NS POWER 2020 IRP
MODELING RESULTS WORKSHOP

JULY 9, 2020

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AGENDA

ASSUMPTION & KEY SCENARIO UPDATES

INITIAL PORTFOLIO STUDY RESULTS

- **COMPARISONS & INSIGHTS**
- **SCENARIO RESULTS**

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PROCESS UPDATE & WORK COMPLETED

UARB NSP Pre-IRP
Deliverables

- Capacity Study
- Supply Options Study
- Demand Response Assumptions
- Stability Study

Core IRP Process
resulting in Final Report

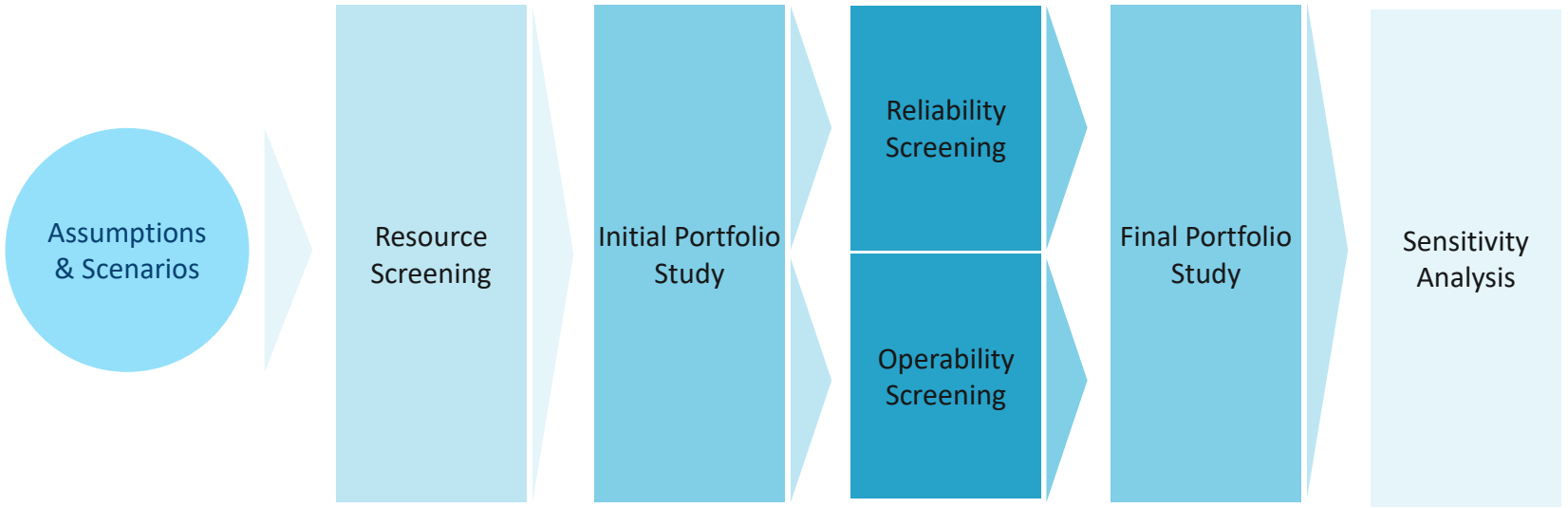
Sept 2020

- Terms of Reference
- Scenario Development
- Modeling Plan
- Assumptions
- Modeling
- Analysis/Conclusions
- Report, Roadmap, & Action Plan

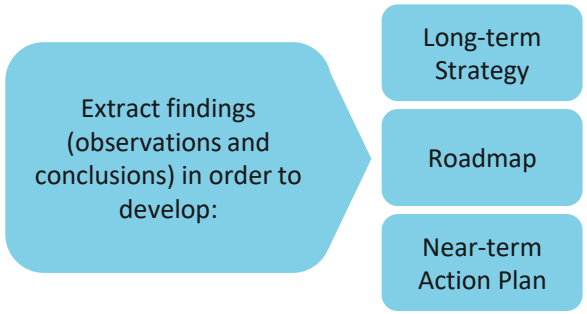
- Previously completed
- Completed since last update
- In Progress

IRP MODELING PLAN

MODELING



POST-MODELING



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ASSUMPTION & KEY SCENARIO UPDATES

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ASSUMPTIONS & KEY SCENARIO UPDATES

Note: NS Power reviewed slides 5-9 from Modeling Results release 2020-06-26

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QUESTIONS & DISCUSSION
ASSUMPTIONS & SCENARIOS

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INITIAL PORTFOLIO STUDY COMPARISONS & INSIGHTS

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RESOURCE SCREENING – DIESEL COMBUSTION TURBINES

- Screening of existing Diesel CTs was conducted by E3 using RESOLVE
- During screening the model was free to re-optimize the resource portfolio and to select any available supply options to replace the CT capacity (e.g. new gas CTs/CCGTs, batteries, firm imports, etc.)
- Analysis was completed on two key scenarios (1.0A and 2.1C)
- Screening results showed that sustaining the existing diesel CT fleet is economic vs. replacement alternatives; Diesel CTs will be assumed “in” in the Initial Portfolio Study runs
- This result was robust to testing with a lower Planning Reserve Margin (PRM) and to testing a single unit retirement

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RESOURCE SCREENING – HYDRO

- Screening of the existing hydro systems was conducted by E3 using RESOLVE
- During screening the model was free to re-optimize the resource portfolio and to select any available supply options to replace the hydro capacity and energy (e.g. new gas CTs/CCGTs, batteries, firm and non-firm imports, wind, etc.)
- Analysis was completed on two key scenarios (1.0A and 2.1C)
- Sustaining and Decommissioning costs were taken from NS Power's recent Hydro Asset Study
- Wreck Cove and Mersey were modeled individually and remaining systems were modeled in two groups with similar operating characteristics
- Screening results showed that sustaining the existing hydro systems is economic vs. replacement alternatives; existing hydro will be assumed "in" in the Initial Portfolio Study runs
- NS Power will conduct a capacity expansion run in PLEXOS with the Mersey hydro system retired

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INITIAL PORTFOLIO STUDY NOTES

- The following slides provide the Initial Portfolio Study results from PLEXOS LT for the key scenarios as well for select sensitivities (full capacity expansion runs)

- The section includes several summary comparison slides as well as detailed outputs of each scenario including energy mix, nameplate capacity installation, emissions compliance, several metrics of NPV of partial revenue requirement, and scenario notes

- NPVs presented in these results are partial revenue requirements that consider modeled costs (i.e. production, O&M, abatement, sustaining capital, and capital investment) and costs considered outside of the long-term model optimization (i.e. energy efficiency costs)

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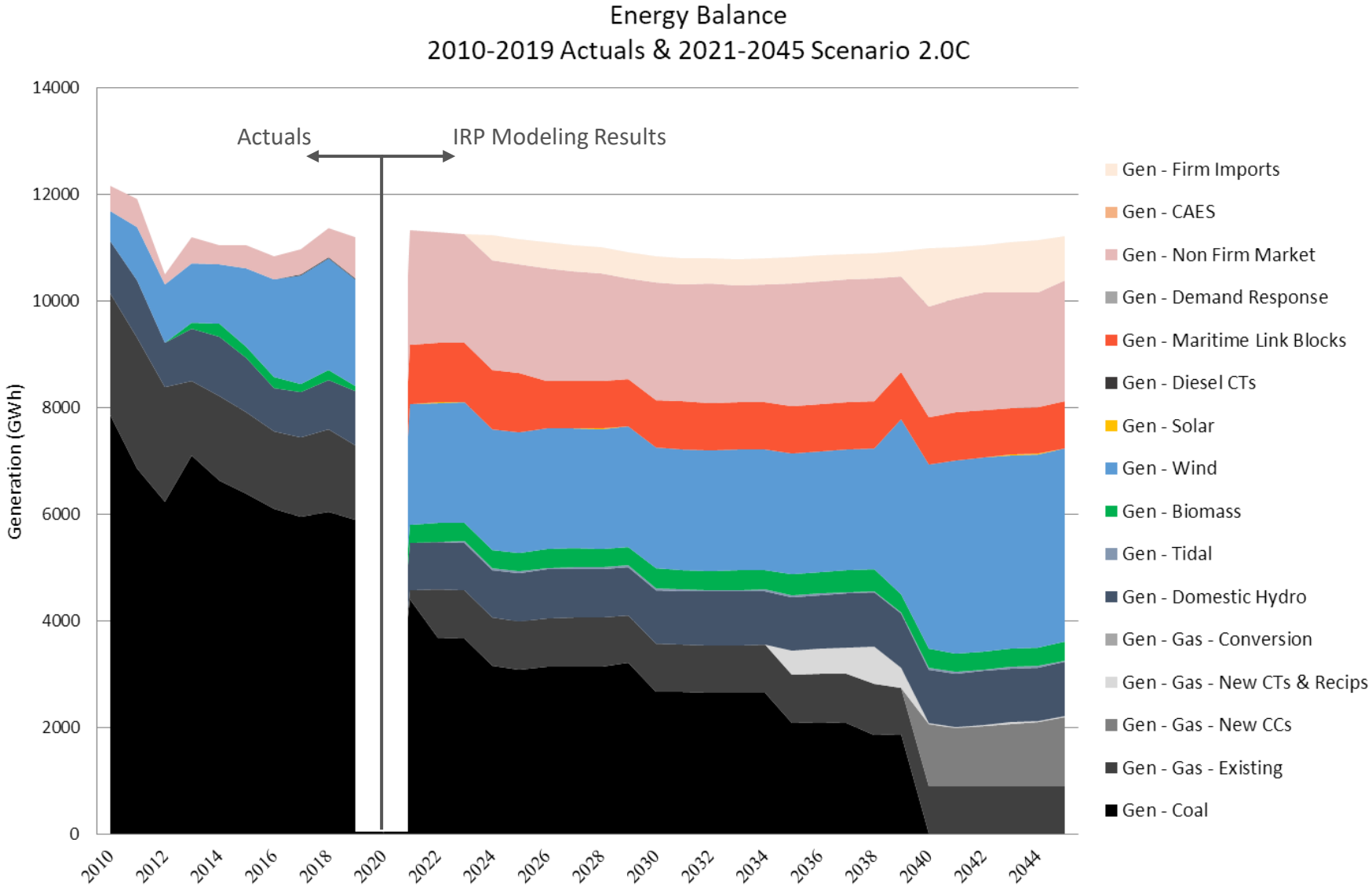
IRP IN THE CONTEXT OF ONGOING GENERATION TRANSFORMATION

- The graph to the right includes actual annual generation for 2010-2019 and forecast generation from PLEXOS LT for 2021-2045 (2020 is left blank)
- This chart highlights the increasing penetration of renewables on the Nova Scotia system since 2010 as well as the anticipated changes due to the availability of energy over the Maritime Link beginning in 2021



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KEY MODELING SCENARIOS

Scenario	Features	Load Drivers	Coal Retires	Resource Strategies Tested	Key Sensitivities
1.0 **Comparator**	Equivalency GHG	Low Elec. Base DSM	2040	A - Current Landscape C – Regional Integration	
2.0 **Net Zero 2050** **Low Electrification**	GHG targets decline linearly from 2030 to 0.5Mt in 2050	Low Elec. Base DSM	2040	A - Current Landscape C - Regional Integration	• DSM Levels
2.1 **Net Zero 2050** **Mid Electrification**	GHG targets decline linearly from 2030 to 0.5Mt in 2050	Mid Elec. Base DSM	2040	A - Current Landscape B - Distributed Resources C - Regional Integration	• DSM Levels • No New Emitting • Target Case for Sensitivity Evaluation
2.2 **Net Zero 2050** **High Electrification**	GHG targets decline linearly from 2030 to 0.5Mt in 2050	High Elec. Max DSM	2040	A - Current Landscape C - Regional Integration	• DSM Levels • No New Emitting
3.1 **Accelerated Net Zero 2045 Mid Electrification**	GHG targets decline from 2025 to 0.5Mt in 2045; path to Absolute Zero 2050	Mid Elec. Base DSM	2030	B - Distributed Resources C - Regional Integration	• DSM Levels • No New Emitting • Target Case for Sensitivity Evaluation
3.2 **Accelerated Net Zero 2045 High Electrification**	GHG targets decline from 2025 to 0.5Mt in 2045; path to Absolute Zero 2050	High Elec. Max DSM	2030	B - Distributed Resources C - Regional Integration	• DSM Levels

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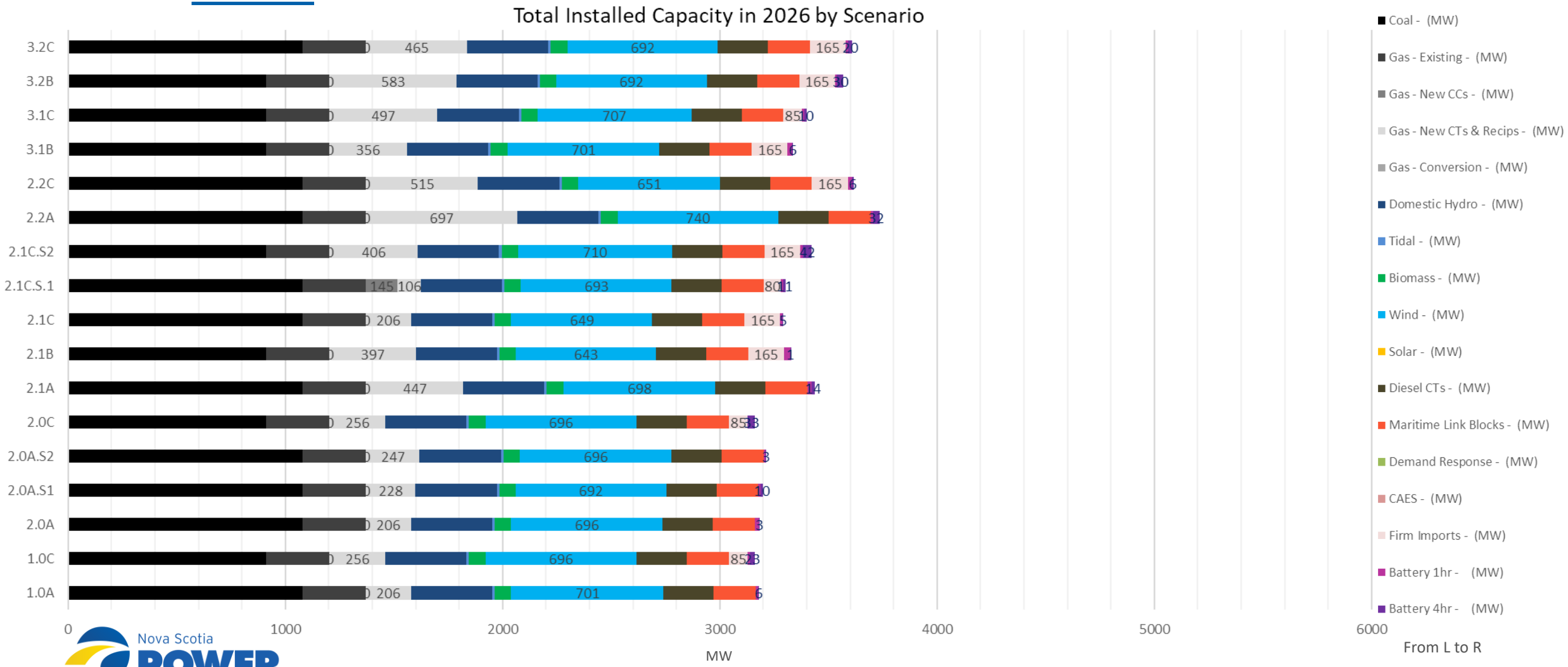
NEAR TERM RESOURCE PORTFOLIOS (2026)



From L to R

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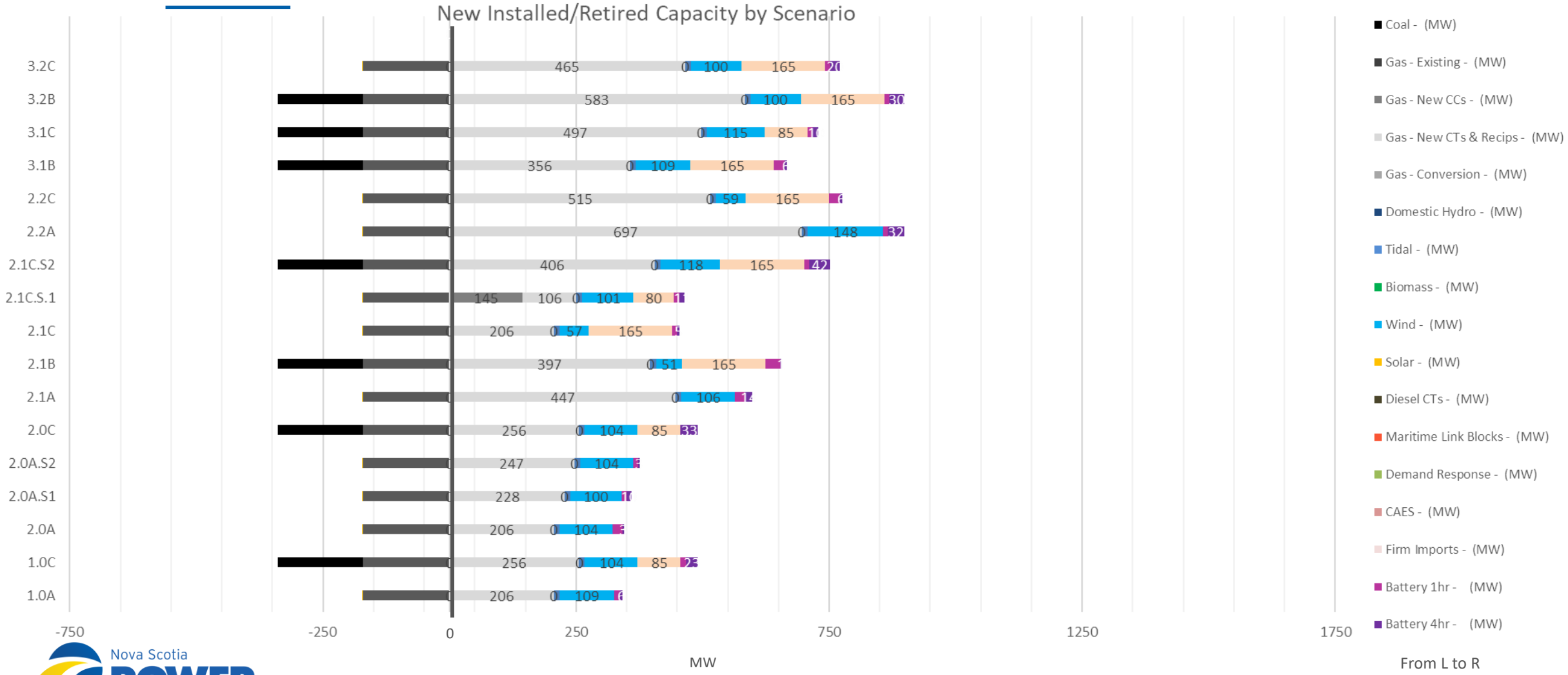
NEAR TERM RESOURCE CHANGES (2026)



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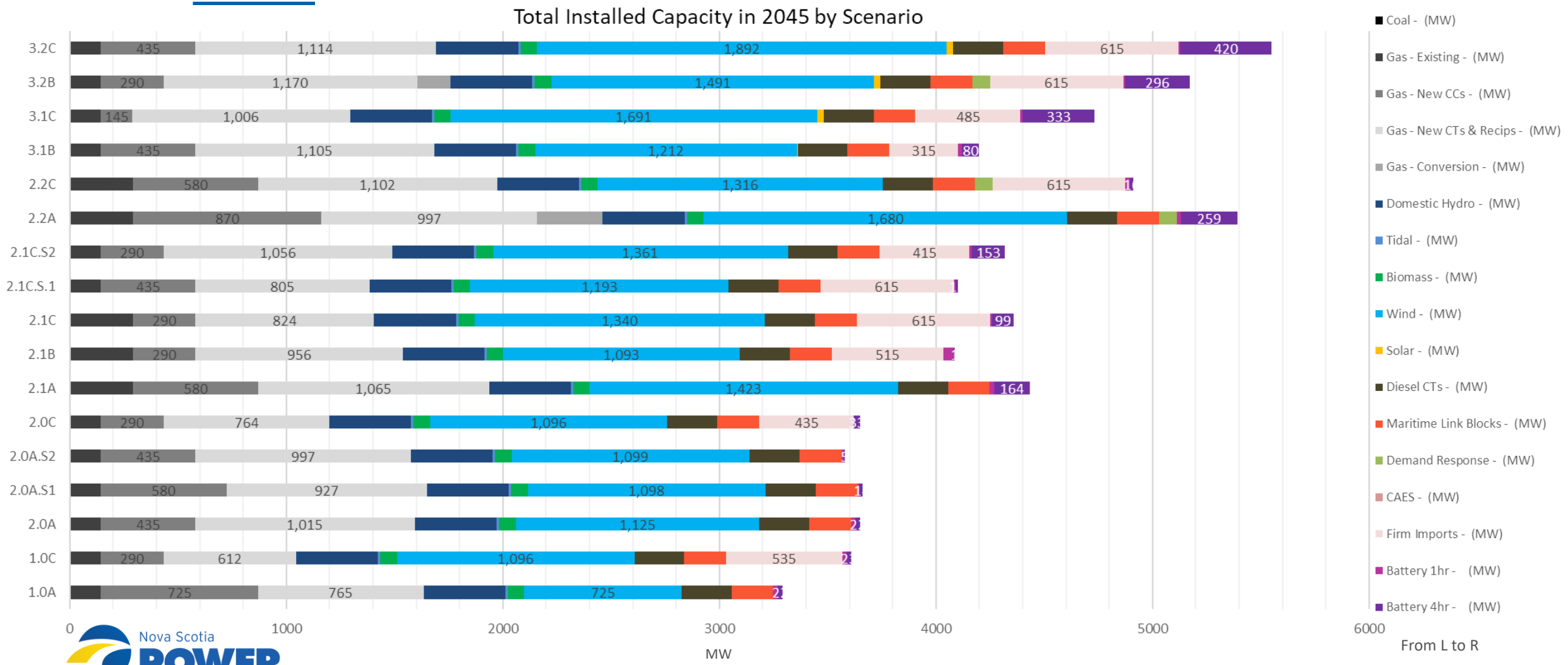
LONG TERM RESOURCE PORTFOLIOS (2045)



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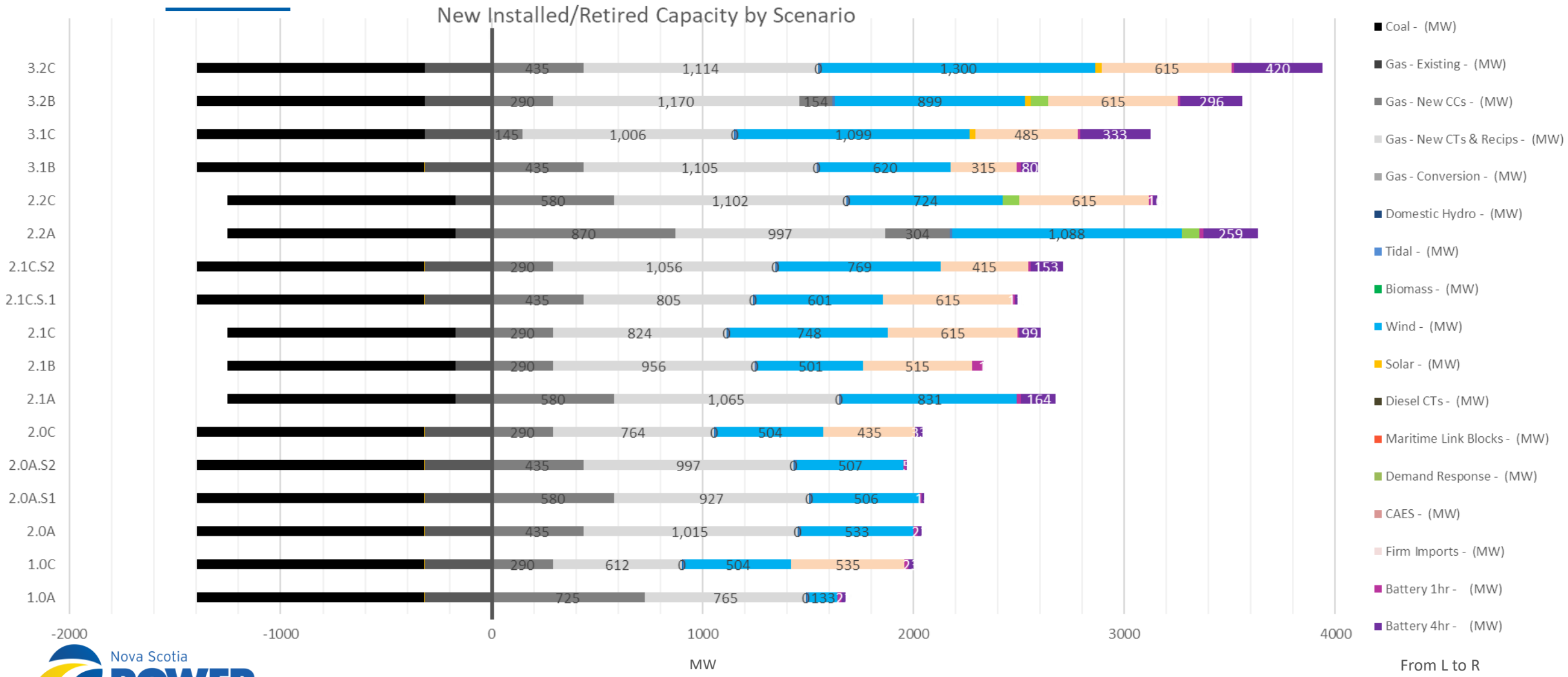
LONG TERM RESOURCE CHANGES (2045)



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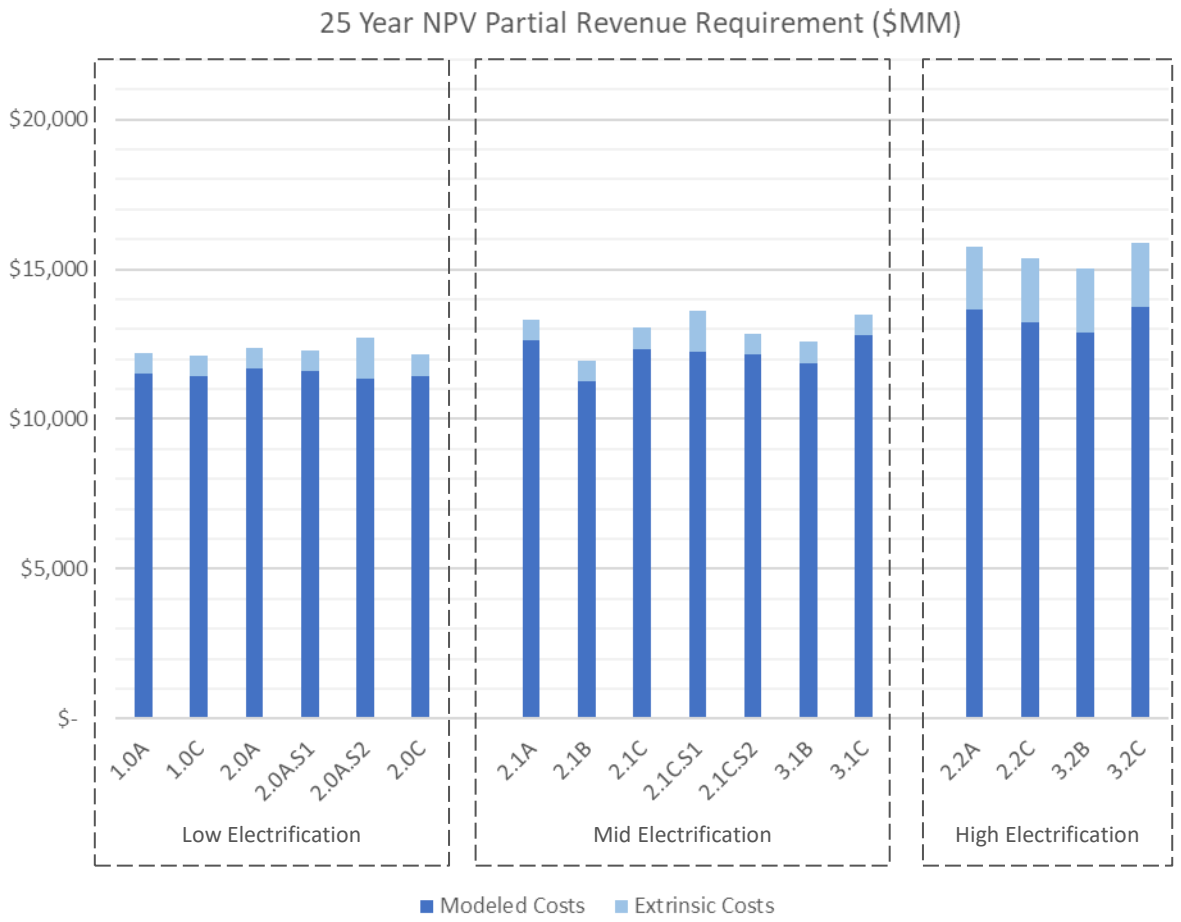
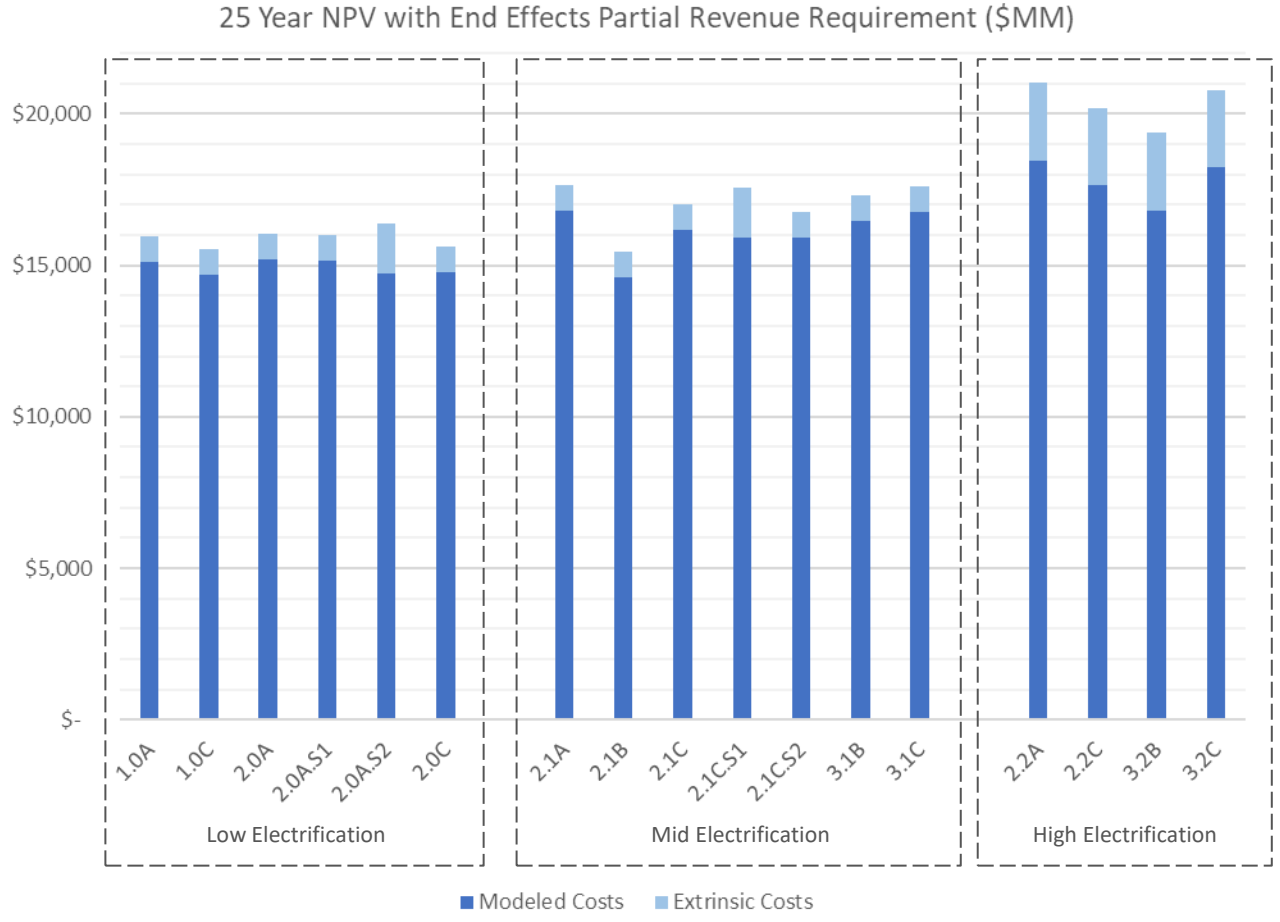
NPV PARTIAL REVENUE REQUIREMENT COMPARISON





Due to differences in forecast system load affecting production costs, resource plan partial revenue requirement results should not be compared across electrification scenarios

QUESTIONS & DISCUSSION
INITIAL PORTFOLIO COMPARISONS

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REGIONAL INTERCONNECTION

- Reliability Tie enabling wind integration was selected in all scenarios other than 1.0A Comparator
  - Could occur in advance of a Regional Interconnection or simultaneously (see table)
  - Available under all scenarios
- Incremental firm imports are selected when offered via a Regional Interconnection
  - Available under all “B” and “C” scenarios
- Both firm and non-firm imports play a significant role to meeting energy requirements in all scenarios examined

Scenario	Reliability Tie Selected	Regional Interconnection Selected
3.2C	2030	2030
3.2B	2029	2030
3.1C	2030	2030
3.1B	2034	2045
2.2C	2034	2039
2.2A	2034	Not Offered
2.1C.S2	2029	2040
S.1C.S1	2038	2040
2.1C	2037	2038
2.1B	2040	2040
2.1A	2031	Not Offered
2.0C	2039	2039
2.0A.S2	2036	Not Offered
2.0A.S1	2029	Not Offered
2.0A	2030	Not Offered
1.0C	2039	2039
1.0A	X	Not Offered

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RENEWABLE GENERATION

- Onshore wind energy selected in all scenarios as the most economic type of domestic renewable generation
- Construction of a Reliability Tie (new 345kV line from Onslow, NS to Salisbury, NB) is preferentially selected as a method of wind integration
  - This option was offered to the model in all scenarios, including “A” (Current Landscape)
- Domestic integration (batteries + synchronous condensers) was selected when the limits of what could be integrated using the Reliability Tie were reached
- The combination of Reliability Tie integration and domestic integration was not examined in the PSC reliability study as part of the Pre-IRP work but was selected in several scenarios after 2030; this will need to be studied further

Available Wind (Nameplate MW)	No Integration Requirements*	Reliability Tie*	Domestic Integration* (Batteries + Sync. Condenser)	Total Available
Low Electrification	100	400	400	900
Mid Electrification	100	500	500	1,100
High Electrification	100	600	600	1,300

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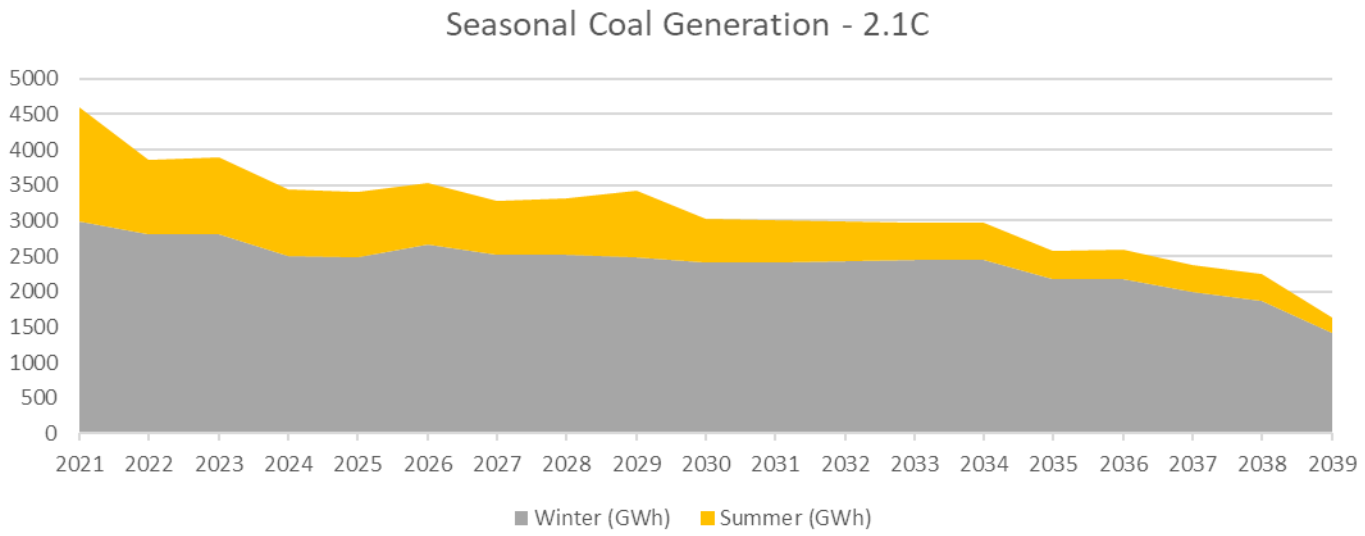
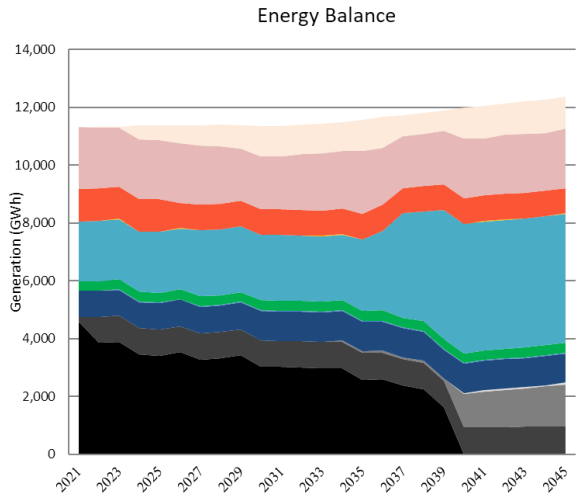
**Local Integration requirements would be determined via specific System Impact Studies*

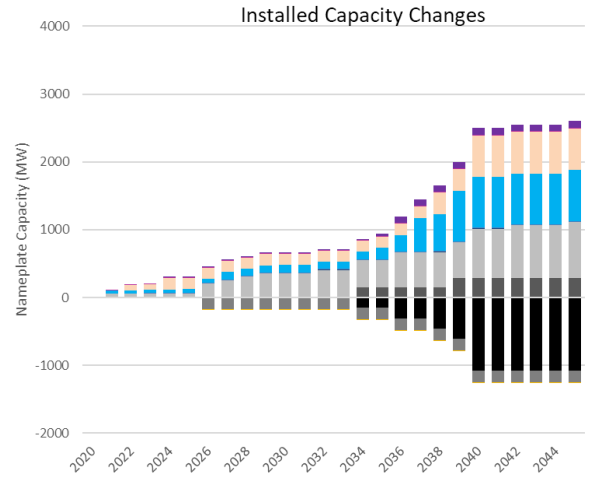
COAL UNITS

- Annual generation declines with emissions limits through the planning horizon
- Coal generation increasingly shifts to winter months (November through March) later in the planning horizon



2.1C





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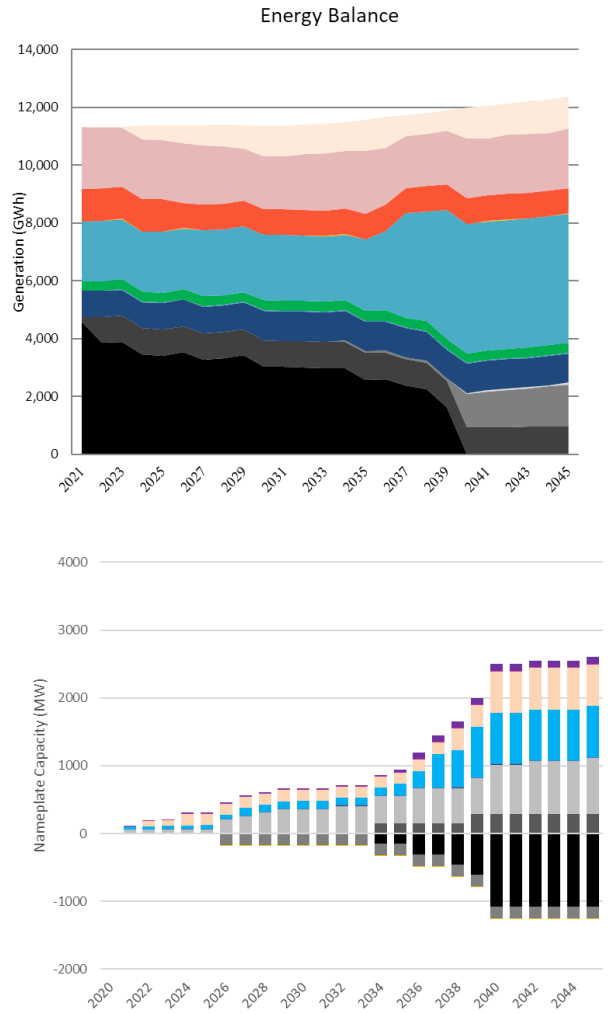
GAS UNITS

- New gas units selected are predominately combustion turbines
- At least one combined cycle unit was selected economically in each scenario (late 2020s-early 2030s)
- For all new gas units, the expansion model selected an economic gas supply option:
  - Combined Cycle units generally select the baseload gas option (with fixed annual transportation cost)
  - Combustion Turbine units generally select the peaking gas option
- Coal to Gas conversion was selected economically in some scenarios
- Small early build of CT / Reciprocating resources resolves existing PRM deficiency (~30MW)
  - Consistent with NS Power's 2020 10-year system outlook

2.1C



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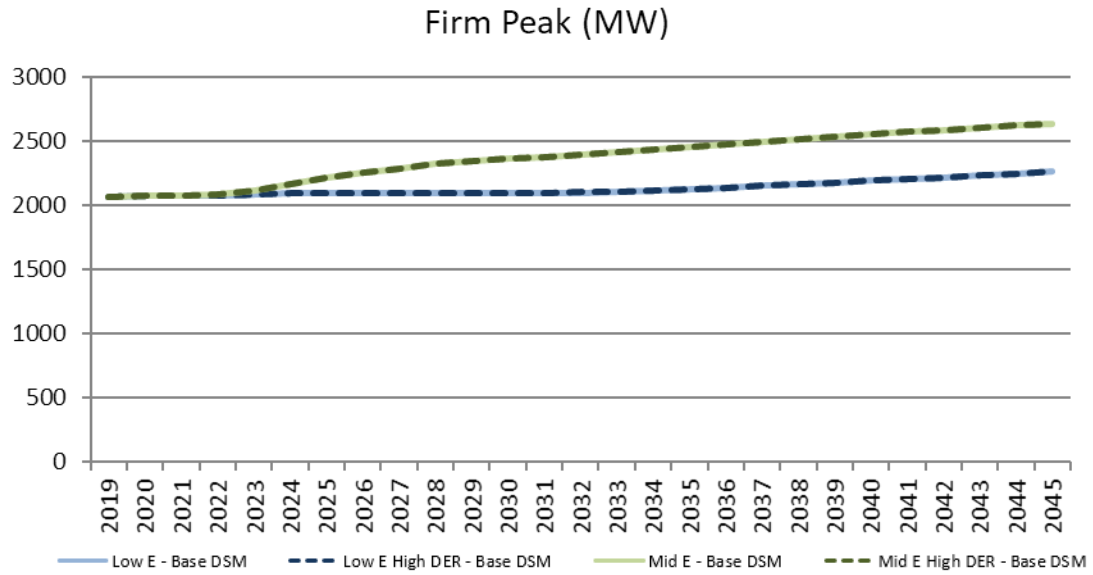
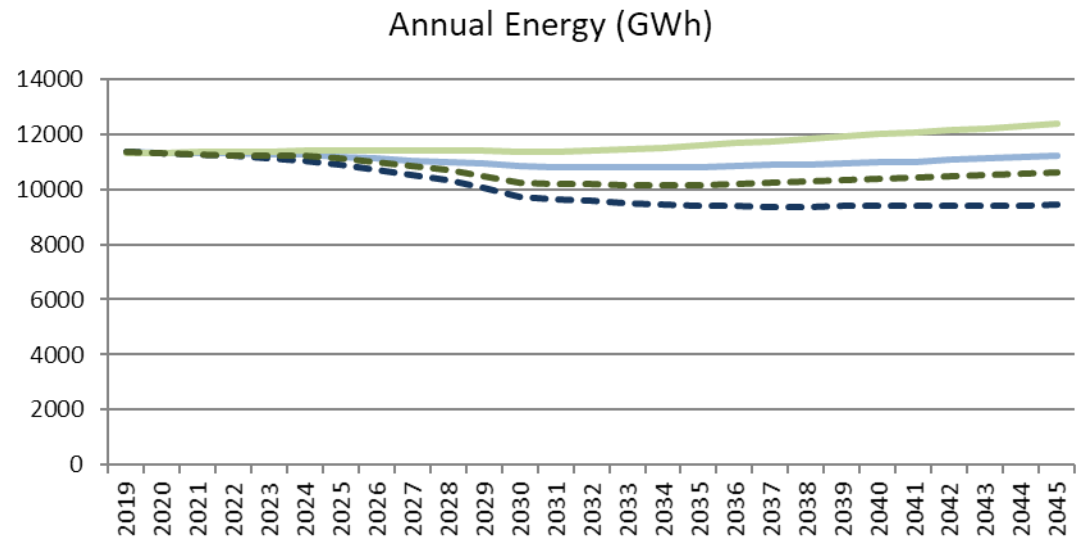
DISTRIBUTED ENERGY RESOURCES

- Distributed Energy Resources (DERs) were included in “B” scenarios and modeled as rooftop solar installations
- Scenarios with DER resources had lower annual energy volumes but the same requirement for firm peak capacity
  - In the resource plans, this leads to lower quantities of wind being selected and lower gas and import generation
  - Resources providing firm capacity (firm imports, gas CTs/CCGTs, batteries) are selected in similar aggregate amounts to meet Planning Reserve Margin requirements
- The cost of DER resources was not included in model NPV calculations; total cost of DERs using IRP assumptions was $1.6B-$2.5B on a 25-year NPV basis
  - In all cases, adding the low DER cost estimate ($1.6B) to the 25-year NPV of the “B” case makes it more expensive than the least cost comparable “A” or “C” scenario





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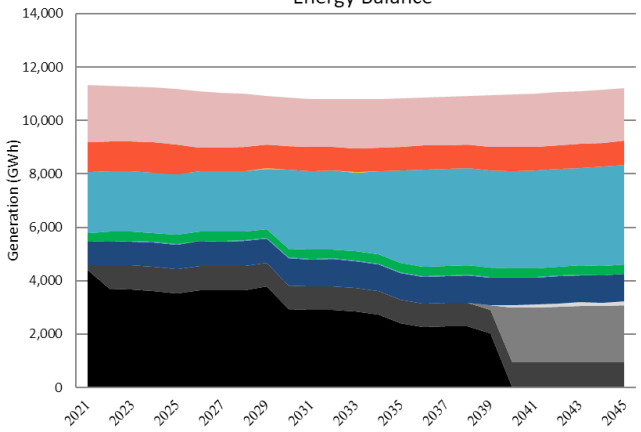
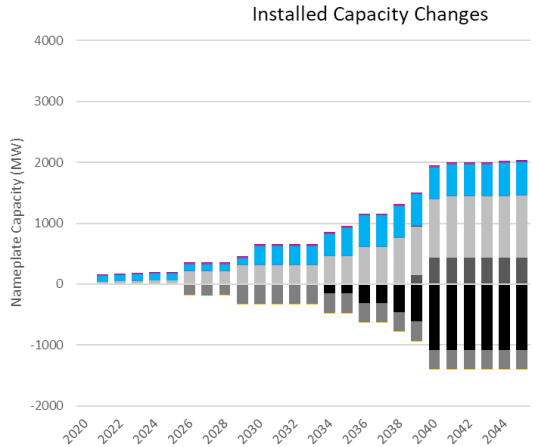
DECOUPLING OF FIRM CAPACITY & ENERGY SUPPLY

- All scenarios show a trend toward decoupling of sources of Firm Capacity and Energy
  - Capacity is generally provided by Combustion Turbines, Firm Imports, Batteries, CCGT
  - Energy sourced from Non-Firm Markets, Wind, CCGT

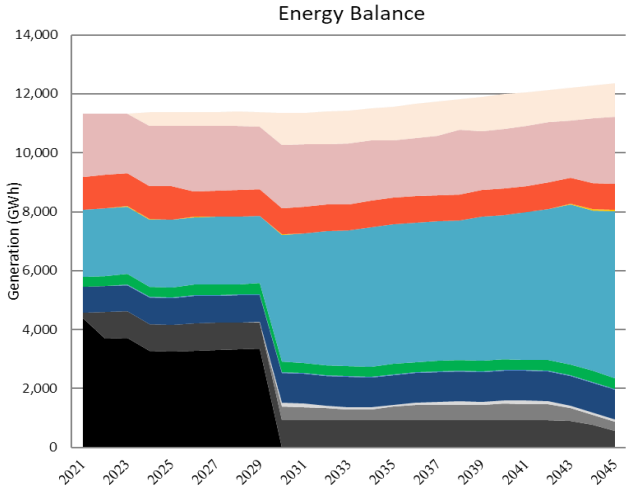
- This becomes more pronounced later in the planning horizon, and under higher load or lower carbon scenarios

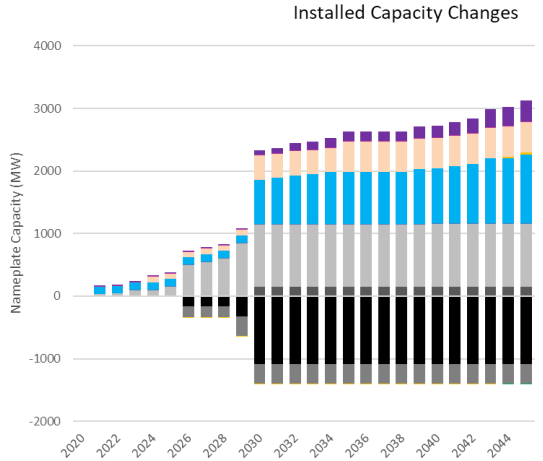
2.0A





3.1C





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QUESTIONS & DISCUSSION
INITIAL PORTFOLIO INSIGHTS

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NEXT STEPS

- Stakeholder Comments on Modeling Results are invited (requested by July 17 – next Friday)
- Draft Findings, Roadmap and Action Plan – July 29

- Ongoing:
  - Completion of sensitivities
  - Operability studies (PLEXOS MT/ST)
  - Reliability studies (RECAP)

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QUESTIONS & DISCUSSION GENERAL

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