**Synapse Comments on Nova Scotia Power Updated Action Plan and Roadmap (August 2023)**

## Introduction

These comments address Nova Scotia Power's August 2023 updated Action Plan and Roadmap items from its 2023 Evergreen Integrated Resource Plan (IRP).

NSPI's modeling exercise in the Evergreen IRP update reflects critical input assumption changes (since the 2020 IRP), including, for example,

- Nova Scotia's policies concerning renewable energy as a percentage of total energy sales (80% by 2030),
- Coal plant phase out / retirement (all units retired by 2030),
- Load trajectory modification: an increase in peak and annual energy during the latter part (generally after 2030) of the planning horizon due to electrification effects,
- Increases in wind power assumed on the system due to rate base procurement (372 MW by 2025), for a "starting" total of more than 900 MW (nameplate) of wind in 2025,
- Changes (i.e., real cost reductions) to underlying wind, solar and storage resources; and explicit inclusion of heavy fuel oil operation for former coal units to provide capacity (with limited expectation of energy production, reflected in the modeling results),
- Exclusion of near-term import capacity over existing transmission interconnections from adjacent Provinces, creating additional pressure for in-Province capacity needs,
- Federal investment tax credits, and a shift from the cap-and-trade system to a Provincial OBPS (output-based pricing system) to account for carbon emissions, and
- Consideration of hydrogen as a potential fuel source for hydrogen-capable combustion turbines (by 2028), and as a potential additional load on the system from proposed hydrogen production facilities.

No changes were made to the assumed capital cost for the Atlantic Loop option, estimated at $1.7 Billion ($2019). Updates were made to prices for Quebec energy that would flow over the Atlantic Loop, based on New England market price projections.

Based on the information provided in the update, no material changes were made to the capacity contribution potentially available from a portfolio of clean resources including (in particular) the combination of solar PV, wind, battery storage, and conventional and emerging-technology-based demand response. The interactivity of these resources *in combination* is critical to accurately establishing their overall contribution towards resource adequacy needs, and thus accurately comparing their marginal value to that of new combustion turbine resources or other fossil-fuel based capacity resources. NSPI uses the same capacity contribution estimates for these resources as was used in the 2020 IRP analysis.

Based on our review of IRP documents, Synapse generally supports the methods underlying the technical and economic analyses and NSPI's associated key findings for many, but not all, of the elements in NSPI's Action Plan and Roadmap. The following contains our detailed comments concerning NSPI's Action Plan elements.

**Overall PLEXOS Modeling, NPVRR and Ranking Implications**

Attached to these comments are two tables, from NSPI's results posted in Excel format. Table 1 contains the modeling results for NSPI's twenty-four (24) scenario and sensitivity runs. Table 2 contains a Synapse-developed "ranking" representation for these 24 runs, used to informally gauge the relative differences in net present value of revenue requirements (NPVRR, $2025) for the model results. The load level varies across some of the scenario and sensitivity runs, thus any direct comparison or NPVRR interpretation between runs with different load levels must be made carefully and selectively. Additional tables with capacity additions by scenario and year are included where relevant in the comments below.

**Action Plan – Key Items**

1. **No Atlantic Loop as Preferred Plan**

The lowest cost 26-year NPVRR (including distributed solar PV costs and end effects) base model run under the "current policy and trends" electrification assumptions for Nova Scotia is the No Atlantic Loop scenario (CE1-E1-R2). It is $130 million (NPVRR) lower cost than CE1-E1-R1, the Atlantic Loop base model run. NSPI does not directly state that it has selected this No Atlantic Loop run as a "preferred portfolio" or recommended plan, but NSPI does indicate in its 2023 10-year System Outlook report[1] that it bases its 10-year resource portfolio on the No Atlantic Loop scenario CE1-E1-R2 model run.

A separate model run for the No Atlantic Loop scenario, known as the "hybrid peak mitigation" scenario, assumes the use of existing fossil or wood heating systems to reduce otherwise-modeled increases in electric peak load under the common electrification framework.[2] This scenario is $2.33 billion lower cost (26-year NPVRR with distributed solar PV and end effects) than the base No Atlantic Loop scenario. The hybrid peak mitigation sensitivity does not include any potential NS Power ratepayer costs associated with ensuring the reduction in peak otherwise associated with the electrified load scenario. Action Plan item 4b includes a plan to further assess the scenario; Synapse fully supports this planned assessment.

A sensitivity to the Atlantic Loop scenario including bi-directional flows between Nova Scotia and Quebec lowers the NPVRR and results in the Atlantic Loop resource in this sensitivity being less expensive than the No Atlantic Loop scenario. Of all 24 model runs, this model run has the lowest NPVRR cost. However, the underlying assumptions for the bi-directional flow sensitivity are not based on any contractual commitments with Quebec, and thus it is unclear how robust is the finding that under a bi-directional contract, the NPVRR costs would remain lower than the No Atlantic Loop costs.

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[1] NS Power, 2023 10-Year System Outlook, June 30, 2023. Pages 44-46.

[2] This means that heat pump installations would result in electrifying heating needs, but existing fossil systems (oil or gas) or wood systems would remain in a form of stand-by mode, for use during extreme cold. This reduces the need for additional electric resistance heat, or additional operation of heat pumps at lower efficiency during extreme cold.

Action Plan item 1b, Regional Integration, includes continuing assessments of the economics of firm import options. Synapse supports these planned assessments and emphasizes a need to clarify both the capital costs of the Atlantic Loop, and the costs associated with any firming of energy import and export assumptions. If or as this information is made available, Synapse recommends a re-running of the bi-directional Atlantic Loop scenario.

## 2. Reliability Tie and Regional Integration

NSPI continues to show need for the development of the Reliability Tie, and the IRP modeling results reflect the inclusion of the Tie, with an in-service date of 2028. Action Plan Item 1a is development of the Tie. Regardless of whether, or not, the full Atlantic Loop is pursued, completion of the Reliability Tie supports necessary wind resource integration in all scenarios. All scenarios find that roughly 600 MW of additional wind is needed by 2028, beyond the 372 MW of currently-planned rate base wind procurement. By 2030, all scenarios indicate a need for at least 2,000 MW (total) of wind in the province. The Reliability Tie is needed; Synapse recommends its development continue as a high priority item for NSPI.

NSPI includes as part of the Action Plan (Item 1b) support for continuing work on possible Atlantic Loop integration activities.

**Wind Nameplate Capacity by Scenario**

| Scenario | 2025 | 2027 | 2029 | 2030 | 2035 | 2050 |
|---|---|---|---|---|---|---|
| CE1-E1-R1 | 919 | 1,497 | 1,897 | 2,097 | 2,497 | 3,077 |
| CE1-E1-R1 AAT | 919 | 1,497 | 1,897 | 2,097 | 2,695 | 3,246 |
| CE1-E1-R1 BD | 919 | 1,497 | 1,897 | 2,847 | 3,586 | 4,011 |
| CE1-E1-R1 BPDSM | 919 | 1,497 | 1,897 | 2,097 | 2,497 | 2,899 |
| CE1-E1-R1 DACC | 919 | 1,497 | 1,897 | 2,097 | 2,516 | 3,339 |
| CE1-E1-R1 DH | 919 | 1,497 | 1,897 | 2,097 | 2,877 | 3,348 |
| CE1-E1-R1 HDER | 919 | 1,497 | 1,897 | 2,097 | 2,401 | 2,509 |
| CE1-E1-R1 HFPP | 919 | 1,497 | 1,897 | 2,097 | 2,619 | 3,115 |
| CE1-E1-R1 LFPP | 919 | 1,497 | 1,897 | 2,097 | 2,503 | 2,907 |
| CE1-E1-R1 MMDSM | 919 | 1,497 | 1,897 | 2,097 | 2,507 | 3,192 |
| CE1-E1-R1 WI | 919 | 1,497 | 1,897 | 2,097 | 2,522 | 3,161 |
| CE1-E1-R2 | 919 | 1,497 | 1,897 | 2,097 | 2,994 | 3,291 |
| CE1-E1-R2 DACC | 919 | 1,497 | 1,897 | 2,097 | 3,011 | 3,380 |
| CE1-E1-R2 DH | 919 | 1,497 | 1,897 | 2,097 | 3,097 | 3,720 |
| CE1-E1-R2 HDER | 919 | 1,497 | 1,897 | 2,097 | 2,508 | 2,975 |
| CE1-E1-R2 MMDSM | 919 | 1,497 | 1,897 | 2,097 | 2,925 | 3,279 |
| CE1-E2-R2 | 919 | 1,497 | 1,897 | 2,097 | 2,973 | 3,662 |
| CE1-E2-R2 HBHR | 919 | 1,497 | 1,897 | 2,097 | 2,830 | 3,565 |
| CE1-E2-R2 MMDSM | 919 | 1,497 | 1,897 | 2,097 | 2,912 | 3,816 |
| CE1-E3-R1 | 919 | 1,497 | 1,897 | 2,097 | 2,724 | 2,967 |
| CE1-E3-R2 | 919 | 1,497 | 1,897 | 2,097 | 3,097 | 3,514 |
| CE2-E1-R1 | 919 | 1,497 | 1,897 | 2,097 | 2,497 | 3,203 |
| CE2-E1-R2 | 919 | 1,497 | 1,897 | 2,097 | 2,787 | 3,441 |
| CE2-E1-R2 DH | 919 | 1,497 | 1,897 | 2,097 | 3,047 | 3,572 |

### 3. Solar and Wind Resource Selection

200 MW of utility-scale solar PV is chosen by the model in all scenarios and is in service by 2025. Including the planned 372 MW of rate base procurement wind, the No Atlantic Loop scenario includes roughly 1,500 MW of new utility-scale wind by 2030. Solar resource capacity by scenario and year is seen in the table below.

**Solar Nameplate Capacity by Scenario**

| Scenario | 2025 | 2027 | 2029 | 2030 | 2035 | 2050 |
|---|---|---|---|---|---|---|
| CE1-E1-R1 | 203 | 202 | 203 | 203 | 203 | 732 |
| CE1-E1-R1 AAT | 203 | 202 | 203 | 203 | 203 | 882 |
| CE1-E1-R1 BD | 202 | 202 | 202 | 202 | 202 | 202 |
| CE1-E1-R1 BPDSM | 203 | 202 | 203 | 203 | 203 | 822 |
| CE1-E1-R1 DACC | 203 | 202 | 203 | 203 | 203 | 872 |
| CE1-E1-R1 DH | 203 | 202 | 203 | 203 | 203 | 802 |
| CE1-E1-R1 HDER | 296 | 498 | 817 | 1,001 | 1,224 | 2,110 |
| CE1-E1-R1 HFPP | 203 | 202 | 203 | 203 | 203 | 802 |
| CE1-E1-R1 LFPP | 203 | 202 | 203 | 203 | 203 | 902 |
| CE1-E1-R1 MMDSM | 203 | 202 | 203 | 203 | 203 | 652 |
| CE1-E1-R1 WI | 203 | 202 | 203 | 203 | 203 | 842 |
| CE1-E1-R2 | 203 | 202 | 203 | 203 | 203 | 1,002 |
| CE1-E1-R2 DACC | 203 | 202 | 203 | 203 | 203 | 1,002 |
| CE1-E1-R2 DH | 203 | 202 | 203 | 203 | 203 | 1,002 |
| CE1-E1-R2 HDER | 486 | 688 | 1,007 | 1,191 | 1,414 | 2,530 |
| CE1-E1-R2 MMDSM | 203 | 202 | 203 | 203 | 203 | 1,002 |
| CE1-E2-R2 | 203 | 202 | 202 | 202 | 202 | 793 |
| CE1-E2-R2 HBHR | 203 | 202 | 202 | 202 | 202 | 203 |
| CE1-E2-R2 MMDSM | 203 | 202 | 202 | 202 | 202 | 213 |
| CE1-E3-R1 | 203 | 202 | 203 | 203 | 203 | 972 |
| CE1-E3-R2 | 203 | 202 | 203 | 203 | 203 | 1,002 |
| CE2-E1-R1 | 203 | 202 | 203 | 203 | 203 | 632 |
| CE2-E1-R2 | 203 | 202 | 203 | 203 | 203 | 1,002 |
| CE2-E1-R2 DH | 203 | 202 | 203 | 203 | 253 | 1,002 |

Action Item 3d is development of a procurement strategy for solar and wind resources, and continuing study work to identify opportunities to reduce curtailment. Synapse emphatically supports these Action Plan elements, and further recommends prioritization by NSPI of a procurement plan and a need to ensure interconnection study resource availability[3] for the sizable level of wind clearly needed on the system under any scenario, and the significant level of solar PV.

### 4. Battery Energy Storage Resource Selection and Capacity Accreditation for Portfolio of Renewables and Battery Energy Storage, with Associated Peak Mitigation Effects from Hybrid and Demand Response Resources

The model selects 4-hour duration battery energy storage resources in variable amounts by scenario and over the planning horizon. The basis of resource selection includes the effect of the ELCC parameter on

[3] Matter 10905, which is in progress, addresses interconnection study needs.

the capacity value for battery nameplate MW. The table below contains the nameplate capacity of battery resource additions by year and scenario.

**Battery Resource Nameplate Capacity by Scenario**

| Scenario | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2035 | 2050 |
|---|---|---|---|---|---|---|---|---|---|
| CE1-E1-R1 | 40 | 90 | 100 | 100 | 100 | 100 | 100 | 100 | 370 |
| CE1-E1-R1 AAT | 0 | 30 | 30 | 50 | 100 | 100 | 140 | 140 | 230 |
| CE1-E1-R1 BD | 0 | 10 | 10 | 20 | 70 | 70 | 160 | 170 | 200 |
| CE1-E1-R1 BPDSM | 0 | 20 | 50 | 50 | 100 | 100 | 100 | 100 | 210 |
| CE1-E1-R1 DACC | 0 | 170 | 170 | 170 | 170 | 170 | 170 | 170 | 200 |
| CE1-E1-R1 DH | 0 | 80 | 120 | 120 | 120 | 120 | 120 | 120 | 840 |
| CE1-E1-R1 HDER | 0 | 40 | 80 | 120 | 120 | 120 | 120 | 120 | 1,280 |
| CE1-E1-R1 HFPP | 0 | 20 | 30 | 30 | 30 | 30 | 30 | 30 | 310 |
| CE1-E1-R1 LFPP | 0 | 0 | 0 | 10 | 30 | 30 | 30 | 30 | 200 |
| CE1-E1-R1 MMDSM | 0 | 20 | 30 | 30 | 40 | 40 | 70 | 70 | 240 |
| CE1-E1-R1 WI | 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 270 |
| CE1-E1-R2 | 0 | 30 | 40 | 90 | 140 | 140 | 200 | 200 | 400 |
| CE1-E1-R2 DACC | 0 | 30 | 40 | 110 | 110 | 110 | 200 | 200 | 360 |
| CE1-E1-R2 DH | 0 | 60 | 80 | 100 | 160 | 160 | 200 | 200 | 430 |
| CE1-E1-R2 HDER | 0 | 120 | 160 | 240 | 440 | 560 | 800 | 800 | 1,720 |
| CE1-E1-R2 MMDSM | 10 | 20 | 30 | 30 | 30 | 30 | 200 | 200 | 430 |
| CE1-E2-R2 | 0 | 50 | 100 | 100 | 130 | 130 | 200 | 200 | 330 |
| CE1-E2-R2 HBHR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 240 |
| CE1-E2-R2 MMDSM | 0 | 0 | 0 | 0 | 110 | 110 | 200 | 200 | 230 |
| CE1-E3-R1 | 0 | 10 | 10 | 10 | 10 | 10 | 100 | 100 | 230 |
| CE1-E3-R2 | 0 | 0 | 0 | 10 | 100 | 100 | 200 | 200 | 430 |
| CE2-E1-R1 | 0 | 0 | 0 | 0 | 10 | 10 | 30 | 30 | 430 |
| CE2-E1-R2 | 0 | 30 | 40 | 60 | 110 | 110 | 200 | 200 | 390 |
| CE2-E1-R2 DH | 0 | 0 | 10 | 20 | 30 | 140 | 200 | 200 | 430 |

Action Plan Item 3f is development of battery storage additions of at least 100 MW by 2030, beginning in 2025. The Action Plan item also states that NSPI will "continue to explore the potential benefits of additional energy storage quantities beyond this target" as part of the transition to reach 2030 with higher levels of renewable energy and coal plant phase out. Synapse notes that even with the ELCC values used in this modeling exercise (see immediate comments below on this issue), Scenario CE1-E1-R2 calls for 140 MW of battery storage development by 2029. Synapse supports NSPI's Action Plan Item 3f but recommends accelerated study to determine the value of considering an increased pace of battery storage implementation.

In our opinion, the pre-IRP capacity value study from 2019 (used in the 2020 IRP) does not fully capture the diversity effects that exist among battery energy storage, wind, solar, and demand response resources, and the capacity accreditation given to battery resources in this IRP update is too low. This affects the PLEXOS model optimization of capacity resources. Prior to the next IRP update, this study and the methods used to capture portfolio diversity should be updated. The new study should reflect the full measure of diversity effect considering all four of these resources, which are highly complementary in the provision of capacity. Demand response resources, or the equivalent capability of mitigating peak increases such as would be seen in the "hybrid peak mitigation" case, have a material influence on the peak load that might otherwise need a higher level of battery resources or other capacity resources to maintain reliability. This would affect the portfolio ELCC and directionally would increase any ELCC factor attributed to the battery energy storage resources.

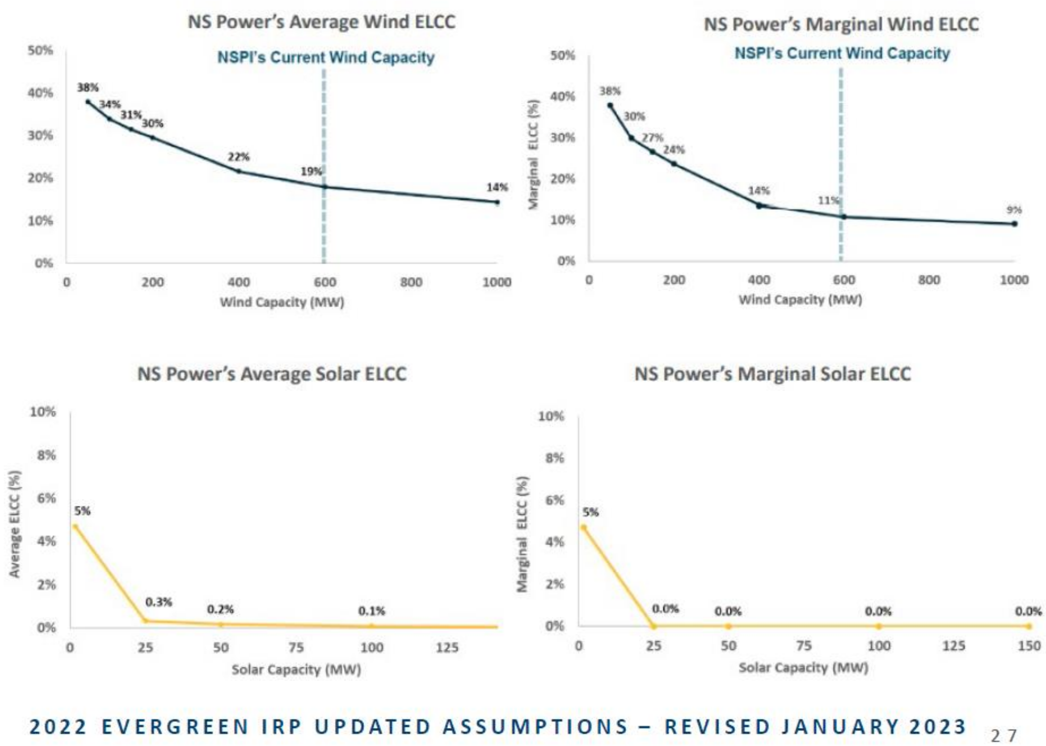
As noted, the battery energy storage ELCC profile used in this IRP update is a critical input value to the modeling that needs to be carefully re-examined in the next IRP or IRP update. The re-examination needs to be conducted in conjunction with an updated "portfolio ELCC" analysis that better considers the interactive effect of all four clean resources (wind, solar PV, battery energy storage, and demand response or peak load mitigation during winter peak periods). The current input assumptions used for ELCC for the portfolio of resources, while reflecting some level of diversity benefit,[4] do not fully capture this critically important dynamic. The effect of this shortcoming is a failure of the capacity expansion portion of the modeling exercise to fully capture the interactive effect and thus produce a potentially sub-optimal output in the selection of capacity resources.

Slide 27 from NSPI's input assumptions slide deck contains the only fully descriptive information on the ELCC considerations, in addition to what is contained in the 2019 Pre-IRP Planning Reserve Margin and Capacity Value Study.

Below is a reproduction of the ELCC components for wind and solar; and while the Capacity Value Study includes more information on the portfolio effect for battery storage and wind, and for solar PV and wind, there is no information available about a combined wind/solar/battery/demand response portfolio combination, and what its impact would be on the modeling under different ELCC input assumptions.

[4] NSPI has indicated in its presentation slides and during technical conference calls that a diversity adder is in place, but its magnitude and the specific scope and vintage of underlying analyses supporting the value is not readily apparent at this time.

**NSPI Input Assumptions for Wind and Solar ELCC**




### 5. Fast Acting Capacity and Plant Retirement and Conversion

The key new capacity resources seen across all of the model runs are 1) conversion of coal to heavy fuel oil (HFO) at relatively low annual capacity factor operation (459 MW, 3 plants); 2) conversion of coal to gas steam (150 MW), 1 unit; and 3) new CT additions. Most scenarios include both the coal-to-HFO conversions (as very low-cost capacity) and the gas steam plant conversion of one unit (as relatively low-cost capacity). The table below shows the variation in capacity addition from the highest cost new fossil capacity, new CTs or reciprocating engines. As seen, there is significant variation in the need for these resources by 2030, by 2035, and by 2050. For the No Atlantic Loop scenarios, the lowest level of CT capacity addition by 2030 is seen in the hybrid peak and modified DSM scenarios.

**New CTs and Reciprocating Plans Nameplate Capacity by Scenario**

| Scenario | 2025 | 2027 | 2029 | 2030 | 2033 | 2035 | 2050 |
|---|---|---|---|---|---|---|---|
| CE1-E1-R1 | 0 | 0 | 150 | 150 | 150 | 300 | 1,550 |
| CE1-E1-R1 AAT | 0 | 150 | 450 | 600 | 750 | 750 | 1,650 |
| CE1-E1-R1 BD | 0 | 170 | 320 | 320 | 320 | 320 | 1,670 |
| CE1-E1-R1 BPDSM | 0 | 0 | 0 | 0 | 150 | 200 | 1,700 |
| CE1-E1-R1 DACC | 0 | 100 | 250 | 250 | 250 | 400 | 1,600 |
| CE1-E1-R1 DH | 0 | 40 | 190 | 190 | 190 | 340 | 1,690 |
| CE1-E1-R1 HDER | 0 | 150 | 300 | 300 | 300 | 450 | 1,650 |
| CE1-E1-R1 HFPP | 0 | 50 | 50 | 50 | 100 | 250 | 1,600 |
| CE1-E1-R1 LFPP | 0 | 50 | 50 | 50 | 200 | 350 | 1,700 |
| CE1-E1-R1 MMDSM | 0 | 0 | 50 | 50 | 50 | 200 | 1,550 |
| CE1-E1-R1 WI | 0 | 150 | 150 | 150 | 150 | 450 | 1,650 |
| CE1-E1-R2 | 0 | 0 | 450 | 450 | 620 | 770 | 1,670 |
| CE1-E1-R2 DACC | 0 | 0 | 450 | 450 | 620 | 770 | 1,670 |
| CE1-E1-R2 DH | 0 | 0 | 450 | 450 | 680 | 680 | 1,580 |
| CE1-E1-R2 HDER | 0 | 0 | 450 | 450 | 600 | 900 | 1,650 |
| CE1-E1-R2 MMDSM | 0 | 150 | 600 | 600 | 600 | 750 | 1,650 |
| CE1-E2-R2 | 0 | 20 | 170 | 320 | 470 | 620 | 1,970 |
| CE1-E2-R2 HBHR | 0 | 150 | 300 | 450 | 600 | 750 | 1,850 |
| CE1-E2-R2 MMDSM | 0 | 0 | 150 | 300 | 350 | 500 | 1,950 |
| CE1-E3-R1 | 0 | 300 | 450 | 450 | 600 | 750 | 1,650 |
| CE1-E3-R2 | 0 | 300 | 750 | 900 | 1,050 | 1,200 | 1,650 |
| CE2-E1-R1 | 0 | 150 | 150 | 150 | 150 | 300 | 1,500 |
| CE2-E1-R2 | 0 | 0 | 450 | 450 | 600 | 750 | 1,600 |
| CE2-E1-R2 DH | 0 | 200 | 650 | 650 | 650 | 800 | 1,600 |

Procurement of capacity resources through new CT additions or conversion of coal resources is seen in Action Plan Items 3c and 3e. While Synapse generally recognizes the value in ensuring low-cost capacity through conversion of coal units as modeled in all scenarios, it is unclear whether or not the level of new CT or reciprocating engine need seen in the results is robust, given our concerns over the capacity value attributed to new battery energy storage resources. Synapse recommends ongoing study under the hybrid peak mitigation scenario and under other No Atlantic Loop scenarios; and an updated IRP analysis of battery energy storage capacity prior to significant commitment to reach the 2029 or 2030 CT additions levels seen in the CE1-E1-R2 scenario above.

## 6. Electrification Strategy

Synapse supports NSPI's ongoing planning for an electrification strategy as seen in Action Plan Item 2a and for data collection (Action Plan Item 2b) and looks forward to reviewing the study when available in 2023.

## 7. Import / Export Parameters and Curtailment

Synapse supports NSPI's plans to continue to review curtailment issues and identify opportunities to reduce curtailment, as seen in Action Plan Item 3d. Synapse recommends that NSPI explicitly make available more detailed information on the temporal patterns of import and export energy flows associated with all of the Scenarios in this modeling update.

Synapse also recommends that the next IRP clearly describes the extent to which exports from Nova Scotia are considered as allowable under the different scenarios. We also recommend that specific scenarios with considerably higher levels of nameplate battery capacity be included as part of the exploration of means to mitigate curtailment levels, regardless of the propensity of the capacity expansion algorithms to limit selection of new battery storage capacity because of diminishing returns to firm capacity value due to the ELCC effect currently in place.

### 8. Hydrogen as a Fuel or Hydrogen Production as Additional Load

The model is allowed to select hydrogen as a zero emissions fuel in all runs. Notably, only 50 MW of hydrogen-fueled CTs are added, and very late in the planning horizon (2047), and only in the one scenario where renewable energy and battery storage resources are assumed to be higher cost. This implies that at this time, hydrogen as a low emissions fuel-source is not competitive with conventional renewable energy and battery storage resources.

Separate sensitivities are run with higher Nova Scotia load reflecting the effect of domestic hydrogen production beginning in 2028. As expected, these higher-load model runs lead to higher NPVRR for those scenarios. At this time, this increase in load from industry activity does not implicate any of the specific nearer-term (pre-2030) Action Items concerning procurement and Reliability Tie development.

## Roadmap

The roadmap items as currently identified are reasonable. Item 2, Sustaining Capital, notes the potential for a possible ELCC or planning reserve margin study, for different reasons than the ones we have identified above. Synapse emphatically supports this roadmap direction.

**Table 1. Modeling Scenario NPVRR Metrics**

| Scenario Info, All Scenarios | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Clean Energy Policy | Electrification Trajectory | Atlantic Loop | Sensitivity | Scenario Name | NPVRR 2025$ | NPV Solar 2025$ | NPVRR End Effects | Solar End Effects | NPVRR w/EE + Solar | 11YR NPVRR | 11 YR NPV Solar | 11 YR NPVRR + Solar |
| NZ 2035 | Current Policy and Trend: | Atlantic Loop | - | CE1-E1-R1 | $ 18,760 | | $ 7,200 | | $ 25,960 | $ 9,310 | | $ 9,310 |
| NZ 2035 | Current Policy and Trend: | Atlantic Loop | Direct Air Carbon Capture | CE1-E1-R1 DACC | $ 19,360 | | $ 7,620 | | $ 26,980 | $ 9,410 | | $ 9,410 |
| NZ 2035 | Current Policy and Trend: | Atlantic Loop | Domestic Hydrogen | CE1-E1-R1 DH | $ 20,350 | | $ 7,790 | | $ 28,140 | $ 10,040 | | $ 10,040 |
| NZ 2035 | Current Policy and Trend: | Atlantic Loop | Low Fuel and Power Pricing | CE1-E1-R1 LFPP | $ 17,670 | | $ 6,750 | | $ 24,420 | $ 8,910 | | $ 8,910 |
| NZ 2035 | Current Policy and Trend: | Atlantic Loop | High Fuel and Power Pricing | CE1-E1-R1 HFPP | $ 20,990 | | $ 7,980 | | $ 28,970 | $ 10,330 | | $ 10,330 |
| NZ 2035 | Current Policy and Trend: | Atlantic Loop | Modified-mid DSM | CE1-E1-R1 MMDSM | $ 19,080 | | $ 7,240 | | $ 26,320 | $ 9,590 | | $ 9,590 |
| NZ 2035 | Current Policy and Trend: | Atlantic Loop | Base plus DSM | CE1-E1-R1 BPDSM | $ 18,900 | | $ 7,230 | | $ 26,130 | $ 9,460 | | $ 9,460 |
| NZ 2035 | Current Policy and Trend: | Atlantic Loop | High DER | CE1-E1-R1 HDER | $ 17,840 | $ 3,100 | $ 6,730 | $ 700 | $ 28,370 | $ 9,060 | $2,500 | $ 11,560 |
| NZ 2035 | Current Policy and Trend: | Atlantic Loop | Adjusted Atlantic Loop Timing | CE1-E1-R1 AAT | $ 18,700 | | $ 7,440 | | $ 26,140 | $ 8,970 | | $ 8,970 |
| NZ 2035 | Current Policy and Trend: | Atlantic Loop | No wind integration constraints | CE1-E1-R1 WI | $ 18,690 | | $ 7,160 | | $ 25,850 | $ 9,260 | | $ 9,260 |
| NZ 2035 | Current Policy and Trend: | Atlantic Loop | Bidirectional Atlantic Loop | CE1-E1-R1 BD | $ 16,950 | | $ 6,210 | | $ 23,160 | $ 8,700 | | $ 8,700 |
| NZ 2050 | Current Policy and Trend: | Atlantic Loop | - | CE2-E1-R1 | $ 18,830 | | $ 7,080 | | $ 25,910 | $ 9,510 | | $ 9,510 |
| NZ 2035 | Accelerated Electrificatio | Atlantic Loop | - | CE1-E3-R1 | $ 20,180 | | $ 7,250 | | $ 27,430 | $ 10,160 | | $ 10,160 |
| NZ 2035 | Current Policy and Trend: | No Atlantic Loop | - | CE1-E1-R2 | $ 17,190 | | $ 8,640 | | $ 25,830 | $ 8,550 | | $ 8,550 |
| NZ 2035 | Current Policy and Trend: | No Atlantic Loop | Direct Air Carbon Capture | CE1-E1-R2 DACC | $ 18,680 | | $ 9,510 | | $ 28,190 | $ 8,700 | | $ 8,700 |
| NZ 2035 | Current Policy and Trend: | No Atlantic Loop | Domestic Hydrogen | CE1-E1-R2 DH | $ 18,640 | | $ 9,230 | | $ 27,870 | $ 9,230 | | $ 9,230 |
| NZ 2035 | Current Policy and Trend: | No Atlantic Loop | Modified-mid DSM | CE1-E1-R2 MMDSM | $ 17,580 | | $ 8,640 | | $ 26,220 | $ 8,830 | | $ 8,830 |
| NZ 2035 | Current Policy and Trend: | No Atlantic Loop | High DER | CE1-E1-R2 HDER | $ 15,870 | $ 3,100 | $ 8,150 | $ 700 | $ 27,820 | $ 7,960 | $ 2,500 | $ 10,460 |
| NZ 2035 | Hybrid Peak Mitigation | No Atlantic Loop | - | CE1-E2-R2 | $ 16,710 | | $ 6,790 | | $ 23,500 | $ 8,340 | | $ 8,340 |
| NZ 2035 | Hybrid Peak Mitigation | No Atlantic Loop | High-Cost Batteries, High-Cost RE | CE1-E2-R2 HBHR | $ 17,790 | | $ 7,530 | | $ 25,320 | $ 8,940 | | $ 8,940 |
| NZ 2035 | Hybrid Peak Mitigation | No Atlantic Loop | Modified-mid DSM | CE1-E2-R2 MMDSM | $ 17,040 | | $ 6,710 | | $ 23,750 | $ 8,620 | | $ 8,620 |
| NZ 2050 | Current Policy and Trend: | No Atlantic Loop | - | CE2-E1-R2 | $ 17,300 | | $ 8,650 | | $ 25,950 | $ 8,680 | | $ 8,680 |
| NZ 2035 | Current Policy and Trend: | No Atlantic Loop | Domestic Hydrogen | CE2-E1-R2 DH | $ 18,590 | | $ 9,070 | | $ 27,660 | $ 9,280 | | $ 9,280 |
| NZ 2035 | Accelerated Electrificatio | No Atlantic Loop | - | CE1-E3-R2 | $ 18,960 | | $ 8,830 | | $ 27,790 | $ 9,600 | | $ 9,600 |

## Table 2. Modeling Scenario NPVRR Ranking

| Scenario Info, All Scenarios | | | | | 26-year NPV, no end-effects (EE) | | | 26-year NPV w/end effects + Solar | | | 11-year NPV w/Solar | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Clean Energy Policy | Electrification Trajectory | Atlantic Loop | Sensitivity | Scenario Name | NPV Rank (1 = least cost) | $ Delta | % Delta | NPV Rank (1 = least cost) | $ Delta | % Delta | NPV Rank (1 = least cost) | $ Delta | % Delta |
| NZ 2035 | Current Policy and Trend | Atlantic Loop | - | CE1-E1-R1 | 16 | $ 2,890 | 18% | 10 | $ 2,800 | 12% | 14 | $ 970 | 4% |
| NZ 2035 | Current Policy and Trend | Atlantic Loop | Direct Air Carbon Capture | CE1-E1-R1 DACC | 21 | $ 3,490 | 22% | 15 | $ 3,820 | 16% | 15 | $ 1,070 | 5% |
| NZ 2035 | Current Policy and Trend | Atlantic Loop | Domestic Hydrogen | CE1-E1-R1 DH | 23 | $ 4,480 | 28% | 21 | $ 4,980 | 22% | 20 | $ 1,700 | 7% |
| NZ 2035 | Current Policy and Trend | Atlantic Loop | Low Fuel and Power Pricing | CE1-E1-R1 LFPP | 8 | $ 1,800 | 11% | 4 | $ 1,260 | 5% | 8 | $ 570 | 2% |
| NZ 2035 | Current Policy and Trend | Atlantic Loop | High Fuel and Power Pricing | CE1-E1-R1 HFPP | 24 | $ 5,120 | 32% | 24 | $ 5,810 | 25% | 22 | $ 1,990 | 9% |
| NZ 2035 | Current Policy and Trend | Atlantic Loop | Modified-mid DSM | CE1-E1-R1 MMDSM | 20 | $ 3,210 | 20% | 14 | $ 3,160 | 14% | 18 | $ 1,250 | 5% |
| NZ 2035 | Current Policy and Trend | Atlantic Loop | Base plus DSM | CE1-E1-R1 BPDSM | 18 | $ 3,030 | 19% | 11 | $ 2,970 | 13% | 16 | $ 1,120 | 5% |
| NZ 2035 | Current Policy and Trend | Atlantic Loop | High DER | CE1-E1-R1 HDER | 10 | $ 1,970 | 12% | 23 | $ 5,210 | 22% | 24 | $ 3,220 | 14% |
| NZ 2035 | Current Policy and Trend | Atlantic Loop | Adjusted Atlantic Loop Timing | CE1-E1-R1 AAT | 15 | $ 2,830 | 18% | 12 | $ 2,980 | 13% | 10 | $ 630 | 3% |
| NZ 2035 | Current Policy and Trend | Atlantic Loop | No wind integration constraints | CE1-E1-R1 WI | 14 | $ 2,820 | 18% | 7 | $ 2,690 | 12% | 12 | $ 920 | 4% |
| NZ 2035 | Current Policy and Trend | Atlantic Loop | Bidirectional Atlantic Loop | CE1-E1-R1 BD | 3 | $ 1,080 | 7% | 1 | $ - | 0% | 5 | $ 360 | 2% |
| NZ 2050 | Current Policy and Trend | Atlantic Loop | - | CE2-E1-R1 | 17 | $ 2,960 | 19% | 8 | $ 2,750 | 12% | 17 | $ 1,170 | 5% |
| NZ 2035 | Accelerated Electrificatio | Atlantic Loop | - | CE1-E3-R1 | 22 | $ 4,310 | 27% | 16 | $ 4,270 | 18% | 21 | $ 1,820 | 8% |
| NZ 2035 | Current Policy and Trend | No Atlantic Loop | - | CE1-E1-R2 | 5 | $ 1,320 | 8% | 6 | $ 2,670 | 12% | 2 | $ 210 | 1% |
| NZ 2035 | Current Policy and Trend | No Atlantic Loop | Direct Air Carbon Capture | CE1-E1-R2 DACC | 13 | $ 2,810 | 18% | 22 | $ 5,030 | 22% | 5 | $ 360 | 2% |
| NZ 2035 | Current Policy and Trend | No Atlantic Loop | Domestic Hydrogen | CE1-E1-R2 DH | 12 | $ 2,770 | 17% | 20 | $ 4,710 | 20% | 11 | $ 890 | 4% |
| NZ 2035 | Current Policy and Trend | No Atlantic Loop | Modified-mid DSM | CE1-E1-R2 MMDSM | 7 | $ 1,710 | 11% | 13 | $ 3,060 | 13% | 7 | $ 490 | 2% |
| NZ 2035 | Current Policy and Trend | No Atlantic Loop | High DER | CE1-E1-R2 HDER | 1 | $ - | 0% | 19 | $ 4,660 | 20% | 23 | $ 2,120 | 9% |
| NZ 2035 | Hybrid Peak Mitigation | No Atlantic Loop | - | CE1-E2-R2 | 2 | $ 840 | 5% | 2 | $ 340 | 1% | 1 | $ - | 0% |
| NZ 2035 | Hybrid Peak Mitigation | No Atlantic Loop | High-Cost Batteries, High-Cost RE | CE1-E2-R2 HBHR | 9 | $ 1,920 | 12% | 5 | $ 2,160 | 9% | 9 | $ 600 | 3% |
| NZ 2035 | Hybrid Peak Mitigation | No Atlantic Loop | Modified-mid DSM | CE1-E2-R2 MMDSM | 4 | $ 1,170 | 7% | 3 | $ 590 | 3% | 3 | $ 280 | 1% |
| NZ 2050 | Current Policy and Trend | No Atlantic Loop | - | CE2-E1-R2 | 6 | $ 1,430 | 9% | 9 | $ 2,790 | 12% | 4 | $ 340 | 1% |
| NZ 2035 | Current Policy and Trend | No Atlantic Loop | Domestic Hydrogen | CE2-E1-R2 DH | 11 | $ 2,720 | 17% | 17 | $ 4,500 | 19% | 13 | $ 940 | 4% |
| NZ 2035 | Accelerated Electrificatio | No Atlantic Loop | - | CE1-E3-R2 | 19 | $ 3,090 | 19% | 18 | $ 4,630 | 20% | 19 | $ 1,260 | 5% |