C-715 G0	-
		x					L7005	3C L7005 3PH Fault G0	-
		x					L7012	3C L7012 3PH Fault G0	-
1N 138kV	x						600	1N BKR 1N-600 1P	-
	x						601	1N BKR 1N-601	-
	x						613	1N BBU 1N-613	-
		x					L6001	1N L6001 3PH Fault	-
		x					L6503	1N L6503 3PH Fault	-
		x					L6513	1N L6513 3PH Fault	-

Elements								2021 Dynamics Contingencies	
Station	**Bkr**	**line**	**Bus**	**Xfmr**	**Var**	**Gen**	**Element**	**Dynamics**	**SPS**
67N 230kV	x						711	67N BBU 67N-711	-
	x						712	67N BBU 67N-712	-
	x						713	67N BBU 67N-713	-
		x					L7005	67N L7005 3PH Fault G0	-
							L7005	67N BBU 67N-811 G0	-
		x					L7018	67N L7005 3PH Fault G3	-
67N 345kV	x						811	67N BBU 67N-811 G5	G5 ONI Lo
								67N L7018 3PH Fault	-
								67N BBU 67N-811 G6	G5 ONI Hi
	x						813	67N BBU 67N-813	-
	x						814	67N BBU 67N-814 G0	-
								67N BBU 67N-814 NSX1	G9 NSX Lo
								67N BBU 67N-814 NSX2	G9 NSX Hi
		x					L8001	67N L8001 3PH Fault G0	-
								67N L8001 3PH Fault NSX1	G9 NSX Lo
								67N L8001 3PH Fault NSX2	G9 NSX Hi
								67N L8001 3PH Fault NSI	G10 NSI
		x					L8002	67N L8002 3PH Fault	-
		x					L8003	67N L8003 3PH Fault G0	-
								67N L8003 3PH Fault G5	G5 ONI Lo
								67N L8003 3PH Fault G6	G6 ONI Hi
79N 138kV	x						601	79N BBU 79N-601 G0	-
								79N BBU 79N-601 G5	G5 CBX Lo
								79N BBU 79N-601 G6	G6 CBX Hi
		x					L6507	79N L6507 3PH Fault	-
79N 345kV	x						803	79N BBU 79N-803 G0	-
								79N BBU 79N-803 G5	G5 CBX Lo
								79N BBU 79N-803 G6	G6 CBX Hi
	x						810	79N BBU 79N-810 G0	-
								79N BBU 79N-810 G5	G5 CBX Lo
								79N BBU 79N-810 G6	G6 CBX Hi
		x					L8003	79N L8003 3PH Fault G0	-
								79N L8003 3PH Fault G5	G5 ONI Lo
								79N L8003 3PH Fault G6	G6 ONI Hi
		x					L8004	79N L8004 3PH Fault G0	-
								79N L8004 3PH Fault G5	G5 CBX Lo
								79N L8004 3PH Fault G6	G6 CBX Hi
				x			79N-T81	79N T81 HV Fault G0	-
								79N T81 HV Fault G5	G5 CBX Lo
								79N T81 HV Fault G6	G6 CBX Hi

Elements								2021 Dynamics Contingencies	
Station	Bkr	line	Bus	Xfmr	Var	Gen	Element	Dynamics	SPS
Dbl Cct TOWERS		x					L6507_L6508	DCT L6507][L6508 79N	-
		x					L6534_L7021	DCT L6534][L7021	-
		x					L7003_L7004	DCT L7003][L7004 G0	-
		x					L7008_L7009	DCT L7008][L7009	-
		x					L7009_L8002	DCT L7009][L8002	-
NB 410N		x					L3006	410N L3006 3PH Fault	-
		x					L8001	410N L8001 3PH Fault	-

Table 6: Dynamic Contingencies

3.3.3 Stability Evaluation

All contingencies were found to be stable and well damped. A summary of the contingency results is included in Appendix F. PSS®E plotted output files for each contingency can be found in Appendices G through I.

4.0 Resource Adequacy

The analysis of Section 3 of this report indicates that ERIS designated transmission interconnected wind generation facilities may be included with the NRIS facilities in the calculation of Resource Adequacy from a system capacity point of view. In other words, at current levels of transmission service and transmission & distribution connected generation, the addition of the Maritime Link Network Upgrades has removed the transmission constraints that would have prevented the full output of the ERIS designated facilities under normal and first contingency conditions.

This study does not attempt to dictate what the overall acceptable level of ELCC contribution should be from the existing transmission and distribution wind on the NSPI system. Two methods of determining this value are currently under review by NSPI and these are presented in Section 8 of the 2017 10 Year System Outlook report, as posted on the NSPI OASIS site at...

http://oasis.nspower.ca/en/home/oasis/forecasts-and-assessments.aspx

A summary of these two methods taken from the 10 Year System Outlook Report is included below.

Analysis of Currently Planned Levels of Variable Generation

NS Power continues to evaluate the coincidence of wind generation with peak load on an annual basis to better understand the Effective Load Carrying Capability (ELCC) or capacity value of wind assets on the NS Power system by completing studies using available data and both the LOLE and Cumulative Frequency Analysis (CFA) methodologies.

> ***Loss of Load Expectation (LOLE):***
>
> *The LOLE methodology is a long standing utility industry standard for planning reserve margin assessment, which can be adapted to assess the capacity value of wind. This calculation is completed using the Probabilistic Assessment of System Adequacy (PASA) module of Plexos, and takes into account hourly actual wind, hourly actual load, generator capacities, and forced outage rates. The advantages of this methodology are that the calculation practices are well-established and the computation considers not just the coincidence of peak load and wind generation, but also the impact of the amount of wind generation proportional to the system (exhibiting declining capacity factor with higher penetration levels of wind). The main disadvantage of the LOLE approach is that the results can vary significantly year over year. As discussed in the 2016 10 Year System Outlook, the International Energy Agency (IEA) Wind Task Final Report recommends that between 10 and 30 years of wind and load data is required to establish a reliable ELCC of wind generation using LOLE calculations.*
>
> ***Cumulative frequency Analysis***
>
> *NS Power's Cumulative Frequency Analysis assessment of the ELCC of wind generation provides a second method of quantifying the capacity value of wind on the NS Power system. This technique analyzes a set of historical data points, in this case hourly wind generation and load, to determine how often a particular value is exceeded (e.g. wind correlation to peak). The objective of the analysis is to determine what minimum capacity factor of wind we can predict to be available to the NS Power system in peak hours, with corresponding certainty. Other jurisdictions including CAISO (California Independent System Operator), BPA (Bonneville Power Administration), and SPP (South West Power Pool) use variations of this approach. The CFA is completed using Excel and Oracle's Crystal Ball software, and takes into account hourly actual wind and hourly actual load, in the top 10 percent of peak demand periods. The advantage of this method is that the analysis is conducted on a top percentile of peak hours, focusing results on key hours for reliability. The disadvantages of the method are that it does not consider the proportion of wind relative to the system, and adjacent peaks can produce skewed results in either direction.*
>
> *Until NS Power gains multi-year operating experience with approximately 600 MW of wind generation, in order to acquire sufficient data to reliably estimate the ELCC of wind generation in Nova Scotia, there could be a risk to system reliability if the capacity value of wind generation is overstated. This is particularly true given the relatively large installed wind capacity on the NS Power system...*

The report notes that the ELCC of wind generation based on the multi-year LOLE methodology varies from 15 to 28 percent depending on the study year, based on the presently contracted level of in-province wind generation (~600 MW). The ELCC of wind generation based on the Cumulative Frequency Methodology estimates the capacity value of wind at approximately 8%, with a 90% confidence level.

The 2017 10-Year System Outlook Report also states in Section 8.3 that...

> *...Loss of Load Expectation is a robust methodology for calculating wind capacity value; however, as 10 to 30 years of data is recommended for accuracy, the Cumulative Frequency Analysis provides important Validation of LOLE results with a focus on reliability. As noted above, further wind generation data at the 600 MW level will need to be studied to produce a more reliable estimate of wind generation capacity value. Incremental wind above the currently planned levels will have a declining capacity value on the system.*
>
> ***ELCC of Wind Generation using Cumulative Frequency Methodology***

Confidence Level	Capacity Value of Wind
95%	4%
90%	8%
85%	12%
80%	16%

> *For the Resource Adequacy Assessment in Section 8 of this report, NS Power continued to use a wind capacity value of 17 percent for NRIS and 0 percent for ERIS resources (averaging to 12 percent overall ELCC of Nova Scotia wind generation resources). NS Power will continue to monitor the system as the additional planned variable COMFIT generation comes online and more experience is gained with an elevated wind penetration.*

At current levels of wind penetration of approximately 610MW, (Transmission: 423MW[1]; Distribution: 185MW), an 8% ELCC would result in 48.8MW of capacity contribution.

5.0 System Requirements

The analysis of Section 3 determined that the Network Upgrades associated with the Maritime Link project were sufficient to enable the existing ERIS designated generating facilities to operate in a manner similar to NRIS facilities. As such, no additional Network Upgrades are required.

It should be noted that a formal request by a facility owner to transition an existing ERIS generating facility to NRIS would incur study costs identified in the Generator Interconnection Procedures (GIP).

[1] The NSPI System Operator considers all wind generation within the Nova Scotia Operating Area in this analysis, as long as they supply load within the Operating Area. This would include supply to NSPI through Power Purchase Agreements and to eligible wholesale load customers through the Open Access Transmission Tariff. It does not include wind generation installed in Nova Scotia for exclusive export to other Operating Areas.

6.0 Conclusions and Recommendations

Technical analysis, including short circuit, steady state, and stability analysis was performed. NSPI and NPCC planning criteria were applied.

The results of the analysis demonstrate the following:

- There are no thermal; voltage; or stability violations on the transmission system resulting from receipt of full output of all existing ERIS wind generation facilities connected to the NSPI transmission system under normal and first contingency conditions with the Maritime Link (ML) upgrades in service. Analysis cases included winter peak, summer peak, and light load scenarios with maximum levels of wind on the NSPI backbone system.

- Short circuit levels at all NSPI and wind generation facility substations (≥ 69 kV) were satisfactory and were confirmed to be below NSPI design criteria levels.

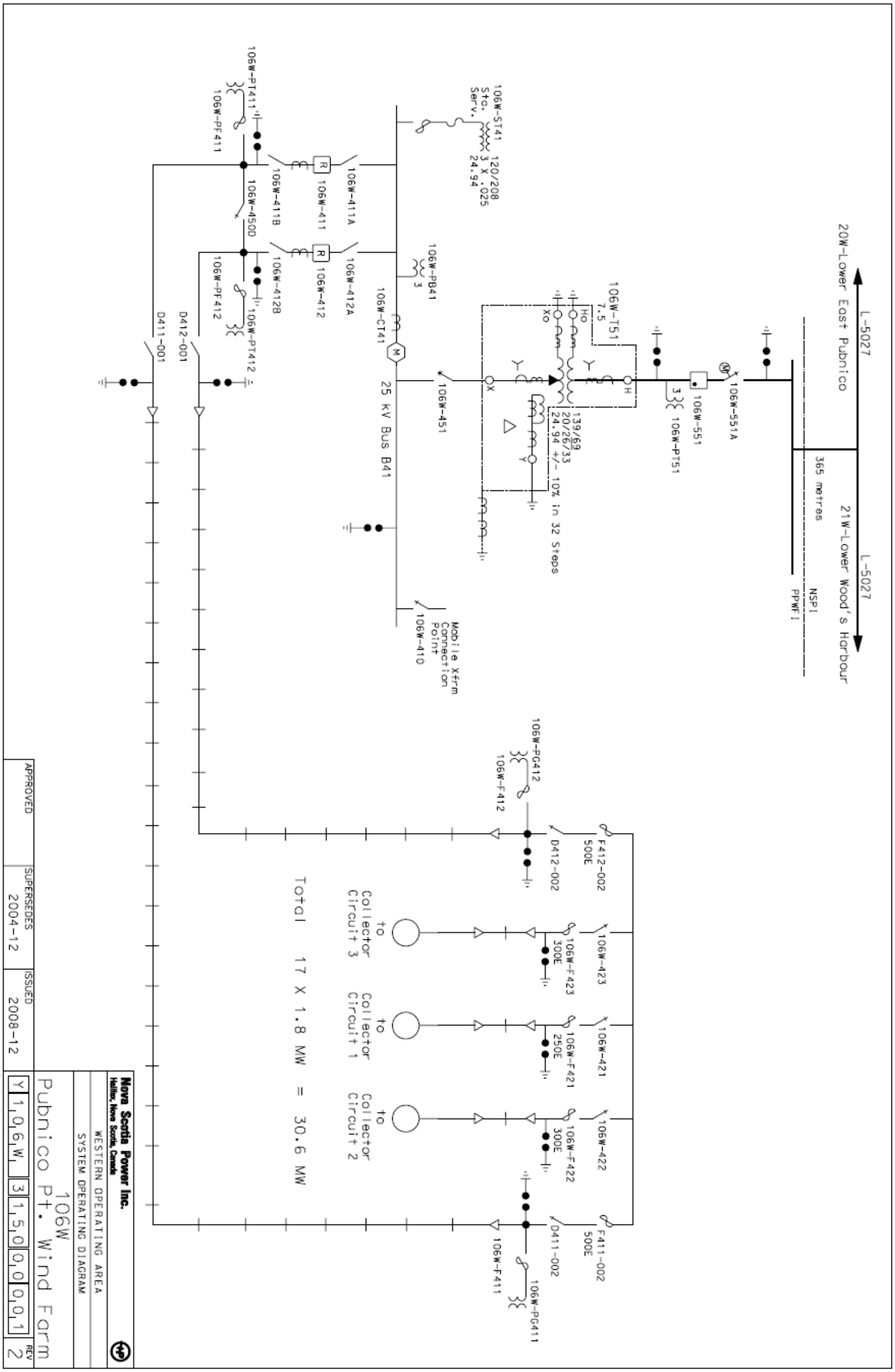
- All NS transmission and distribution connected wind can be included in the ELCC calculations from the perspective of transmission system capacity. Note that this study did not attempt to define what the ELCC contribution from wind generation facilities should be, as NSPI is currently studying methodologies based on *Loss of Load Expectation (LOLE)*, and on *Cumulative Frequency Analysis (CFA)* to determine the appropriate ELCC value for Nova Scotia. At present, CFA analysis shows that an overall ELCC of 8% could be obtained with a confidence level of 90%. This would result in an ELCC contribution of 48.8MW based on existing wind resources of approximately 610MW.

- No additional facilities are required in order to operate existing ERIS designated facilities in the same manner as existing NRIS facilities.

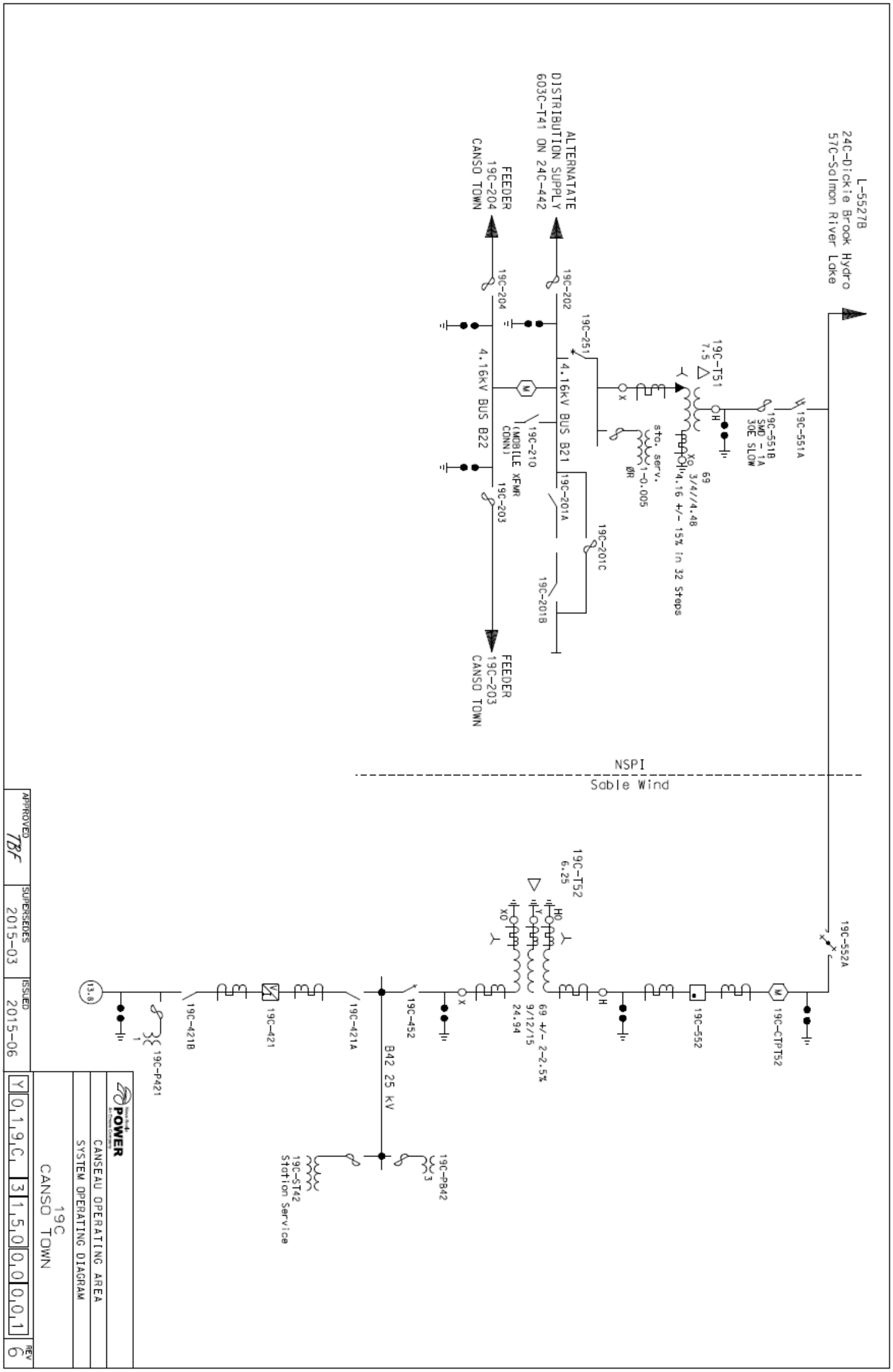
- Analysis of wind generation includes all facilities under the jurisdiction of the NSPI System Operator, not just facilities with a power purchase agreement with NSPI.

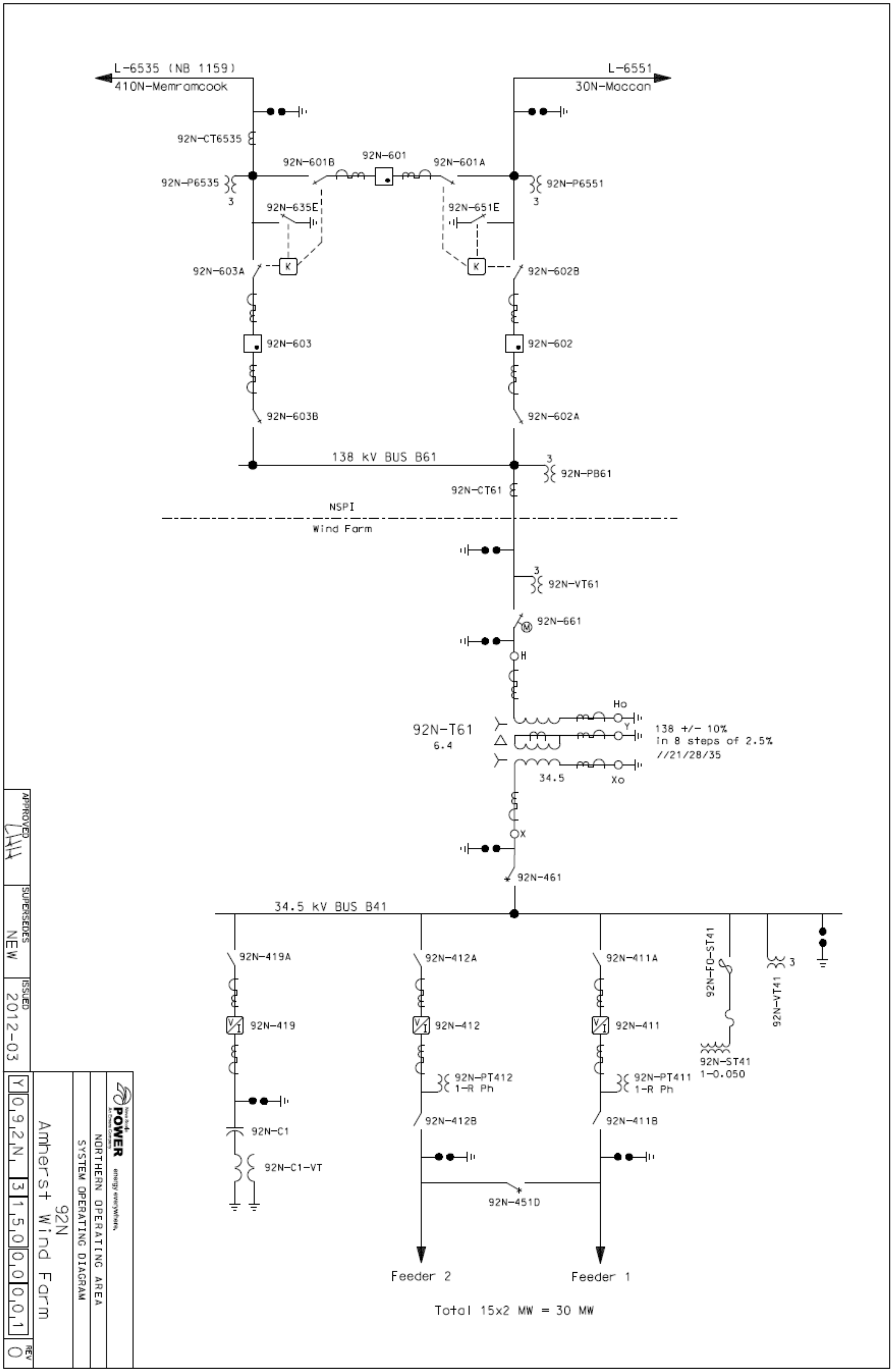
Appendix A

Transmission Connected Wind Farms: 1-Line Diagrams

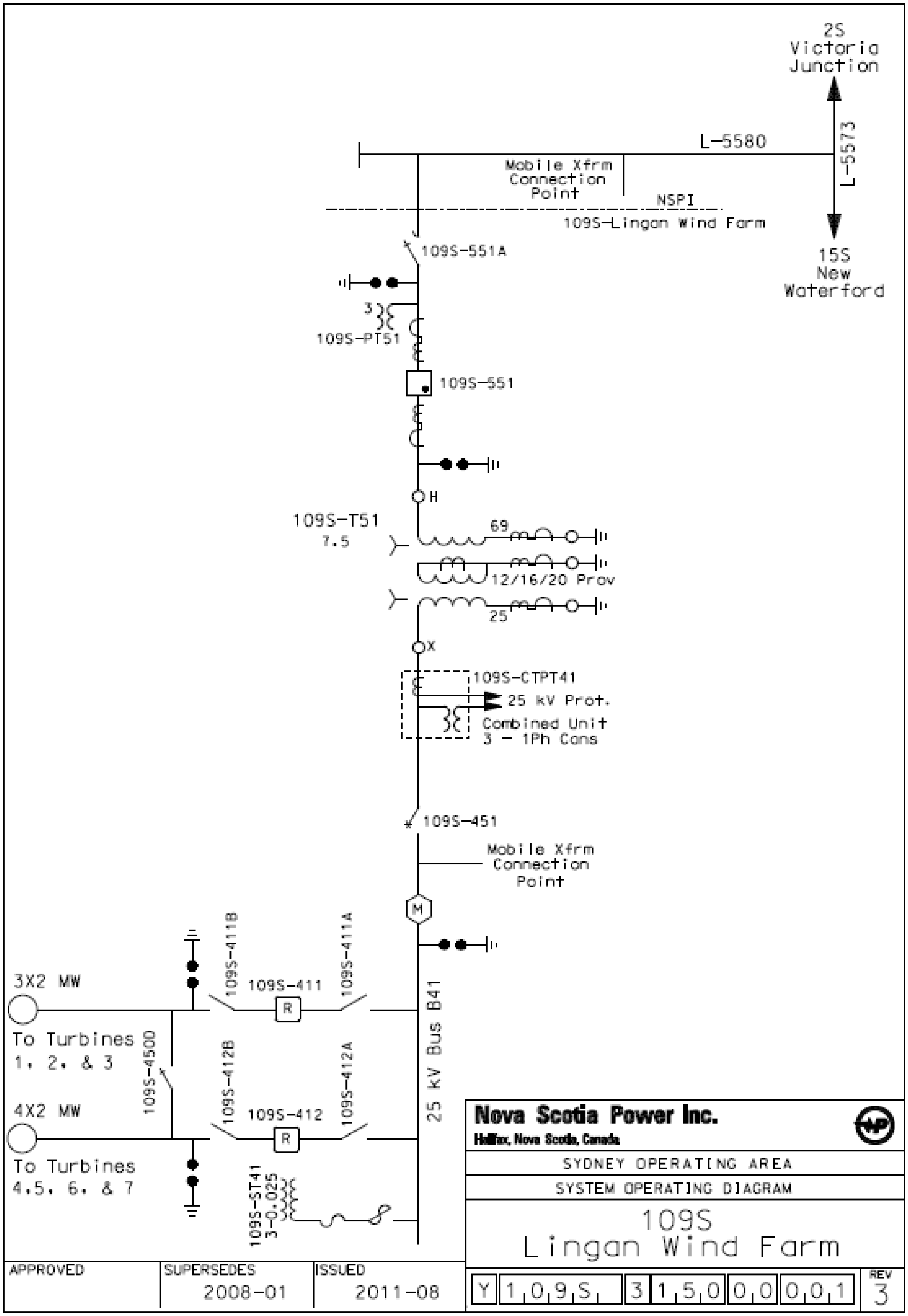


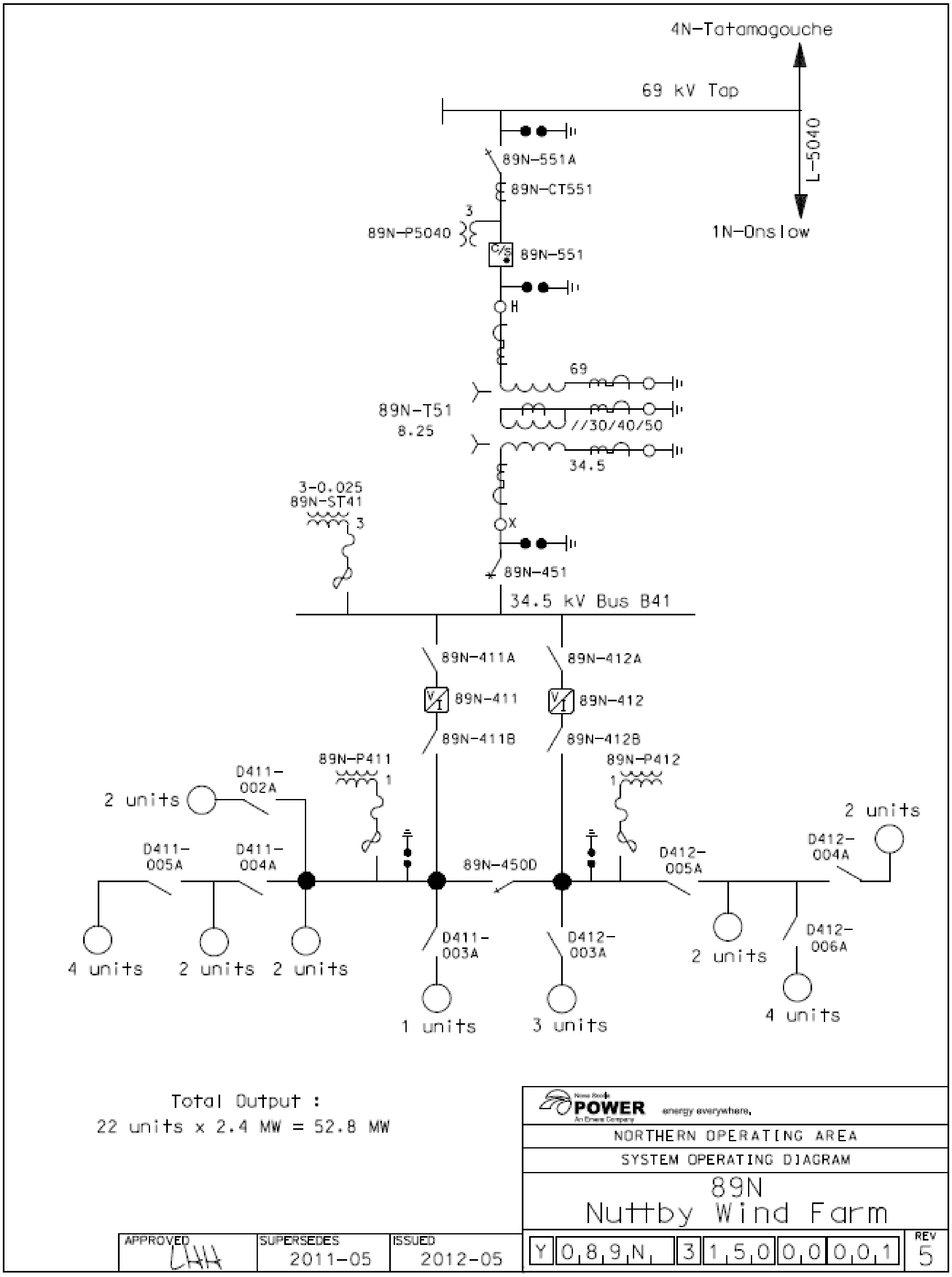
L-5027
20W-Lower East Pubnico
L-5027
21W-Lower Wood's Harbour
365 metres
NSPI
PPWFI
106W-551A
106W-551
106W-PT51
106W-T51
7.5
139/69
20/26/33
24.94 +/- 10% in 32 Steps
Ho
Xo
H
X
106W-451
25 kV Bus B41
106W-CT41
106W-PB41
106W-ST41
Sta. Serv.
120/208
3 X .025
24.94
106W-411A
106W-411
106W-411B
106W-450D
106W-PT411
106W-PF411
106W-412A
106W-412
106W-412B
106W-PT412
106W-PF412
D411-001
D412-001
Mobile Xfrm Connection Point
106W-410
106W-PG412
106W-F412
F412-002
500E
D412-002
106W-423
106W-F423
300E
to Collector Circuit 3
106W-421
106W-F421
250E
to Collector Circuit 1
106W-422
106W-F422
300E
to Collector Circuit 2
F411-002
500E
D411-002
106W-F411
106W-PG411
Total 17 X 1.8 MW = 30.6 MW
APPROVED
SUPERSEDES
2004-12
ISSUED
2008-12
Nova Scotia Power Inc.
Halifax, Nova Scotia, Canada
WESTERN OPERATING AREA
SYSTEM OPERATING DIAGRAM
106W
Pubnico Pt. Wind Farm
Y106W 31500001
REV
2


L-5527B
24C-Dickie Brook Hydro
57C-Salmon River Lake
ALTERNATATE
DISTRIBUTION SUPPLY
603C-T41 ON 24C-442
FEEDER
19C-204
CANSO TOWN
19C-202
19C-204
19C-251
19C-T51
7.5
19C-551A
19C-551B
SMD - 1A
30E SLOW
69
3/4//4.48
4.16 +/- 15% in 32 Steps
sta. serv.
1-0.005
ØR
4.16kV BUS B21
4.16kV BUS B22
19C-210
(MOBILE XFMR
CONN)
19C-201A
19C-201C
19C-201B
19C-203
FEEDER
19C-203
CANSO TOWN
NSPI
Sable Wind
19C-552A
19C-CTPT52
19C-552
19C-T52
6.25
69 +/- 2-2.5%
9/12/15
24.94
19C-452
B42 25 kV
19C-421A
19C-421
19C-421B
19C-P421
13.8
19C-PB42
19C-ST42
Station Service
APPROVED
TBF
SUPERSEDES
2015-03
ISSUED
2015-06
POWER
CANSEAU OPERATING AREA
SYSTEM OPERATING DIAGRAM
19C
CANSO TOWN
Y 0 1 9 C 3 1 5 0 0 0 0 0 1
REV
6

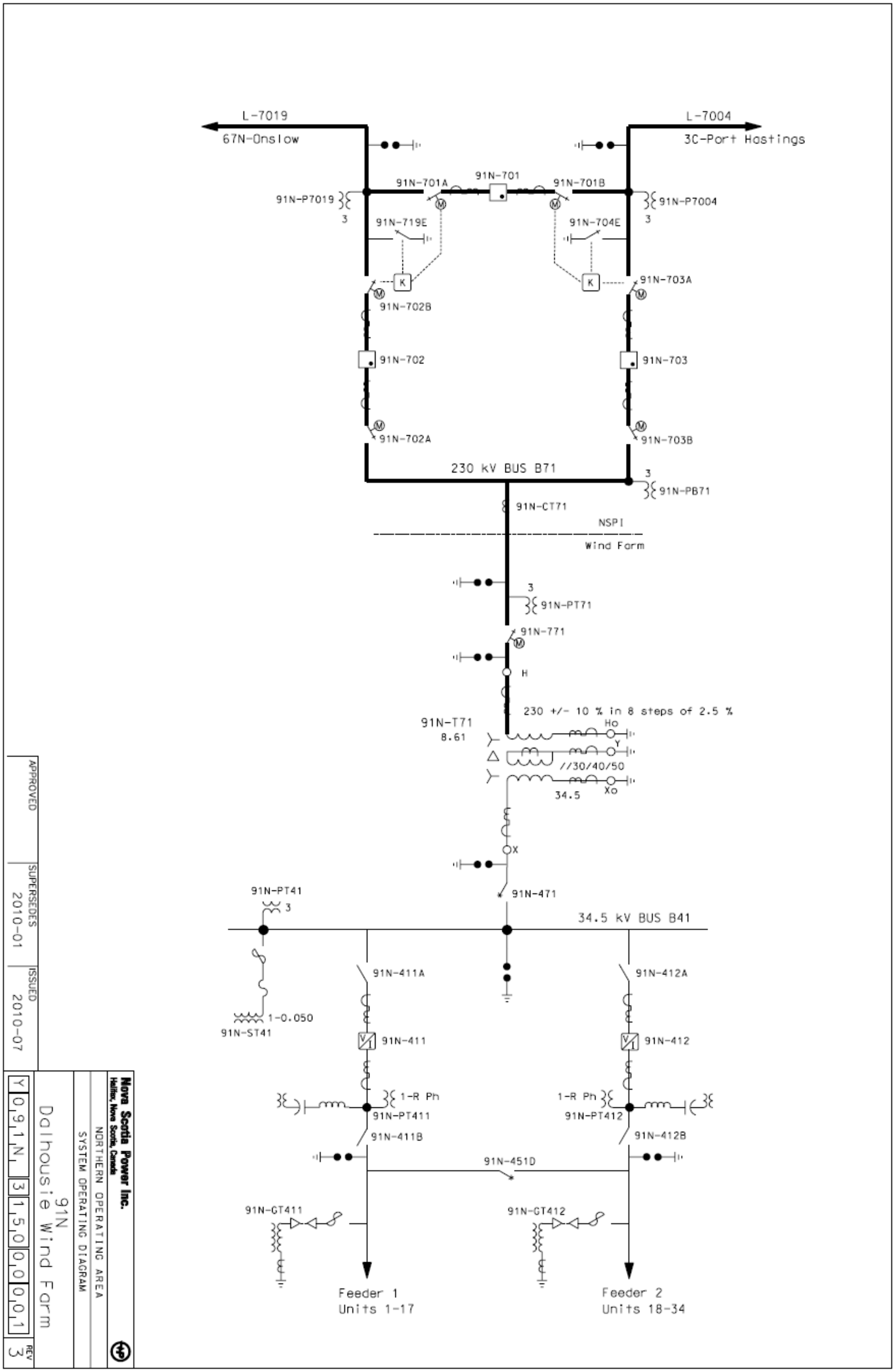


L-6535 (NB 1159)
410N-Memramcook
L-6551
30N-Maccan
92N-CT6535
92N-P6535
92N-601B
92N-601
92N-601A
92N-P6551
92N-635E
92N-651E
92N-603A
92N-602B
92N-603
92N-602
92N-603B
92N-602A
138 kV BUS B61
92N-PB61
92N-CT61
NSPI
Wind Farm
92N-VT61
92N-661
92N-T61
6.4
138 +/- 10%
in 8 steps of 2.5%
//21/28/35
34.5
92N-461
34.5 kV BUS B41
92N-419A
92N-412A
92N-411A
92N-FO-ST41
92N-VT41
92N-419
92N-412
92N-411
92N-ST41
1-0.050
92N-PT412
1-R Ph
92N-PT411
1-R Ph
92N-412B
92N-411B
92N-C1
92N-C1-VT
92N-451D
Feeder 2
Feeder 1
Total 15x2 MW = 30 MW
APPROVED
SUPERSEDES
NEW
ISSUED
2012-03
POWER
NORTHERN OPERATING AREA
SYSTEM OPERATING DIAGRAM
92N
Amherst Wind Farm
Y 0 9 2 N 3 1 5 0 0 0 0 1
REV
0

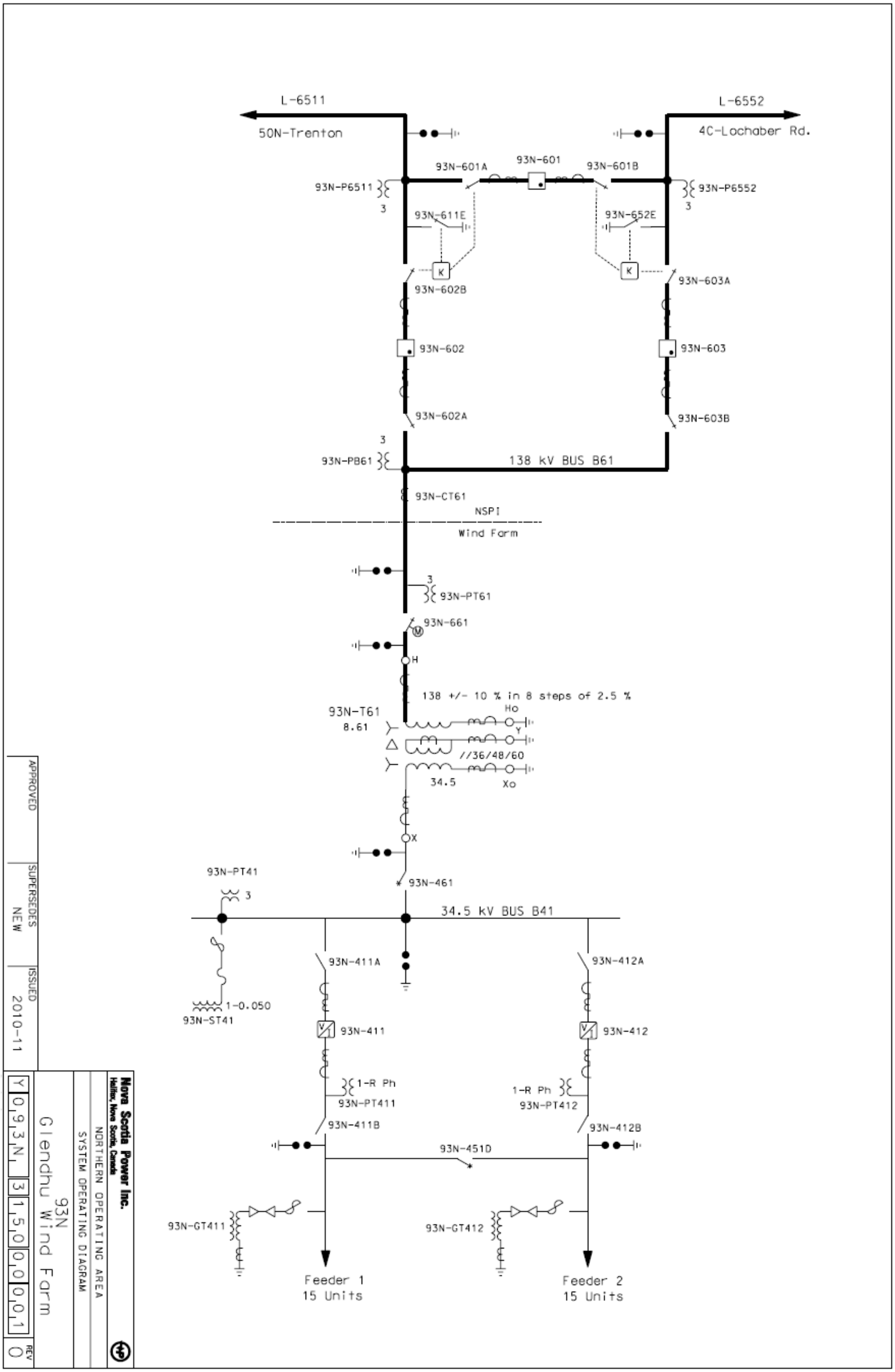

2S
Victoria
Junction
L-5580
L-5573
Mobile Xfrm
Connection
Point
NSPI
109S-Lingan Wind Farm
15S
New
Waterford
109S-551A
3
109S-PT51
109S-551
H
109S-T51
7.5
69
12/16/20 Prov
25
X
109S-CTPT41
25 kV Prot.
Combined Unit
3 - 1Ph Cans
109S-451
Mobile Xfrm
Connection
Point
M
109S-411B
109S-411
109S-411A
3X2 MW
To Turbines
1, 2, & 3
109S-450D
109S-412B
109S-412
109S-412A
25 kV Bus B41
4X2 MW
To Turbines
4,5, 6, & 7
109S-ST41
3-0.025
Nova Scotia Power Inc.
Halifax, Nova Scotia, Canada
SYDNEY OPERATING AREA
SYSTEM OPERATING DIAGRAM
109S
Lingan Wind Farm
APPROVED
SUPERSEDES
2008-01
ISSUED
2011-08
Y 1 0 9 S 3 1 5 0 0 0 0 0 1
REV
3



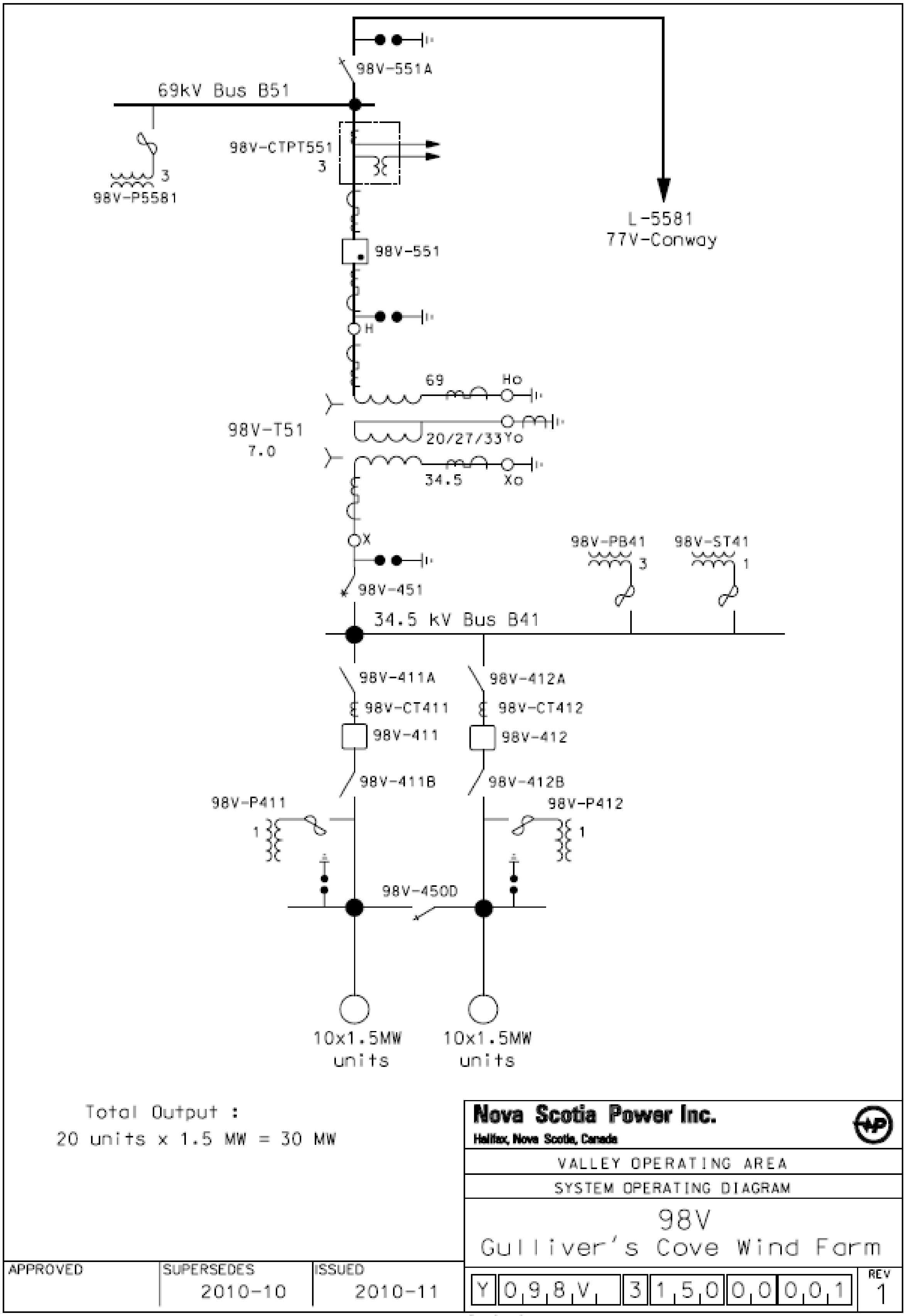
4N-Tatamagouche
69 kV Tap
L-5040
1N-Onslow
89N-551A
89N-CT551
89N-P5040
89N-551
89N-T51
8.25
69
//30/40/50
34.5
3-0.025
89N-ST41
89N-451
34.5 kV Bus B41
89N-411A
89N-412A
89N-411
89N-412
89N-411B
89N-412B
89N-P411
89N-P412
D411-002A
D411-005A
D411-004A
89N-450D
D412-005A
D412-004A
D412-006A
D411-003A
D412-003A
2 units
4 units
1 units
3 units
Total Output :
22 units x 2.4 MW = 52.8 MW
Nova Scotia POWER energy everywhere.
NORTHERN OPERATING AREA
SYSTEM OPERATING DIAGRAM
89N
Nuttby Wind Farm
APPROVED
SUPERSEDES
2011-05
ISSUED
2012-05
Y 0,8,9,N, 3 1,5,0 0,0 0,0,1
REV
5

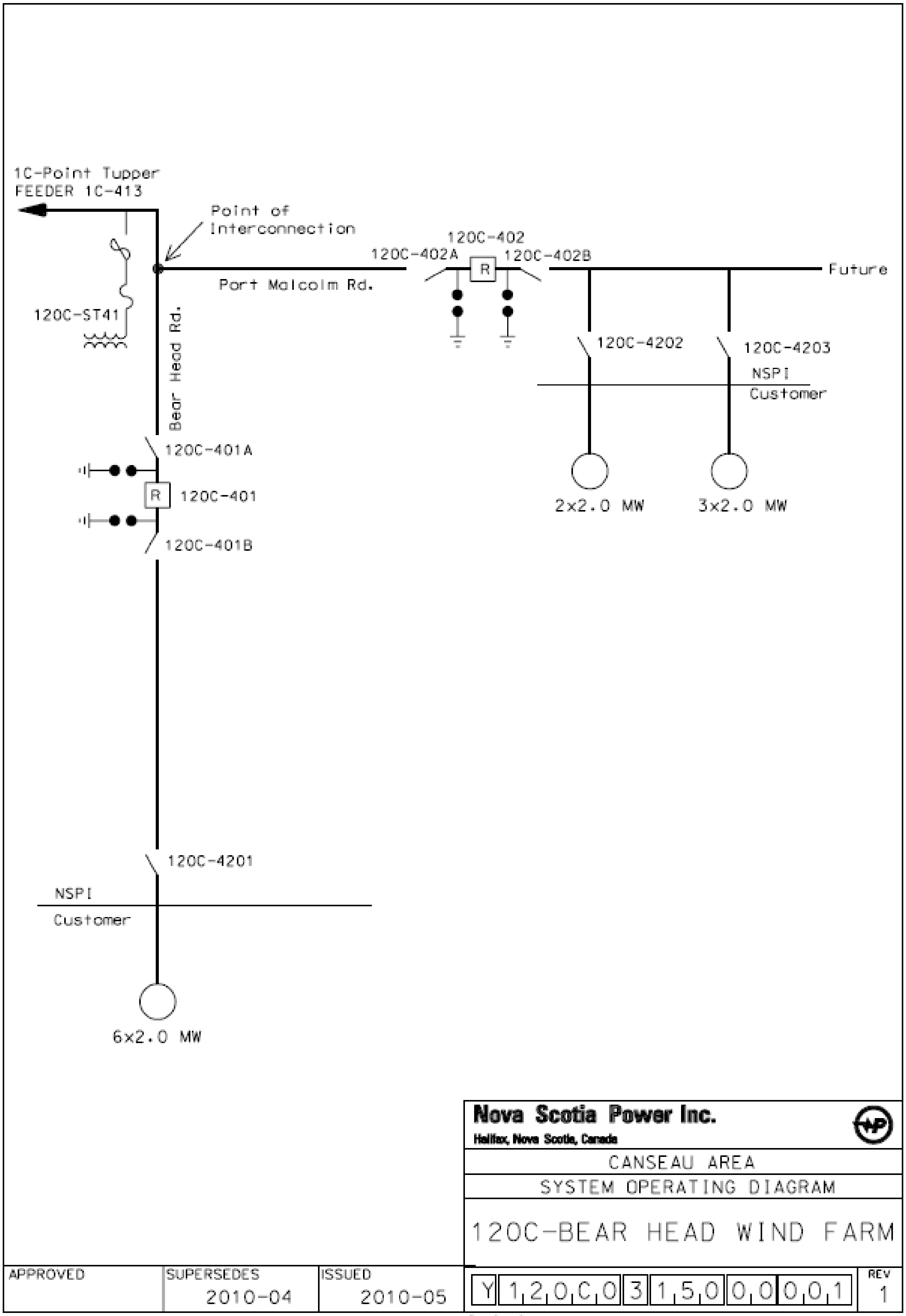


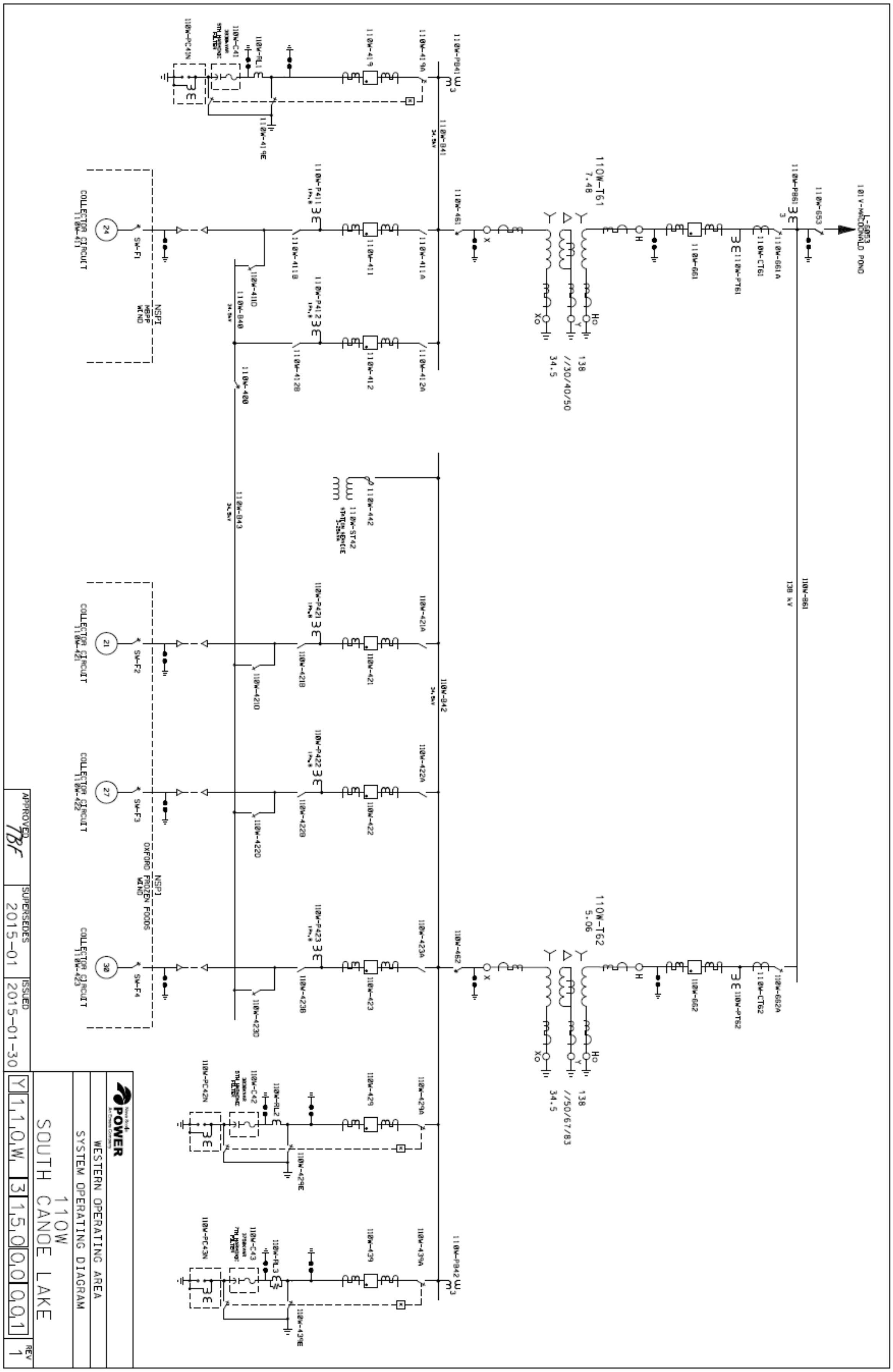
L-7019
67N-Onslow
L-7004
3C-Port Hastings
91N-701
91N-701A
91N-701B
91N-P7019
91N-P7004
91N-719E
91N-704E
91N-703A
91N-702B
91N-702
91N-703
91N-702A
91N-703B
230 kV BUS B71
91N-PB71
91N-CT71
NSPI
Wind Farm
91N-PT71
91N-771
91N-T71
8.61
230 +/- 10 % in 8 steps of 2.5 %
//30/40/50
34.5
91N-471
91N-PT41
34.5 kV BUS B41
91N-411A
91N-412A
1-0.050
91N-ST41
91N-411
91N-412
1-R Ph
91N-PT411
91N-PT412
91N-411B
91N-412B
91N-451D
91N-GT411
91N-GT412
Feeder 1
Units 1-17
Feeder 2
Units 18-34
APPROVED
SUPERSEDES 2010-01
ISSUED 2010-07
Nova Scotia Power Inc.
Halifax, Nova Scotia, Canada
NORTHERN OPERATING AREA
SYSTEM OPERATING DIAGRAM
91N
Dalhousie Wind Farm
Y091N 31500001
REV 3

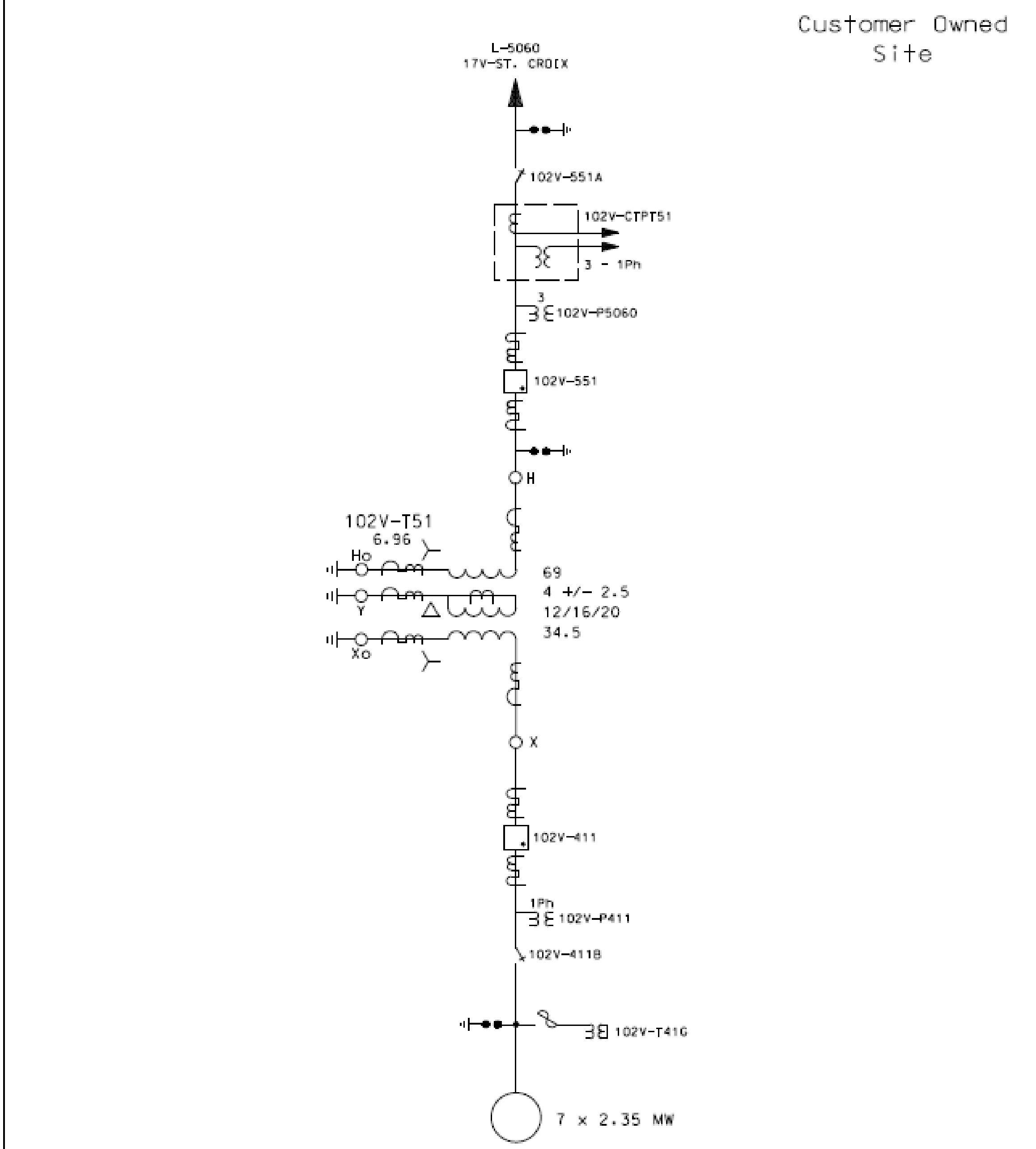


L-6511
50N-Trenton
L-6552
4C-Lochaber Rd.
93N-601A
93N-601
93N-601B
93N-P6511
93N-P6552
93N-611E
93N-652E
93N-602B
93N-603A
93N-602
93N-603
93N-602A
93N-603B
93N-PB61
138 kV BUS B61
93N-CT61
NSPI
Wind Farm
93N-PT61
93N-661
138 +/- 10 % in 8 steps of 2.5 %
93N-T61
8.61
//36/48/60
34.5
93N-PT41
93N-461
34.5 kV BUS B41
93N-411A
93N-412A
1-0.050
93N-ST41
93N-411
93N-412
1-R Ph
93N-PT411
93N-PT412
93N-411B
93N-412B
93N-451D
93N-GT411
93N-GT412
Feeder 1
15 Units
Feeder 2
15 Units
APPROVED
SUPERSEDES NEW
ISSUED 2010-11
Nova Scotia Power Inc.
Halifax, Nova Scotia, Canada
NORTHERN OPERATING AREA
SYSTEM OPERATING DIAGRAM
93N
Glendhu Wind Farm
Y093N 31500001
REV 0


98V-551A
69kV Bus B51
98V-CTPT551
3
98V-P5581
3
L-5581
77V-Conway
98V-551
H
69
Ho
98V-T51
7.0
20/27/33
Yo
34.5
Xo
X
98V-451
98V-PB41
3
98V-ST41
1
34.5 kV Bus B41
98V-411A
98V-CT411
98V-411
98V-411B
98V-412A
98V-CT412
98V-412
98V-412B
98V-P411
1
98V-P412
1
98V-450D
10x1.5MW
units
10x1.5MW
units
Total Output :
20 units x 1.5 MW = 30 MW
Nova Scotia Power Inc.
Halifax, Nova Scotia, Canada
VALLEY OPERATING AREA
SYSTEM OPERATING DIAGRAM
98V
Gulliver's Cove Wind Farm
APPROVED
SUPERSEDES
2010-10
ISSUED
2010-11
Y 0 9 8 V 3 1 5 0 0 0 0 0 1
REV
1


1C-Point Tupper
FEEDER 1C-413
Point of
Interconnection
120C-402
120C-402A
120C-402B
Future
Port Malcolm Rd.
120C-ST41
Bear Head Rd.
120C-4202
120C-4203
NSPI
Customer
120C-401A
120C-401
120C-401B
2x2.0 MW
3x2.0 MW
120C-4201
NSPI
Customer
6x2.0 MW
Nova Scotia Power Inc.
Halifax, Nova Scotia, Canada
CANSEAU AREA
SYSTEM OPERATING DIAGRAM
120C-BEAR HEAD WIND FARM
APPROVED
SUPERSEDES
2010-04
ISSUED
2010-05
Y 1 2 0 C 0 3 1 5 0 0 0 0 0 1
REV
1


WESTERN OPERATING AREA
SYSTEM OPERATING DIAGRAM
110W
SOUTH CANOE LAKE
APPROVED
SUPERSEDES
2015-01
ISSUED
2015-01-30
REV
1
110W-T61
110W-T62
COLLECTOR CIRCUIT
NSPI
OXFORD FROZEN FOODS
WIND



POWER

VALLEY OPERATING AREA

SYSTEM OPERATING DIAGRAM

102V
ELLERSHOUSE WIND

APPROVED	SUPERSEDES	ISSUED		REV
TBF	2015-10	2017-01	Y 1,0,2,V, 3 1,5,0 0,0 0,0,1	1

Appendix B

Short Circuit Levels

Maximum Short Circuit Level					
NO	BUS	KV	Max Amps	X/R	Max MVA
199010	2S-VJ	69	10958.3	7.9	1310
199011	84S-VJ_DIST	69	10353.8	6.6	1237
199012	4S-TOWNSEND	69	8402.6	4.8	1004
199013	6S-TERRACE	69	8148.5	5.1	974
199014	82S-WHITNEY	69	5978.7	4.1	715
199015	15S-WATRFORD	69	3491	3.2	417
199016	109S-LINWIND	69	4411.9	4.1	527
199017	6S-TERR_EXT	69	8156.7	5.3	975
199018	11S-KELTIC_D	69	3991.9	3.9	477
199019	81S-RESERVE	69	5371.8	3.7	642
199020	1S-SEABOARD	69	5234.3	3.3	626
199022	97S-DONKINRD	69	4788.1	2.9	572
199023	57S-ALBERT_B	69	2068.1	1.6	247
199026	3S-GANNON_RD	69	3358.2	5.7	401
199066	67C-WHYCOCO	69	1995.9	5.5	239
199067	9C-ABERDEEN	69	1534.4	3.8	183
199068	58C-SW_MARG	69	1078.6	3	129
199069	103C-CHETCMP	69	711.1	2.7	85
199077	4C-LOCHABER	69	1523.4	9.7	182
199078	57C-SALMON_R	69	1164.1	3.7	139
199079	24C-DICKIEBR	69	1089.5	3.4	130
199080	19C-CANSO	69	874.3	3.6	104
199091	50N-TRENTON	69	9596.3	10.8	1147
199092	62N-BRIDG_AV	69	3843.9	4.4	459
199094	0N-STELLAR	69	5276.7	3	631
199095	89H-TRAFALGR	69	1937.3	3	232
199096	88H-UP_MUSQ	69	1035.2	1.8	124
199097	95H-MALAY_FL	69	1197.7	3.6	143
199098	96H-RUTH_FLS	69	1109.2	3.3	133
199102	54N-ABERCROM	69	6153.9	5.3	735
199104	53N-KIMCLRK	69	5554.2	4.6	664
199106	56N-HALIBURT	69	4484.6	3.5	536
199107	55N-PICTOU	69	3745.6	3	448
199111	1N-ONSLOW_A	69	5311.9	16.6	635
199112	1N-ONSLOW_B	69	5356.2	11.1	640
199114	15N-WILLOWLN	69	4317.9	5.7	516
199115	11N-LAFARGE	69	2542.6	4	304
199116	16N-STEWIAKE	69	1957.3	3.3	234
199118	4N-TATAMAG	69	1466.5	3.1	175
199136	74N-SPRINGHL	69	3450	10	412

Maximum Short Circuit Level					
NO	BUS	KV	Max Amps	X/R	Max MVA
199137	3N-OXFORD	69	2260.6	6.8	270
199138	7N-PUGWASH	69	1300.1	5.7	155
199139	10N-ABER_ST	69	3114.2	7	372
199141	6N-BLK_RIV	69	2755.5	5.4	329
199146	30N-MACCAN	69	3128.9	8.9	374
199147	37N-PARSBORO	69	1411.1	5.1	169
199148	75N-DOMTAR	69	2337.1	4.2	279
199149	20N-PARKST	69	2535.3	5.7	303
199151	17N-BROWNELL	69	2403.7	4.8	287
199166	91H-TUFTCOVE	69	18597	10.9	2223
199170	99H-FARRELL	69	17976.1	10.2	2148
199171	62H-ALBRO	69	13086.5	6.8	1564
199172	40H-WOODLAWN	69	7852.2	5.6	938
199173	58H-IMPERIAL	69	8427.5	4.8	1007
199175	48H-PENHORN	69	9988.9	5.1	1194
199176	54H-MAPLE_ST	69	12452.1	6.1	1488
199177	124H-AKERLEY	69	11600.8	6.4	1386
199178	90H-SACKVILL	69	10108.5	8.5	1208
199179	23H-ROCKHAM	69	4686.6	4.8	560
199180	20H-SPRYFLD	69	2182	12.7	261
199196	34H-GEIZERS	69	2468.4	27.8	295
199205	103H-LAKSIDE	69	2806.1	66.9	335
199211	87W-HUBBARDS	69	2166.8	7.7	259
199212	86W-EASTRIV	69	1893.3	5.5	226
199213	86W-MIDRIVSW	69	1563.3	4.2	187
199215	85W-CANEXEL	69	1753.6	5	210
199216	84W-ROB-SONS	69	1432.5	3.3	171
199218	75W-WESTHAVE	69	3055.8	10.8	365
199219	77W-MAHONE_T	69	2601.6	4.5	311
199220	78W-MARTINS	69	2215.6	3	265
199221	79W-LUN_SWST	69	2094.4	2.7	250
199222	81W-LUNENBUR	69	2021.8	2.5	242
199223	82W-NATIONNS	69	1833.2	2.3	219
199224	80W-INDIANNS	69	1606.7	2.4	192
199225	76W-MAHONE_B	69	2487.4	4	297
199231	99W-BRIDGEWT	69	4955.1	20.5	592
199232	89W-E_B-WATR	69	3711.5	7.5	444
199233	73W-AUBURNDA	69	4622.2	14	552
199234	73W-WILEVILL	69	4164.6	9.7	498
199235	70W-HIGHSTBW	69	3813.8	7.9	456

Maximum Short Circuit Level					
NO	BUS	KV	Max Amps	X/R	Max MVA
199246	50W-MILTON	69	4987.8	9.7	596
199249	4W-L_GR_BRK	69	4162.2	5.1	497
199252	3W-BIG_FALL	69	3521.5	4	421
199259	91W-MIDDLEFI	69	2421.3	2.1	289
199260	57W-CALEDONI	69	1859	1.7	222
199263	48W-WATERLOO	69	3302.1	5.1	395
199264	46W-BROADRVR	69	2901.9	2.9	347
199265	36W-GREENHBR	69	2108.2	3	252
199266	37W-LOCKPORT	69	1809.6	2.8	216
199271	30W-SOURIQUO	69	2335.6	5	279
199272	25W-SHELBURN	69	2123.5	4.4	254
199274	23W-CLYDE_RI	69	1317.6	2.9	157
199275	106W-PUBWND	69	1937	5.2	231
199276	22W-BARRINGT	69	1276.2	3.6	153
199281	9W-TUSKET	69	4461.2	6.6	533
199282	19W-ARGYLE	69	2726.1	4.8	326
199283	20W-PUBNICO	69	1961.5	5.2	234
199284	21W-WOODSHBR	69	1546.6	4.5	185
199286	10W-TUSKETGT	69	4011.7	5.4	479
199288	16W-HEBRON	69	2914.9	3.2	348
199290	11W-KING_ST	69	2292.3	2.2	274
199291	88W-PLEASANT	69	2387.1	2.3	285
199292	92W-CARLETON	69	2761.2	2.2	330
199294	88W-PLSNT_B5	69	2251.5	2.8	269
199301	17V-ST_CROIX	69	8038.6	10.3	961
199303	1V-AVON	69	2821.4	2.2	337
199307	18V-BURLINGT	69	3271.1	1.5	391
199308	17V-L5016TAP	69	6131.9	5.1	733
199309	79V-3MIPLAIN	69	5359.2	3.5	640
199310	79V-L5015TAP	69	5402	3.5	646
199311	20V-FIVE_PT	69	4735.7	3.6	566
199321	83V-WOLFVILL	69	4548.2	3.6	544
199322	43V-CANAANRD	69	6907.9	5.8	826
199323	50V-KLONDIKE	69	2882	2.3	344
199324	22V-NEWMINAS	69	4802.6	3.6	574
199325	36V-HILLATON	69	3080.2	2.8	368
199326	3V-HELS_GATE	69	4182	8.1	500
199332	6V-HOLLOW_A	69	4352.4	3.3	520
199335	92V-MICH_WAT	69	3837.1	3.8	459
199336	55V-WATERTAP	69	3743.6	3.6	447

Maximum Short Circuit Level					
NO	BUS	KV	Max Amps	X/R	Max MVA
199337	55V-WATERVLL	69	3535.5	3.4	423
199338	53V-BERWKTAP	69	3648.2	3.3	436
199339	52V-BERWICK	69	3326.5	3.1	398
199341	5V-LUMDEN-A	69	5541.2	4.3	662
199342	7V-METHAL-A	69	2846.8	2.6	340
199346	51V-TREMONT	69	5261.4	5.4	629
199347	64V-GREENWD	69	4526.6	4.1	541
199348	63V-KINGSTON	69	3975.7	3.8	475
199351	12V-LEQUILLE	69	2824.6	3.9	338
199352	81V-ANNAPTAP	69	2841.7	4	340
199354	70V-BRIDGTAP	69	2870.3	4.4	343
199355	70V-BRIDGTWN	69	2600.4	4.1	311
199356	11V-PARADISE	69	2975.8	4.5	356
199358	65V-MIDDLTAP	69	3864.6	4.7	462
199359	65V-MIDDLETN	69	3315.5	4.2	396
199360	10V-NICTAUX	69	3916.1	4.8	468
199362	74V-CORNWTAP	69	2612.8	3.3	312
199363	74V-CORNWLLS	69	2366	2.6	283
199364	13V-GULCH	69	2615.6	2.9	313
199366	77V-CONWAY	69	1697.3	1.9	203
199367	14V-RIDGE_HY	69	2257	2.3	270
199369	76V-MAITLAND	69	1760.9	1.8	210
199370	15V-SISSIBOO	69	2028.9	2	242
199374	16V-WEYMOUTH	69	425.2	39	51
199376	93V-SAULNIER	69	67.5	0.1	8
199581	89N_NUTBHV	69	2276.4	3.8	272
199635	102V-ELLERSH	69	6734.8	7.4	805
199710	98V-GULLCOVE	69	1281	2.1	153
199855	DC_POLE1	120	6583.4	21	1368
199857	DC_POLE2	120	6583.4	21	1368
199005	88S-LINGAN_A	138	8313.2	11.9	1987
199006	88S-LINGAN_B	138	8346.5	12.8	1995
199007	2S-VICTORIA	138	8963.9	8.5	2143
199025	3S-GANNON_RD	138	4919.6	5.3	1176
199031	5S-GLEN_TOSH	138	5517.4	6.8	1319
199033	104S-BADDECK	138	4701.9	6	1124
199035	85S-WRK_COVE	138	5674.9	12.4	1356
199051	2C-HASTINGS	138	11647.1	9.7	2784
199052	1C-TUPPER	138	9555.5	9.3	2284
199053	47C-NEW_PAGE	138	9452.2	9.1	2259

Maximum Short Circuit Level					
NO	BUS	KV	Max Amps	X/R	Max MVA
199056	59C-STPETERS	138	4407.2	5.4	1053
199057	67C-WHYC_TAP	138	4319.7	5.3	1033
199058	67C-WHYCOCO	138	3256	4.8	778
199063	22C-CLEVLAND	138	6951.4	6.4	1662
199075	100C-PORCUPN	138	9867.7	8.1	2359
199076	4C-LOCHABER	138	4885	4.7	1168
199090	50N-TRENTON	138	11913.7	10.1	2848
199100	49N-MICHGRAN	138	9161.8	9.5	2190
199110	1N-ONSLOW	138	9610.2	7.6	2297
199121	79N-HOPWELL	138	10560.3	11.4	2524
199134	81N-DEBERT	138	6496.3	5.7	1553
199135	74N-SPRNGHIL	138	5080.8	4.2	1214
199145	30N-MACCAN	138	4575.9	4.2	1094
199152	22N-CHURCHST	138	4323.7	4.2	1033
199154	82V-ELMSDALE	138	5314.1	5.3	1270
199156	127H-AEROTAP	138	6298.9	5.6	1506
199158	139H-DARTCRO	138	11157.5	7.1	2667
199159	132H-SPIDRLK	138	9056.3	6.7	2165
199161	113H-EASTDRT	138	9570.9	6.8	2288
199162	126H-PORTERS	138	5170.3	5.6	1236
199163	87H-MUSQ.HBR	138	3594.1	5.2	859
199165	91H-TUFTCOVE	138	15416.1	8.9	3685
199184	90H-SACKVILL	138	15033.6	7.4	3593
199185	101H-COBEQUI	138	13233.3	6.9	3163
199187	108H-BURNSID	138	13911.9	7.6	3325
199190	103H-LAKSIDE	138	12268.5	7.6	2932
199192	129H-KEARNEY	138	8762.2	7.3	2094
199193	1H-WATER_ST	138	10018.6	6.6	2395
199198	104H-KEMPT_R	138	12019.1	7.8	2873
199201	120H-BRUSHY	138	14360.9	8.1	3433
199204	92H-TIDEWTR	138	4945.8	4.6	1182
199208	137H-HAMMNDS	138	9815.3	8.3	2346
199210	87W-HUBBARDS	138	3718.6	4.3	889
199214	103W-GOLD_RV	138	2509.1	4.2	600
199217	75W-WESTHAVE	138	4346.5	6.9	1039
199228	74W-MICHBWTP	138	5873.7	9.7	1404
199229	74W-MICH_B-W	138	5564.7	9	1330
199230	99W-BRIDGEWT	138	5882.3	9.8	1406
199245	50W-MILTON	138	4863.3	9.1	1162
199270	30W-SOURIQUO	138	2365.4	4.4	565

Maximum Short Circuit Level					
NO	BUS	KV	Max Amps	X/R	Max MVA
199277	101W-BMPC	138	4398.7	9	1051
199280	9W-TUSKET_A	138	1908.2	8.4	456
199287	9W-TUSKET_B	138	1869.5	5.3	447
199298	104W-BROOKLY	138	4421.8	9	1057
199300	17V-ST_CROIX	138	7957.2	6.8	1902
199333	99V-HIGHBURY	138	4871.7	5	1164
199340	43V-CANAANRD	138	5342.3	5.2	1277
199345	51V-TRMT_B61	138	3561.3	4.8	851
199501	110W-S_CANOE	138	3720.8	5.7	889
199530	92N-AMHSTWIN	138	4708	4.2	1125
199610	93N-GLENDHU	138	5111.4	5	1222
199000	88S-LINGAN	230	9194.7	13.6	3663
199042	101S-WOODBIN	230	9442.3	13.1	3762
199044	89S-PT_ACONI	230	4634.8	13.3	1846
199050	3C-HASTINGS	230	8033.9	8.9	3200
199130	67N-ONSLOW	230	10520.8	8.6	4191
199200	120H-BRUSHY	230	8652.5	8.3	3447
199240	99W-BWATER_A	230	3316.8	9.4	1321
199241	99W-BWATER_B	230	3859.8	10.4	1538
199590	91N-DALHOUS	230	5787.9	6.9	2306
199045	101S-WOODBIN	345	5424.5	15.4	3241
199120	79N-HOPWELL	345	5890.3	10.7	3520
199125	67N-ONSLOW	345	7276.4	8.9	4348
199195	103H-LAKSIDE	345	4309.1	9.7	2575

Appendix C

Distributed Generation – Bus Load Adjustments

PSSe Load Data	% Distributed Generation (x)	70%

PSS/e Load Data 2021LL Case				Distribution Generation (MW)						Net MW at x%	Est Mvar
Bus #	Bus Name	MW	Mvar	Wind	Biogas	Biomass	Hydro	Tidal	Total		
199001	88S-LINGAN_114.400	8.1	4.1						0.0	8.1	4.10
199002	88S-LINGAN_214.400	7.8	4						0.0	7.8	4.00
199003	88S-LINGAN_314.400	8.2	4.2						0.0	8.2	4.20
199004	88S-LINGAN_414.400	8	4.1						0.00	8.0	4.10
199011	84S-VJ_DIST 69.000	2.71	1.47	2.3					2.30	1.1	0.71
199012	4S-TOWNSEND 69.000	10.65	5.78						0.00	10.7	5.78
199013	6S-TERRACE 69.000	1.76	0.73						0.00	1.8	0.73
199014	82S-WHITNEY 69.000	2.15	0.26	2.35					2.35	0.5	0.22
199015	15S-WATRFORD69.000	1.5	0.57	2.35					2.35	0.0	0.18
199018	11S-KELTIC_D69.000	11.3	4.71	4					4.00	8.5	3.35
199019	81S-RESERVE 69.000	9.73	3.09	4.8					4.80	6.4	1.95
199023	57S-ALBERT_B69.000	2.63	0.84	2.3					2.30	1.0	0.58
199026	3S-GANNON_RD69.000	9.74	1.65	6.35					6.35	5.3	1.08
199033	104S-BADDECK138.00	1.77	0.47	1.7					1.70	0.6	0.37
199035	85S-WRK_COVE138.00	1.81	0.47						0.00	1.8	0.47
199043	102S-ACONI 20.000	14.2	7.3						0.00	14.2	7.30
199051	2C-HASTINGS 138.00	1.51	0.22	2					2.00	0.1	0.18
199052	1C-TUPPER 138.00	0.43	0.09						0.00	0.4	0.09
199054	47C-NEW_PAGE13.800	33.6	21						0.00	33.6	21.00
199055	1C-TUPPER_GN14.400	6	2						0.00	6.0	2.00
199056	59C-STPETERS138.00	1.02	0.21						0.00	1.0	0.21
199058	67C-WHYCOCO 138.00	2.45	0.07	1.7					1.70	1.3	0.07
199060	47C-NP_PMP2 13.800	32.3	19						0.00	32.3	19.00
199063	22C-CLEVLAND138.00	4.51	0.91	1.99					1.99	3.1	0.83
199065	47C-NP_RL3 13.800	10.6	7.5						0.00	10.6	7.50
199067	9C-ABERDEEN 69.000	0.23	0.01						0.00	0.2	0.01
199068	58C-SW_MARG 69.000	2.77	0.08	2					2.00	1.4	0.08
199069	103C-CHETCMP69.000	1.16	0.03	1.6					1.60	0.0	0.03
199075	100C-PORCUPN138.00	4.16	1.53		0.23				0.23	4.0	1.53
199076	4C-LOCHABER 138.00	5.51	2.3	10.6	0.5				11.10	0.0	0.00
199077	4C-LOCHABER 69.000	0	0						0.00	0.0	0.00
199078	57C-SALMON_R69.000	1.51	0.47						0.00	1.5	0.47
199080	19C-CANSO 69.000	0.39	0.19						0.00	0.4	0.19
199082	24C-DICKIEBR25.000	1.34	0.24						0.00	1.3	0.24
199085	50N-TRENTON518.000	7.8	4.1						0.00	7.8	4.10
199086	50N-TRENTON613.800	7.2	3.7						0.00	7.2	3.70
199091	50N-TRENTON 69.000	7.21	1.21	7.8					7.80	1.8	0.37
199091	50N-TRENTON 69.000	2.2	2.71						0.00	2.2	2.71
199092	62N-BRIDG_AV69.000	7.6	3.3	13.2					13.20	0.0	0.00
199096	88H-UP_MUSQ 69.000	1.71	0.74			1.1			1.10	0.9	0.74
199096	88H-UP_MUSQ 69.000	1.46	1.5						0.00	1.5	1.50
199098	96H-RUTH_FLS69.000	1.19	0.52	1.5					1.50	0.1	0.31
199100	49N-MICHGRAN138.00	11.37	3.08						0.00	11.4	3.08
199105	53N-NRT PULP13.800	25	3						0.00	25.0	3.00
199106	56N-HALIBURT69.000	3.07	1.33	3					3.00	1.0	0.50
199106	56N-HALIBURT69.000	0	0						0.00	0.0	0.00
199107	55N-PICTOU 69.000	1.33	0.58						0.00	1.3	0.58
199110	1N-ONSLOW 138.00	7.06	1.33	5		1			6.00	2.9	0.90
199111	1N-ONSLOW_A 69.000	3.65	1.78						0.00	3.7	1.78
199112	1N-ONSLOW_B 69.000	2.31	0.13						0.00	2.3	0.13

PSSe Load Data	% Distributed Generation (x)	70%

PSS/e Load Data 2021LL Case				Distribution Generation (MW)						Net MW at x%	Est Mvar
Bus #	Bus Name	MW	Mvar	Wind	Biogas	Biomass	Hydro	Tidal	Total		
199114	15N-WILLOWLN69.000	11.2	4.29	13.8					13.80	1.5	0.00
199114	15N-WILLOWLN69.000	3.19	0						0.00	3.2	0.00
199114	15N-WILLOWLN69.000	0.27	0.15						0.00	0.3	0.15
199115	11N-LAFARGE 69.000	3.59	1.2						0.00	3.6	1.20
199116	16N-STEWIAKE69.000	0.95	0.28		0.5				0.50	0.6	0.28
199118	4N-TATAMAG 69.000	2.28	0.57	1.6					1.60	1.2	0.49
199134	81N-DEBERT 138.00	4.15	2.08	3.6					3.60	1.6	0.48
199136	74N-SPRINGHL69.000	5.46	0.7						0.00	5.5	0.70
199137	3N-OXFORD 69.000	2.47	1.26						0.00	2.5	1.26
199137	3N-OXFORD 69.000	0.47	0.19						0.00	0.5	0.19
199138	7N-PUGWASH 69.000	1.42	0.47						0.00	1.4	0.47
199138	7N-PUGWASH 69.000	1.1	0.05						0.00	1.1	0.05
199141	6N-BLK_RIV 69.000	2.15	0.87	1.2					1.20	1.3	0.75
199141	6N-BLK_RIV 69.000	1.76	0.96						0.00	1.8	0.96
199146	30N-MACCAN 69.000	0.76	0.28						0.00	0.8	0.28
199147	37N-PARSBORO69.000	1.93	0.57						0.00	1.9	0.57
199147	37N-PARSBORO69.000	0.14	0.14						0.00	0.1	0.14
199148	75N-DOMTAR 69.000	3	0.74						0.00	3.0	0.74
199149	20N-PARKST 69.000	0.61	0.13						0.00	0.6	0.13
199151	17N-BROWNELL69.000	0.76	0.16						0.00	0.8	0.16
199152	22N-CHURCHST138.00	9.63	2.84	6					6.00	5.4	1.31
199153	139H_25KV 25.000	9.7	4.3	2					2.00	8.3	3.91
199155	82V-ELMSDALE26.400	11.27	3.18	10	1.1				11.10	3.5	0.00
199155	82V-ELMSDALE26.400	0.44	0.25						0.00	0.4	0.25
199155	82V-ELMSDALE26.400	0.3	0						0.00	0.3	0.00
199155	82V-ELMSDALE26.400	0.23	0.08						0.00	0.2	0.08
199156	127H-AEROTAP138.00	6.79	1.89				0.5		0.50	6.4	1.89
199156	127H-AEROTAP138.00	1.71	0.25						0.00	1.7	0.25
199157	133H-HBR EST138.00	4.74	1.7						0.00	4.7	1.70
199160	113H-EASTDRT25.000	17.53	5.02						0.00	17.5	5.02
199162	126H-PORTERS138.00	3.7	0.29	3.2					3.20	1.5	0.26
199163	87H-MUSQ.HBR138.00	2.36	0.18	2.3					2.30	0.8	0.16
199167	91H-TUFTCV1 13.800	4.1	1.3						0.00	4.1	1.30
199168	91H-TUFTCV2 13.800	3.7	1.2						0.00	3.7	1.20
199169	91H-TUFTCV3 14.400	8	4						0.00	8.0	4.00
199170	99H-FARRELL 69.000	4.28	1.36						0.00	4.3	1.36
199171	62H-ALBRO 69.000	3.17	0.89						0.00	3.2	0.89
199172	40H-WOODLAWN69.000	4.18	0.09						0.00	4.2	0.09
199173	58H-IMPERIAL69.000	6.16	1.23						0.00	6.2	1.23
199174	58H-IMPERIAL26.400	8.97	2.84						0.00	9.0	2.84
199175	48H-PENHORN 69.000	7.58	2.84						0.00	7.6	2.84
199176	54H-MAPLE_ST69.000	5.01	3.27						0.00	5.0	3.27
199177	124H-AKERLEY69.000	2.27	0.94						0.00	2.3	0.94
199179	23H-ROCKHAM 69.000	7.08	2.37						0.00	7.1	2.37
199180	20H-SPRYFLD 69.000	10.44	3.79	4.6					4.60	7.2	2.42
199186	101H-COBEQUI26.400	17.3	6.39						0.00	17.3	6.39
199187	108H-BURNSID138.00	6.68	3.44						0.00	6.7	3.44
199191	103H-LAKSIDE26.400	14.05	4.74	7.05					7.05	9.1	1.97
199192	129H-KEARNEY138.00	9.62	3.33						0.00	9.6	3.33
199194	1H-WATER_ST 26.400	27.35	9.06						0.00	27.4	9.06

PSSe Load Data	% Distributed Generation (x)	70%

PSS/e Load Data 2021LL Case				Distribution Generation (MW)						Net MW at x%	Est Mvar
Bus #	Bus Name	MW	Mvar	Wind	Biogas	Biomass	Hydro	Tidal	Total		
199194	1H-WATER_ST 26.400	2.55	1.04						0.00	2.6	1.04
199194	1H-WATER_ST 26.400	0.25	0.04						0.00	0.3	0.04
199197	2H-ARMDALE 138.00	14.53	4.74						0.00	14.5	4.74
199199	104H-KEMPT_R26.400	38.95	13.23						0.00	39.0	13.23
199199	104H-KEMPT_R26.400	0.81	0.3						0.00	0.8	0.30
199199	104H-KEMPT_R26.400	0.36	0.07						0.00	0.4	0.07
199203	131H-LUCASVL138.00	11.18	3.88	8	2.1	3.1			13.20	1.9	0.10
199206	92H-TIDEWTR 13.200	3.13	1.42						0.00	3.1	1.42
199209	137H-HAMONDS26.470	7.51	2.24	10					10.00	0.5	0.00
199210	87W-HUBBARDS138.00	1.56	0.31						0.00	1.6	0.31
199214	103W-GOLD_RV138.00	2.97	0.59						0.00	3.0	0.59
199215	85W-CANEXEL 69.000	1.15	0.28						0.00	1.2	0.28
199216	84W-ROB-SONS69.000	1.81	0.36	2					2.00	0.4	0.28
199220	78W-MARTINS 69.000	0.68	0.28						0.00	0.7	0.28
199222	81W-LUNENBUR69.000	1.49	0.47						0.00	1.5	0.47
199223	82W-NATIONNS69.000	0.96	0.2						0.00	1.0	0.20
199224	80W-INDIANNS69.000	1.87	0.57						0.00	1.9	0.57
199225	76W-MAHONE_B69.000	0.57	0.19						0.00	0.6	0.19
199229	74W-MICH_B-W138.00	12.78	6.35						0.00	12.8	6.35
199229	74W-MICH_B-W138.00	1.89	0.85						0.00	1.9	0.85
199232	89W-E_B-WATR69.000	3.65	1.06	4					4.00	0.9	0.40
199233	73W-AUBURNDA69.000	2.59	0.95				0.85		0.85	2.0	0.95
199235	70W-HIGHSTBW69.000	6.3	1.89	3.2					3.20	4.1	1.44
199246	50W-MILTON 69.000	3.52	1.03	3.6					3.60	1.0	0.49
199259	91W-MIDDLEFI69.000	0.78	0.39						0.00	0.8	0.39
199260	57W-CALEDONI69.000	0.68	0.34						0.00	0.7	0.34
199263	48W-WATERLOO69.000	1.99	1.37						0.00	2.0	1.37
199264	46W-BROADRVR69.000	0.87	0.28						0.00	0.9	0.28
199265	36W-GREENHBR69.000	0.65	0.19						0.00	0.7	0.19
199266	37W-LOCKPORT69.000	0.41	0.09						0.00	0.4	0.09
199272	25W-SHELBURN69.000	5.88	1.89						0.00	5.9	1.89
199274	23W-CLYDE_RI69.000	3.17	0.61						0.00	3.2	0.61
199276	22W-BARRINGT69.000	2.91	0.82	3.2					3.20	0.7	0.42
199277	101W-BMPC 138.00	0.85	0.28						0.00	0.9	0.28
199282	19W-ARGYLE 69.000	1.09	0.31						0.00	1.1	0.31
199283	20W-PUBNICO 69.000	0.68	0.19						0.00	0.7	0.19
199284	21W-WOODSHBR69.000	0.64	0.18						0.00	0.6	0.18
199286	10W-TUSKETGT69.000	2.48	0.25						0.00	2.5	0.25
199288	16W-HEBRON 69.000	2.24	0.47	2					2.00	0.8	0.38
199290	11W-KING_ST 69.000	1.31	0.25						0.00	1.3	0.25
199291	88W-PLEASANT69.000	4.08	0.78	4					4.00	1.3	0.49
199292	92W-CARLETON69.000	0.33	0.09						0.00	0.3	0.09
199294	88W-PLSNT_B569.000	3.26	1.14						0.00	3.3	1.14
199303	1V-AVON 69.000	1	0.04						0.00	1.0	0.04
199307	18V-BURLINGT69.000	1.93	0.47	2					2.00	0.5	0.35
199309	79V-3MIPLAIN69.000	6.7	2.13	6					6.00	2.5	0.35
199311	20V-FIVE_PT 69.000	0.93	0.37						0.00	0.9	0.37
199313	41V-MBPP 23.000	3.22	3.25						0.00	3.2	3.25
199321	83V-WOLFVILL69.000	3.21	1.14						0.00	3.2	1.14
199323	50V-KLONDIKE69.000	6.99	1.89			6			6.00	2.8	1.89

PSSe Load Data	% Distributed Generation (x)	70%

PSS/e Load Data 2021LL Case				Distribution Generation (MW)						Net MW at x%	Est Mvar
Bus #	Bus Name	MW	Mvar	Wind	Biogas	Biomass	Hydro	Tidal	Total		
199324	22V-NEWMINAS69.000	8	1.85						0.00	8.0	1.85
199325	36V-HILLATON69.000	3	0.69						0.00	3.0	0.69
199325	36V-HILLATON69.000	0.27	0.21						0.00	0.3	0.21
199329	45V-ACADIA 23.000	0.45	0.05						0.00	0.5	0.05
199333	99V-HIGHBURY138.00	3.79	1.23						0.00	3.8	1.23
199335	92V-MICH_WAT69.000	8.22	2.14						0.00	8.2	2.14
199337	55V-WATERVLL69.000	4.78	1.61						0.00	4.8	1.61
199339	52V-BERWICK 69.000	1.54	0.47						0.00	1.5	0.47
199346	51V-TREMONT 69.000	1.42	0.68						0.00	1.4	0.68
199347	64V-GREENWD 69.000	2.39	0.38						0.00	2.4	0.38
199348	63V-KINGSTON69.000	4.24	0.67						0.00	4.2	0.67
199351	12V-LEQUILLE69.000	2.21	0.6	2					2.00	0.8	0.46
199355	70V-BRIDGTWN69.000	2.38	0.65						0.00	2.4	0.65
199359	65V-MIDDLETN69.000	2.62	0.95						0.00	2.6	0.95
199363	74V-CORNWLLS69.000	0.64	0.18						0.00	0.6	0.18
199365	13V-GULCH 13.800	1.15	0.16						0.00	1.2	0.16
199366	77V-CONWAY 69.000	4.52	0.38	1.7				2	3.70	1.9	0.37
199369	76V-MAITLAND69.000	0.15	0.08						0.00	0.2	0.08
199374	16V-WEYMOUTH69.000	0.97	0.98			0.3			0.30	0.8	0.98
199376	93V-SAULNIER69.000	3.82	1.23	0.6					0.60	3.4	1.21
199376	93V-SAULNIER69.000	0.85	0.19						0.00	0.9	0.19
199690	1C-TUPPER 25.000	2.95	1.72	0.8					0.80	2.4	1.61
199690	1C-TUPPER 25.000	0.6	0.2						0.00	0.6	0.20
199690	1C-TUPPER 25.000	0.06	0.07						0.00	0.1	0.07
	Totals	810.06	295.67	184.99	4.43	11.5	1.35	2	204.27	671.12	256.94

PSSe Load Data	% Distributed Generation (x)	70%

PSS/e Load Data 2021SUM Case				Distribution Generation (MW)						Net MW at x%	Est Mvar
Bus #	Bus Name	MW	Mvar	Wind	Biogas	Biomass	Hydro	Tidal	Total		
199001	88S-LINGAN_114.400	8.10	4.10						0.0	8.1	4.10
199002	88S-LINGAN_214.400	7.80	4.00						0.0	7.8	4.00
199003	88S-LINGAN_314.400	8.20	4.20						0.0	8.2	4.20
199004	88S-LINGAN_414.400	8.00	4.10						0.00	8.0	4.10
199011	84S-VJ_DIST 69.000	6.61	2.97	2.3					2.30	5.0	2.45
199012	4S-TOWNSEND 69.000	26.03	11.69						0.00	26.0	11.69
199013	6S-TERRACE 69.000	3.77	1.73						0.00	3.8	1.73
199014	82S-WHITNEY 69.000	4.64	0.93	2.35					2.35	3.0	0.82
199015	15S-WATRFORD69.000	6.81	1.46	2.35					2.35	5.2	1.34
199018	11S-KELTIC_D69.000	24.21	11.08	4					4.00	21.4	9.44
199019	81S-RESERVE 69.000	5.18	7.43	4.8					4.80	1.8	0.00
199023	57S-ALBERT_B69.000	1.40	2.01	2.3					2.30	0.0	0.00
199026	3S-GANNON_RD69.000	18.35	5.02	6.35					6.35	13.9	3.54
199033	104S-BADDECK138.00	3.87	1.05	1.7					1.70	2.7	0.95
199035	85S-WRK_COVE138.00	2.23	1.32						0.00	2.2	1.32
199043	102S-ACONI 20.000	14.20	7.30						0.00	14.2	7.30
199051	2C-HASTINGS 138.00	3.19	0.76	2					2.00	1.8	0.65
199052	1C-TUPPER 138.00	0.97	0.00						0.00	1.0	0.00
199054	47C-NEW_PAGE13.800	33.60	21.00						0.00	33.6	21.00
199055	1C-TUPPER_GN14.400	6.00	2.00						0.00	6.0	2.00
199056	59C-STPETERS138.00	2.09	0.60						0.00	2.1	0.60
199058	67C-WHYCOCO 138.00	5.34	1.45	1.7					1.70	4.2	1.35
199060	47C-NP_PMP2 13.800	32.30	19.00						0.00	32.3	19.00
199063	22C-CLEVLAND138.00	9.25	2.65	1.99					1.99	7.9	2.49
199065	47C-NP_RL3 13.800	10.60	7.50						0.00	10.6	7.50
199067	9C-ABERDEEN 69.000	0.50	0.14						0.00	0.5	0.14
199068	58C-SW_MARG 69.000	6.05	1.64	2					2.00	4.7	1.50
199069	103C-CHETCMP69.000	2.52	0.69	1.6					1.60	1.4	0.60
199075	100C-PORCUPN138.00	6.46	4.79		0.23				0.23	6.3	4.79
199076	4C-LOCHABER 138.00	23.97	7.26	10.6	0.5				11.10	16.2	2.21
199077	4C-LOCHABER 69.000	0.00	0.00						0.00	0.0	0.00
199078	57C-SALMON_R69.000	3.17	-0.62						0.00	3.2	-0.62
199080	19C-CANSO 69.000	0.83	-0.16						0.00	0.8	-0.16
199082	24C-DICKIEBR25.000	2.81	-0.55						0.00	2.8	-0.55
199085	50N-TRENTON518.000	7.80	4.10						0.00	7.8	4.10
199086	50N-TRENTON613.800	7.20	3.70						0.00	7.2	3.70
199091	50N-TRENTON 69.000	15.33	4.60	7.8					7.80	9.9	1.92
199091	50N-TRENTON 69.000	3.62	3.65						0.00	3.6	3.65
199092	62N-BRIDG_AV69.000	21.15	12.03	13.2					13.20	11.9	0.00
199096	88H-UP_MUSQ 69.000	4.75	2.70			1.1			1.10	4.0	2.70
199096	88H-UP_MUSQ 69.000	0.00	0.00						0.00	0.0	0.00
199098	96H-RUTH_FLS69.000	3.32	1.89	1.5					1.50	2.3	1.53
199100	49N-MICHGRAN138.00	19.89	8.86						0.00	19.9	8.86
199105	53N-NRT PULP13.800	25.00	4.68						0.00	25.0	4.68
199106	56N-HALIBURT69.000	7.60	2.73	3					3.00	5.5	2.16
199106	56N-HALIBURT69.000	1.17	1.15						0.00	1.2	1.15
199107	55N-PICTOU 69.000	3.29	1.18						0.00	3.3	1.18
199110	1N-ONSLOW 138.00	14.38	4.34	5		1			6.00	10.2	3.22
199111	1N-ONSLOW_A 69.000	6.93	3.47						0.00	6.9	3.47
199112	1N-ONSLOW_B 69.000	3.85	0.57						0.00	3.9	0.57

PSSe Load Data	% Distributed Generation (x)	70%

PSS/e Load Data 2021SUM Case				Distribution Generation (MW)						Net MW at x%	Est Mvar
Bus #	Bus Name	MW	Mvar	Wind	Biogas	Biomass	Hydro	Tidal	Total		
199114	15N-WILLOWLN69.000	24.87	11.10	13.8					13.80	15.2	0.00
199114	15N-WILLOWLN69.000	3.13	-3.15						0.00	3.1	-3.15
199114	15N-WILLOWLN69.000	1.07	0.48						0.00	1.1	0.48
199115	11N-LAFARGE 69.000	4.78	-0.31						0.00	4.8	-0.31
199116	16N-STEWIAKE69.000	0.88	-2.31		0.5				0.50	0.5	0.00
199118	4N-TATAMAG 69.000	5.84	1.46	1.6					1.60	4.7	1.38
199134	81N-DEBERT 138.00	10.91	0.64	3.6					3.60	8.4	0.62
199136	74N-SPRINGHL69.000	4.78	1.96						0.00	4.8	1.96
199137	3N-OXFORD 69.000	2.91	0.22						0.00	2.9	0.22
199137	3N-OXFORD 69.000	2.85	1.48						0.00	2.9	1.48
199138	7N-PUGWASH 69.000	1.94	0.14						0.00	1.9	0.14
199138	7N-PUGWASH 69.000	2.70	0.38						0.00	2.7	0.38
199141	6N-BLK_RIV 69.000	3.79	1.54	1.2					1.20	3.0	1.42
199141	6N-BLK_RIV 69.000	1.75	0.95						0.00	1.8	0.95
199146	30N-MACCAN 69.000	2.16	1.62						0.00	2.2	1.62
199147	37N-PARSBORO69.000	4.15	0.13						0.00	4.2	0.13
199147	37N-PARSBORO69.000	0.02	0.05						0.00	0.0	0.05
199148	75N-DOMTAR 69.000	0.39	0.31						0.00	0.4	0.31
199149	20N-PARKST 69.000	1.48	0.30						0.00	1.5	0.30
199151	17N-BROWNELL69.000	1.84	0.37						0.00	1.8	0.37
199152	22N-CHURCHST138.00	20.06	4.64	6					6.00	15.9	3.70
199153	139H_25KV 25.000	27.00	8.60	2					2.00	25.6	8.40
199155	82V-ELMSDALE26.400	23.79	7.57	10	1.1				11.10	16.0	2.61
199155	82V-ELMSDALE26.400	0.43	0.27						0.00	0.4	0.27
199155	82V-ELMSDALE26.400	0.34	-0.13						0.00	0.3	-0.13
199155	82V-ELMSDALE26.400	1.01	0.47						0.00	1.0	0.47
199156	127H-AEROTAP138.00	18.19	-1.17				0.5		0.50	17.8	0.00
199156	127H-AEROTAP138.00	2.91	0.63						0.00	2.9	0.63
199157	133H-HBR EST138.00	10.78	3.56						0.00	10.8	3.56
199160	113H-EASTDRT25.000	38.82	12.94						0.00	38.8	12.94
199162	126H-PORTERS138.00	7.64	1.51	3.2					3.20	5.4	1.31
199163	87H-MUSQ.HBR138.00	4.87	0.97	2.3					2.30	3.3	0.87
199167	91H-TUFTCV1 13.800	4.10	1.30						0.00	4.1	1.30
199168	91H-TUFTCV2 13.800	3.70	1.20						0.00	3.7	1.20
199169	91H-TUFTCV3 14.400	8.00	4.00						0.00	8.0	4.00
199170	99H-FARRELL 69.000	7.81	2.78						0.00	7.8	2.78
199171	62H-ALBRO 69.000	9.28	3.57						0.00	9.3	3.57
199172	40H-WOODLAWN69.000	10.66	2.95						0.00	10.7	2.95
199173	58H-IMPERIAL69.000	19.28	3.71						0.00	19.3	3.71
199174	58H-IMPERIAL26.400	10.24	7.90						0.00	10.2	7.90
199175	48H-PENHORN 69.000	15.37	4.96						0.00	15.4	4.96
199176	54H-MAPLE_ST69.000	11.38	3.67						0.00	11.4	3.67
199177	124H-AKERLEY69.000	6.87	3.26						0.00	6.9	3.26
199179	23H-ROCKHAM 69.000	12.12	3.06						0.00	12.1	3.06
199180	20H-SPRYFLD 69.000	18.88	5.21	4.6					4.60	15.7	4.42
199186	101H-COBEQUI26.400	34.51	10.78						0.00	34.5	10.78
199187	108H-BURNSID138.00	15.10	5.39						0.00	15.1	5.39
199191	103H-LAKSIDE26.400	30.59	9.94	7.05					7.05	25.7	7.37
199192	129H-KEARNEY138.00	0.00	0.00						0.00	0.0	0.00
199194	1H-WATER_ST 26.400	64.90	27.86						0.00	64.9	27.86

PSSe Load Data	% Distributed Generation (x)	70%

PSS/e Load Data 2021SUM Case				Distribution Generation (MW)						Net MW at x%	Est Mvar
Bus #	Bus Name	MW	Mvar	Wind	Biogas	Biomass	Hydro	Tidal	Total		
199194	1H-WATER_ST 26.400	0.20	0.06						0.00	0.2	0.06
199194	1H-WATER_ST 26.400	3.46	1.65						0.00	3.5	1.65
199197	2H-ARMDALE 138.00	30.03	9.25						0.00	30.0	9.25
199199	104H-KEMPT_R26.400	74.73	27.54						0.00	74.7	27.54
199199	104H-KEMPT_R26.400	2.05	0.96						0.00	2.1	0.96
199199	104H-KEMPT_R26.400	1.52	0.62						0.00	1.5	0.62
199203	131H-LUCASVL138.00	25.23	7.63	8	2.1	3.1			13.20	16.0	4.76
199206	92H-TIDEWTR 13.200	6.51	1.30						0.00	6.5	1.30
199209	137H-HAMONDS26.470	15.97	6.45	10					10.00	9.0	0.00
199210	87W-HUBBARDS138.00	3.23	0.65						0.00	3.2	0.65
199214	103W-GOLD_RV138.00	6.17	1.23						0.00	6.2	1.23
199215	85W-CANEXEL 69.000	2.60	1.77						0.00	2.6	1.77
199216	84W-ROB-SONS69.000	3.76	0.75	2					2.00	2.4	0.67
199220	78W-MARTINS 69.000	1.61	0.32						0.00	1.6	0.32
199222	81W-LUNENBUR69.000	3.51	0.70						0.00	3.5	0.70
199223	82W-NATIONNS69.000	2.06	0.17						0.00	2.1	0.17
199224	80W-INDIANNS69.000	4.40	0.88						0.00	4.4	0.88
199225	76W-MAHONE_B69.000	1.35	0.27						0.00	1.4	0.27
199229	74W-MICH_B-W138.00	13.31	5.80						0.00	13.3	5.80
199229	74W-MICH_B-W138.00	2.16	0.97						0.00	2.2	0.97
199232	89W-E_B-WATR69.000	9.96	4.11	4					4.00	7.2	2.78
199233	73W-AUBURNDA69.000	6.92	1.37				0.85		0.85	6.3	1.37
199235	70W-HIGHSTBW69.000	16.84	3.32	3.2					3.20	14.6	3.12
199246	50W-MILTON 69.000	7.27	2.58	3.6					3.60	4.8	1.78
199259	91W-MIDDLEFI69.000	2.37	1.65						0.00	2.4	1.65
199260	57W-CALEDONI69.000	2.07	1.44						0.00	2.1	1.44
199263	48W-WATERLOO69.000	2.01	1.92						0.00	2.0	1.92
199264	46W-BROADRVR69.000	1.91	0.41						0.00	1.9	0.41
199265	36W-GREENHBR69.000	1.44	0.31						0.00	1.4	0.31
199266	37W-LOCKPORT69.000	0.90	0.19						0.00	0.9	0.19
199272	25W-SHELBURN69.000	4.77	0.38						0.00	4.8	0.38
199274	23W-CLYDE_RI69.000	2.58	0.21						0.00	2.6	0.21
199276	22W-BARRINGT69.000	10.05	4.89	3.2					3.20	7.8	3.70
199277	101W-BMPC 138.00	0.54	0.32						0.00	0.5	0.32
199282	19W-ARGYLE 69.000	3.76	1.83						0.00	3.8	1.83
199283	20W-PUBNICO 69.000	2.33	1.14						0.00	2.3	1.14
199284	21W-WOODSHBR69.000	2.21	1.07						0.00	2.2	1.07
199286	10W-TUSKETGT69.000	4.46	0.61						0.00	4.5	0.61
199288	16W-HEBRON 69.000	4.74	1.37	2					2.00	3.3	1.21
199290	11W-KING_ST 69.000	2.68	0.67						0.00	2.7	0.67
199291	88W-PLEASANT69.000	8.35	2.10	4					4.00	5.6	1.60
199292	92W-CARLETON69.000	0.83	-0.26						0.00	0.8	-0.26
199294	88W-PLSNT_B569.000	6.90	0.81						0.00	6.9	0.81
199303	1V-AVON 69.000	2.33	0.32						0.00	2.3	0.32
199307	18V-BURLINGT69.000	4.40	0.87	2					2.00	3.0	0.79
199309	79V-3MIPLAIN69.000	15.64	5.60	6					6.00	11.4	3.34
199311	20V-FIVE_PT 69.000	2.73	0.76						0.00	2.7	0.76
199313	41V-MBPP 23.000	3.05	3.01						0.00	3.1	3.01
199321	83V-WOLFVILL69.000	6.69	1.01						0.00	6.7	1.01
199323	50V-KLONDIKE69.000	16.15	4.30			6			6.00	12.0	4.30

PSSe Load Data		% Distributed Generation (x)	70%

PSS/e Load Data 2021SUM Case				Distribution Generation (MW)						Net MW at x%	Est Mvar
Bus #	Bus Name	MW	Mvar	Wind	Biogas	Biomass	Hydro	Tidal	Total		
199324	22V-NEWMINAS69.000	19.31	7.08						0.00	19.3	7.08
199325	36V-HILLATON69.000	7.21	2.64						0.00	7.2	2.64
199325	36V-HILLATON69.000	0.35	0.24						0.00	0.4	0.24
199329	45V-ACADIA 23.000	0.76	0.20						0.00	0.8	0.20
199333	99V-HIGHBURY138.00	7.55	2.70						0.00	7.6	2.70
199335	92V-MICH_WAT69.000	10.44	4.59						0.00	10.4	4.59
199337	55V-WATERVLL69.000	12.89	3.64						0.00	12.9	3.64
199339	52V-BERWICK 69.000	4.15	1.17						0.00	4.2	1.17
199346	51V-TREMONT 69.000	1.75	-1.06						0.00	1.8	-1.06
199347	64V-GREENWD 69.000	5.59	1.55						0.00	5.6	1.55
199348	63V-KINGSTON69.000	9.94	2.76						0.00	9.9	2.76
199351	12V-LEQUILLE69.000	4.89	1.62	2					2.00	3.5	1.40
199355	70V-BRIDGTWN69.000	5.26	1.74						0.00	5.3	1.74
199359	65V-MIDDLETN69.000	7.46	2.14						0.00	7.5	2.14
199363	74V-CORNWLLS69.000	1.42	0.47						0.00	1.4	0.47
199365	13V-GULCH 13.800	1.65	1.14						0.00	1.7	1.14
199366	77V-CONWAY 69.000	9.19	1.53	1.7				2	3.70	6.6	1.49
199369	76V-MAITLAND69.000	0.46	0.32						0.00	0.5	0.32
199374	16V-WEYMOUTH69.000	1.75	1.85			0.3			0.30	1.5	1.85
199376	93V-SAULNIER69.000	10.70	2.80	0.6					0.60	10.3	2.79
199376	93V-SAULNIER69.000	0.83	-0.06						0.00	0.8	-0.06
199690	1C-TUPPER 25.000	6.64	2.76	0.8					0.80	6.1	2.71
199690	1C-TUPPER 25.000	1.12	1.24						0.00	1.1	1.24
199690	1C-TUPPER 25.000	0.24	0.20						0.00	0.2	0.20
	Totals	1457.49	517.49	184.99	4.43	11.5	1.35	2	204.27	1314.71	447.82

PSSe Load Data	% Distributed Generation (x)	70%

PSS/e Load Data 2021WIN Case				Distribution Generation (MW)						Net MW at x%	Est Mvar
Bus #	Bus Name	MW	Mvar	Wind	Biogas	Biomass	Hydro	Tidal	Total		
199001	88S-LINGAN_114.400	8.10	4.10						0.0	8.1	4.10
199002	88S-LINGAN_214.400	7.80	4.00						0.0	7.8	4.00
199003	88S-LINGAN_314.400	8.20	4.20						0.0	8.2	4.20
199004	88S-LINGAN_414.400	8.00	4.10						0.00	8.0	4.10
199011	84S-VJ_DIST 69.000	8.61	2.29	2.3					2.30	7.0	2.11
199012	4S-TOWNSEND 69.000	33.92	9.04						0.00	33.9	9.04
199013	6S-TERRACE 69.000	6.31	2.12						0.00	6.3	2.12
199014	82S-WHITNEY 69.000	8.51	1.21	2.35					2.35	6.9	1.15
199015	15S-WATRFORD69.000	11.46	3.20	2.35					2.35	9.8	2.99
199018	11S-KELTIC_D69.000	40.46	13.60	4					4.00	37.7	12.71
199019	81S-RESERVE 69.000	32.31	7.35	4.8					4.80	29.0	6.77
199023	57S-ALBERT_B69.000	8.74	1.99	2.3					2.30	7.1	1.86
199026	3S-GANNON_RD69.000	31.99	6.16	6.35					6.35	27.5	5.43
199033	104S-BADDECK138.00	5.95	2.10	1.7					1.70	4.8	1.92
199035	85S-WRK_COVE138.00	4.27	1.20						0.00	4.3	1.20
199043	102S-ACONI 20.000	14.20	7.30						0.00	14.2	7.30
199051	2C-HASTINGS 138.00	3.99	1.30	2					2.00	2.6	1.09
199052	1C-TUPPER 138.00	1.12	0.32						0.00	1.1	0.32
199054	47C-NEW_PAGE13.800	33.60	21.00						0.00	33.6	21.00
199055	1C-TUPPER_GN14.400	6.00	2.00						0.00	6.0	2.00
199056	59C-STPETERS138.00	3.28	0.96						0.00	3.3	0.96
199058	67C-WHYCOCO 138.00	8.23	2.91	1.7					1.70	7.0	2.73
199060	47C-NP_PMP2 13.800	32.30	19.00						0.00	32.3	19.00
199063	22C-CLEVLAND138.00	14.55	4.22	1.99					1.99	13.2	4.06
199065	47C-NP_RL3 13.800	10.60	7.50						0.00	10.6	7.50
199067	9C-ABERDEEN 69.000	0.78	0.27						0.00	0.8	0.27
199068	58C-SW_MARG 69.000	9.31	3.28	2					2.00	7.9	3.04
199069	103C-CHETCMP69.000	3.89	1.37	1.6					1.60	2.8	1.21
199075	100C-PORCUPN138.00	8.40	7.00		0.23				0.23	8.2	7.00
199076	4C-LOCHABER 138.00	38.20	10.01	10.6	0.5				11.10	30.4	6.23
199077	4C-LOCHABER 69.000	0.00	0.00						0.00	0.0	0.00
199078	57C-SALMON_R69.000	6.06	2.11						0.00	6.1	2.11
199080	19C-CANSO 69.000	1.58	0.54						0.00	1.6	0.54
199082	24C-DICKIEBR25.000	5.36	1.62						0.00	5.4	1.62
199085	50N-TRENTON518.000	7.80	4.10						0.00	7.8	4.10
199086	50N-TRENTON613.800	7.20	3.70						0.00	7.2	3.70
199091	50N-TRENTON 69.000	28.82	7.36	7.8					7.80	23.4	5.42
199091	50N-TRENTON 69.000	3.35	3.14						0.00	3.3	3.14
199092	62N-BRIDG_AV69.000	37.32	11.66	13.2					13.20	28.1	3.32
199096	88H-UP_MUSQ 69.000	8.39	2.62			1.1			1.10	7.6	2.62
199096	88H-UP_MUSQ 69.000	0.61	0.51						0.00	0.6	0.51
199098	96H-RUTH_FLS69.000	5.87	1.83	1.5					1.50	4.8	1.72
199100	49N-MICHGRAN138.00	11.47	5.07						0.00	11.5	5.07
199105	53N-NRT PULP13.800	8.92	3.08						0.00	8.9	3.08
199106	56N-HALIBURT69.000	12.99	2.41	3					3.00	10.9	2.26
199106	56N-HALIBURT69.000	1.19	0.82						0.00	1.2	0.82
199107	55N-PICTOU 69.000	5.63	1.04						0.00	5.6	1.04
199110	1N-ONSLOW 138.00	22.61	4.99	5		1			6.00	18.4	4.39
199111	1N-ONSLOW_A 69.000	4.55	0.76						0.00	4.6	0.76
199112	1N-ONSLOW_B 69.000	10.40	3.21						0.00	10.4	3.21

PSSe Load Data	% Distributed Generation (x)	70%

PSS/e Load Data 2021WIN Case				Distribution Generation (MW)						Net MW at x%	Est Mvar
Bus #	Bus Name	MW	Mvar	Wind	Biogas	Biomass	Hydro	Tidal	Total		
199114	15N-WILLOWLN69.000	46.01	18.96	13.8					13.80	36.3	3.11
199114	15N-WILLOWLN69.000	3.30	1.00						0.00	3.3	1.00
199114	15N-WILLOWLN69.000	0.36	0.14						0.00	0.4	0.14
199115	11N-LAFARGE 69.000	1.17	0.08						0.00	1.2	0.08
199116	16N-STEWIAKE69.000	5.63	1.62		0.5				0.50	5.3	1.62
199118	4N-TATAMAG 69.000	10.75	2.69	1.6					1.60	9.6	2.61
199134	81N-DEBERT 138.00	29.00	9.69	3.6					3.60	26.5	8.98
199136	74N-SPRINGHL69.000	7.97	2.25						0.00	8.0	2.25
199137	3N-OXFORD 69.000	2.97	0.86						0.00	3.0	0.86
199137	3N-OXFORD 69.000	2.79	1.52						0.00	2.8	1.52
199138	7N-PUGWASH 69.000	1.98	0.54						0.00	2.0	0.54
199138	7N-PUGWASH 69.000	3.09	0.67						0.00	3.1	0.67
199141	6N-BLK_RIV 69.000	5.42	1.50	1.2					1.20	4.6	1.44
199141	6N-BLK_RIV 69.000	1.40	0.87						0.00	1.4	0.87
199146	30N-MACCAN 69.000	3.09	2.63						0.00	3.1	2.63
199147	37N-PARSBORO69.000	6.90	2.15						0.00	6.9	2.15
199147	37N-PARSBORO69.000	0.18	0.12						0.00	0.2	0.12
199148	75N-DOMTAR 69.000	0.52	0.14						0.00	0.5	0.14
199149	20N-PARKST 69.000	2.76	0.57						0.00	2.8	0.57
199151	17N-BROWNELL69.000	3.41	0.71						0.00	3.4	0.71
199152	22N-CHURCHST138.00	23.72	7.52	6					6.00	19.5	5.74
199153	139H_25KV 25.000	35.21	10.77	2					2.00	33.8	10.58
199155	82V-ELMSDALE26.400	44.66	12.92	10	1.1				11.10	36.9	8.82
199155	82V-ELMSDALE26.400	0.74	0.48						0.00	0.7	0.48
199155	82V-ELMSDALE26.400	0.49	0.32						0.00	0.5	0.32
199155	82V-ELMSDALE26.400	0.36	0.16						0.00	0.4	0.16
199156	127H-AEROTAP138.00	26.02	3.27				0.5		0.50	25.7	3.27
199156	127H-AEROTAP138.00	1.79	0.48						0.00	1.8	0.48
199157	133H-HBR EST138.00	14.97	4.99						0.00	15.0	4.99
199160	113H-EASTDRT25.000	71.84	19.38						0.00	71.8	19.38
199162	126H-PORTERS138.00	19.20	4.45	3.2					3.20	17.0	4.18
199163	87H-MUSQ.HBR138.00	12.24	2.83	2.3					2.30	10.6	2.69
199167	91H-TUFTCV1 13.800	4.10	1.30						0.00	4.1	1.30
199168	91H-TUFTCV2 13.800	3.70	1.20						0.00	3.7	1.20
199169	91H-TUFTCV3 14.400	8.00	4.00						0.00	8.0	4.00
199170	99H-FARRELL 69.000	13.09	3.36						0.00	13.1	3.36
199171	62H-ALBRO 69.000	12.87	2.63						0.00	12.9	2.63
199172	40H-WOODLAWN69.000	15.18	4.31						0.00	15.2	4.31
199173	58H-IMPERIAL69.000	6.05	2.00						0.00	6.1	2.00
199174	58H-IMPERIAL26.400	17.02	3.71						0.00	17.0	3.71
199175	48H-PENHORN 69.000	20.96	4.53						0.00	21.0	4.53
199176	54H-MAPLE_ST69.000	15.98	3.46						0.00	16.0	3.46
199177	124H-AKERLEY69.000	6.48	3.14						0.00	6.5	3.14
199179	23H-ROCKHAM 69.000	23.11	5.22						0.00	23.1	5.22
199180	20H-SPRYFLD 69.000	47.03	14.97	4.6					4.60	43.8	13.92
199186	101H-COBEQUI26.400	69.11	19.38						0.00	69.1	19.38
199187	108H-BURNSID138.00	19.04	4.50						0.00	19.0	4.50
199191	103H-LAKSIDE26.400	51.74	17.23	7.05					7.05	46.8	14.53
199192	129H-KEARNEY138.00	41.15	11.11						0.00	41.2	11.11
199194	1H-WATER_ST 26.400	50.39	14.94						0.00	50.4	14.94

PSSe Load Data	% Distributed Generation (x)	70%

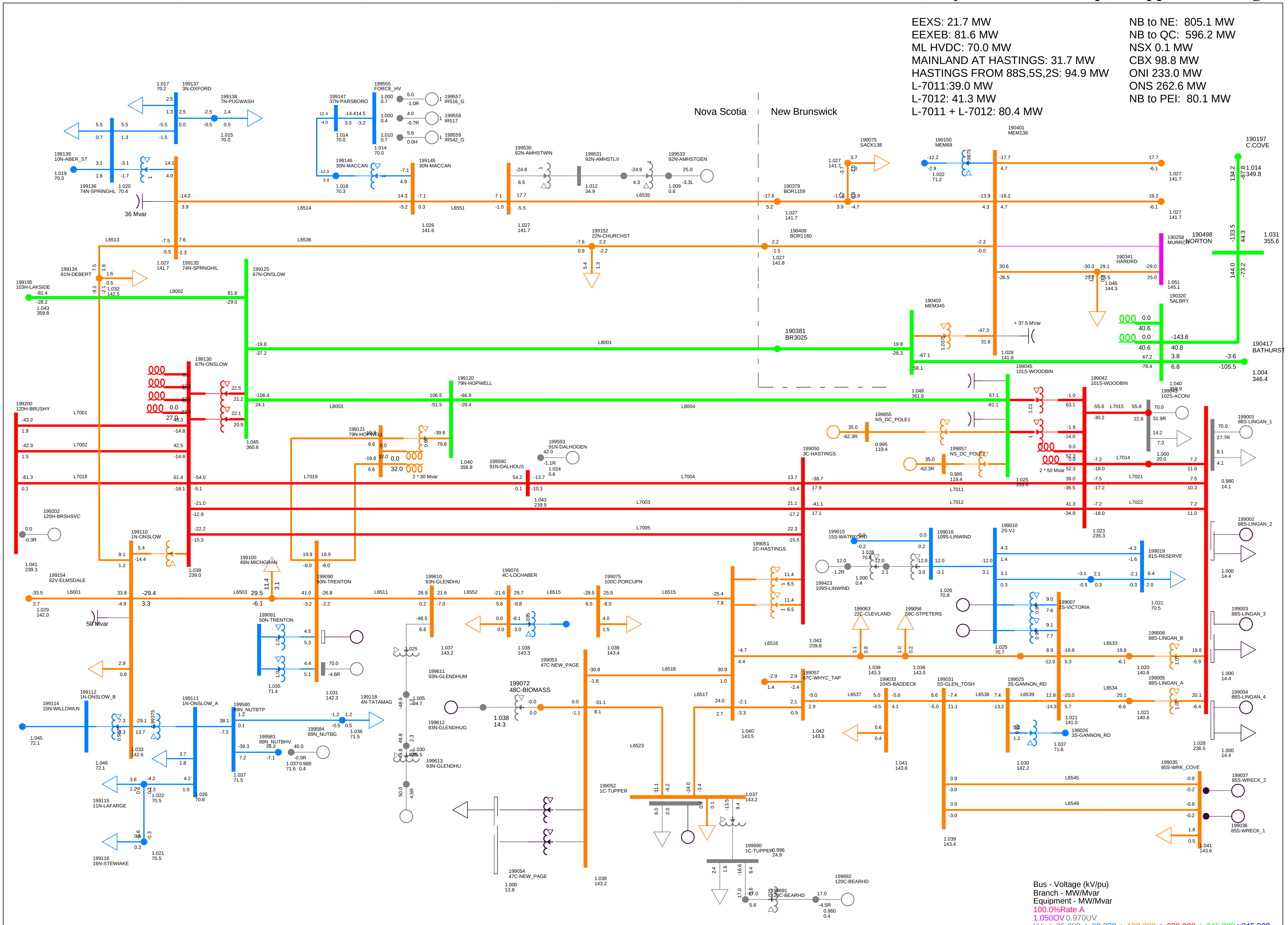
PSS/e Load Data 2021WIN Case				Distribution Generation (MW)						Net MW at x%	Est Mvar
Bus #	Bus Name	MW	Mvar	Wind	Biogas	Biomass	Hydro	Tidal	Total		
199194	1H-WATER_ST 26.400	0.47	0.05						0.00	0.5	0.05
199194	1H-WATER_ST 26.400	4.32	1.50						0.00	4.3	1.50
199197	2H-ARMDALE 138.00	33.27	8.61						0.00	33.3	8.61
199199	104H-KEMPT_R26.400	115.14	26.92						0.00	115.1	26.92
199199	104H-KEMPT_R26.400	0.59	0.20						0.00	0.6	0.20
199199	104H-KEMPT_R26.400	1.23	0.49						0.00	1.2	0.49
199203	131H-LUCASVL138.00	64.69	16.15	8	2.1	3.1			13.20	55.4	14.20
199206	92H-TIDEWTR 13.200	15.91	3.19						0.00	15.9	3.19
199209	137H-HAMONDS26.470	28.20	4.93	10					10.00	21.2	3.43
199210	87W-HUBBARDS138.00	7.91	1.58						0.00	7.9	1.58
199214	103W-GOLD_RV138.00	15.08	3.01						0.00	15.1	3.01
199215	85W-CANEXEL 69.000	2.83	1.63						0.00	2.8	1.63
199216	84W-ROB-SONS69.000	9.20	1.84	2					2.00	7.8	1.76
199220	78W-MARTINS 69.000	3.01	0.51						0.00	3.0	0.51
199222	81W-LUNENBUR69.000	6.60	1.12						0.00	6.6	1.12
199223	82W-NATIONNS69.000	1.78	0.26						0.00	1.8	0.26
199224	80W-INDIANNS69.000	8.27	1.40						0.00	8.3	1.40
199225	76W-MAHONE_B69.000	2.54	0.43						0.00	2.5	0.43
199229	74W-MICH_B-W138.00	11.51	5.15						0.00	11.5	5.15
199229	74W-MICH_B-W138.00	1.85	0.83						0.00	1.9	0.83
199232	89W-E_B-WATR69.000	15.46	4.09	4					4.00	12.7	3.54
199233	73W-AUBURNDA69.000	12.58	2.55				0.85		0.85	12.0	2.55
199235	70W-HIGHSTBW69.000	30.62	6.22	3.2					3.20	28.4	6.02
199246	50W-MILTON 69.000	13.92	4.01	3.6					3.60	11.4	3.48
199259	91W-MIDDLEFI69.000	2.95	0.98						0.00	3.0	0.98
199260	57W-CALEDONI69.000	2.56	0.86						0.00	2.6	0.86
199263	48W-WATERLOO69.000	9.52	1.93						0.00	9.5	1.93
199264	46W-BROADRVR69.000	3.66	0.10						0.00	3.7	0.10
199265	36W-GREENHBR69.000	2.75	0.08						0.00	2.7	0.08
199266	37W-LOCKPORT69.000	1.72	0.04						0.00	1.7	0.04
199272	25W-SHELBURN69.000	8.70	0.93						0.00	8.7	0.93
199274	23W-CLYDE_RI69.000	4.69	0.51						0.00	4.7	0.51
199276	22W-BARRINGT69.000	15.20	4.21	3.2					3.20	13.0	3.83
199277	101W-BMPC 138.00	0.74	0.20						0.00	0.7	0.20
199282	19W-ARGYLE 69.000	5.69	1.57						0.00	5.7	1.57
199283	20W-PUBNICO 69.000	3.53	0.98						0.00	3.5	0.98
199284	21W-WOODSHBR69.000	3.34	0.93						0.00	3.3	0.93
199286	10W-TUSKETGT69.000	8.41	1.64						0.00	8.4	1.64
199288	16W-HEBRON 69.000	9.36	3.01	2					2.00	8.0	2.81
199290	11W-KING_ST 69.000	4.10	0.72						0.00	4.1	0.72
199291	88W-PLEASANT69.000	12.78	2.23	4					4.00	10.0	1.99
199292	92W-CARLETON69.000	1.71	1.91						0.00	1.7	1.91
199294	88W-PLSNT_B569.000	13.61	1.79						0.00	13.6	1.79
199303	1V-AVON 69.000	4.02	0.34						0.00	4.0	0.34
199307	18V-BURLINGT69.000	4.87	1.62	2					2.00	3.5	1.40
199309	79V-3MIPLAIN69.000	29.93	9.28	6					6.00	25.7	7.59
199311	20V-FIVE_PT 69.000	4.68	1.14						0.00	4.7	1.14
199313	41V-MBPP 23.000	2.24	0.93						0.00	2.2	0.93
199321	83V-WOLFVILL69.000	12.99	1.86						0.00	13.0	1.86
199323	50V-KLONDIKE69.000	21.10	3.81			6			6.00	16.9	3.81

PSSe Load Data	% Distributed Generation (x)	70%

PSS/e Load Data 2021WIN Case				Distribution Generation (MW)						Net MW at x%	Est Mvar
Bus #	Bus Name	MW	Mvar	Wind	Biogas	Biomass	Hydro	Tidal	Total		
199324	22V-NEWMINAS69.000	22.44	5.36						0.00	22.4	5.36
199325	36V-HILLATON69.000	8.40	2.00						0.00	8.4	2.00
199325	36V-HILLATON69.000	0.31	0.19						0.00	0.3	0.19
199329	45V-ACADIA 23.000	2.70	0.56						0.00	2.7	0.56
199333	99V-HIGHBURY138.00	11.97	2.23						0.00	12.0	2.23
199335	92V-MICH_WAT69.000	8.47	4.09						0.00	8.5	4.09
199337	55V-WATERVLL69.000	19.96	3.95						0.00	20.0	3.95
199339	52V-BERWICK 69.000	6.43	1.27						0.00	6.4	1.27
199346	51V-TREMONT 69.000	4.44	1.08						0.00	4.4	1.08
199347	64V-GREENWD 69.000	8.52	1.62						0.00	8.5	1.62
199348	63V-KINGSTON69.000	15.14	2.87						0.00	15.1	2.87
199351	12V-LEQUILLE69.000	7.94	1.91	2					2.00	6.5	1.79
199355	70V-BRIDGTWN69.000	8.55	2.06						0.00	8.5	2.06
199359	65V-MIDDLETN69.000	13.05	2.79						0.00	13.0	2.79
199363	74V-CORNWLLS69.000	2.30	0.55						0.00	2.3	0.55
199365	13V-GULCH 13.800	3.31	1.08						0.00	3.3	1.08
199366	77V-CONWAY 69.000	15.25	2.79	1.7				2	3.70	12.7	2.74
199369	76V-MAITLAND69.000	0.58	0.19						0.00	0.6	0.19
199374	16V-WEYMOUTH69.000	2.97	1.08			0.3			0.30	2.8	1.08
199376	93V-SAULNIER69.000	14.12	3.23	0.6					0.60	13.7	3.22
199376	93V-SAULNIER69.000	0.26	0.15						0.00	0.3	0.15
199690	1C-TUPPER 25.000	8.98	2.99	0.8					0.80	8.4	2.96
199690	1C-TUPPER 25.000	0.81	0.68						0.00	0.8	0.68
199690	1C-TUPPER 25.000	0.20	0.17						0.00	0.2	0.17
	Totals	2207.04	638.08	184.99	4.43	11.5	1.35	2	204.27	2064.05	584.59

Appendix D

Steady State Cases – Load Flow Diagrams



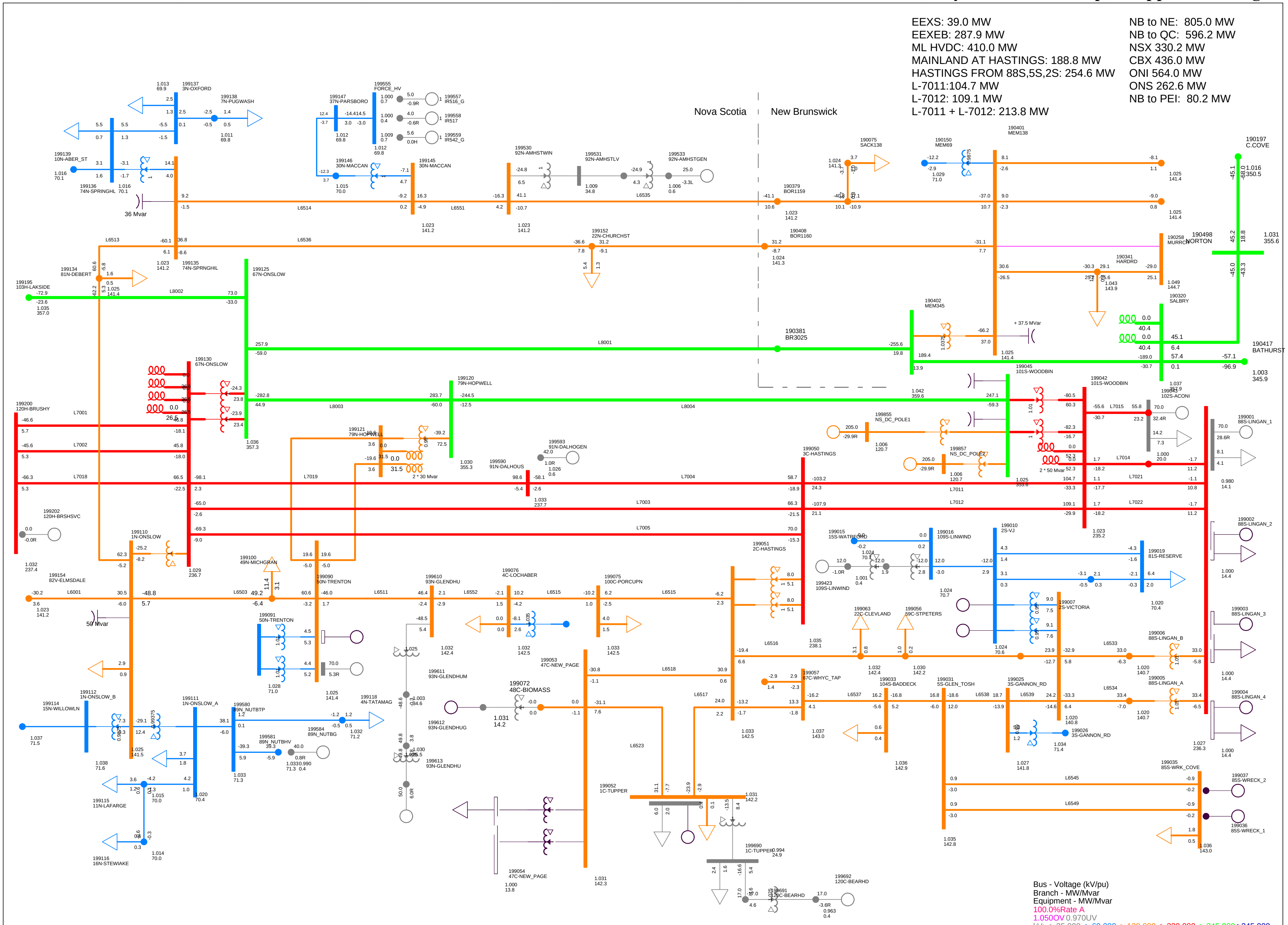
2021 LIGHT LOAD: 2021LL - FULL WIND ON BACKBONE
FROM UPDATE OF 2014 SERIES MMWG 2020 SPRING LIGHT LOAD
SUN, OCT 01 2017 0:02

Total Wind Gen: 207.5 MW	Gross Tupper 0.0 MW	Gross Wreck Cove 0.0 MW	Net NewPage Load 61.9 MW
Gross Lingan 70.0 MW	Gross Trenton 70.0 MW	Gross Gas Turbine 0.0 MW	Gross NewPage Load 61.9 MW
Gross Pt Aconi 70.0 MW	Gross Tuft's Cove 70.0 MW	Gross Small Hydro 14.6 MW	Total BMPC Load -0.9 MW
Total Gross Gen: 502.1 MW	ML HVDC: 70.0 MW	Gross Gen + ML: 572.1 MW	

Summer Ratings

Includes 70% Distributed Generation modeled as Negative Load: -143.0 MW

Figure D-1



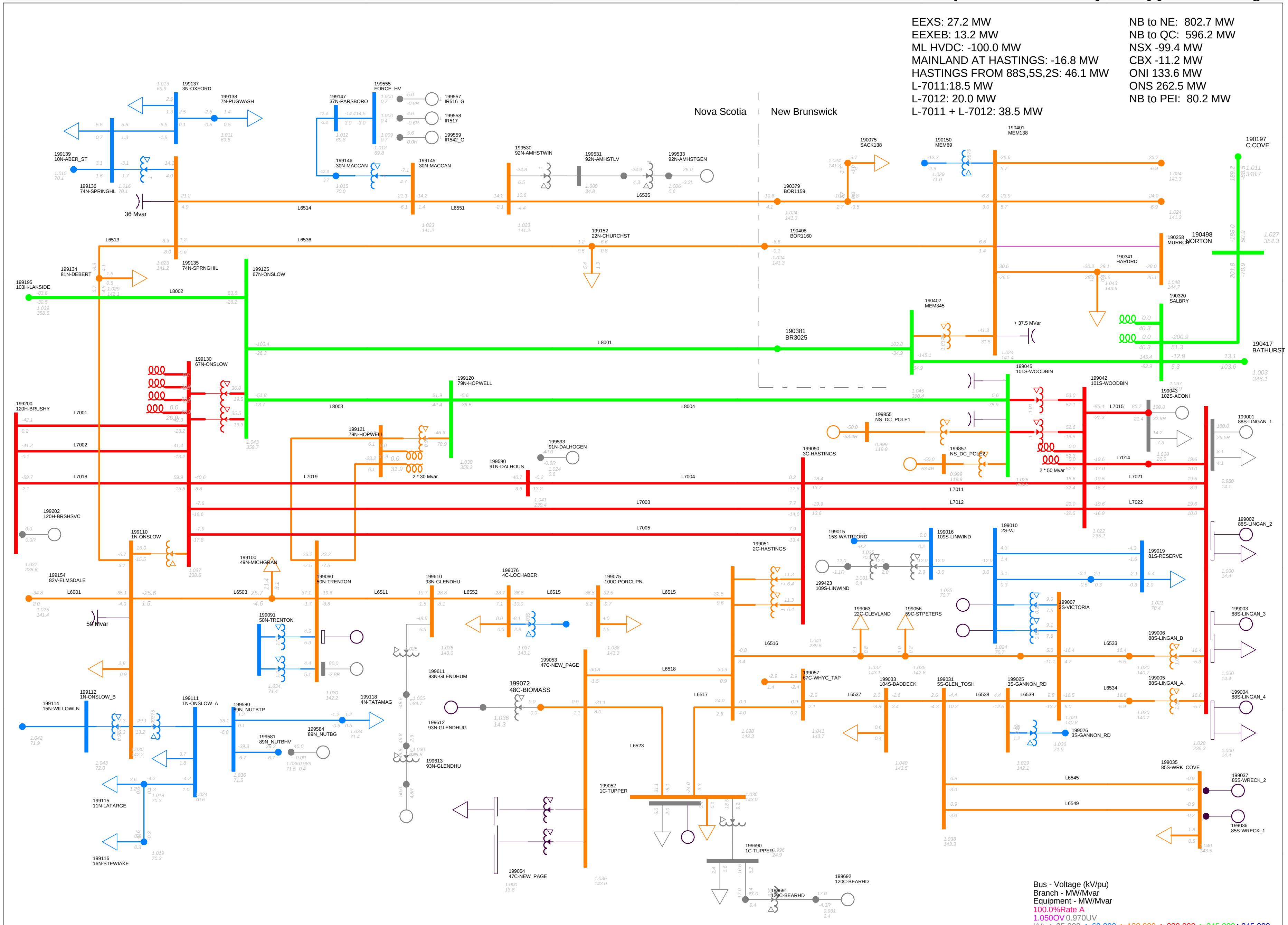
2021 LIGHT LOAD: 2021LL-1 - FULL WIND ON BACKBONE
FROM UPDATE OF 2014 SERIES MMWG 2020 SPRING LIGHT LOAD
SUN, OCT 01 2017 0:00

Total Wind Gen: 207.5 MW	Gross Tupper 0.0 MW	Gross Wreck Cove 0.0 MW	Net NewPage Load 61.9 MW
Gross Lingan 70.0 MW	Gross Trenton 70.0 MW	Gross Gas Turbine 0.0 MW	Gross NewPage Load 61.9 MW
Gross Pt Aconi 70.0 MW	Gross Tuft's Cove 70.0 MW	Gross Small Hydro 14.6 MW	Total BMPC Load -0.9 MW
Total Gross Gen: 502.1 MW	ML HVDC: 410.0 MW	Gross Gen + ML: 912.1 MW	

Summer Ratings

Includes 70% Distributed Generation modeled as Negative Load: -143.0 MW

Figure D-2



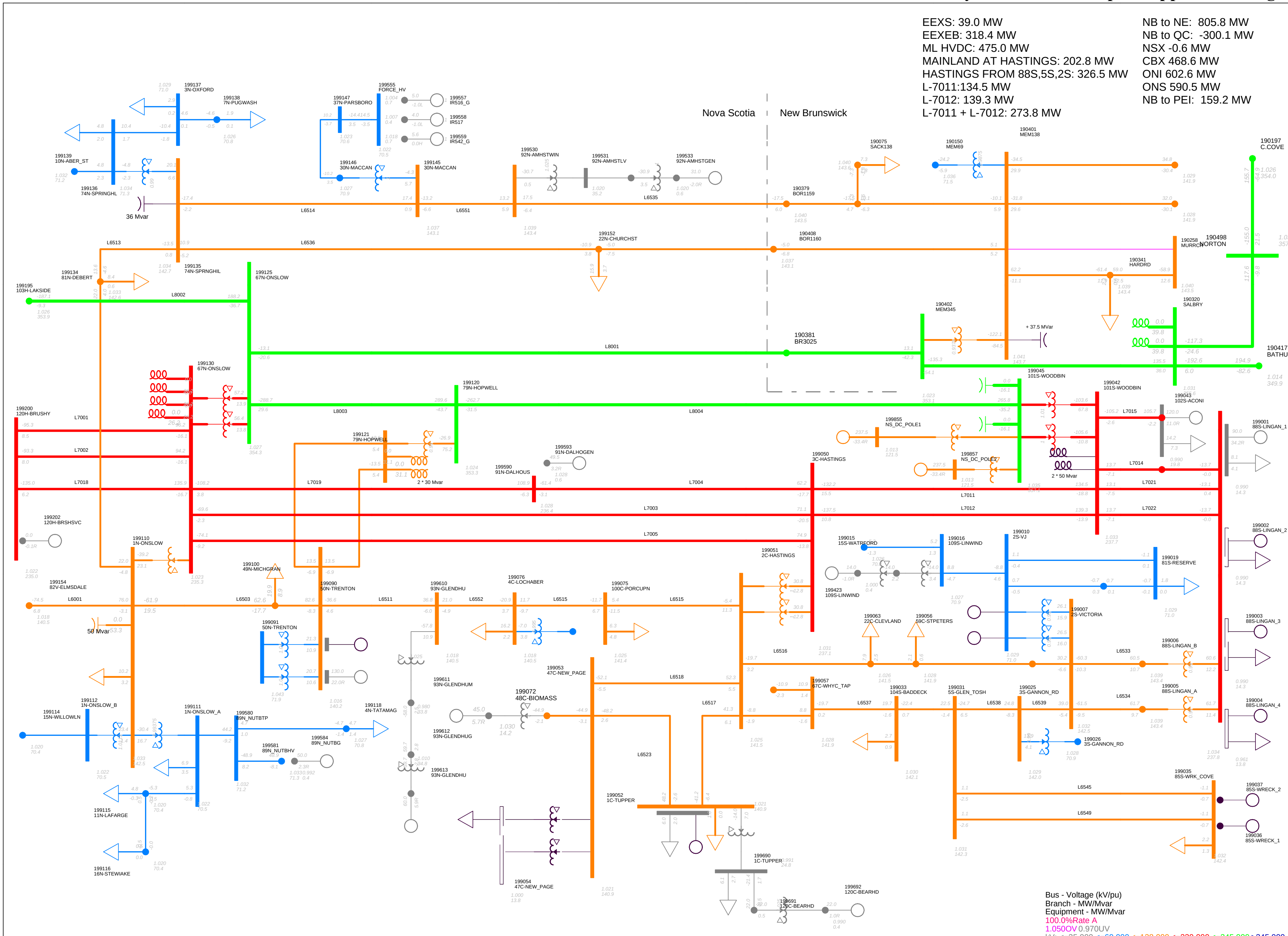
2021 LIGHT LOAD: 2021LL-2 - FULL WIND ON BACKBONE
FROM UPDATE OF 2014 SERIES MMWG 2020 SPRING LIGHT LOAD
SUN, OCT 01 2017 0:29

Total Wind Gen: 207.5 MW	Gross Tupper 0.0 MW	Gross Wreck Cove 0.0 MW	Net NewPage Load 61.9 MW
Gross Lingan 100.0 MW	Gross Trenton 80.0 MW	Gross Gas Turbine 0.0 MW	Gross NewPage Load 61.9 MW
Gross Pt Aconi 100.0 MW	Gross Tuft's Cove 70.0 MW	Gross Small Hydro 14.6 MW	Total BMPC Load -0.9 MW
Total Gross Gen: 572.1 MW	ML HVDC: -100.0 MW	Gross Gen + ML: 472.1 MW	

Summer Ratings

Includes 70% Distributed Generation modeled as Negative Load: -143.0 MW

Figure D-3



2021 SUMMER PEAK: 2021SUM - FULL WIND ON BACKBONE
DERIVED FROM UPDATE OF 2014 SERIES MMWG 2020 SUMMER PEAK
SAT, SEP 30 2017 18:46

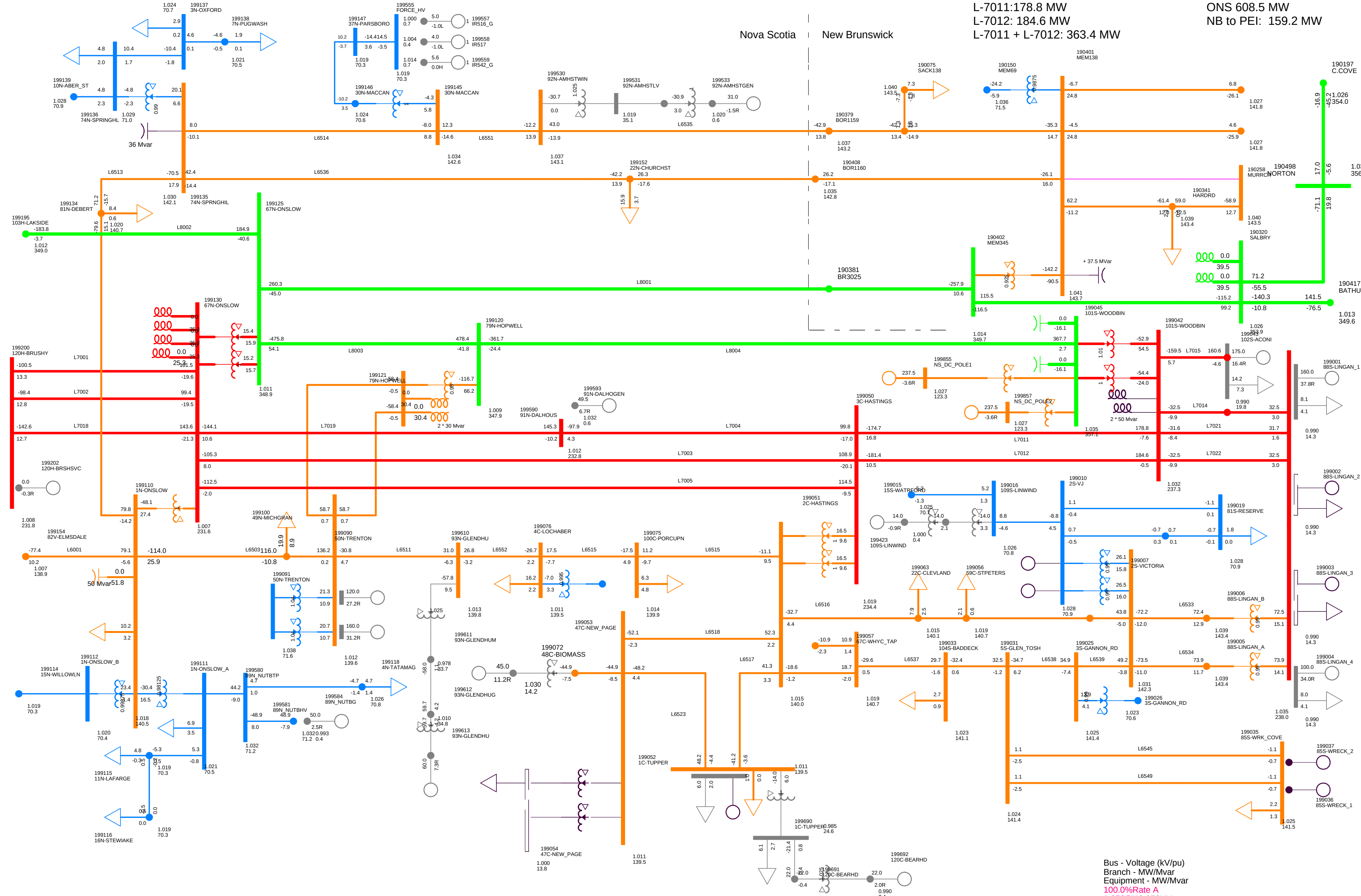
Total Wind Gen: 303.7 MW	Gross Tupper 0.0 MW	Gross Wreck Cove 0.0 MW	Net NewPage Load 100.3 MW
Gross Lingan 90.0 MW	Gross Trenton 130.0 MW	Gross Gas Turbine 0.0 MW	Gross NewPage Load 145.3 MW
Gross Pt Aconi 120.0 MW	Gross Tuft's Cove 109.0 MW	Gross Small Hydro 74.3 MW	Total BMPC Load -0.5 MW
Total Gross Gen: 827.0 MW	ML HVDC: 475.0 MW	Gross Gen + ML: 1302.0 MW	

Summer Ratings

Figure D-4

EEXS: 108.8 MW
EEXEB: 444.0 MW
ML HVDC: 475.0 MW
MAINLAND AT HASTINGS: 312.0 MW
HASTINGS FROM 88S,5S,2S: 439.7 MW
L-7011:178.8 MW
L-7012: 184.6 MW
L-7011 + L-7012: 363.4 MW

NB to NE: 806.7 MW
NB to QC: -300.1 MW
NSX 329.5 MW
CBX 679.7 MW
ONI 951.7 MW
ONS 608.5 MW
NB to PEI: 159.2 MW



Bus - Voltage (kV/pu)
Branch - MW/Mvar
Equipment - MW/Mvar
100.0%Rate A
1.050OV 0.970UV
kV: <=35.000 <=69.000 <=138.000 <=230.000 <=345.000 >345.000

2021 SUMMER PEAK: 2021SUM-1 - FULL WIND ON BACKBONE
DERIVED FROM UPDATE OF 2014 SERIES MMWG 2020 SUMMER PEAK
SAT, SEP 30 2017 19:18

Total Wind Gen: 303.7 MW	Gross Tupper 0.0 MW	Gross Wreck Cove 0.0 MW	Net NewPage Load 100.3 MW
Gross Lingan 260.0 MW	Gross Trenton 280.0 MW	Gross Gas Turbine 0.0 MW	Gross NewPage Load 145.3 MW
Gross Pt Aconi 175.0 MW	Gross Tuft's Cove 92.0 MW	Gross Small Hydro 74.3 MW	Total BMPC Load -0.5 MW
Total Gross Gen: 1185.0 MW	ML HVDC: 475.0 MW	Gross Gen + ML: 1660.0 MW	

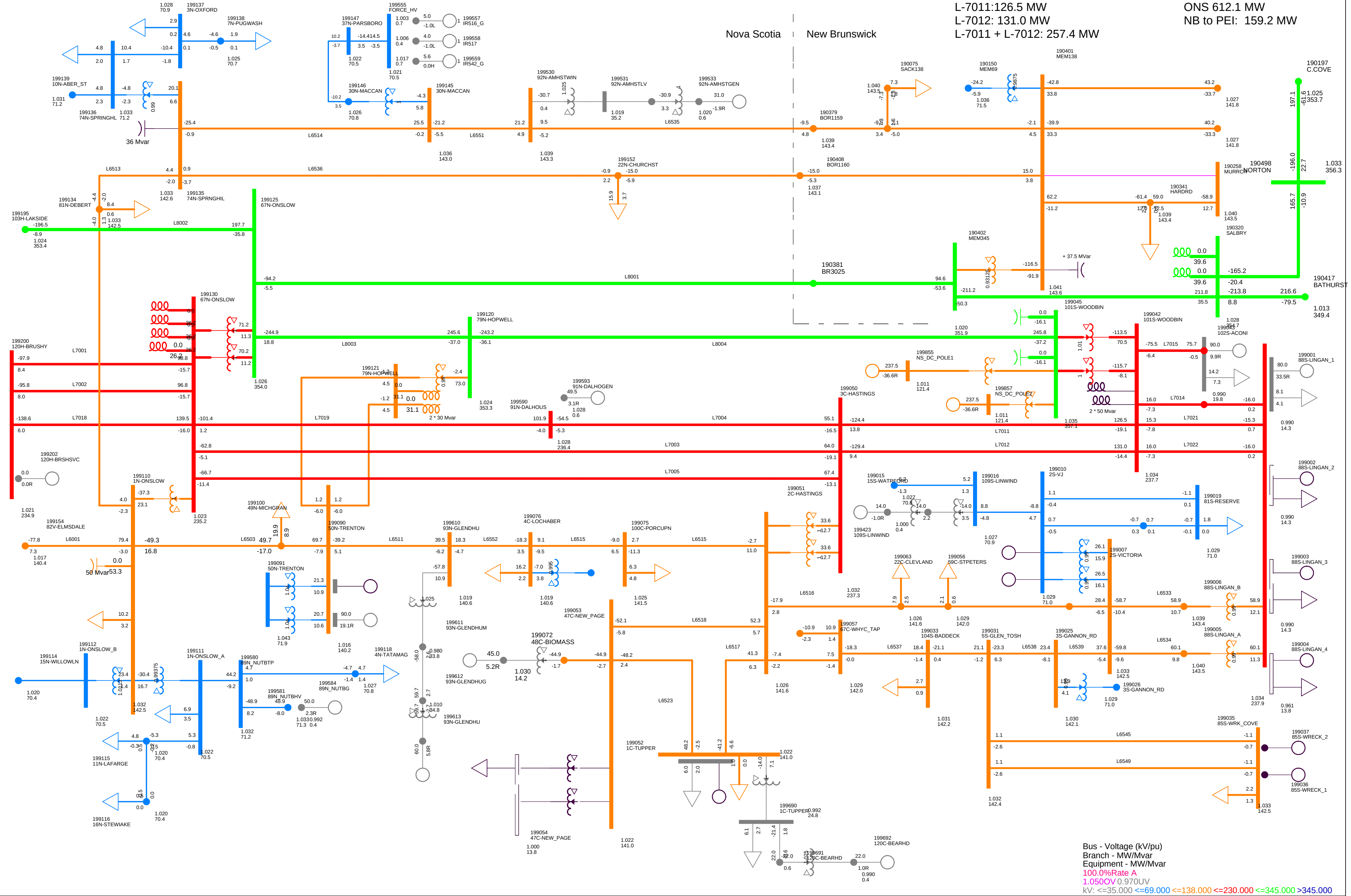
Summer Ratings

Includes 70% Distributed Generation modeled as Negative Load: -143.0 MW

Figure D-5

EEXS: 33.5 MW
EEXEB: 295.2 MW
ML HVDC: 475.0 MW
MAINLAND AT HASTINGS: 183.7 MW
HASTINGS FROM 88S,5S,2S: 306.9 MW
L-7011:126.5 MW
L-7012: 131.0 MW
L-7011 + L-7012: 257.4 MW

NB to NE: 807.1 MW
NB to QC: -300.1 MW
NSX -99.7 MW
CBX 429.5 MW
ONI 525.1 MW
ONS 612.1 MW
NB to PEI: 159.2 MW



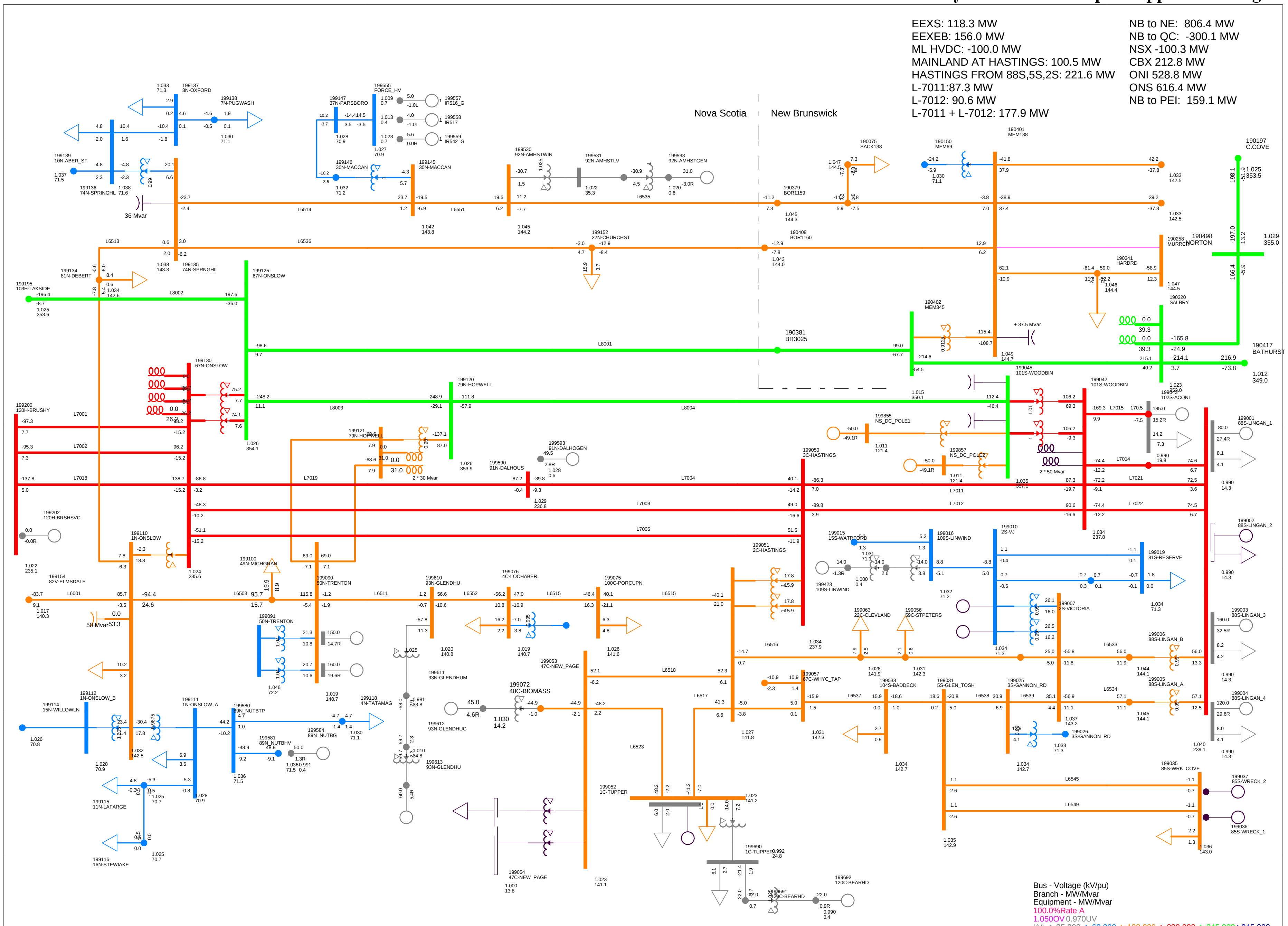
2021 SUMMER PEAK: 2021SUM-2 - FULL WIND ON BACKBONE
DERIVED FROM UPDATE OF 2014 SERIES MMWG 2020 SUMMER PEAK
SAT, SEP 30 2017 20:33

Total Wind Gen: 303.7 MW	Gross Tupper 0.0 MW	Gross Wreck Cove 0.0 MW	Net NewPage Load 100.3 MW
Gross Lingan 80.0 MW	Gross Trenton 90.0 MW	Gross Gas Turbine 0.0 MW	Gross NewPage Load 145.3 MW
Gross Pt Aconi 90.0 MW	Gross Tuft's Cove 88.0 MW	Gross Small Hydro 74.3 MW	Total BMPC Load -0.5 MW
Total Gross Gen: 726.0 MW	ML HVDC: 475.0 MW	Gross Gen + ML: 1201.0 MW	

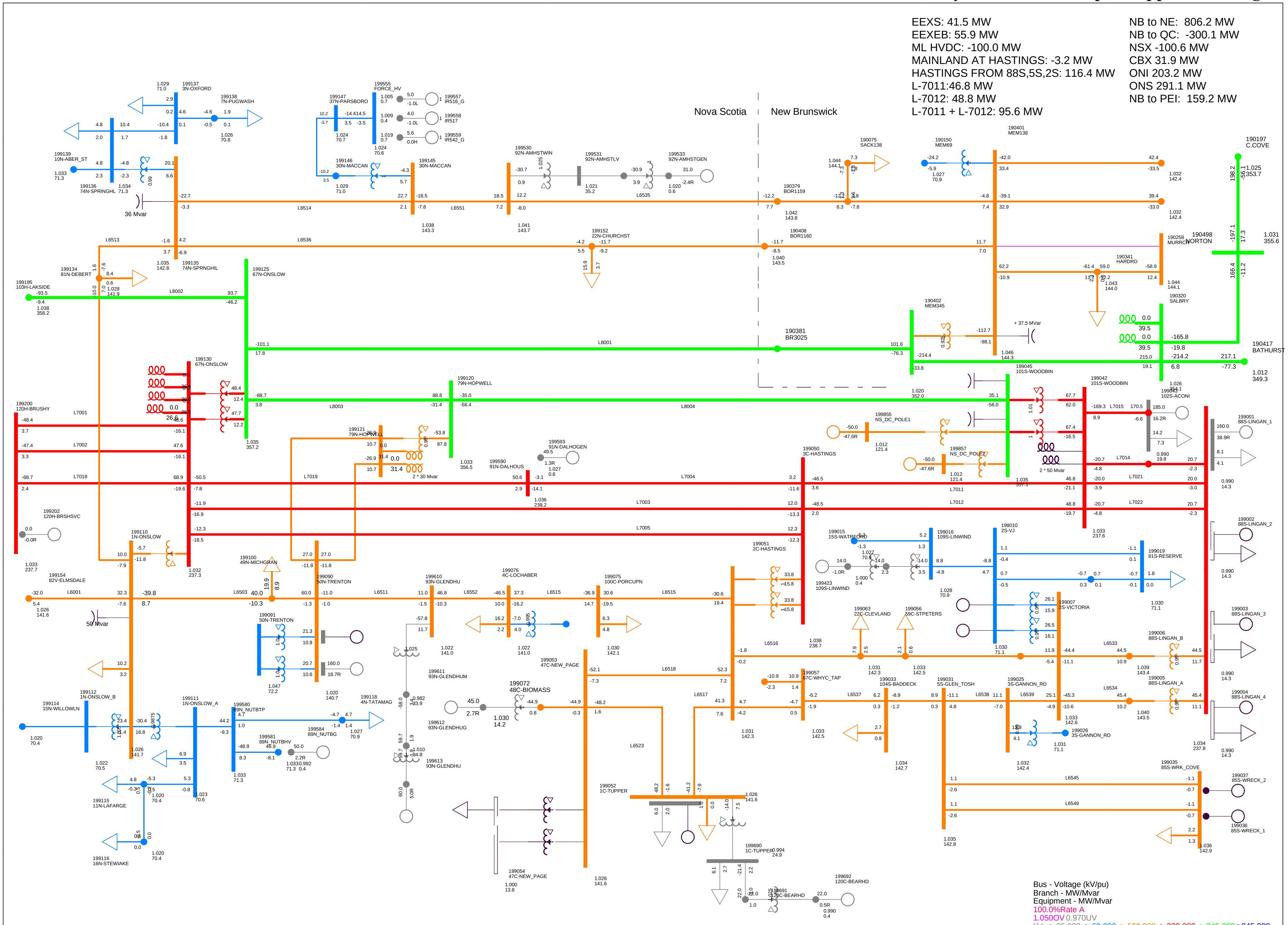
Summer Ratings

Includes 70% Distributed Generation modeled as Negative Load: -143.0 MW

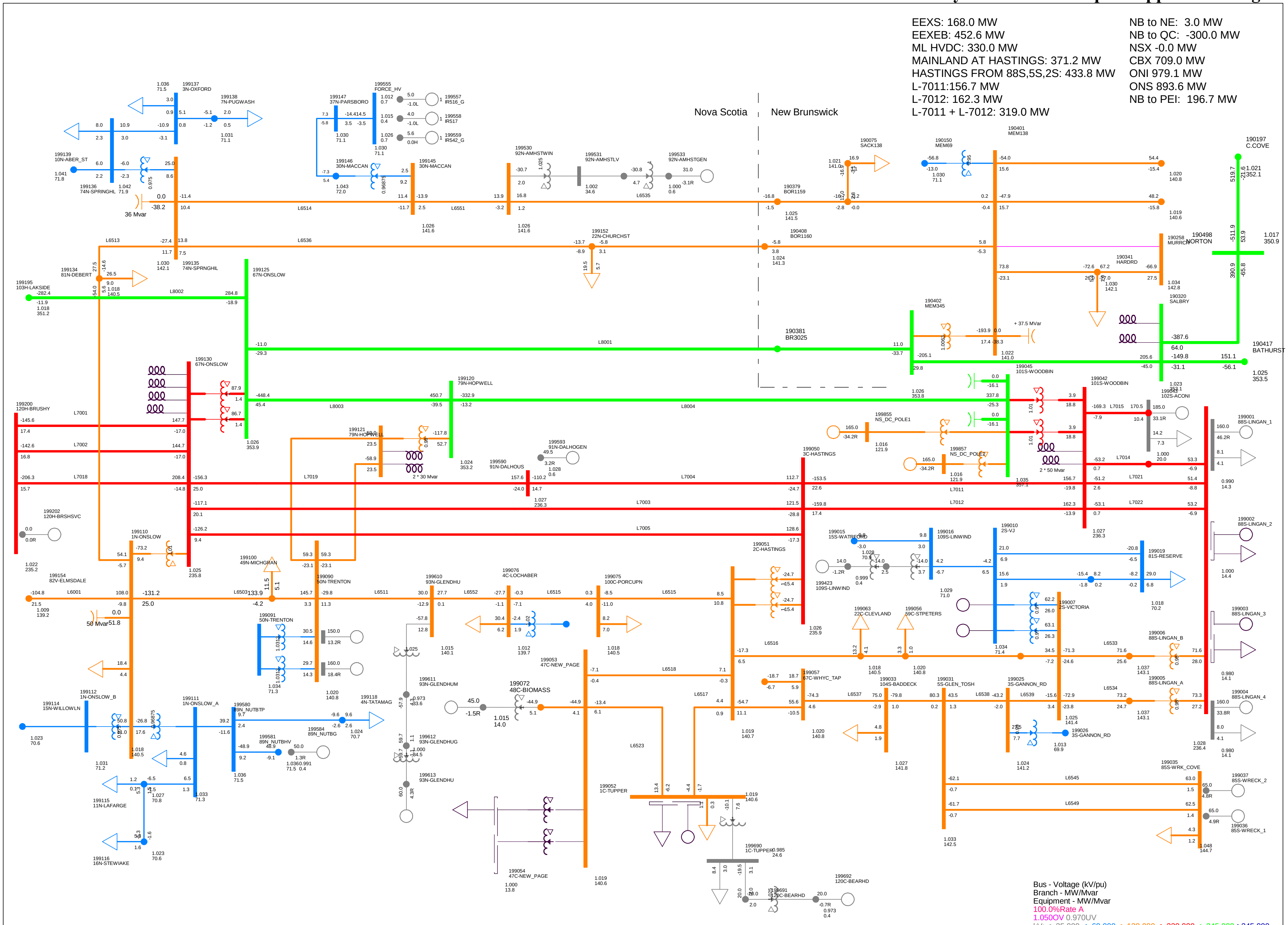
Figure D-6



2021 SUMMER PEAK: 2021SUM-3 - FULL WIND ON BACKBONE DERIVED FROM UPDATE OF 2014 SERIES MMWG 2020 SUMMER PEAK SAT, SEP 30 2017 20:55	Total Wind Gen: 303.7 MW Gross Lingan 360.0 MW Gross Pt Aconi 185.0 MW Total Gross Gen: 1317.0 MW	Gross Tupper 0.0 MW Gross Trenton 310.0 MW Gross Tuft's Cove 84.0 MW ML HVDC: -100.0 MW	Gross Wreck Cove 0.0 MW Gross Gas Turbine 0.0 MW Gross Small Hydro 74.3 MW Gross Gen + ML: 1217.0 MW	Net NewPage Load 100.3 MW Gross NewPage Load 145.3 MW Total BMPC Load -0.5 MW	Summer Ratings Includes 70% Distributed Generation modeled as Negative Load: -143.0 MW	Figure __D-7



2021 SUMMER PEAK: 2021SUM-3A - FULL WIND ON BACKBONE DERIVED FROM UPDATE OF 2014 SERIES MMWG 2020 SUMMER PEAK SAT, SEP 30 2017 21:39	Total Wind Gen: 303.7 MW Gross Lingan 160.0 MW Gross Pt Aconi 185.0 MW Total Gross Gen: 1294.0 MW	Gross Tupper 0.0 MW Gross Trenton 160.0 MW Gross Tuft's Cove 411.0 MW ML HVDC: -100.0 MW	Gross Wreck Cove 0.0 MW Gross Gas Turbine 0.0 MW Gross Small Hydro 74.3 MW Gross Gen + ML: 1194.0 MW	Net NewPage Load 100.3 MW Gross NewPage Load 145.3 MW Total BMPC Load -0.5 MW	Summer Ratings Includes 70% Distributed Generation modeled as Negative Load: -143.0 MW	Figure D-8

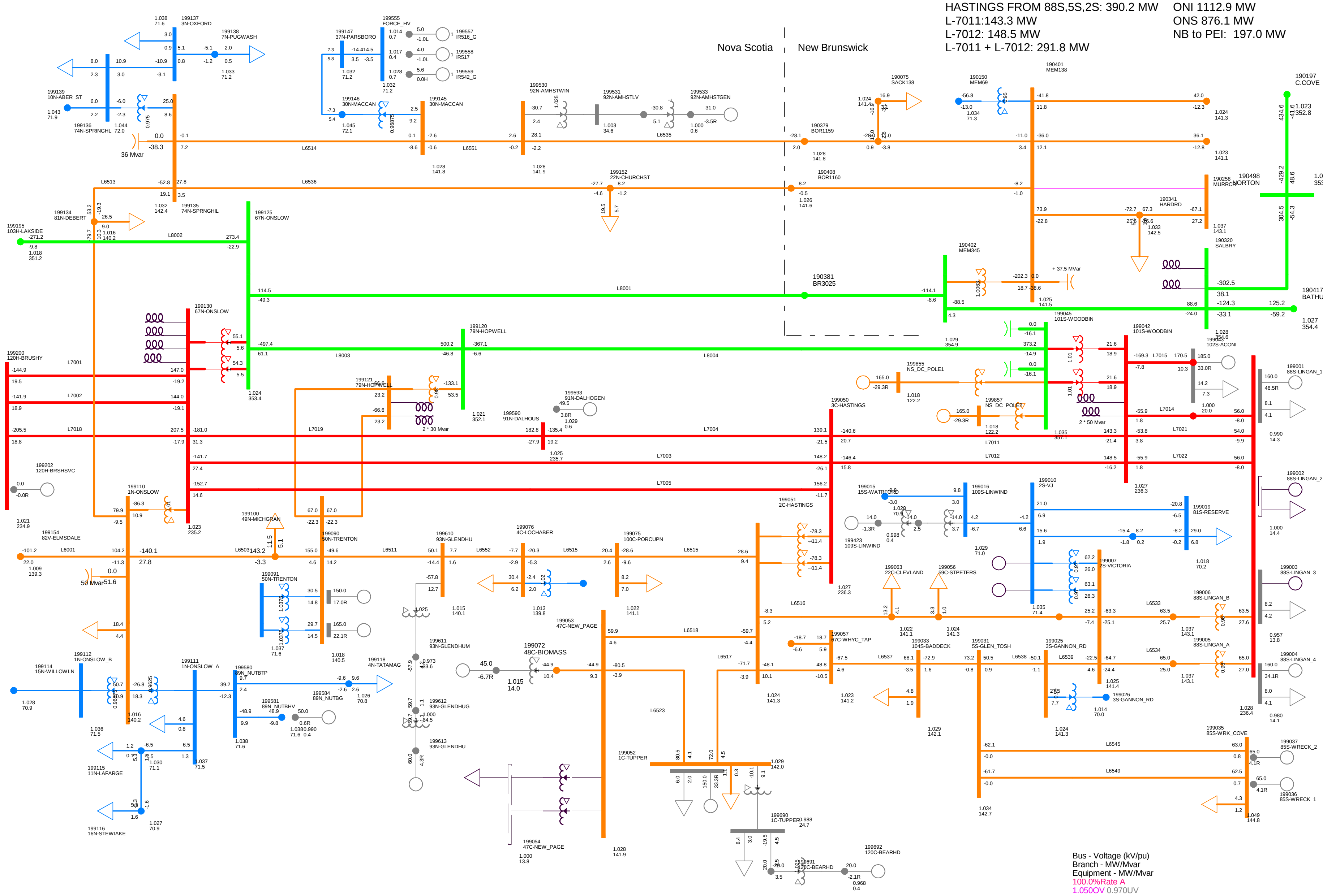


2021 WINTER PEAK: 2021WIN - FULL WIND ON BACKBONE DERIVED FROM UPDATE OF 2014 SERIES MMWG 2020 WINTER PEAK FRI, SEP 29 2017 21:51	Total Wind Gen: 301.7 MW Gross Lingan 320.0 MW Gross Pt Aconi 185.0 MW Total Gross Gen: 1665.4 MW	Gross Tupper 0.0 MW Gross Trenton 310.0 MW Gross Tuft's Cove 250.0 MW ML HVDC: 330.0 MW	Gross Wreck Cove 130.0 MW Gross Gas Turbine 15.0 MW Gross Small Hydro 177.7 MW Gross Gen + ML: 1995.4 MW	Net NewPage Load 20.5 MW Gross NewPage Load 65.5 MW Total BMPC Load -0.7 MW	Winter Ratings Includes 70% Distributed Generation modeled as Negative Load: -143.0 MW

Figure D-9

EEXS: 154.4 MW
EEXEB: 471.6 MW
ML HVDC: 330.0 MW
MAINLAND AT HASTINGS: 472.2 MW
HASTINGS FROM 88S,5S,2S: 390.2 MW
L-7011:143.3 MW
L-7012: 148.5 MW
L-7011 + L-7012: 291.8 MW

NB to NE: 0.6 MW
NB to QC: -300.0 MW
NSX 150.9 MW
CBX 845.3 MW
ONI 1112.9 MW
ONS 876.1 MW
NB to PEI: 197.0 MW



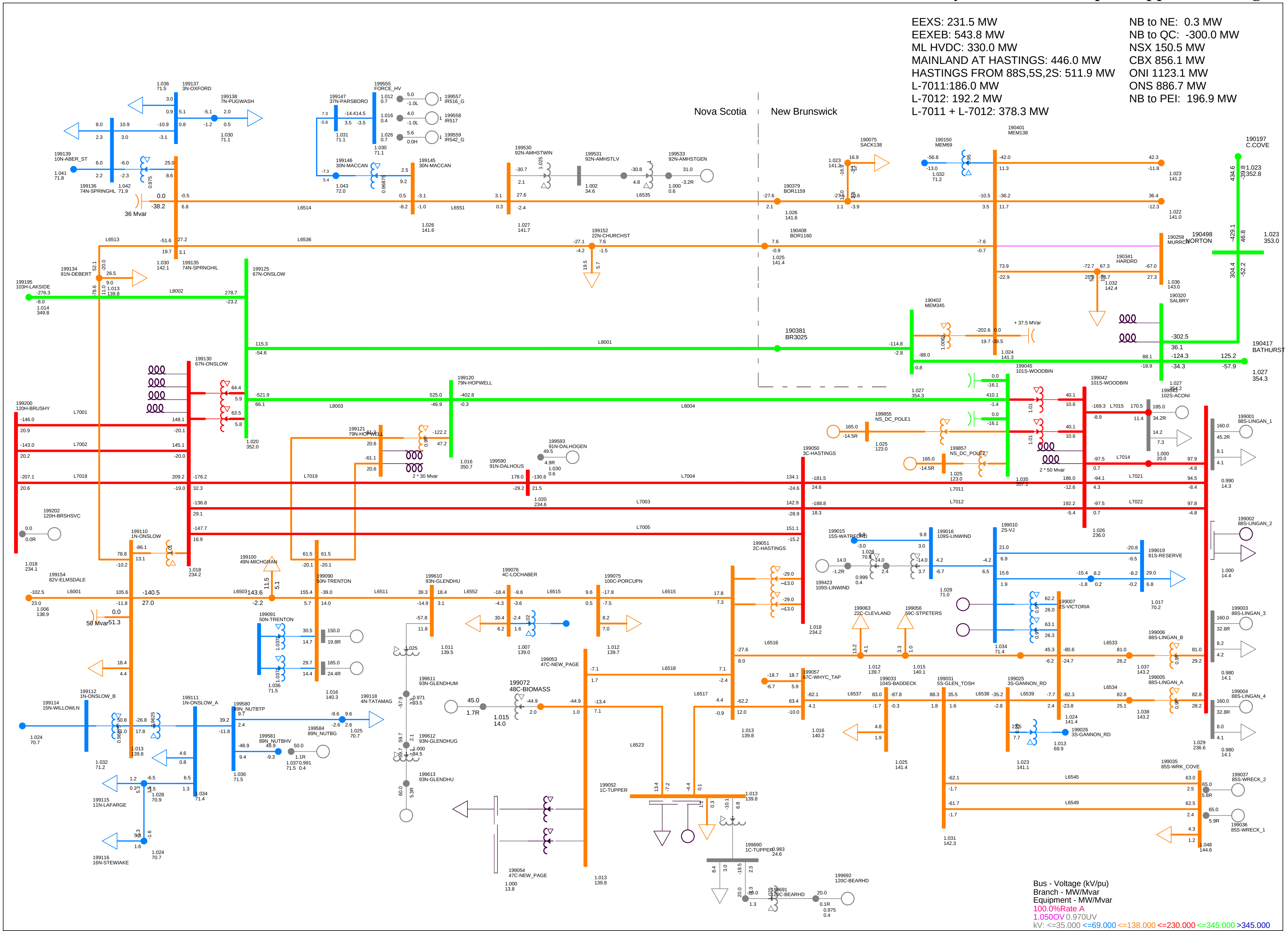
2021 WINTER PEAK: 2021WIN-1 - FULL WIND ON BACKBONE, NSX 150
DERIVED FROM UPDATE OF 2014 SERIES MMWG 2020 WINTER PEAK
FRI, SEP 29 2017 22:56

Total Wind Gen: 301.7 MW	Gross Tupper 150.0 MW	Gross Wreck Cove 130.0 MW	Net NewPage Load 20.5 MW
Gross Lingan 320.0 MW	Gross Trenton 315.0 MW	Gross Gas Turbine 15.0 MW	Gross NewPage Load 65.5 MW
Gross Pt Aconi 185.0 MW	Gross Tuft's Cove 267.0 MW	Gross Small Hydro 177.7 MW	Total BMPC Load -0.7 MW
Total Gross Gen: 1837.4 MW	ML HVDC: 330.0 MW	Gross Gen + ML: 2167.4 MW	

Winter Ratings

Includes 70% Distributed Generation modeled as Negative Load: -143.0 MW

Figure D-10



2021 WINTER PEAK: 2021WIN-1A - FULL WIND ON BACKBONE,
DERIVED FROM UPDATE OF 2014 SERIES MMWG 2020 WINTER PEAK
SAT, SEP 30 2017 8:58

Total Wind Gen: 301.7 MW	Gross Tupper 0.0 MW	Gross Wreck Cove 130.0 MW	Net NewPage Load 20.5 MW
Gross Lingan 480.0 MW	Gross Trenton 315.0 MW	Gross Gas Turbine 15.0 MW	Gross NewPage Load 65.5 MW
Gross Pt Aconi 185.0 MW	Gross Tuft's Cove 257.0 MW	Gross Small Hydro 177.7 MW	Total BMPC Load -0.7 MW
Total Gross Gen: 1837.4 MW	ML HVDC: 330.0 MW	Gross Gen + ML: 2167.4 MW	

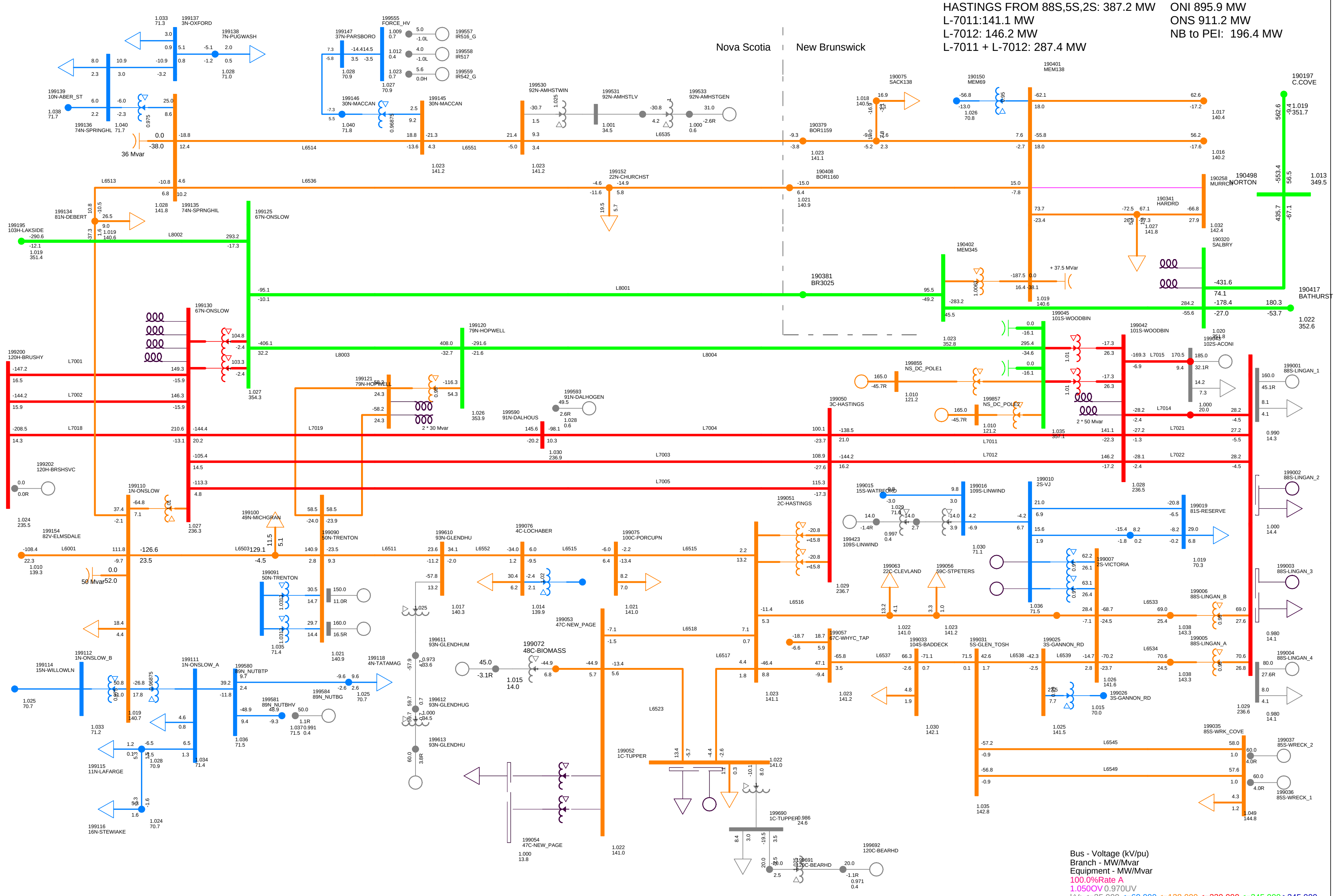
Winter Ratings

Includes 70% Distributed Generation modeled as Negative Load: -143.0 MW

Figure D-11

EEXS: 128.0 MW
EEXEB: 395.3 MW
ML HVDC: 330.0 MW
MAINLAND AT HASTINGS: 326.4 MW
HASTINGS FROM 88S,5S,2S: 387.2 MW
L-7011:141.1 MW
L-7012: 146.2 MW
L-7011 + L-7012: 287.4 MW

NB to NE: -0.7 MW
NB to QC: -300.0 MW
NSX -100.8 MW
CBX 621.9 MW
ONI 895.9 MW
ONS 911.2 MW
NB to PEI: 196.4 MW



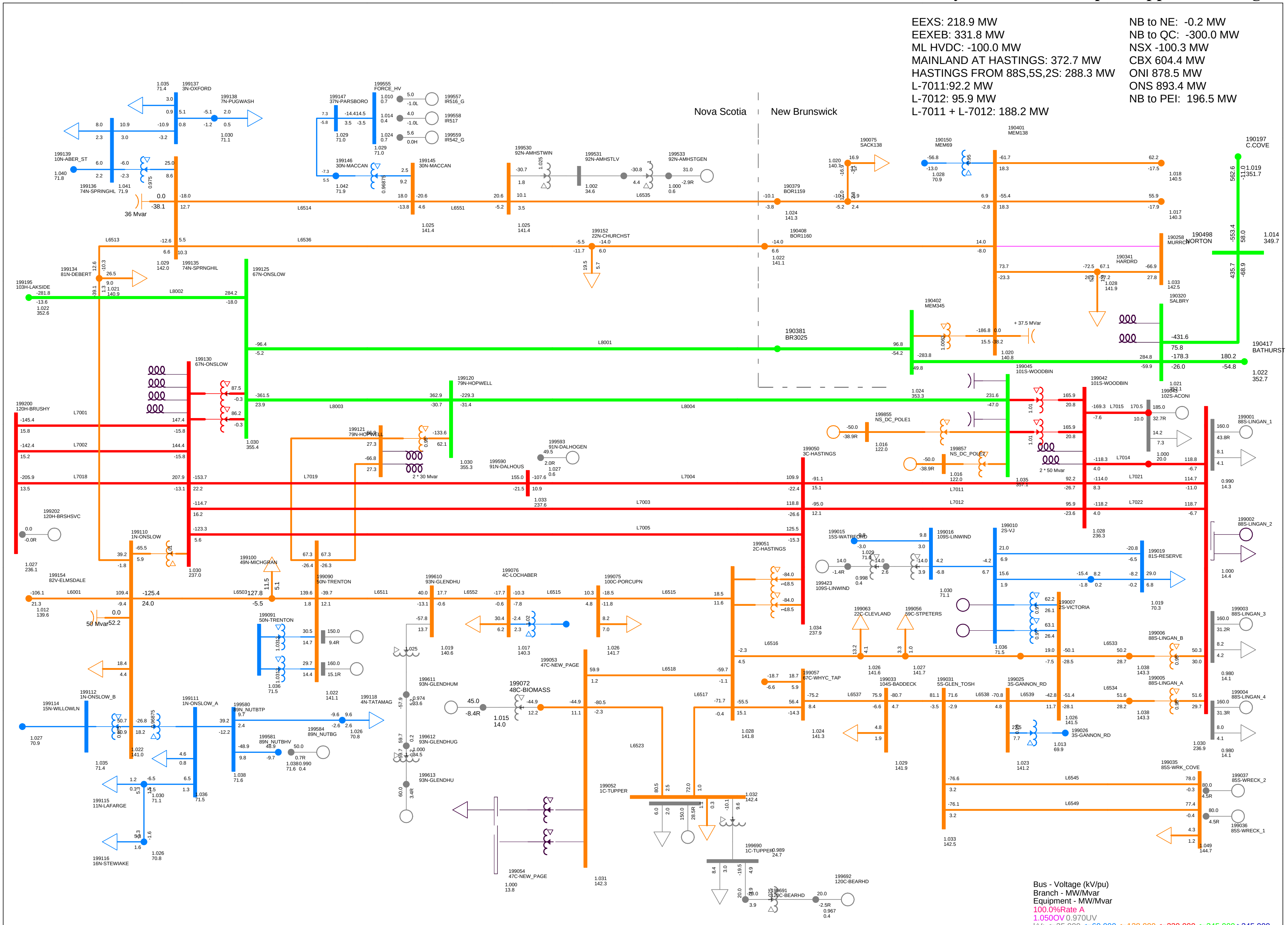
2021 WINTER PEAK: 2021WIN-2 - FULL WIND ON BACKBONE
DERIVED FROM UPDATE OF 2014 SERIES MMWG 2020 WINTER PEAK
SAT, SEP 30 2017 11:10

Total Wind Gen: 301.7 MW	Gross Tupper 0.0 MW	Gross Wreck Cove 120.0 MW	Net NewPage Load 20.5 MW
Gross Lingan 240.0 MW	Gross Trenton 310.0 MW	Gross Gas Turbine 15.0 MW	Gross NewPage Load 65.5 MW
Gross Pt Aconi 185.0 MW	Gross Tuft's Cove 233.0 MW	Gross Small Hydro 177.7 MW	Total BMPC Load -0.7 MW
Total Gross Gen: 1558.4 MW	ML HVDC: 330.0 MW	Gross Gen + ML: 1888.4 MW	

Winter Ratings

Includes 70% Distributed Generation modeled as Negative Load: -143.0 MW

Figure D-12



2021 WINTER PEAK: 2021WIN-3 - FULL WIND ON BACKBONE
DERIVED FROM UPDATE OF 2014 SERIES MMWG 2020 WINTER PEAK
SAT, SEP 30 2017 12:24

Total Wind Gen: 301.7 MW	Gross Tupper 150.0 MW	Gross Wreck Cove 160.0 MW	Net NewPage Load 20.5 MW
Gross Lingan 480.0 MW	Gross Trenton 310.0 MW	Gross Gas Turbine 15.0 MW	Gross NewPage Load 65.5 MW
Gross Pt Aconi 185.0 MW	Gross Tuft's Cove 250.0 MW	Gross Small Hydro 177.7 MW	Total BMPC Load -0.7 MW
Total Gross Gen: 2005.4 MW	ML HVDC: -100.0 MW	Gross Gen + ML: 1905.4 MW	

Winter Ratings

Includes 70% Distributed Generation modeled as Negative Load: -143.0 MW

Figure D-13

Appendix E

Steady State Results

Elements							Load Flow Contingencies		2021 Load Flow Cases Studied												
Station	Bkr	line	Bus	Xfmr	Var	Gen	Load Flow	SPS	2021WIN (Normal)	2021WIN-1 (NSX:150MW)	2021WIN-1a (NSX:150MW)	2021WIN-2 (NSX:-100MW)	2021WIN-3 (NSX:-100MW NS-NL: 100MW)	2021SUM (Normal)	2021SUM-1 (NSX:330MW)	2021SUM-2 (NSX:-100MW)	2021SUM-3 (NSX:-100MW NS-NL: 100MW)	2021SUM-3a (NSX:-100MW NS-NL: 100MW)	2021LL (Normal)	2021LL-1 (NSX:330MW)	2021LL-2 (NSX:-100MW)
88S 230kV	x						88S, 88S-710	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						88S, 88S-711	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						88S, 88S-712	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						88S, 88S-713	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						88S, 88S-720	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						88S, 88S-721	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						88S, 88S-722	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						88S, 88S-723, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
							88S, 88S-723, G8	G8 BBU	-	-	-	-	-	-	-	-	-	-	-	-	-
		x					88S, L-7014	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					88S, L-7021, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					88S, L-7022, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
				x			88S, 88S-T71	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
101S 230kV	x						101S, 101S-701, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						101S, 101S-702, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						101S, 101S-703	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						101S, 101S-704, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						101S, 101S-705, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						101S, 101S-706, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						101S, 101S-711, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						101S, 101S-712	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						101S, 101S-713	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					101S, L-7011, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					101S, L-7012, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					101S, L-7015	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
101S 345kV	x						101S, 101S-811	-	ok	-	-	-	-	-	-	-	-	-	ok	ok	ok
	x						101S, 101S-812, G0	-	ok	ok	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
							101S, 101S-812, G5	G5 CBX Lo	-	-	ok	-	-	-	-	-	-	-	-	-	-
							101S, 101S-812, G6	G6 CBX Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
	x						101S, 101S-813, G0	-	ok	ok	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
							101S, 101S-813, G5	G5 CBX Lo	-	-	ok	-	-	-	-	-	-	-	-	-	-
							101S, 101S-813, G6	G6 CBX Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
	x						101S, 101S-814	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						101S, 101S-816	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					101S, ML-POLE1	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					101S, ML-BIPOLE	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	It. Limit	ok
		x					101S, L-8004, G0	-	ok	ok	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
							101S, L-8004, G5	G5 CBX Lo	-	-	ok	-	-	-	-	-	-	-	-	-	-
							101S, L-8004, G6	G6 CBX Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
				x	x		101S, 101S-T81	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok

Elements							Load Flow Contingencies		2021 Load Flow Cases Studied												
Station	Bkr	line	Bus	Xfmr	Var	Gen	Load Flow	SPS	2021WIN (Normal)	2021WIN-1 (NSX:150MW)	2021WIN-1a (NSX:150MW)	2021WIN-2 (NSX:-100MW)	2021WIN-3 (NSX:-100MW NS-NL: 100MW)	2021SUM (Normal)	2021SUM-1 (NSX:330MW)	2021SUM-2 (NSX:-100MW)	2021SUM-3 (NSX:-100MW NS-NL: 100MW)	2021SUM-3a (NSX:-100MW NS-NL: 100MW)	2021LL (Normal)	2021LL-1 (NSX:330MW)	2021LL-2 (NSX:-100MW)
2C 138kV		x					2C, L-6515	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					2C, L-6516	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					2C, L-6517	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					2C, L-6518	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					2C, L-6537, G0	-	ok	ok	ok	ok	-	ok	ok	ok	ok	ok	ok	ok	ok
							2C, L-6537, G20	WC L6538 o/l	-	-	-	-	ok	-	-	-	-	-			
			x				2C, 2C-B61, G0	-	ok	ok	ok	ok	-	ok	ok	ok	ok	ok	ok	ok	ok
							2C, 2C-B61, G20	WC L6538 o/l	-	-	-	-	ok	-	-	-	-	-	-	-	-
			x				2C, 2C-B62	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
3C 230kV	x						3C, 3C-710, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						3C, 3C-711, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						3C, 3C-712, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						3C, 3C-713, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						3C, 3C-714, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						3C, 3C-715, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						3C, 3C-716, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						3C, 3C-720, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					3C, L-7003, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					3C, L-7004, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					3C, L-7005, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
				x			3C, 3C-T71	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
1N 138kV	x						1N, 1N-600	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						1N, 1N-601	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						1N, 1N-613	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					1N, L-6001	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					1N, L-6503	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					1N, L-6513	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
			x				1N, 1N-B61	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
			x				1N, 1N-B62	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
67N 230kV	x						67N, 67N-701, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						67N, 67N-702, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						67N, 67N-703, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						67N, 67N-704, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						67N, 67N-705, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						67N, 67N-706, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						67N, 67N-710, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						67N, 67N-711, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						67N, 67N-712, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						67N, 67N-713, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					67N, L-7001	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					67N, L-7002	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					67N, L-7018	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					67N, L-7019	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
				x			67N, 67N-T71	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok

Elements							Load Flow Contingencies		2021 Load Flow Cases Studied												
Station	Bkr	line	Bus	Xfmr	Var	Gen	Load Flow	SPS	2021WIN (Normal)	2021WIN-1 (NSX:150MW)	2021WIN-1a (NSX:150MW)	2021WIN-2 (NSX:-100MW)	2021WIN-3 (NSX:-100MW NS-NL: 100MW)	2021SUM (Normal)	2021SUM-1 (NSX:330MW)	2021SUM-2 (NSX:-100MW)	2021SUM-3 (NSX:-100MW NS-NL: 100MW)	2021SUM-3a (NSX:-100MW NS-NL: 100MW)	2021LL (Normal)	2021LL-1 (NSX:330MW)	2021LL-2 (NSX:-100MW)
67N 345kV							67N, 67N-811, G0	-	ok	-	-	ok	ok	ok	-	ok	ok	ok	ok	ok	ok
	x						67N, 67N-811, G5	G5 ONI Lo	-	ok	ok	-	-	-	ok	-	-	-	-	-	-
							67N, 67N-811, G6	G5 ONI Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
	x						67N, 67N-812	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						67N, 67N-813	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
							67N, 67N-814, G0	-	ok	-	-	ok	ok	ok	-	ok	ok	ok	ok	-	ok
	x						67N, 67N-814, NSX1	G9 NSX Lo	-	ok	ok	-	-	-	-	-	-	-	-	-	-
							67N, 67N-814, NSX2	G9 NSX Hi	-	-	-	-	-	-	ok	-	-	-	-	It. Limit	-
							67N, 67N-815, G0	-	ok	-	-	ok	ok	ok	-	ok	ok	ok	ok	-	ok
	x						67N, 67N-815, NSX1	G9 NSX Lo	-	ok	ok	-	-	-	-	-	-	-	-	-	-
							67N, 67N-815, NSX2	G9 NSX Hi	-	-	-	-	-	-	ok	-	-	-	-	It. Limit	-
							67N, 67N-816, G0	-	ok	-	-	ok	ok	ok	-	ok	ok	ok	ok	ok	ok
	x						67N, 67N-816, G5	G5 ONI Lo	-	ok	ok	-	-	-	ok	-	-	-	-	-	-
							67N, 67N-816, G6	G6 ONI Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
							67N, L-8001, G0	-	ok	-	-	ok	ok	ok	-	ok	ok	ok	ok	-	ok
		x					67N, L-8001, G5	G9 NSX Lo	-	ok	ok	-	-	-	-	-	-	-	-	-	-
							67N, L-8001, G6	G9 NSX Hi	-	-	-	-	-	-	ok	-	-	-	-	It. Limit	-
		x					67N, L-8002	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
				x	x		67N, 67N-T81	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
79N 138kV							79N, 79N-601	-	ok	ok	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						79N, 79N-601, G5	G5 CBX Lo	-	-	ok	-	-	-	-	-	-	-	-	-	-
							79N, 79N-601, G6	G6 CBX Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
							79N, 79N-606	-	ok	ok	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						79N, 79N-606, G5	G5 CBX Lo	-	-	ok	-	-	-	-	-	-	-	-	-	-
							79N, 79N-606, G6	G6 CBX Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
		x					79N, L-6507	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					79N, L-6508	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
79N 345kV							79N, 79N-803, G0	-	ok	ok	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						79N, 79N-803, G5	G5 CBX Lo	-	-	ok	-	-	-	-	-	-	-	-	-	-
							79N, 79N-803, G6	G6 CBX Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
							79N, 79N-810, G0	-	ok	ok	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						79N, 79N-810, G5	G5 CBX Lo	-	-	ok	-	-	-	-	-	-	-	-	-	-
							79N, 79N-810, G6	G6 CBX Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
							79N, L-8003, G0	-	ok	-	-	ok	ok	ok	-	ok	ok	ok	ok	ok	ok
		x					79N, L-8003, G5	G5 ONI Lo	-	ok	ok	-	-	-	ok	-	-	-	-	-	-
							79N, L-8003, G6	G6 ONI Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
							79N, 79N-T81, G0	-	ok	ok	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
				x	x		79N, 79N-T81, G5	G5 CBX Lo	-	-	ok	-	-	-	-	-	-	-	-	-	-
							79N, 79N-T81, G6	G6 CBX Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
91N 230kV	x						91N, 91N-701	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						91N, 91N-702	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						91N, 91N-703	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
			x				91N, 91N-B71	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok

Elements							Load Flow Contingencies		2021 Load Flow Cases Studied												
Station	Bkr	line	Bus	Xfmr	Var	Gen	Load Flow	SPS	2021WIN (Normal)	2021WIN-1 (NSX:150MW)	2021WIN-1a (NSX:150MW)	2021WIN-2 (NSX:-100MW)	2021WIN-3 (NSX:-100MW NS-NL: 100MW)	2021SUM (Normal)	2021SUM-1 (NSX:330MW)	2021SUM-2 (NSX:-100MW)	2021SUM-3 (NSX:-100MW NS-NL: 100MW)	2021SUM-3a (NSX:-100MW NS-NL: 100MW)	2021LL (Normal)	2021LL-1 (NSX:330MW)	2021LL-2 (NSX:-100MW)
DCT		x					DCT, L-6507][L-6508	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					DCT, L-6534][L-7021	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					DCT, L-7003][L-7004, G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
							DCT, L-7003][L-7004, G3	G4 BBU 1	-	-	-	-	-	-	-	-	-	-	-	-	-
		x					DCT, L-7008][L-7009	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					DCT, L-7009][L-8002	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok

Appendix F

Stability Results

2016 BPS/BES Elements							2021 Dynamics Contingencies		Contingencies Studied												
Station	Bkr	line	Bus	Xfmr	Var	Gen	Dynamics	SPS	2021WIN (Normal)	2021WIN-1 (NSX:150MW)	2021WIN-1a (NSX:150MW)	2021WIN-2 (NSX:-100MW)	2021WIN-3 (NSX:-100MW)	2021SUM (NSX:0MW, NLX: 475MW)	2021SUM-1 (NSX:330MW, NLX: 475MW)	2021SUM-2 (NSX:-100MW, NLX: 475MW)	2021SUM-3 (NSX:-100MW, NLX: -100MW)	2021SUM-3a (NSX:-100MW, NLX: -100MW)	2021LL (NSX: 0MW, NLX: 475MW)	2021LL-1 (NSX:330MW, NLX: 475MW)	2021LL-2 (NSX:-100MW, NLX: -100MW)
88S 230kV	x						88S BBU 88S-713	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						88S BBU 88S-720	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						88S BBU 88S-721	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						88S BBU 88S-722	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						88S BBU 88S-723 G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					88S L7014 3PH Fault	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					88S L7021 3PH Fault	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					88S L7022 3PH Fault	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
101S 230kV	x						101S BBU 101S-701 G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						101S BBU 101S-702 G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						101S BBU 101S-706	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						101S BBU 101S-712	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					101S L7011 3PH Fault G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					101S L7012 3PH Fault G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					101S L7014 3PH Fault	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					101S L7021 3PH Fault	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					101S L7022 3PH Fault	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
101S 345kV	x						101S BBU 101S-811	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						101S BBU 101S-812 G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
							101S BBU 101S-812 G5	G5 CBX Lo	-	-	-	-	-	-	-	-	-	-	-	-	-
							101S BBU 101S-812 G6	G6 CBX Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
	x						101S BBU 101S-813 G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
							101S BBU 101S-813 G5	G5 CBX Lo	-	-	-	-	-	-	-	-	-	-	-	-	-
							101S BBU 101S-813 G6	G6 CBX Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
					x		101S, MLBIPOLE	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					101S L8004 3PH Fault G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
							101S L8004 3PH Fault G5	G5 CBX Lo	-	-	-	-	-	-	-	-	-	-	-	-	-
							101S L8004 3PH Fault G6	G6 CBX Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
2C 138kV			x				2C BUS 2C-B62 3PH Fault	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
3C 230kV	x						3C BBU 3C-711 G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						3C BBU 3C-715 G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					3C L7005 3PH Fault G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					3C L7012 3PH Fault G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
1N 138kV	x						1N BKR 1N-600 1P	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						1N BKR 1N-601	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						1N BBU 1N-613	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					1N L6001 3PH Fault	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					1N L6503 3PH Fault	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					1N L6513 3PH Fault	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok

2016 BPS/BES Elements							2021 Dynamics Contingencies		Contingencies Studied												
Station	Bkr	line	Bus	Xfmr	Var	Gen	Dynamics	SPS	2021WIN (Normal)	2021WIN-1 (NSX:150MW)	2021WIN-1a (NSX:150MW)	2021WIN-2 (NSX:-100MW)	2021WIN-3 (NSX:-100MW)	2021SUM (NSX:0MW, NLX: 475MW)	2021SUM-1 (NSX:330MW, NLX: 475MW)	2021SUM-2 (NSX:-100MW, NLX: 475MW)	2021SUM-3 (NSX:-100MW, NLX: -100MW)	2021SUM-3a (NSX:-100MW, NLX: -100MW)	2021LL (NSX: 0MW, NLX: 475MW)	2021LL-1 (NSX:330MW, NLX: 475MW)	2021LL-2 (NSX:-100MW, NLX: -100MW)
67N 230kV	x						67N BBU 67N-711	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						67N BBU 67N-712	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						67N BBU 67N-713	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					67N L7005 3PH Fault G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
							67N BBU 67N-811 G0	-	ok	-	-	ok	ok	ok	-	ok	ok	ok	ok	ok	ok
		x					67N L7005 3PH Fault G3	-	-	ok	ok	-	-	-	-	-	-	-	-	-	-
67N 345kV	x						67N BBU 67N-811 G5	G5 ONI Lo	-	ok	ok	-	-	-	ok	-	-	-	-	-	-
							67N L7018 3PH Fault	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
							67N BBU 67N-811 G6	G5 ONI Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
	x						67N BBU 67N-813	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
	x						67N BBU 67N-814 G0	-	ok	-	-	ok	ok	ok	-	ok	ok	ok	ok	-	ok
							67N BBU 67N-814 NSX1	G9 NSX Lo	-	ok	ok	-	-	-	-	-	-	-	-	-	-
							67N BBU 67N-814 NSX2	G9 NSX Hi	-	-	-	-	-	-	ok	-	-	-	-	ok	-
		x					67N L8001 3PH Fault G0	-	ok	-	-	ok	ok	ok	-	ok	ok	ok	ok	-	ok
							67N L8001 3PH Fault NSX1	G9 NSX Lo	-	ok	ok	-	-	-	-	-	-	-	-	-	-
							67N L8001 3PH Fault NSX2	G9 NSX Hi	-	-	-	-	-	-	ok	-	-	-	-	ok	-
							67N L8001 3PH Fault NSI	G10 NSI	-	-	-	-	-	-	-	-	-	-	-	-	-
		x					67N L8002 3PH Fault	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					67N L8003 3PH Fault G0	-	ok	-	-	ok	ok	ok	-	ok	ok	ok	ok	ok	ok
							67N L8003 3PH Fault G5	G5 ONI Lo	-	ok	ok	-	-	-	ok	-	-	-	-	-	-
							67N L8003 3PH Fault G6	G6 ONI Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
79N 138kV	x						79N BBU 79N-601 G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
							79N BBU 79N-601 G5	G5 CBX Lo	-	-	-	-	-	-	-	-	-	-	-	-	-
							79N BBU 79N-601 G6	G6 CBX Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
		x					79N L6507 3PH Fault	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
79N 345kV	x						79N BBU 79N-803 G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
							79N BBU 79N-803 G5	G5 CBX Lo	-	-	-	-	-	-	-	-	-	-	-	-	-
							79N BBU 79N-803 G6	G6 CBX Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
	x						79N BBU 79N-810 G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
							79N BBU 79N-810 G5	G5 CBX Lo	-	-	-	-	-	-	-	-	-	-	-	-	-
							79N BBU 79N-810 G6	G6 CBX Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
		x					79N L8003 3PH Fault G0	-	ok	-	-	ok	ok	ok	-	ok	ok	ok	ok	ok	ok
							79N L8003 3PH Fault G5	G5 ONI Lo	-	ok	ok	-	-	-	ok	-	-	-	-	-	-
							79N L8003 3PH Fault G6	G6 ONI Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
		x					79N L8004 3PH Fault G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
							79N L8004 3PH Fault G5	G5 CBX Lo	-	-	-	-	-	-	-	-	-	-	-	-	-
							79N L8004 3PH Fault G6	G6 CBX Hi	-	-	-	-	-	-	-	-	-	-	-	-	-
				x			79N T81 HV Fault G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
							79N T81 HV Fault G5	G5 CBX Lo	-	-	-	-	-	-	-	-	-	-	-	-	-
							79N T81 HV Fault G6	G6 CBX Hi	-	-	-	-	-	-	-	-	-	-	-	-	-

2016 BPS/BES Elements							2021 Dynamics Contingencies		Contingencies Studied												
Station	Bkr	line	Bus	Xfmr	Var	Gen	Dynamics	SPS	2021WIN (Normal)	2021WIN-1 (NSX:150MW)	2021WIN-1a (NSX:150MW)	2021WIN-2 (NSX:-100MW)	2021WIN-3 (NSX:-100MW)	2021SUM (NSX:0MW, NLX: 475MW)	2021SUM-1 (NSX:330MW, NLX: 475MW)	2021SUM-2 (NSX:-100MW, NLX: 475MW)	2021SUM-3 (NSX:-100MW, NLX: -100MW)	2021SUM-3a (NSX:-100MW, NLX: -100MW)	2021LL (NSX: 0MW, NLX: 475MW)	2021LL-1 (NSX:330MW, NLX: 475MW)	2021LL-2 (NSX:-100MW, NLX: -100MW)
Dbl Cct TOWERS		x					DCT L6507][L6508 79N	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					DCT L6534][L7021	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					DCT L7003][L7004 G0	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					DCT L7008][L7009	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					DCT L7009][L8002	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
NB 410N		x					410N L3006 3PH Fault	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
		x					410N L8001 3PH Fault	-	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok

Appendix G

Stability Results 2021LL Cases

Appendix H

Stability Results 2021SUM Cases

Appendix I

Stability Results 2021WIN Cases