Memorandum

TO: NSPI

CC: STEVE PRONKO, VINCENT MUSCO

FROM: BOB FAGAN, RACHEL WILSON, DEVI GLICK, SHELLEY KWOK

DATE: MARCH 3, 2020

RE: COMMENTS ON NSPI 2020 IRP ANALYSIS PLAN AND ASSUMPTIONS

This memo provides draft comments on the Analysis Plan and the Assumptions for the 2020 NSP IRP. These comments include referencing the extent to which NSPI has or has not yet addressed the recommendations from Synapse's Generation Utilization and Optimization Study, and from the Bates/White Fuel Audit concerns, as per the NS UARB's letter of October 2018 addressing the IRP process.[1]

Summary – Identification of Key Elements

The following identifies our core comments on key Scenario Analysis Plan and Assumptions elements. The memo provides supporting detail on these and other elements.

- **Scenario Analysis plan**: Number and key driving elements of scenario/resource strategy pairs for preliminary modeling runs. We also note the value of iterative techniques that may be employed in the early modeling stages to ensure consistency (e.g., prevent excessively low or high LOLE values after an initial optimal plan for any given scenario).
- **Carbon emissions modeling in Plexos**: Emissions constraints in Plexos, and how the economics around NS and Federal CA GHG policies are appropriately modeled, especially the Sustainable Development Goals Act (SDGA), the Cap and Trade regulatory framework, and the effective presence of a cost of carbon for marginal emissions in the Province.
- **Coal unit economic retirement in Plexos**. Endogenous retirement structure in Plexos to allow for full economic test of retention vs. replacement for thermal fleet units.
- **ELCC for Wind/Storage portfolio effect**. ELCC for Wind/Storage combinations. Relationship to how the PRM is set in the model.

[1] NS UARB Letter, Case M08059, October 5, 2018.

- **Net Load scenarios**: Load permutations incorporating different levels of energy efficiency, and electrifications; treatment of demand response, and use of load shape parameters to distinguish temporal patterns of incremental EV load and potentially incremental heating/industrial sector electrification load.

- **Resource costs**: Underlying battery energy storage, wind and solar cost assumptions.

- **Model RE build limitations**: Wind build limitations in model / intertie assumptions.

Scenario Analysis Plan

Overall

Based on NSPI's "Analysis Plan Discussion" (1/7/2020) and the "2020 Integrated Resource Plan Draft Scenarios and Modeling Plan" (2/26/2020), Synapse supports the overall *approach* under consideration: to define a set of candidate scenarios from which "optimal portfolios" can be determined by using the PLEXOS LT module to optimize a resource build, given underlying parameters. The use of the Plexos LT tool to optimize resource selection will be complemented with use of the E3 Resolve model, a reduced form capacity expansion model, to determine a path for inclusion of, for example, certain CT resources and the Mersey hydro resource.[2] As long as consistent, transparent inputs are used, and data made available for review, Synapse does not oppose the use of the RESOLVE tool to aid in an efficient process.

The approach also includes the use of E3's RECAP tool in the "Reliability Screening" phase to assess the overall reliability of a preliminary portfolio.[3] This part of the analytical process could be very important to resolve any issues that might arise concerning whether a preliminary portfolio exhibits loss-of-load-expectation values that are well below (or well above) the accepted one-day-in-ten (or 0.1/year LOLE) reliability/resource adequacy criteria. For example, if the parameters used as inputs to the PLEXOS LT module lead to an 'overbuild' of capacity resources, testing the portfolios via RECAP could lead to input parameter adjustment to ensure the resulting PLEXOS build doesn't result in, e.g., "too much" resource adequacy (as measured by the LOLE metrics). This could imply an adjustment either to a planning reserve margin (PRM) constraint in Plexos, or an adjustment to the ELCC values provided as inputs for certain resources or resource portfolio groupings. Synapse supports the efficient use of iterating model results and input parameters in the initial stages of the process and would expect ongoing discussion with NSPI to ensure this methodology is appropriately utilized.

[2] As discussed at the 2/27/2020 stakeholder session (Mersey), and as discussed with NSPI after the 1/28/2020 stakeholder session (CTs).

[3] NSPI noted this in the 2/27/2020 presentation. Also, in the Pre-IRP Deliverables Report, NSPI notes the reasons why such iteration may be important: "The PRM is dependent on the composition of a portfolio; changes in the resource mix can trigger changes in the PRM requirement. Accordingly, NS Power plans to incorporate a proposal for iterating on the PRM calculation in the Analysis Plan, particularly for portfolios with significant resource differences (e.g. high levels of renewables or major unit retirements), to provide insight on how the required PRM may change with different resource mixes." Page 11.

Potential Additions to Scenarios Considered

The following tables illustrates our recommendation for consideration of additional scenarios, beyond (or as a substitution for some of) those contained in NSPI's "Scenarios" plan.

The table below shows:

- NSPI's ten preliminary scenarios, with the values or "states" for key parameters.
- Eleven additional scenarios for consideration, with comparative "states".

The eleven scenarios listed contain a mix of different levels of emission constraints, load components, DG representation, and intertie ("regional integration") consideration. We are prepared to discuss these additional considered scenarios. The formulation of these additional considered scenarios was based on the following:

- Stricter interpretation of "net zero" emissions policies. Three regimes are defined/labeled: 1) Cap and Trade I; 2) Cap and Trade II (steeper path); 3) steepest path of CO2 reduction, in line with electric sector carbon budget contained in the Ecology Action Center report.[4]
- Producing an "envelope" of net load effects reflecting the critical components of 1) reduced load through DSM, and 2) increased load through electrification. The load scenarios represented here reflect a mix of base, mid, and max DSM levels;[5] and a presumption of two different "electrification" states: low (or baseline), and high.[6]
- Two different states for hard-coded, DG resources in the model; we anticipate that these resources would primarily be a mix of solar PV and small-scale batteries, but we also use this scenario to include a "max" DSM path.
- Room for "one off" scenario definition that could be further refined to reflect the intent to run a number of different scenarios with a set mix of net load, emissions, DG, and intertie parameters. This is also how additional scenarios such as a "Mersey" scenario could be handled (as the converse to whatever baseline Mersey status is used in the main set of runs).
- In all cases except the "EAC" scenario, we have excluded any "hard coding" of coal retirement paths, as our expectation is that emissions constraints and the marginal emissions cost construct should economically define the retirement path.
- In all instances, we assume demand response resources are handled separately as a supply side option. Alternatively, or supplementary, it would be possible to more carefully define a "DG" parameter that includes such DR resources.

[4] As noted in EAC comments, page 3, Figure ES-2.

[5] From the Efficiency One DSM Potential Report, and as presented in NSPI Assumptions deck (1/20/2020).

[6] We offer no specific electrification quantities at this time, but may provide further comment upon review of NSPI detailed electrification pathways.

- The net load inputs do not attempt to define any particular load shape refinement that may result from scenarios of increased electrification. This is a critical area for review, as the peak period increase in load for any given electrification scenario could vary considerably.

  In all cases, additional questions are likely to arise over the exact parameterization used in Plexos to represent any given input. We anticipate ongoing discussion with NSPI to resolve any disagreements on how model parameterization will be consistent with any given scenario definition.

Scenarios Table For Discussion

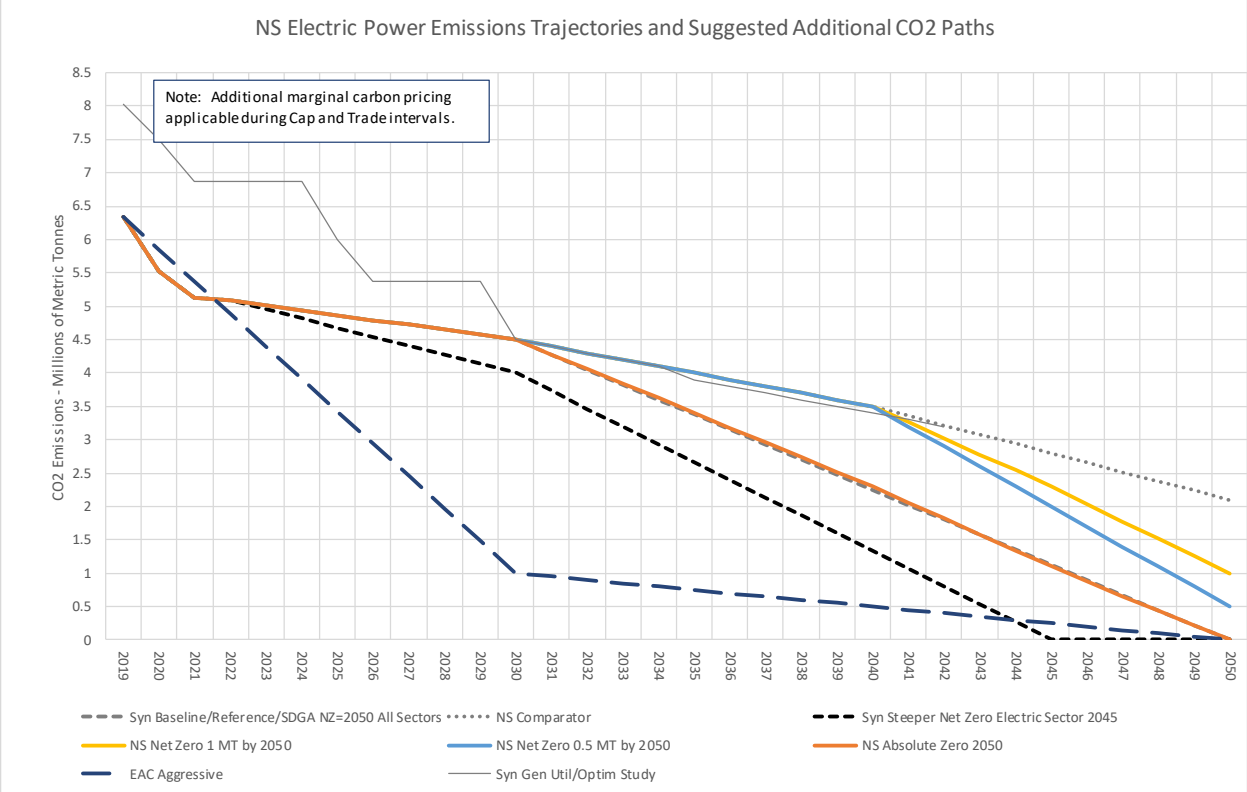
NSPI Suggested		Electric Sector CO2 Emissions					Coal Closure	Resource Landscape			Net Load components			
Scenario #	Scenario Name	Pre-2030	2030	2040	2045	2050	EconRetire + end date:	New intertie	DG Promoted	No new Emitting	Gross Load Level (Economy)	DSM Level (Base, Mid/Max)	Electrification (low=Base, High)	Net Load Level (derived) pre-DG
1	Comparator	Exist HardCap	4.5	3.5	2.8	2.1	2040	No	No	No	Base	Base	Base	Base
2	Net Zero - High Elec - CurrResource	Exist HardCap	4.5	3.5	2.3	1	2040	No	No	No	Base	Base	High	High Elec
3	Net Zero - High Elec - DG	Exist HardCap	4.5	3.5	2.3	1	2040	No	Yes	No	Base	Base	High	High Elec
4	Net Zero - High Elec - RegInteg	Exist HardCap	4.5	3.5	2.3	1	2040	Yes	No	No	Base	Base	High	High Elec
5	Net Zero - Mod Elec - CurrResource	Exist HardCap	4.5	3.5	2.0	0.5	2040	No	No	No	Base	Base	Mod	Mod Elec
6	Net Zero - Mod Elec - DG	Exist HardCap	4.5	3.5	2.0	0.5	2040	No	Yes	No	Base	Base	Mod	Mod Elec
7	Net Zero - Mod Elec - RegInteg	Exist HardCap	4.5	3.5	2.0	0.5	2040	Yes	No	No	Base	Base	Mod	Mod Elec
8	Net Zero - Mod Elec - Early CoalClos	Exist HardCap	4.5	3.5	2.0	0.5	2030	Yes	No	No	Base	Base	Mod	Mod Elec
9	AbsZero - RegInteg	Exist HardCap	4.5	2.3	1.1	0	2030	Yes	No	No	Base	Base	Mod	Mod Elec
10	AbsZero - No New Emitting	Exist HardCap	4.5	2.3	1.1	0	2030	No	No	Yes	Base	Base	Mod	Mod Elec

Other Scenarios for Consideration		Electric Sector CO2 Emissions (excluding marginal pricing increment effect)						Resource Landscape			Net Load components			
Scenario #	Scenario Name	Pre-2030	2030	2040	2045	2050	Forced End Date - Coal	New intertie	DG Promoted	No new Emitting	Gross Load Level (Economy)	DSM Level (Base, Mid, Max)	Electrification (low=Base, High)	Net Load Level: DSM/Electrif.
	With NB Tie													
11	SDGA Baseline - Base DSM, Base Electrif. - NB Tie	CapTradeDecline-I	4.5	2.25	1.125	0	No	Yes	No	No	Base	Base	Base	Base/Base
12	SDGA Accelerrated - Mid DSM, Base Electrif. - NB Tie	CapTradeDecline-II	4	1.33	0	0	No	Yes	No	No	Base	Mid	Base	Mid/Base
13	SDGA Baseline - Base DSM, High Electrif. - NB Tie	CapTradeDecline-I	4.5	2.25	1.125	0	No	Yes	No	No	Base	Base	High	Base/High
14	SDGA Accelerrated - Mid DSM, High Electrif. - NB Tie	CapTradeDecline-II	4	1.33	0	0	No	Yes	No	No	Base	Mid	High	Mid/High
15	SDGA Baseline - Base DSM, Base Electrif. - DG - NB Tie	CapTradeDecline-I	4.5	2.25	1.125	0	No	Yes	Yes	No	Base	Base	Base	Base/Base
16	SDGA Accelerrated - Max DSM, High Electrif. - DG - NB Tie	CapTradeDecline-II	4	1.33	0	0	No	Yes	Yes	No	Base	Max	HIgh	Max/High
	Without NB Tie													
17	SDGA Baseline - Base DSM, Base Electrif. - No NB Tie	CapTradeDecline-I	4.5	2.25	1.125	0	No	No	No	No	Base	Base	Base	Base/Base
18	SDGA Accelerrated - Mid DSM, Base Electrif. - No NB Tie	CapTradeDecline-II	4	1.33	0	0	No	No	No	No	Base	Mid	Base	Mid/Base
19	SDGA Baseline - Base DSM, Base Electrif. - DG - No NB Tie	CapTradeDecline-I	4.5	2.25	1.125	0	No	No	Yes	No	Base	Base	High	Base/High
20	SDGA Accelerrated - Max DSM, High Electrif. - DG - NO NB Tie	CapTradeDecline-II	4	1.33	0	0	No	No	Yes	No	Base	Max	High	Max/High
21	SDGA More Aggressive (~EAC)	CapTradeDecline-III	0.5	0	0	0	Yes - 2030	Yes	Yes	No	Base	Max	High	Max/High
22	Mersey (in or out, relative to above runs)	CapTradeDecline-I	4.5	2.25	1.125	0	No	Open to suggestion						
23-?	Other scenarios/sensitivities as needed	CapTradeDecline-I	4.5	2.25	1.125	0	No	Open to suggestion						

Carbon Emissions Modeling in Plexos – Nature, Level and Mechanism to Address Carbon Constraints

The current NSPI Scenario Plan defines five possible electric sector GHG emissions scenarios (and four of those five are considered Scenarios in Figure 7 at page 7 of the plan). Of the four considered scenarios, all start at a 4.5 million metric tons/year limit in 2030. The figure below shows these four paths, along with three additional benchmarks for a carbon emissions path: 1) our recommended baseline path, which is aligned with the "NS Absolute Zero" trajectory; 2) a suggested steeper path, reaching electric sector emissions of zero in 2045, and a path intended to align with the Ecology Action Center trajectory which appears to reach roughly 1 million tons/year by 2030 (EAC comments, Figure ES-2, electric sector component emissions visually interpreted from graph).

In all cases, the effect of the Cap and Trade Regulations will be to provide an effective shadow price on incremental carbon emissions (beyond NSPI's free allocation of carbon emission allowances). Critically, we recommend this effect be directly incorporated in the model as pricing for any NSPI increased emissions, and an allowance sales opportunity for any decreased NSPI emissions, for all years of the analysis. While the structure of the regulations, and the level of the "cap", is uncertain for out years, some form of "floor" price should be considered for all years.



Source: NSPI Scenario Assumptions; EAC comments; Synapse.

Coal Unit Economic Retirement

We appreciate NSPI's willingness to consider different retirement paths for coal units. Inclusion of stricter retirement paths (e.g., closure by 2030) is critical. We do anticipate, however, that i) more stringent emissions criteria as reflected in the "net zero" trajectories; ii) inclusion of the impact of avoiding sustaining capital costs (in addition to avoiding fuel, fixed and variable O&M costs); and iii) including the effect of the Cap and Trade regulations could lead to optimal retirement outcomes within the model itself.

ELCC / Diversity Effects of Resource Portfolios

Diversity Benefit of Portfolio: Wind plus Storage

- The construct as presented in the pre-IRP report may fail to capture critical synergies between low levels of storage resource (e.g., the first few hundred MW of resource), and high levels of wind. Use of RECAP or alternative approaches to ensure that the economically optimal mix of wind/storage is directly tested or considered in the modeling process is critical.

- We recommend (and NSPI supports) use of model iteration in the early stages to ensure that LOLE targets are not significantly exceeded (in either direction) for any given optimized resource plan.

Net Load Scenarios

- A mix of net load scenarios is presented in the comments above, on additional considered Scenarios.

- The general form of testing an "envelope" of net load scenarios as presented by NSPI at the 2/27/2020 conference is reasonable.

- Given the more stringent emissions standards applicable in the Province, we believe it is critical to test the effect of both "mid" levels of DSM, and "max" levels of DSM (energy efficiency) pursuant to the parameters for these DSM levels in the Efficiency One potential study.

- The presence of interval metering in the Province portends an ability to carefully allow newly electrifying load to be subject to differential pricing for peak and off-peak periods, potentially mitigating to some extent otherwise-anticipated peak load increasing effects associated with newly electrifying load. We plan to further discuss and review the particular loading parameters for consideration by NSPI in the modeling inputs.

Resource Costs

<u>Batteries</u>

- We recommend using a 2-hour battery resource in addition to a 1- and 4-hour battery in all runs of Plexos. Batteries for capacity and ancillary service provision could be critical in

an emission-constrained Province, and the optimal choices should allow for flexibility to provide both short-duration and long-duration attributes for this resource.

- The 4-hour battery 2019 costs reflected in the updated assumptions are still materially higher than NREL 2019 midrange for battery costs; and are higher than the imputed mid-range from Lazard 5.0. [i.e., ~$1,800-1,900/kW, versus $2,125/kW). Unless E3 or NSPI has a clear reason to depart from the NREL mid-range cost, we recommend use of the lower value.

- The updated assumptions slide deck does not indicate if the battery cost trajectory is linear or otherwise between 2020 and 2030. While the most recent Lazard studies do not provide information in this regard, the 2018 Lazard study (v. 4.0) did indicate a non-linear (e.g., steeper drop during earlier years) pattern (i.e., 28% CAGR decline over the first five years). Please confirm the year-over-year cost trajectory to be used.

Wind

- While wind cost updates do align with the 2019 NREL data, the cost values used ($2,100/kW) for 2019 are higher than the Lazard "high" costs ($1,980/kW, version 13.0, Lazard LCOE, corrected for CA currency). Wind cost updates may not reflect the potential for even lower costs in the Province, e.g. due to potentially lower costs from repowering older sites.

- An anecdotal report from a potential wind project in New Brunswick (i.e., the Burchill wind farm) indicates costs that appear to be aligned with the "low" Lazard study costs, rather than the $2,100/kW benchmark.[7]

- We recommend E3 and NSPI further explore the extent to which a reduction in costs below the $2,100/kW benchmark is reasonable for Nova Scotia. At a minimum, at least one wind cost sensitivity/scenario should be explored if the $2,100/kW benchmark is to be retained.

- Incremental renewable energy amounts pursuant to Federal government "greening" initiatives (for Federal load in the Province) would accelerate use of renewable energy for that load. Current expansion considerations within the Province's Electricity Act may also impact the pace of transitioning to greater levels of renewable energy. While we anticipate that the IRP results will include significant increases of economic wind energy early in the planning period (i.e., essentially covering these increments), we recommend that NSPI directly consider whether further modeling parameterization might be needed to address these initiatives.

[7] https://www.cbc.ca/news/canada/new-brunswick/saint-john-energy-wind-farm-project-natural-forces-1.5270134. The report states a $60 million cost for an up-to 42 MW wind farm, equivalent to $1,429/kW.

Model Build Limitations

- Based on statements made during the 2/27/2020 stakeholder conference, it appears that NSPI will generally not limit the ability of the Plexos model to choose economic levels of new wind, even beyond a 1,000 MW total for the Province. We support such relaxation of any limitations.

- We note that the outcomes between model runs without a new NB intertie, and those with a new NB intertie, may require careful review to ensure reliability and operational stability. We anticipate further discussion with NSPI as these runs are developed.

Additional Comments

- Hydro Asset Study. We presume that use of RESOLVE will help to determine the best approach to include, or exclude, the Mersey system hydro resources as part of the base profile of resources used in Plexos.

    - We recommend that multiple cost points for the Mersey project be directly analyzed in RESOLVE.

    - We also recommend that Decommissioning costs, for the alternative of not including Mersey as a resource, be considered at different cost points. This is a correction to what was stated by Bob Fagan at the technical conference on 2/27/2020. For any circumstance where Mersey is not considered to be an economic resource over the long-term, decommissioning costs that reflect something short of 'full return to pre-hydro asset conditions' should be reviewed.

- DR Options.

    - The availability of "load management" (Plexos supply option) in addition to peak period load reduction from energy efficiency is critical. We presume, and support, NSPI inclusion of all cost-effective DR peak reductions as presented in the Efficiency One Potential Study.

Checking Adherence to Agreed-Upon Conditions Arising from Generation Utilization / Optimization Study

1. Confirm costs and achievable potential for incremental energy efficiency. As seen, energy efficiency displaces higher cost energy sources in the province (gas, oil, imports) and the IRP must fully reflect this resource option. [Note that EfficiencyOne has been directed to file a DSM Potential Study by July 31,2019.]

    - E1 DSM Potential Study (Navigant) to be utilized to inform both costs and quantities of DSM tested in the IRP.

    - Different costs and quantities for peak reduction from EE and from DR must still be teased out in the detailed parameterization of the model. We expect the IRP group will finalize this approach in early March.

2. Determine costs and achievable potential for peak-load reducing demand response. Construct specific cost and quantity curves to allow for either resource selection (in Plexos) based on specific demand side resources, or scenario analysis utilizing alternative peak load and annual energy projections.

    - Use the Navigant "achievable cost-effective demand response" directly in the IRP modeling.

3. Monitor and comprehensively investigate costs for bulk-scale battery storage of different durations. The Plexos results indicate economic battery builds in different scenarios and reflect the importance of this resource to serve as peaking capacity.

    - See battery cost comments above. NSP is in the process of finalizing most recent cost estimates from Lazard, NREL, and E3.

4. Monitor, track and project sustaining capital costs for the thermal fleet. Sustaining capital costs incurred a range of 6.5% to 10.4% of total NPVRR costs in our main scenarios. It is critical to continue to assess the pattern of these costs and project future costs.

    - Underway.

5. Establish requirements to allow increased levels of wind on NSPI system. Two threshold criteria to allow increased levels of cost-effective wind resources are completion of a second 345 kV intertie to New Brunswick, and assessment of NSPI's Provincial transmission system and related support services (to maintain stability and voltage criteria). NSPI should determine, with specificity, the set of technical improvements required to allow different increments of additional wind on their system. This should include the effect of additional transmission capacity to New Brunswick, the presence of the Maritime Link, and the ability to further increase wind penetration through transmission grid reinforcement. This should also recognize that the introduction of bulk scale battery storage as a possible capacity resource that can provide co-benefits associated with stability and voltage support.

    - Model runs will generally not limit wind.

    - Potential for some runs to limit wind to just 1,000 MW total.

    - Curtailment practices as deployed in the Plexos model need to be discussed.

6. Continue joint dispatch efforts and investigate increased planning, unit commitment and reserve sharing opportunities with New Brunswick, Newfoundland and Prince Edward Island. Increased coordination among the Maritime Provinces is likely required to maintain reliability with increased wind resource utilization.

    - Discussion still required to address how this will be treated in the modeling.

7. Determine the capacity and unit commitment requirements needed in association with the Tufts Cove thermal units, to allow appropriate parameterization in Plexos to enable possible economic retirement.

- We understand that all transmission and operating reserve requirements around the use of the Tufts Cove units will be relaxed or eliminated in the Plexos setup – this element remains to be confirmed by NSPI.

8. Identify candidates for the "next" coal retirement alternative after Lingan 2. Consider "rank ordering" the units to establish a priority order reflecting best-to-worst economic performers across the thermal fleet. While projecting sustainable capital needs is an uncertain exercise, the potential to avoid significant major expenses at different points in time over the next decade illustrates the importance of establishing such a ranking.

    - This remains to be done; we anticipate it will occur likely following the results from the model runs.

9. Monitor natural gas price and availability trends in the Maritimes.

    - Gas price and quantity inputs into the Plexos model appear to be based on monitored price and availability trends.

Bates/White Concerns – IRP Modeling Issues

• Continue to evaluate new and existing wind resources in order to establish an appropriate firm capacity value for each installation.

- This is underway, as part of the ELCC Portfolio diversity issues addressed in the comments above.

• The 2013 CT Asset Optimization Study does not fully inform the decision to invest in the preservation of these units vis-a-vis replacing them with more modern CTs or another type of fast ramping generation unit. NSPI should compare the economics of replacing them with newer CTs or another type of fast ramping generation.

- Use of RESOLVE in the preliminary modeling stages is anticipated to address this issue, in accordance with discussion following the 1/27/2020 stakeholder conference.

• Determine the extent of any capital investment that may be required at Trenton 6 or the Point Tupper Marine Terminal after the current supply of domestic coal is no longer available at the end of 2019.

- This remains outstanding.

• Complete a detailed analysis to determine the lowest planning reserve margin necessary to meet NPCC requirements, rather than just assessing if 20% remains in compliance. Considering that NERC's current North American references range between 10.6% and 23.7%, perhaps the analysis should assess reliability and economics for a range of planning reserve margins.

- Still under development: the use of iterative techniques during the early stages of modeling is anticipated to address this issue.