EVERGREEN IRP
DRAFT RESULTS AND PROCESS UPDATE

JANUARY 13, 2023

Nova Scotia POWER
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EVERGREEN IRP PROCESS UPDATE

Following the development of evergreen IRP assumptions and scenarios, the NS Power team has progressed to the modeling phase of the process.

NS Power is focused on developing a robust long-term planning study that guides the future resource mix based on known and potential future planning considerations.

In this draft results release, NS Power is presenting modeling results from a subset of scenarios.

With the recent significant changes in the planning environment (addressed later in this material), additional work will be required to update the assumptions and re-model the scenarios presented here. Although these changes mean that more modeling is required, NS Power believes it is valuable to share these results with stakeholders as a draft, in order to begin to understand the range of potential planning outcomes.

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SUMMARY OF FINDINGS – DRAFT RESULTS

The following are high level key findings and insights from the draft results:

- All scenarios modeled incorporate the addition of significant capacity of variable renewables resources, which will require further study to understand impacts on system strength, stability, and operational considerations.
- Optimized plans include the continued use of existing gas resources as well as selection of HFO conversions and the addition of new fast acting gas generation; these resources provide firm capacity and support balancing variable renewable generation after the 2030 coal phase-out; results demonstrate decreasing gas generation over the planning horizon as a result of the net zero 2035 targets.
- Both the 2030 and 2035 Atlantic Loop in-service dates produce a lower NPVRR than the No Atlantic Loop scenarios. The absence of the Atlantic Loop drives an increase in variable renewable energy resource additions as well the addition of emerging technology resources and additional battery storage.
- With increasing wind capacity additions relative to load and system peak an increase in curtailment is observed over the planning horizon.

DRAFT MODELING RESULTS

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EVERGREEN IRP MODELING SCENARIOS LIST

The scenarios in **green** reflect the scenarios modeled in the draft modeling results:

Scenarios**	Clean Energy Policy	Electrification	Resource Strategy	Sensitivities
CE1-E1-R1	NZ2035	Current Policy and Trends	Atlantic Loop	Base
CE1-E1-R1-DH				Domestic Hydrogen
CE1-E1-R1-LFPP				Fuel and PP - Low
CE1-E1-R1-HFPP				Fuel and PP - High
CE1-E1-R1-MDSM				Mid DSM
CE1-E1-R1-MMDSM*				Modified Mid DSM
CE1-E1-R1-BPDSM*				Base+ DSM
CE1-E1-R1-HDER				High Distributed Energy Resources
CE1-E1-R1-AAT*				Adjusted Available Timing – Atlantic Loop
CE1-E1-R1-NoECEI*				No Fixed ECEI Projects
CE1-E1-R2	NZ2035	Current Policy and Trends	No Atlantic Loop	Base
CE1-E1-R2-DH				Domestic Hydrogen
CE1-E1-R2-MMDSM*				Modified Mid DSM
CE1-E1-R2-HDER*				High Distributed Energy Resources
CE1-E1-R2-NF				No Additional Firm
CE1-E2-R2	NZ2035	Hybrid Peak Mitigation	No Atlantic Loop	Base
CE1-E1-R2-LB/LR				Low-Cost Battery Storage/Low-Cost Renewables
CE1-E1-R2-MMDSM*				Modified Mid DSM
CE2-E1-R1	NZ2050	Current Policy and Trends	Atlantic Loop	Base
CE2-E1-R2	NZ2050	Current Policy and Trends	No Atlantic Loop	Base
CE2-E1-R2-DH				Domestic Hydrogen

**Updated following the most recent stakeholder engagement session and feedback period – please see the "Updated Modeling Scenarios" on the NSP IRP website*

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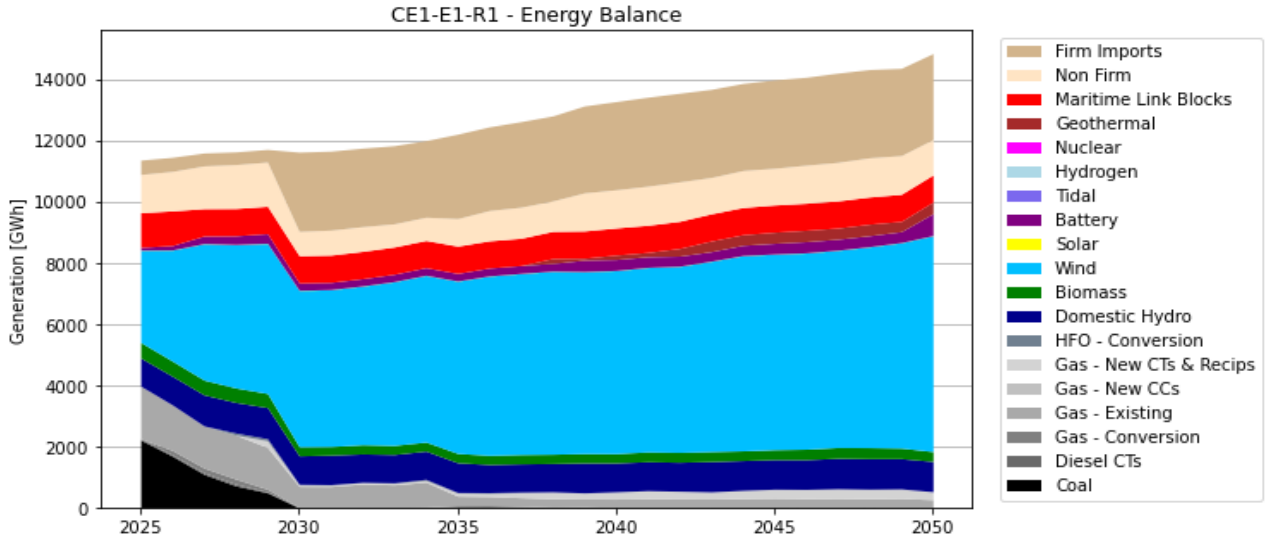
DRAFT RESULTS

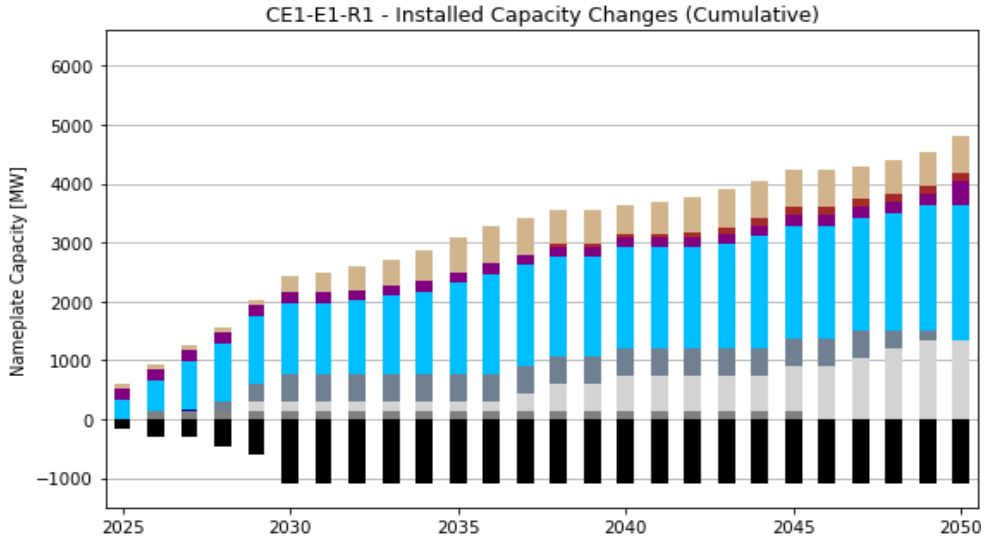
The draft modeling results are organized as follows:

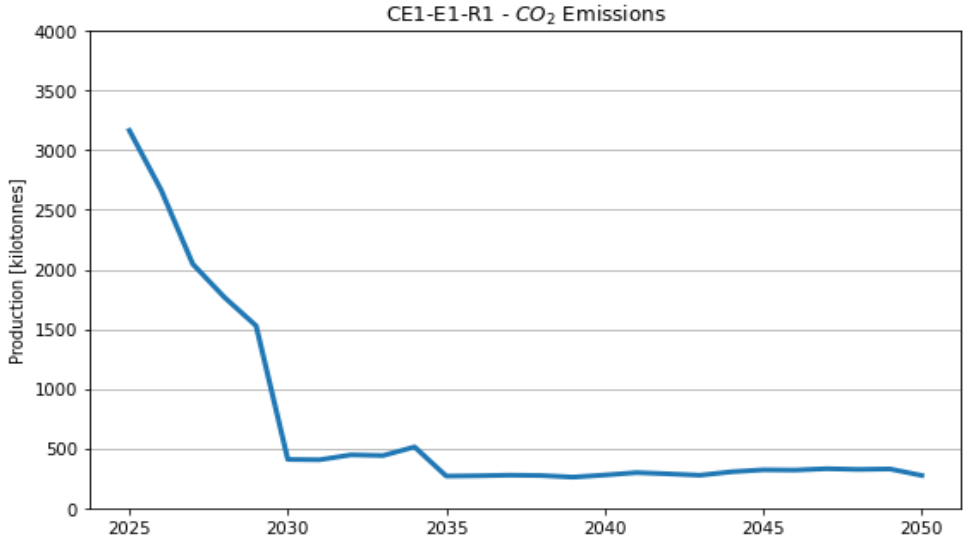
- The first slide for each scenario includes charts for Installed Capacity (MW), Generation (GWh), UCAP Planning Reserve Margin (PRM, %) and GHG Emissions (MT)
  - Capacity charts reflect nameplate capacity for each generating type
  - UCAP PRM – maintains a flat 9% minimum requirement over the modeling horizon (equivalent to 20% ICAP PRM), as confirmed in the 2020 IRP
- The second slide for each modeling scenario includes a summary of the following:
  - Scenario economics (NPVRR)
  - Total GHG emissions by time period (MT)
  - Input assumptions characteristic of the scenario (highlights differences from the CE1-R1-E1 scenario)
  - Key observations for capacity additions, retirements, generation, emissions and cost

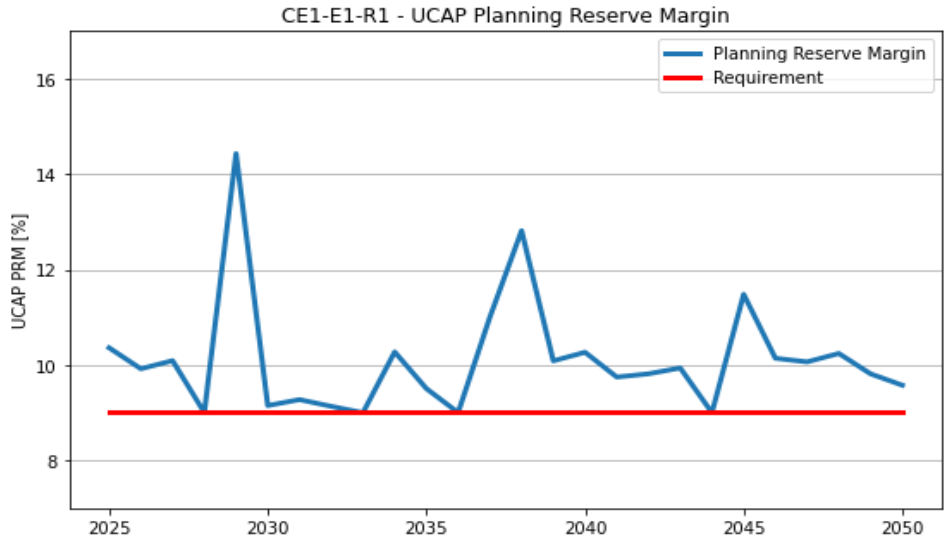
CE1-E1-R1

NZ 2035-CURRENT POLICY AND TRENDS-ATLANTIC LOOP









CE1-E1-R1

NZ 2035-CURRENT POLICY AND TRENDS-ATLANTIC LOOP

Preliminary Scenario Metrics and Evaluation	
26 Year NPVRR ($MM 2025$)	$19,011
26 Year NPVRR with End Effects ($MM 2025$)	$26,005
Total CO_2 Emissions 2025-2030 (MT)	11.3
Total CO_2 Emissions 2031-2035 (MT)	2.1
Total CO_2 Emissions 2035-2050 (MT)	4.4
Total CO_2 Emissions 2025-2050 (MT)	17.8

Key Input Assumptions and Observations

Capacity Expansion*

- Reliability Tie added in 2027
- Atlantic Loop in-service date of 2030; capacity purchases economically optimized over the planning horizon in 50 MW blocks
- ECEI projects fixed (BESS, Wind, Coal-to-Gas Conversion)
- Rate Base Procurement of 350 MW in 2024/25 (100 MW/250 MW)
- Significant wind build selected to accommodate decarbonization targets and carbon pricing (~2800 MW total capacity by 2050)
- As coal is phased out and firm peaks increase, new gas units and HFO conversions are added to provide firm capacity at low utilization factors
- Geothermal is added later in the planning horizon (2038+)

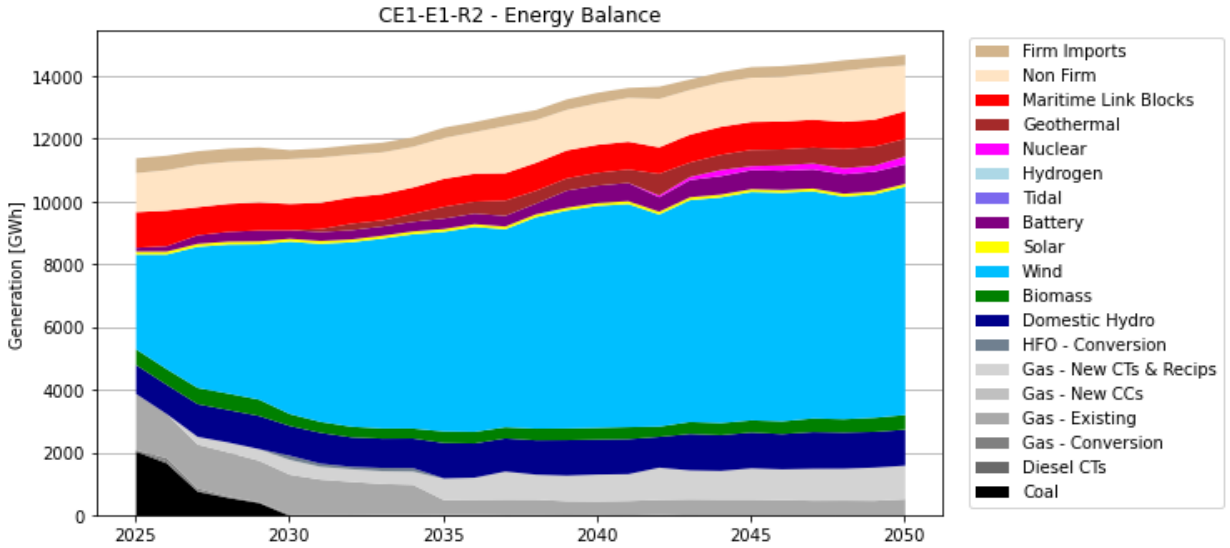
Other

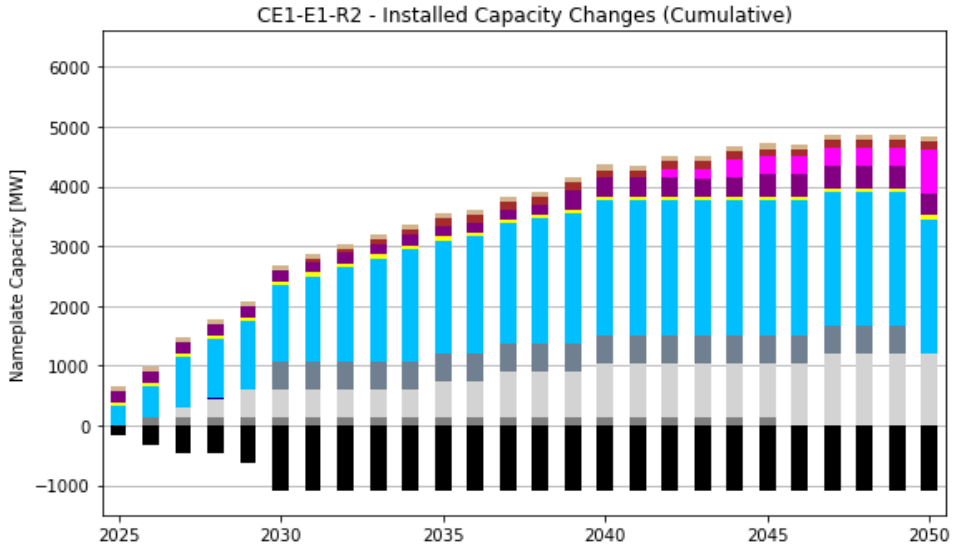
- 2030 coal phase-out is achieved
- 80% Renewable Electricity Standard achieved in 2030
- OBPS performance standards and Federal Carbon price to 2030 (2% escalation post-2030)
- 2035+ Net Zero assumptions - Federal Carbon price applies to all emissions; 50g/kWh system annual emissions intensity hard cap

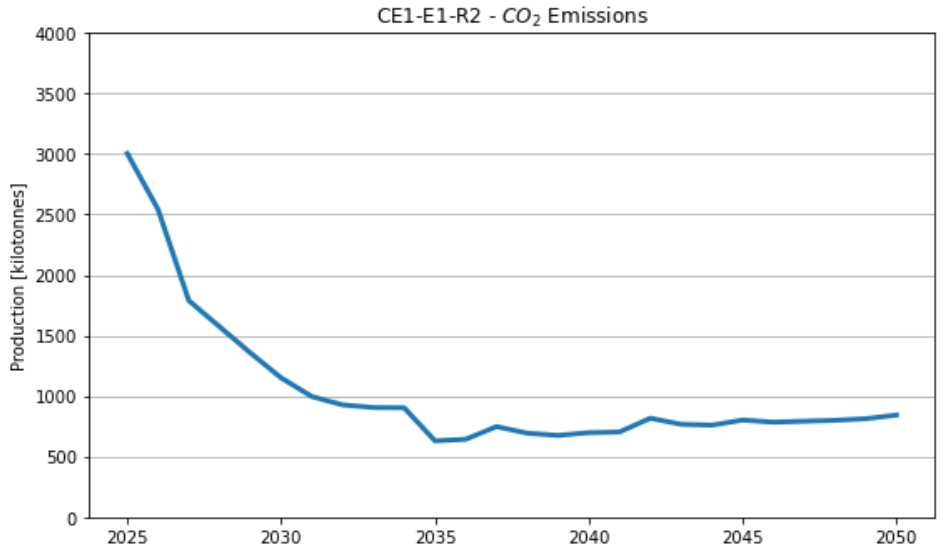
**ECEI project assumptions per the Evergreen IRP Updated Assumptions (August 2022); please see "Planning Environment Changes" section for more details*

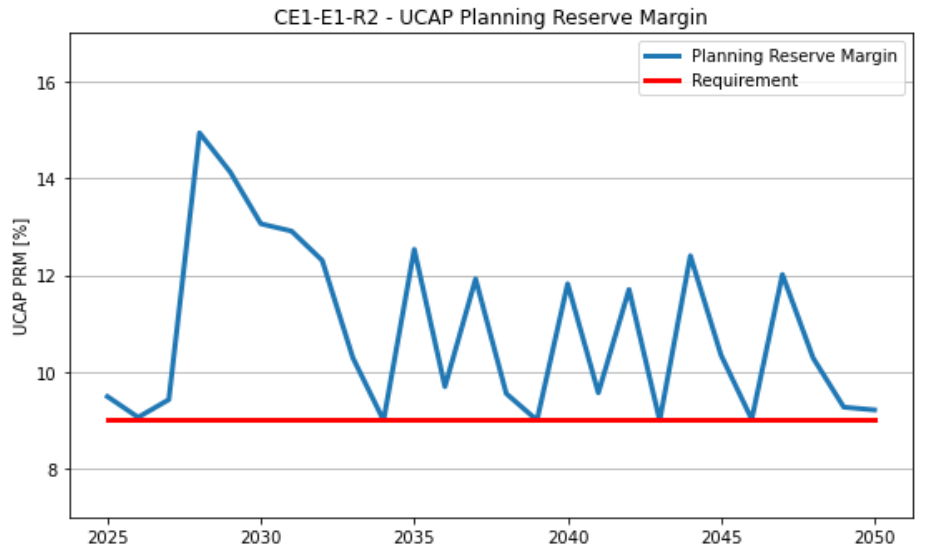
CE1-E1-R2

NZ 2035-CURRENT POLICY AND TRENDS-NO ATLANTIC LOOP









CE1-E1-R2

NZ 2035-CURRENT POLICY AND TRENDS-NO ATLANTIC LOOP

Preliminary Scenario Metrics and Evaluation	
26 Year NPVRR ($MM 2025$)	$19,263
26 Year NPVRR with End Effects ($MM 2025$)	$28,447
Total CO_2 Emissions 2025-2030 (MT)	11.2
Total CO_2 Emissions 2031-2035 (MT)	4.3
Total CO_2 Emissions 2035-2050 (MT)	11.3
Total CO_2 Emissions 2025-2050 (MT)	26.8

Key Input Assumptions and Observations (as compared to CE1-E1-R1)

Capacity Expansion

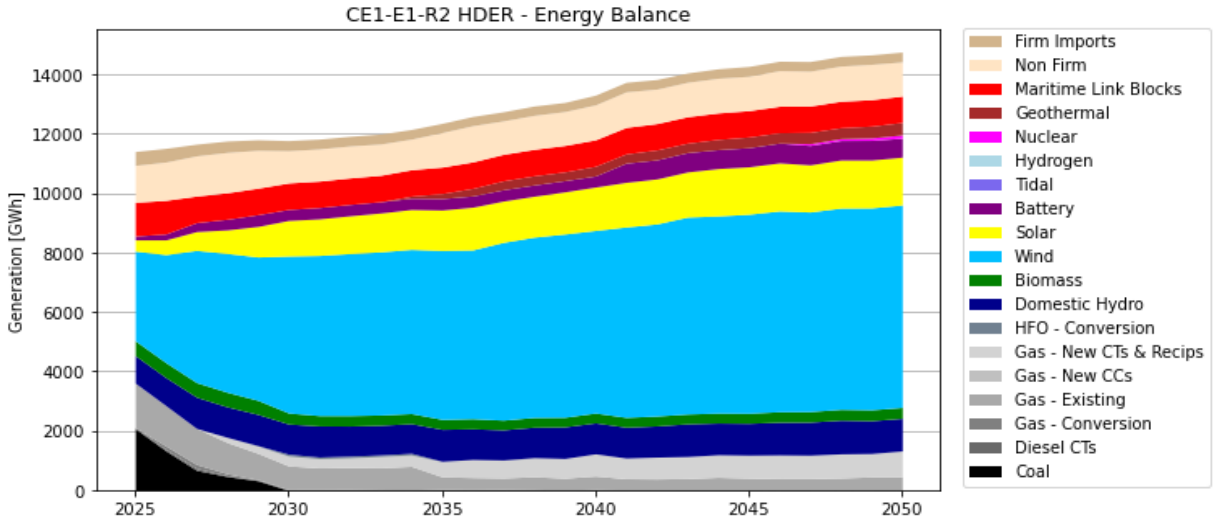
- Atlantic Loop is not available
- 750 MW of SMR capacity by 2050 not seen in scenario CE1-E1-R1
- Comparable installed wind capacity over the modeling horizon (by 2050) as compared to CE1-E1-R1 (with Atlantic Loop); however, higher wind capacity builds are observed earlier in this scenario (+400 MW in 2033)
- Observed new fast-acting gas additions earlier in the modeling horizon with comparable new gas capacity by 2050

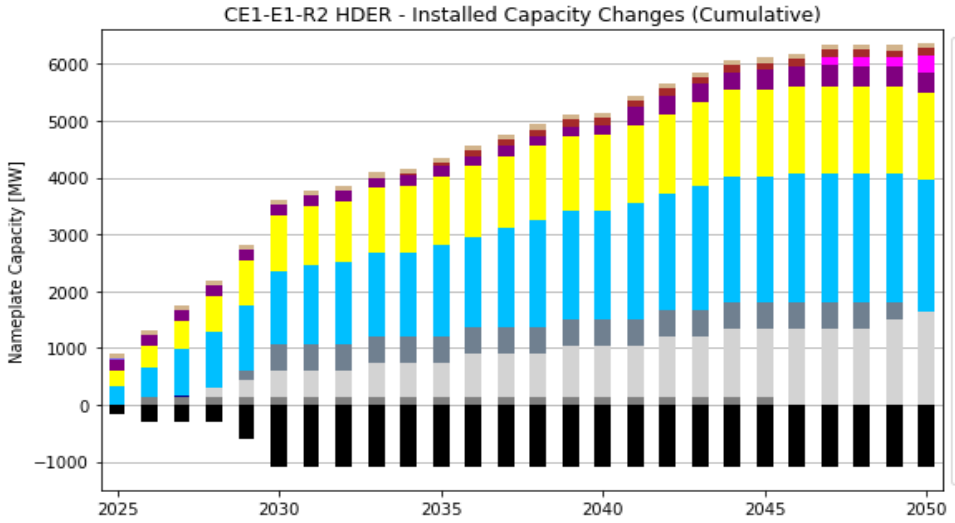
Other

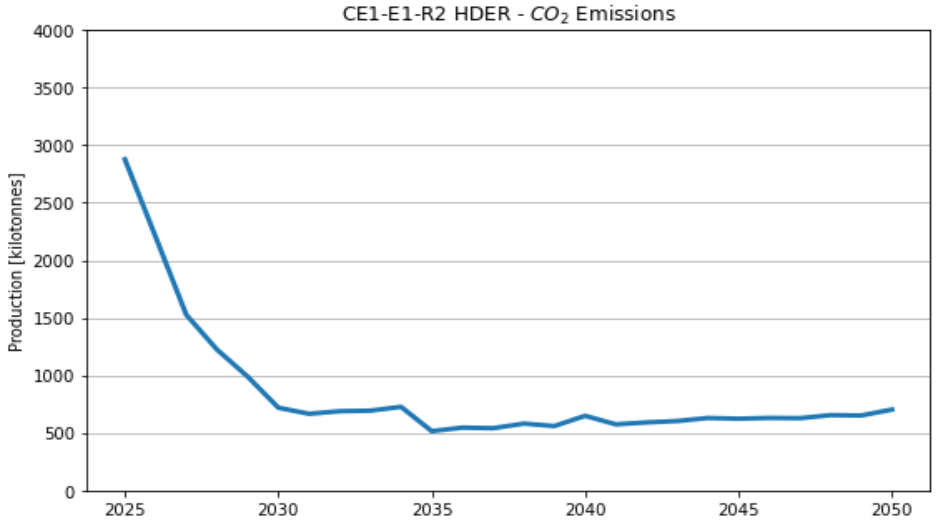
- NPV Difference –$2.4B higher than CE1-E1-R1 (with end effects)
- Total Emissions – higher emissions from 2035-2050 as compared to CE1-E1-R1 – more reliance on emitting generation without Atlantic Loop

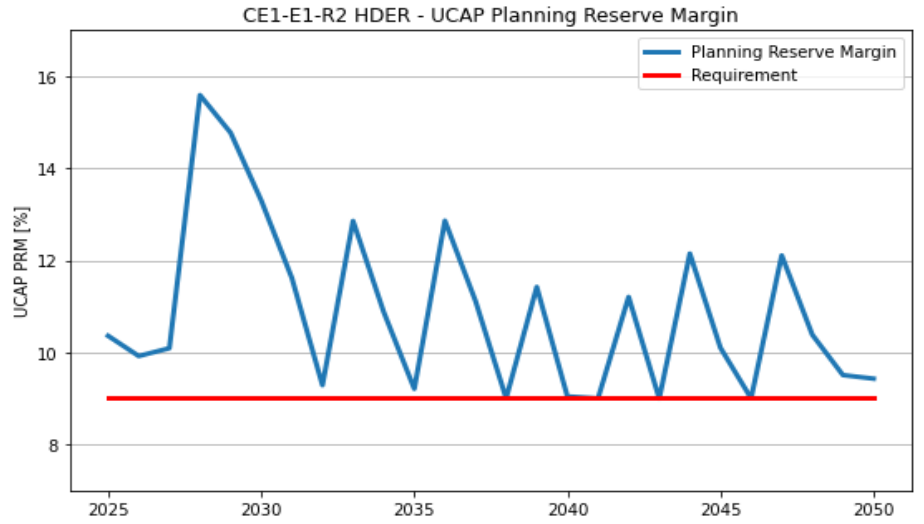
CE1-E1-R2-HDER

NZ 2035-CURRENT POLICY AND TRENDS-NO ATLANTIC LOOP-HIGH DISTRIBUTED ENERGY









CE1-E1-R2-HDER

NZ 2035-CURRENT POLICY AND TRENDS-NO ATLANTIC LOOP-HIGH DISTRIBUTED ENERGY

Preliminary Scenario Metrics and Evaluation	
26 Year NPVRR ($MM 2025$)*	$16,869
26 Year NPVRR with End Effects ($MM 2025$)*	$24,105
NPV Capital Cost – Solar ($MM 2025$)**	$3,074
NPV Capital Cost – Solar with End Effects ($MM 2025$)	$3,771
Total CO_2 Emissions 2025-2030 (MT)	9.3
Total CO_2 Emissions 2031-2035 (MT)	3.3
Total CO_2 Emissions 2035-2050 (MT)	9.1
Total CO_2 Emissions 2025-2050 (MT)	21.8

Key Input Assumptions and Observations

Capacity Expansion (as compared to CE1-E1-R1)

- Atlantic Loop is not available
- High distributed energy resource (DER) profile included in scenario – high penetration of variable renewable energy would have to be studied for system strength, stability and operability considerations
- More gas added earlier in the modeling horizon and more installed capacity than CE1-E1-R1 by 2050 (+300 MW)
- Comparable installed wind capacity by 2050; higher wind capacity additions from 2030 to 2035 to account for the lack of Atlantic Loop imports even with solar additions

Other

- High penetrations of variable renewable energy (wind + solar) results in significant curtailment versus CE1-E1-R1 (~ 40% higher on average over the modeling horizon)
- NPV Difference - ~$1.8B higher NPV as compared to CE1-E1-R1 (with end effects) including cost of DER resources
- Total Emissions – emissions to 2030 slightly lower (higher solar generation); higher emissions from 2035-2050 as compared to CE1-E1-R1 due to the higher installed capacity of new gas

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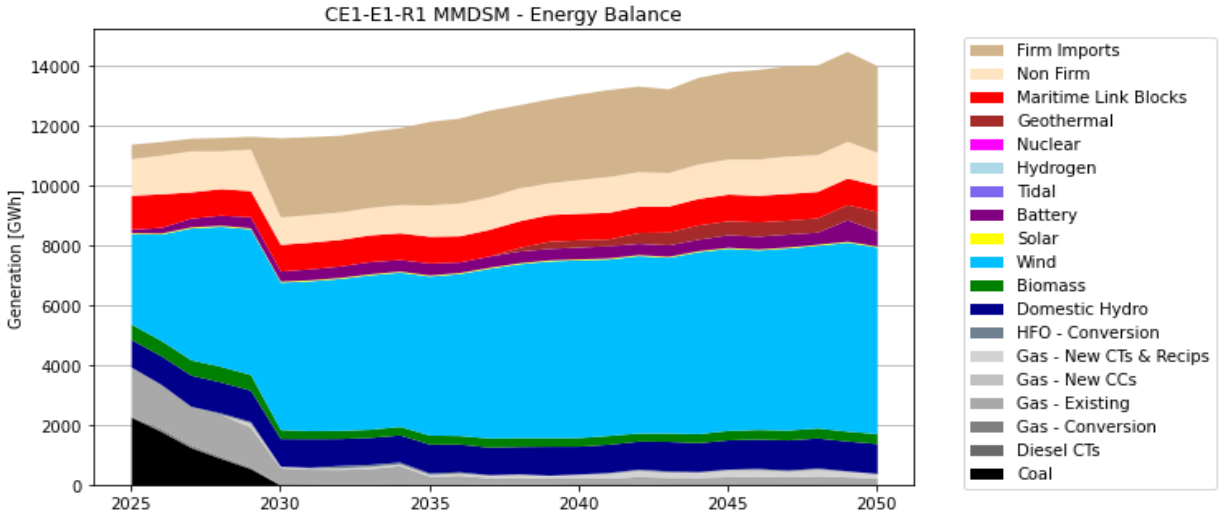
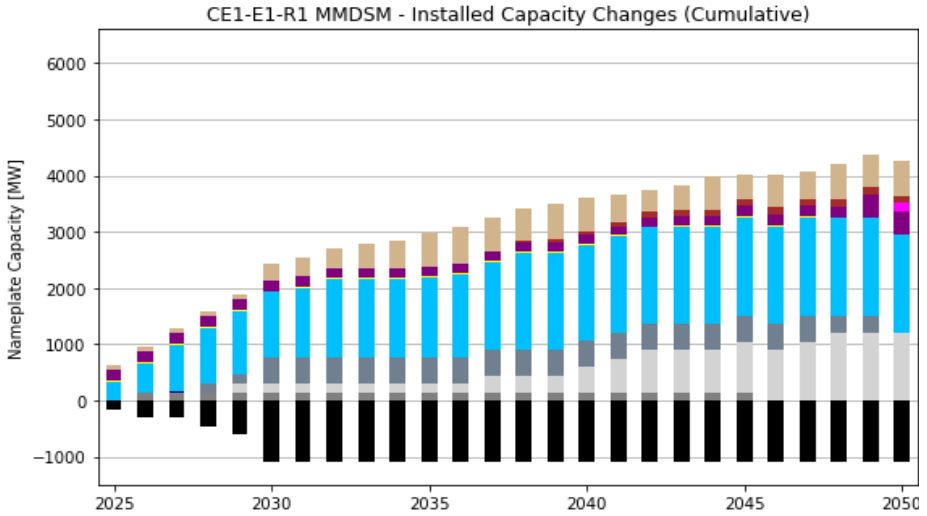
**Does not include solar capital cost*

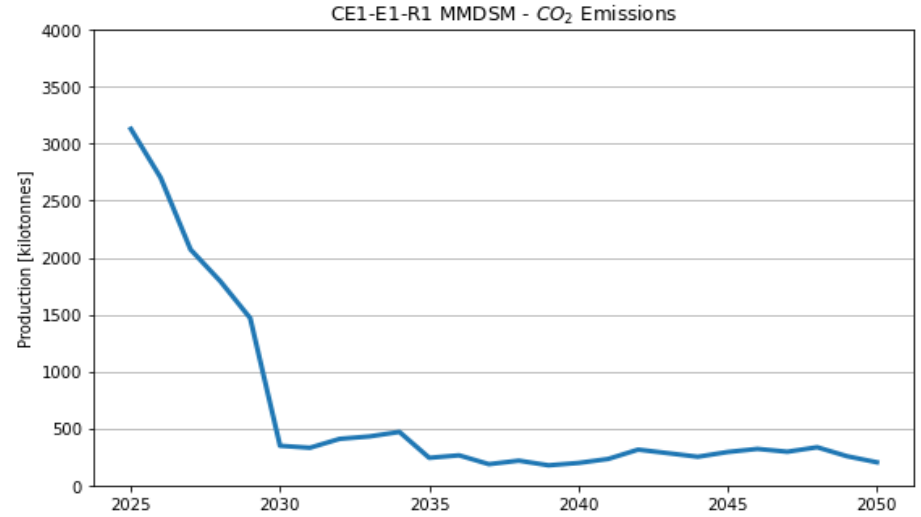
***HDER CAPEX assumption based on $3/watt (2022$); NREL's forecasted cost decline trajectory used to adjust the base estimate for subsequent additions*

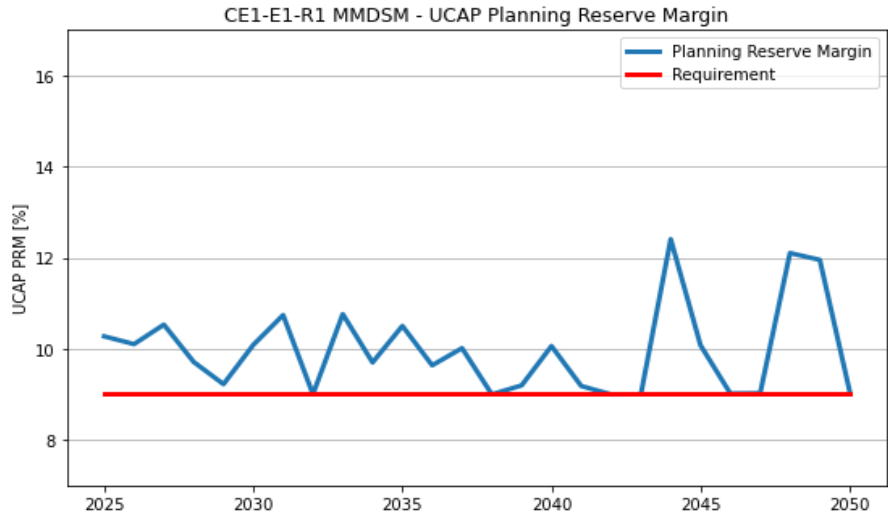
CE1-E1-R1-MMDSM

NZ 2035-CURRENT POLICY AND TRENDS-ATLANTIC LOOP-MOD MID-DSM









CE1-E1-R1-MMDSM

NZ 2035-CURRENT POLICY AND TRENDS-ATLANTIC LOOP-MOD MID DSM

Preliminary Scenario Metrics and Evaluation	
26 Year NPVRR ($MM 2025$)	$19,205
26 Year NPVRR with End Effects ($MM 2025$)	$26,410
Total CO_2 Emissions 2025-2030 (MT)	11.2
Total CO_2 Emissions 2031-2035 (MT)	1.9
Total CO_2 Emissions 2035-2050 (MT)	3.8
Total CO_2 Emissions 2025-2050 (MT)	16.9

Key Input Assumptions and Observations

Capacity Expansion (as compared to CE1-E1-R1)

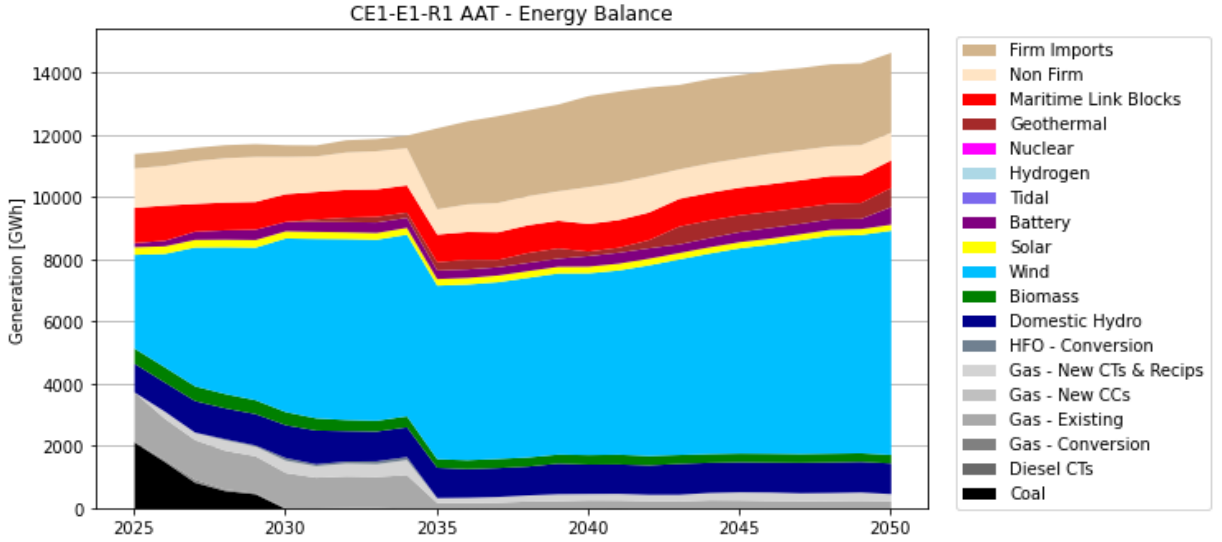
- Modified Mid DSM (MMDSM) profile modeled in place of base DSM profile (MMDSM provided by E1)
- Reduced wind capacity additions as compared to CE1-E1-R1 by ~500 MW
- Increase in SMR capacity (150 MW of installed capacity by 2050 as compared to no nuclear additions for CE1-E1-R1)

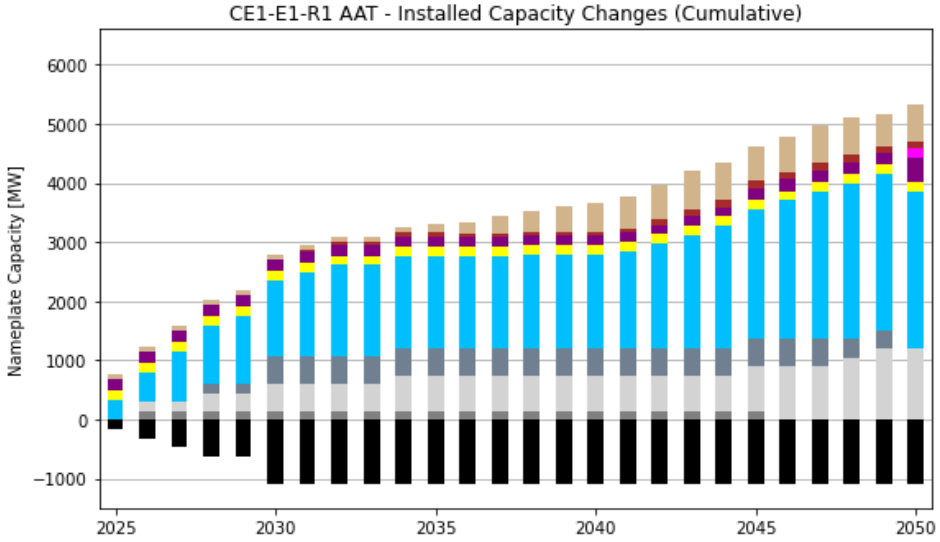
Other

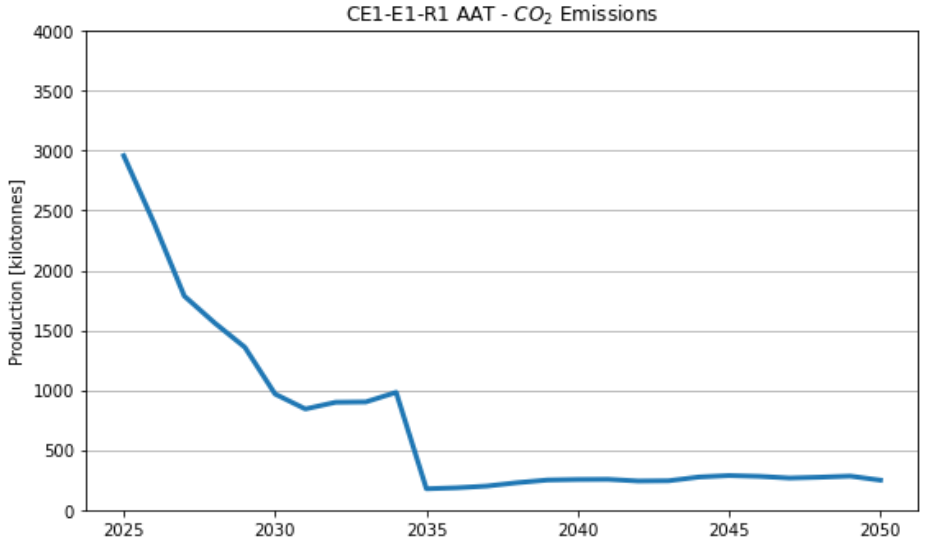
- NPV Difference – higher NPV values compared to CE1-E1-R1 (~$0.4B higher with end effects)
- Total Emissions – comparable emissions profile to CE1-E1-R1

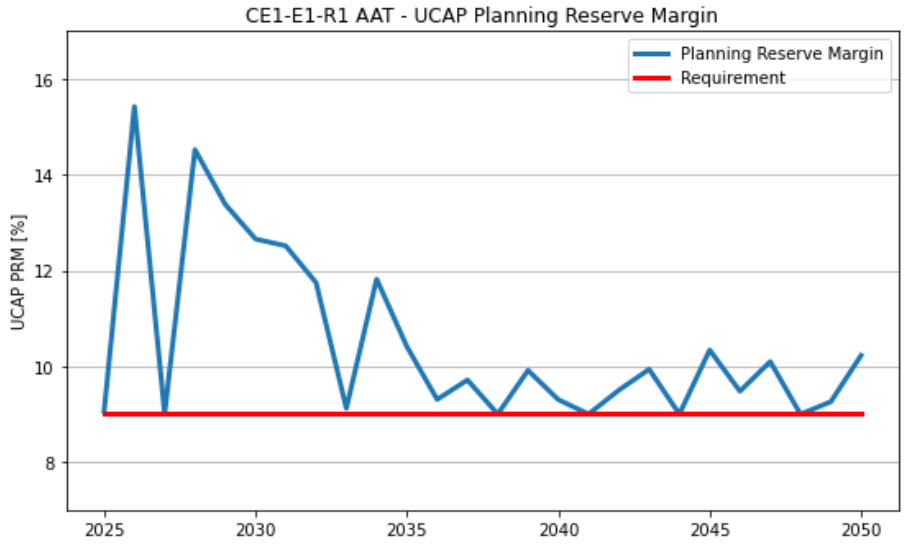
CE1-E1-R1-AAT

NZ 2035-CURRENT POLICY AND TRENDS-ATLANTIC LOOP-ATLANTIC LOOP ADJUSTED TIMING









CE1-E1-R1-AAT

NZ 2035-CURRENT POLICY AND TRENDS-ATLANTIC LOOP-ATLANTIC LOOP ADJUSTED TIMING

Preliminary Scenario Metrics and Evaluation	
26 Year NPVRR ($MM 2025$)	$18,788
26 Year NPVRR with End Effects ($MM 2025$)	$26,336
Total CO_2 Emissions 2025-2030 (MT)	10.8
Total CO_2 Emissions 2031-2035 (MT)	3.8
Total CO_2 Emissions 2035-2050 (MT)	3.8
Total CO_2 Emissions 2025-2050 (MT)	18.3

Key Input Assumptions and Observations

Capacity Expansion (as compared to CE1-E1-R1)

- Atlantic Loop delayed in-service of 2035; capacity purchases economically optimized over the planning horizon in 50 MW blocks
- Higher solar capacity additions by 160 MW as compared to CE1-E1-R1
- Increase in nuclear (150 MW of installed capacity by 2050 as compared to no nuclear capacity additions in CE1-E1-R1)

Other

- NPV Difference – higher NPV values compared to CE1-E1-R1 (~$0.3B higher with end effects)
- Total Emissions – comparable total emissions over the modeling horizon to CE1-E1-R1
- 2030 PRM requirements met without the Atlantic Loop via advancement of fast acting generation capacity (gas build by 2040 is the same as CE1-E1-R1); suggests that the Atlantic Loop still provides value relative to CE1-E1-R2 even if the in-service date is delayed past 2030 coal phase-out target

SUMMARY OF DRAFT RESULTS
INSTALLED CAPACITY

WIND

- All scenarios continue to add significant wind resources with total capacity reaching 1800 MW by 2030 including existing wind and committed projects
- Absence of the Atlantic Loop drives higher wind capacity builds earlier in the planning horizon – observed a departure in the wind capacity build beyond 2033 for the no Atlantic Loop scenario (+400 MW) however, the total wind capacity by 2050 is comparable between the CE1-E1-R1 (with the Atlantic Loop) and CE1-R2-E1 (without the Atlantic Loop)
- Modified mid-DSM scenario shows the lowest wind build as compared to the other scenarios

SOLAR

- Some scenarios select up to ~150 MW of grid scale solar by 2030 if Atlantic Loop is delayed or not included in the scenario
- Highest installed capacity of solar is reflected in the HDER scenario by design, increasing to 1500 MW installed capacity in 2040s
- High penetration of variable renewable energy would have to be studied for system strength, stability and operability considerations

GEOTHERMAL

- Addition of ~125 MW of Geothermal by 2050 for all scenarios, beginning in 2030s
- Early capacity additions reflected in the delayed and no Atlantic Loop scenarios
- NS Power is reviewing IRP assumptions for Geothermal in the context of information released by the province in Fall 2022

NUCLEAR (SMR)

- CE1-E1-R2 (No Atlantic Loop) scenario results in the addition of 750 MW of SMRs by 2050
- SMR capacity additions observed in many scenarios to a lesser degree and later in the planning horizon (beyond 2040)

SUMMARY OF DRAFT RESULTS
INSTALLED CAPACITY (CONTINUED)

COAL

- Coal generation is phased out by 2030 in all scenarios
- Unit retirements or fuel conversions are economically delayed to the later part of the 2020s in all scenarios

GAS AND OIL RESOURCES

- All scenarios sustain existing gas resources through the planning horizon, providing firm capacity but with declining energy output as additional renewable resources are added to the system
- All scenarios select the conversion of 3 coal units to HFO operation as firm capacity assets by 2030; these represent a low-cost source of firm capacity with very limited energy output (and very low associated emissions)
- All scenarios add at least 150 MW of new fast acting gas resources by 2030, with up to 450 MW in several scenarios, in order to provide firm capacity and support balancing of variable renewable generation

BATTERY STORAGE

- Battery storage additions consistent between scenarios until 2038 at 200 MW/800 MWh
- Observed additional battery storage additions in 2039 and beyond
  - No Atlantic Loop scenarios – additional storage additions in 2039 (CE1-E1-R2) and 2041 (CE1-E1-R2-HDER) of 160 MW with the increase in variable renewable generation
  - All scenarios – additional storage additions by end of planning horizon (total range of 370 MW to 430 MW)

SUMMARY OF DRAFT RESULTS
GENERATION

NEW AND EXISTING GAS

- Observe more gas utilization for existing gas and new gas in No Atlantic Loop scenarios as compared to CE1-E1-R1
- Existing gas sees a noticeable decline in generation across all scenarios starting in 2035 as a result of the net-zero requirements; units remain to provide firm capacity and peaking generation
- Increase in emissions for the no Atlantic Loop scenarios given the increased reliance on emitting generation

WIND AND SOLAR

- Significant contribution from wind generation for all scenarios; additional wind generation in the No Atlantic Loop scenario as compared to CE1-E1-R1 in 2030 and beyond
- Delayed Atlantic Loop scenario showing the highest solar generation (second to the HDER scenario)
- With increasing wind capacity additions relative to load and system peak, combined with system strength and stability constraints, an increase in curtailment is observed over the planning horizon (up to 2800 GWh in later years of CE1-E1-R1)

FIRM IMPORTS

- Less reliance on firm import energy over the planning horizon in the delayed Atlantic Loop scenario as a result of the system adding other types of generating capacity (solar, CT) in the early years to meet the 2030 environmental targets

PLANNING ENVIRONMENT CHANGES

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MODELING UPDATES: ASSUMPTIONS

Assumption	Update	Rationale
2023 to 2030 Carbon Policy	The Province of Nova Scotia will be developing carbon policy regulations (NS OBPS) to establish the performance standards for emitting generation in the electricity sector from 2023 to 2030. This new performance standard will be included in the updated assumptions set.	New legislation has created a provincial OBPS framework to replace the cap-and-trade system; input assumptions will reflect the updated provincial carbon performance standards.
ML Imports	Incremental firm capacity import from NL via Maritime Link will no longer be offered as a resource option.	Based on review of recently published Nalcor Reliability and Resource Adequacy Study indicating Nalcor will be in a capacity deficit position over the 2020s.
ECEI Projects	ECEI Projects (wind, battery storage, and coal to gas conversions) will not be fixed into the PLEXOS model. Atlantic Loop will continue to be studied as a Resource Strategy.	As a result of Bill 212, the ECEI projects have been paused and the timing of the projects is under review, warranting an adjustment to the evergreen IRP assumptions.
Federal Investment Tax Credit (ITC)	Modification of capital costs for applicable clean energy resources to account for the announced clean energy Federal Tax Credit.	The Federal Government announced a 30% refundable investment tax credit for clean energy technologies (including wind, solar, and storage).

PLANNING ENVIRONMENT CHANGES PROVINCIAL CARBON POLICY

- Under the terms of the federal carbon framework to 2030, the Province of Nova Scotia was required to determine whether to extend the existing cap-and-trade system, create a set of provincial performance standards / retail fuel levies, or rely on the federal backstop carbon pricing system
- The Province has since updated the existing *Environmental Act* legislation to indicate a transition from the current cap and trade system to a provincial OBPS system (NS OBPS) beginning in 2023
- The specific regulations associated with the NS OBPS have not been released
- Once the details of the NS OBPS are available, NS Power will include the updated performance standards in the model for the 2023 to 2030 period

PLANNING ENVIRONMENT CHANGES ADDITIONAL FIRM IMPORTS AND RELIABILITY

- Nalcor filed its "Reliability and Resource Adequacy Study – 2022 Update" on October 3, 2022 which points to both:
  - On-Island capacity constraints in meeting NL load requirements and the need for more on-island firm generation
  - Reliability challenges with the LIL that are anticipated to persist into the mid-term and will reduce the reliability of imports from Labrador
- Based on the findings from the report, NS Power is assuming the ML Block B candidate resource is unavailable
- NS Power will also update the ELCC of the Nova Scotia Block from 98% to 95% to reflect the anticipated LIL forced outage rate discussed in the report

PLANNING ENVIRONMENT CHANGES
RATE CAP LEGISLATION

- NS Power was engaged in a General Rate Application (GRA) over the course of 2022
- The Province passed legislation to limit the increase in electricity rates
- This legislation (Bill 212) has created uncertainty regarding the ECEI investments included in ACE 2022
- Of those investments, the following has been confirmed:
    - The planned investments in the Eastern Clean Energy Initiative (ECEI) on hold
    - As part of this, the progression of the Atlantic Loop has been put on pause as well
- As a result, the ECEI investments, which were included in the evergreen IRP assumptions, will not be fixed in the next round of modeling

PLANNING ENVIRONMENT CHANGES
FEDERAL INVESTMENT TAX CREDIT (ITC)

The Federal Government announced an investment tax credit for clean technologies, with a focus on net-zero technologies and battery storage solutions to incent progress towards a net-zero economy.

- The plan as announced would provide a refundable tax credit equal to 30% of capital cost of investments
- Qualifying clean technologies would include solar, SMRs, wind, storage systems that do not use fossil fuels in their operation, low carbon heat equipment and industrial zero-emission vehicles and related charging or refueling equipment
- A clean hydrogen investment tax credit also exists but is understood to apply to hydrogen production equipment and not hydrogen-fueled generators

The investment tax credit will be available for eligible investments made starting in the first year of the planning horizon (2025):

- The net zero technologies will be subject to phase out as early as 2032 with the program ending in 2035
- For the evergreen IRP modeling assumptions, the capital costs for new investments in wind, solar, SMR and storage systems will be adjusted to reflect the ITC

NEXT STEPS

- NS Power will update assumptions as described in this package and continue modeling
- Schedule of Next Steps:
  - Provide updated assumptions – January 26th
  - Stakeholder feedback on draft results and updated assumptions – requested by February 9th
  - Complete and issue modeling results using updated assumptions - March 30th
  - Results Workshop – to be scheduled the week of April 3rd
  - Stakeholder feedback on modeling results - requested by April 21st
  - Report on Outcomes and Update IRP Action Plan – May 10th

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