PNM 2023-2042 IRP: Modeling Results Update

FACILITATED STAKEHOLDER MEETING

JUL 27, 2023

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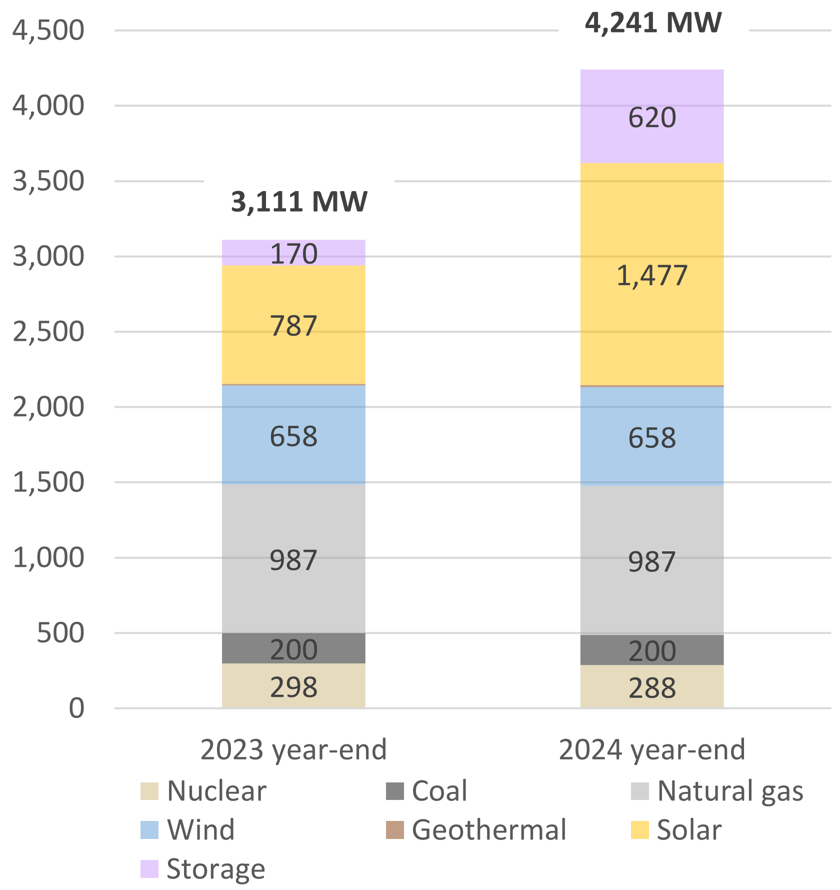
PNM'S EXISTING RESOURCE PORTFOLIO AND NEAR-TERM RESOURCE ADEQUACY

Installed capacity, MW



2024 capacity

Storage: 620

Solar: 1,477

Wind: 658

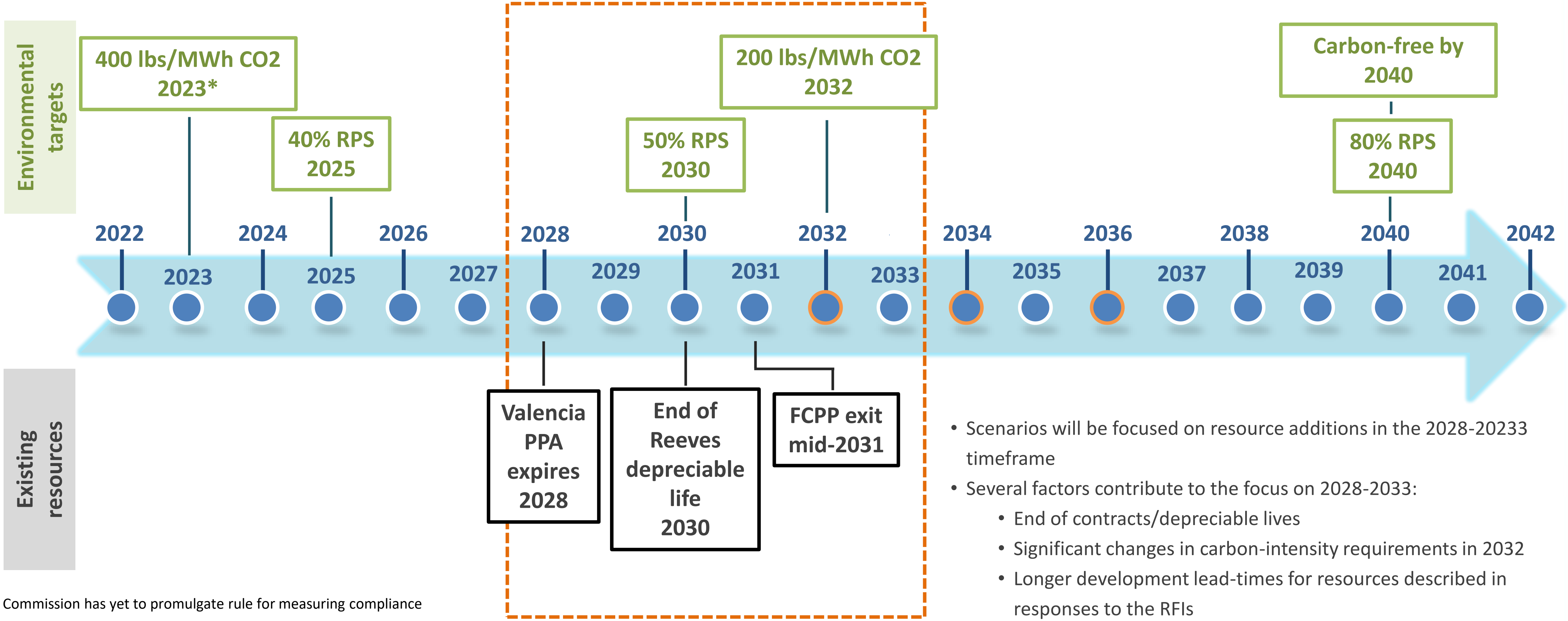
Natural Gas: 987

Coal: 200 MW

Nuclear: 288 MW share of Palo Verde

- Near term additions include 400 MW of solar and 170 MW of storage by the end of 2023
- By year-end 2024, PNM will have added an additional 690 MW of solar and 450 MW of storage
- RFPs for 2026-2028 are currently ongoing

KEY ELEMENTS WITHIN TIMELINE FOR 2023 IRP ANALYSIS POINT TO 2028-2033 AS A CRITICAL PERIOD



- Scenarios will be focused on resource additions in the 2028-20233 timeframe
- Several factors contribute to the focus on 2028-2033:
  - End of contracts/depreciable lives
  - Significant changes in carbon-intensity requirements in 2032
  - Longer development lead-times for resources described in responses to the RFIs

* Commission has yet to promulgate rule for measuring compliance

TECHNOLOGIES AVAILABLE IN PHASES 1-2

Base technologies only

PNM relies on solar, wind, and storage (lithium-ion) to meet future need and carbon emission reduction goals

Base + long-duration Storage

PNM makes a commitment to add long-duration storage in the 2028-2033 timeframe to meet future capacity need and facilitate clean energy transition

Base + natural gas

PNM allows new build of natural gas resources that will be converted to utilize hydrogen in 2040

Base + wind expansion

PNM seeks strategic transmission expansion in the late 2020's/early 2030s to integrate a large quantity of wind resources

Base + carbon capture

PNM relies on carbon capture and sequestration technologies to meet future capacity need and facilitate clean energy transition

Base + H2/early gas conversion

PNM pilots use of hydrogen before 2040 by creating green hydrogen via electrolysis for use in new or existing CTs

Energy efficiency and demand response included in all scenarios

DISCLAIMER - RESULTS ARE PRELIMINARY DRAFT

- PNM has incorporated numerous updates to its modeling in this IRP cycle
- While we have taken every effort to ensure the validity of these techniques, please understand that the results we will discuss are considered preliminary draft results and will likely change as we continue to refine the analysis
- In previous IRP cycles we would not present results before a full draft of the IRP was ready; we have made efforts to get stakeholders involved earlier in this IRP cycle, starting the public advisory process earlier than ever
- In order to maximize stakeholder involvement, presenting preliminary results and inviting feedback earlier is equally important
- At this stage, we will highlight some of the key trends we see so far, and some of the areas that require further study and refinement

PHASE 1 SCENARIOS EXPLORE ATTRIBUTES OF A VARIETY OF TECHNOLOGIES

Scenario Name	Scenario-Specific Assumptions
Base technologies	Only solar, storage, and EE, DR allowed through 2032
LD storage - CAES	At least 100 MW of compressed air energy storage by 2032
LD storage - Flow	At least 100 MW of flow batteries by 2032
LD storage - IAS	At least 100 MW of iron air energy storage by 2032
LD storage - LAES	At least 100 MW of liquid air energy storage by 2032
LD storage - PHS 8-hr	300 MW of pumped storage (8hr) by 2032
LD storage - PHS 70-hr	300 MW of pumped storage (70hr) by 2032
LD storage - Thermal	At least 150 MW of thermal energy storage by 2032
Thermal - CT	New hydrogen-ready CTs allowed
Thermal - Linear	New hydrogen-ready linear generators allowed
Wind expansion	New wind & associated transmission allowed beginning in 2028
CCS - CCGT retrofit	Afton CC (235 MW) retrofitted with CCS capability
CCS - Net Power	280 MW NET power plant added by 2032
Green hydrogen	~250 MW hydrogen-fueled CT & ~750 MW electrolyzer added in 2031

- In Phase 1, technology-specific scenarios are screened under the following conditions:
  1. **CT&P future (capacity expansion run)**
     a) P50 load 8760 production cost run
     b) Extreme weather load 8760 production cost run
- **This approach gives PNM the ability to evaluate scenarios based on:**
  - Overall cost
  - Ability to accommodate extreme weather load
- All portfolios include option to add base technologies (including DR and EE) at any time
- ***All portfolios required to meet reliability, RPS, and carbon-intensity targets***

Preliminary

PHASE 2 SCENARIOS EXPLORE SYNERGIES BETWEEN TECHNOLOGIES

Preliminary

Scenario Name	Scenario-Specific Assumptions
PHS 70-hr + CT	300 MW of pumped storage (70-hr) by 2032; new hydrogen-ready CTs allowed
PHS 70-hr + CT + wind	300 MW of pumped storage (70-hr) by 2032; new hydrogen-ready CTs allowed; new wind beginning in 2028
PHS 70-hr + Linear gen.	300 MW of pumped storage (70-hr) by 2032; new hydrogen-ready linear generators allowed
PHS 70-hr + Afton CCS	300 MW of pumped storage (70-hr) by 2032; Afton CC (235 MW) retrofitted with CCS capability
PHS 8-hr + CT	300 MW of pumped storage (8-hr) by 2032; new hydrogen-ready CTs allowed
PHS 8-hr + CT + wind	300 MW of pumped storage (8-hr) by 2032; new hydrogen-ready CTs allowed; new wind beginning in 2028
PHS 8-hr + Linear gen.	300 MW of pumped storage (8-hr) by 2032; new hydrogen-ready linear generators allowed
PHS 8-hr + Afton CCS	300 MW of pumped storage (8-hr) by 2032; Afton CC (235 MW) retrofitted with CCS capability
IAS + CT	At least 100 MW of iron air energy storage by 2032; new hydrogen-ready CTs allowed
IAS + CT + wind	At least 100 MW of iron air energy storage by 2032; new hydrogen-ready CTs allowed; new wind beginning in 2028
IAS + Linear gen.	At least 100 MW of iron air energy storage by 2032; new hydrogen-ready linear generators allowed
IAS + Afton CCS	At least 100 MW of iron air energy storage by 2032; Afton CC (235 MW) retrofitted with CCS capability
Wind expansion + CAES	At least 100 MW of compressed air energy storage by 2032; new wind beginning in 2028
Wind expansion + BESS	New wind beginning in 2028; battery storage can be added in wind zone
IAS + LAES	At least 100 MW of iron air energy storage and at least 100 MW liquid air energy storage by 2032
Green hydrogen + wind	~250 MW hydrogen-fueled CT & ~750 MW electrolyzer added in 2031; new wind beginning in 2028
Flow + CT	At least 100 MW of flow batteries (10-hr) by 2032; new hydrogen-ready CTs allowed
Flow + CCS	At least 100 MW of flow batteries (10-hr) by 2032; Afton CC (235 MW) retrofitted with CCS capability
Base tech + CT + LDES	Model has option to add base technologies, CTs (2026+), and any long-duration storage technology (2028-2033)
Base tech + LDES	Model has option to add base technologies and any long-duration storage technology (2028-2033)

- In Phase 2, PNM designed more complex portfolios consisting of two or more RFI technologies – the intent is to explore synergistic effects of combining operating characteristics
- All portfolios include option to add base technologies (including DR and EE) at any time
- Scenarios are screened under the same conditions as in Phase 1
- ***All portfolios required to meet reliability, RPS, and carbon-intensity targets***

PNM MODELING RESULTS UPDATE – PRELIMINARY

PROPOSED PORTFOLIO EVALUATION CRITERIA: PHASES 1-2

RELIABILITY (INITIAL HURDLE)

- Check to ensure unserved energy is within a reasonable range
- Compare EnCompass portfolio EUE from extreme weather simulations to EUE from a SERVM tested reliable portfolio
- If EnCompass portfolio EUE falls within range of EUE from SERVM reliable portfolio, then portfolio/technology passes reliability test

COST (SCORE COMPONENT)

- Measured as present Value of Revenue Requirement, which reflects total cost of portfolio across study period
- Comparison of overall costs

TECHNOLOGY RISK (SCORE COMPONENT)

- Measured as a weighted average Technology Readiness Level
- Each portfolio assigned a weighted average TRL based on the 2032 firm capacity breakdown
- Comparison of dependence on less proven technologies on a capacity basis

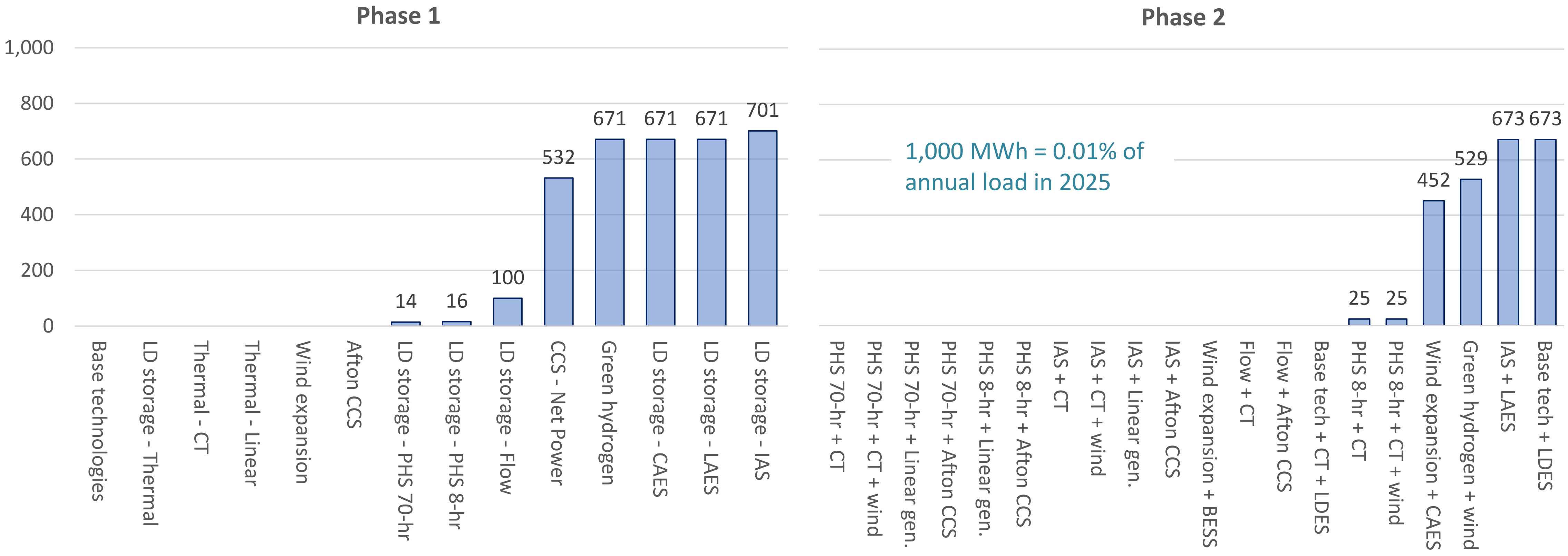
CARBON EMISSIONS (SCORE COMPONENT)

- Measured as NPV of total carbon emissions across study period
- Comparison of carbon emissions associated with scenario-specific combination of technologies
- Earlier abatement improves CO2 metric

Preliminary results

PORTFOLIOS RANKED BY UNSERVED ENERGY UNDER EXTREME WEATHER LOAD CASE

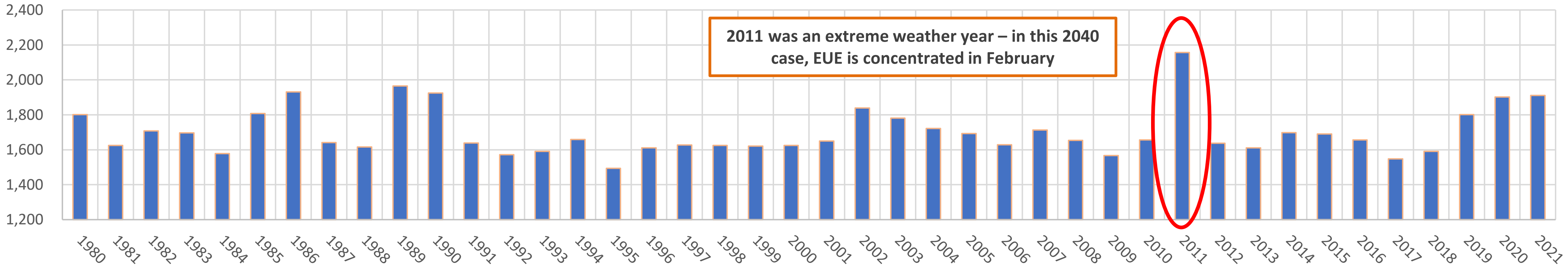
2040 unserved energy under extreme weather load case, MWh



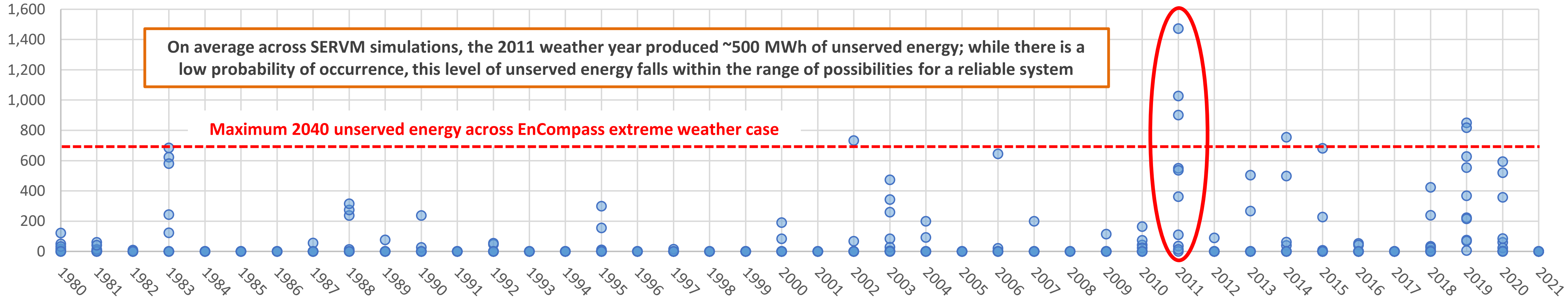
Preliminary results

PUTTING UNSERVED ENERGY IN CONTEXT: 2040 RESULTS FROM 0.1 LOLE CASE (BASE TECHNOLOGIES ONLY)

2040 peak February load by weather year, MW

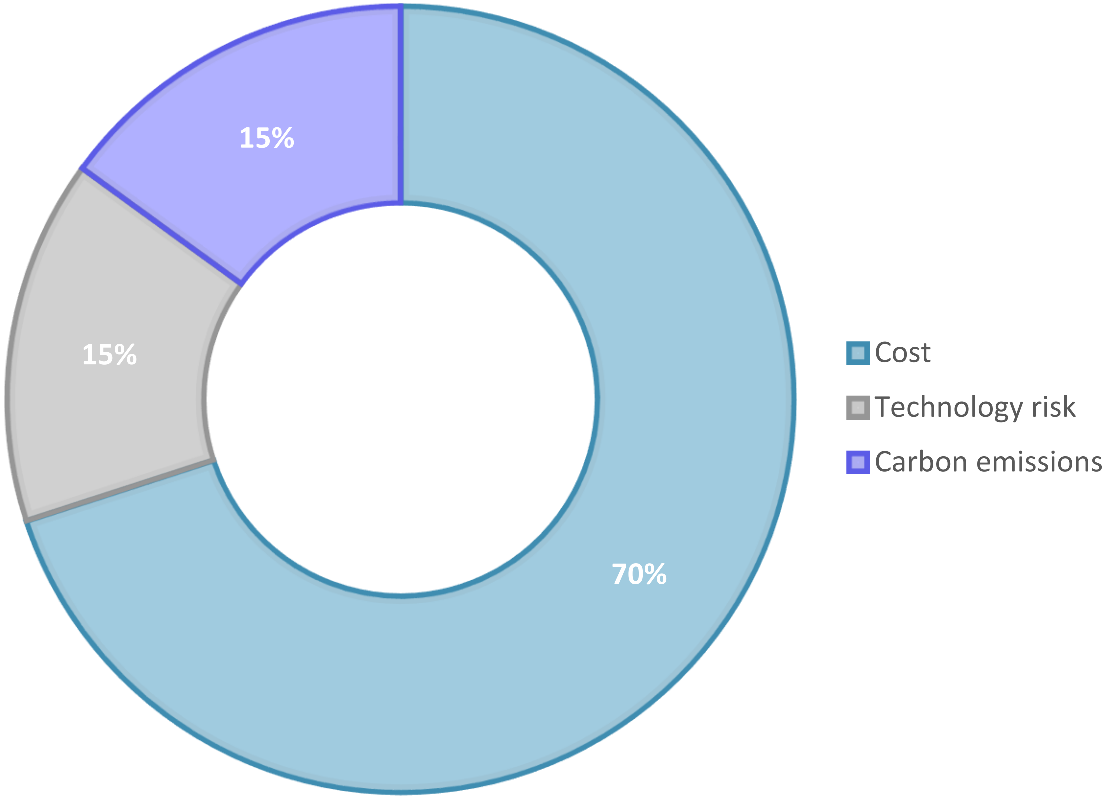


2040 EUE across 10 simulations by weather year, MWh



SCORING MATRIX APPROACH AND POTENTIAL CRITERIA WEIGHTING (PHASE 1 & 2)

Preliminary PNM evaluation criteria weighting for overall portfolio score



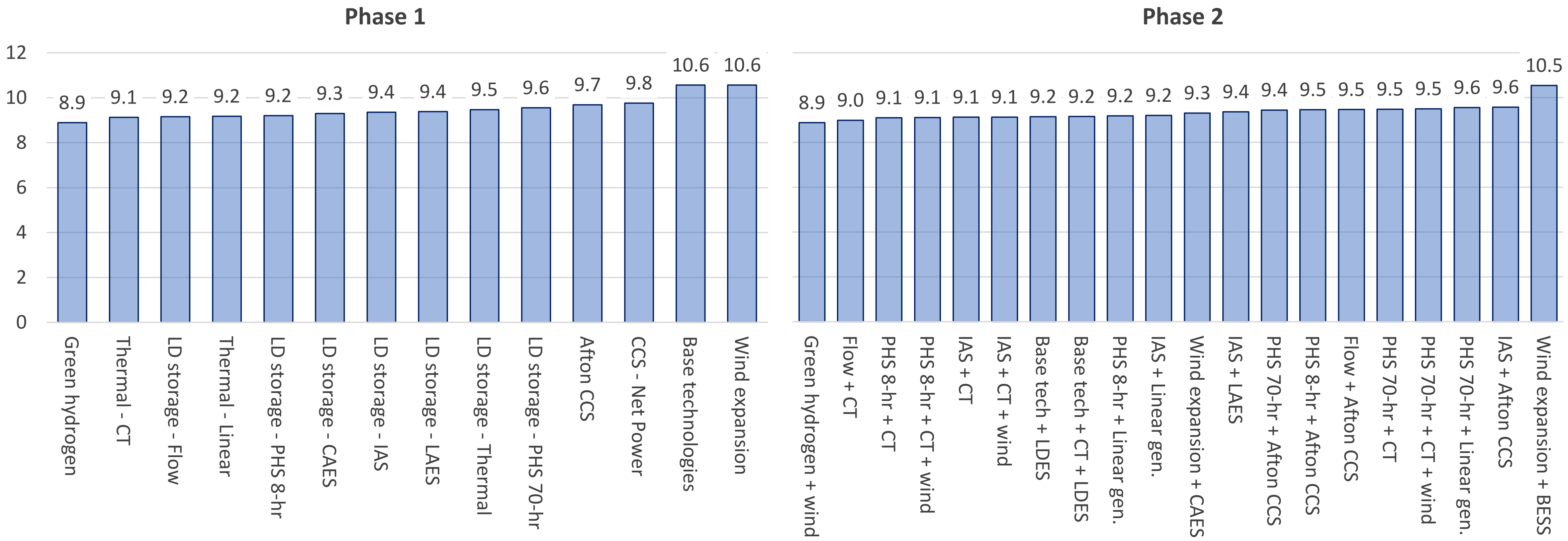
- Each portfolio is given a score for each metric
- Scores range from 1 to 10, with 1 being the highest possible score
- For example, the portfolio with the lowest PVRR across all portfolios receives a score of 1 for the PVRR metric, the portfolio with the highest PVRR receives a score of 10
- The scores are then weighted and summed for a final portfolio score; portfolios with lower scores are preferred

All portfolios meet carbon intensity and RPS requirements

Preliminary results

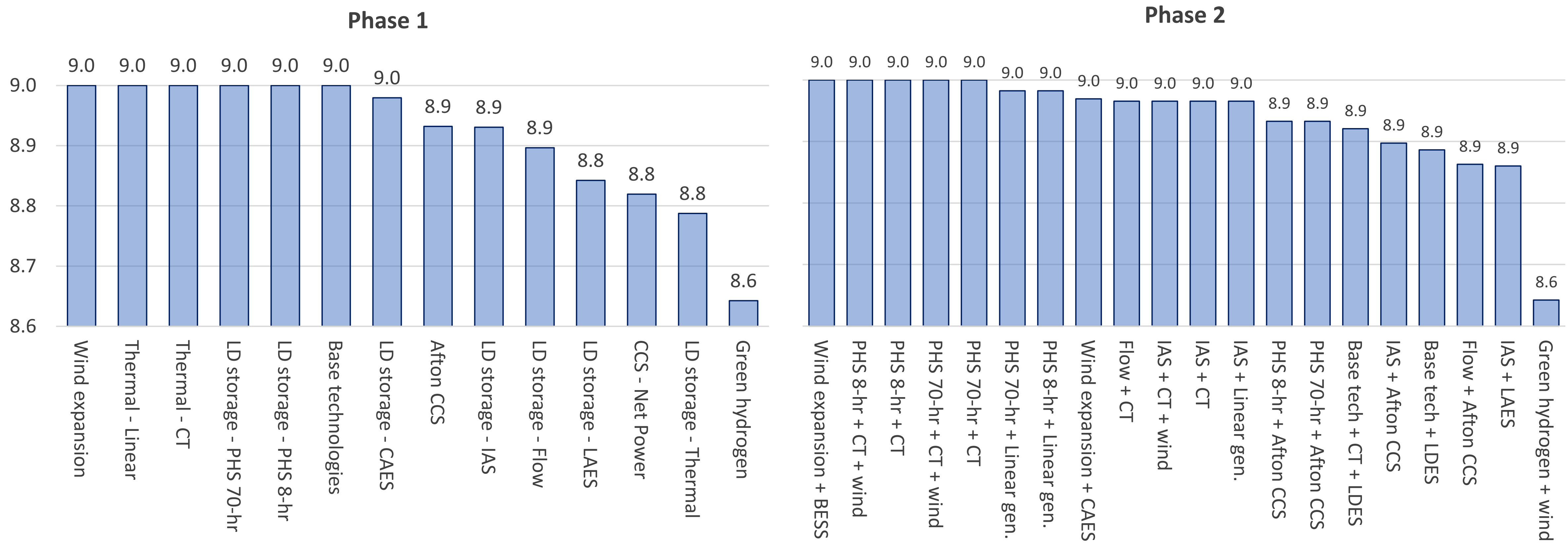
PORTFOLIOS RANKED BY PRESENT VALUE OF REVENUE REQUIREMENT

Present value of Revenue Requirement, $B



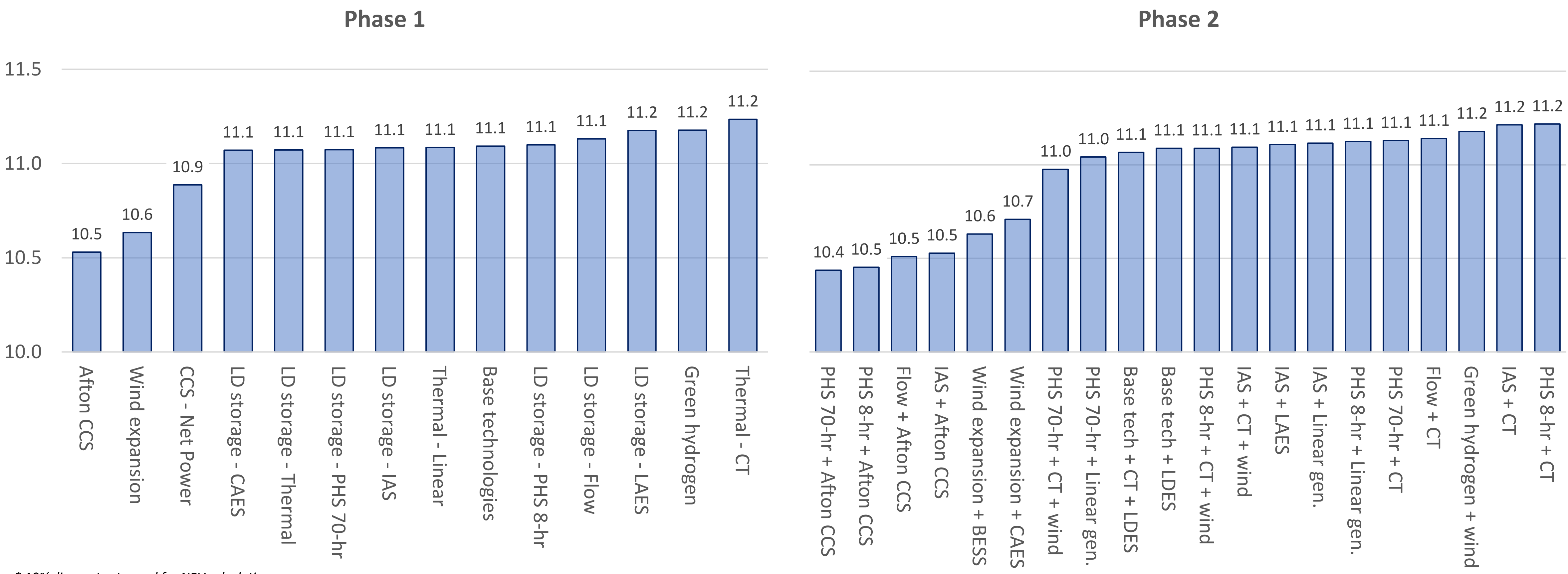
PORTFOLIOS RANKED BY WEIGHTED AVERAGE TECHNOLOGY READINESS LEVEL

Weighted average TRL (based on installed capacity in 2032)



PORTFOLIOS RANKED BY TOTAL CARBON EMISSIONS 2023-2042

NPV of carbon emissions 2026-2042, MM tons*



** 10% discount rate used for NPV calculation*

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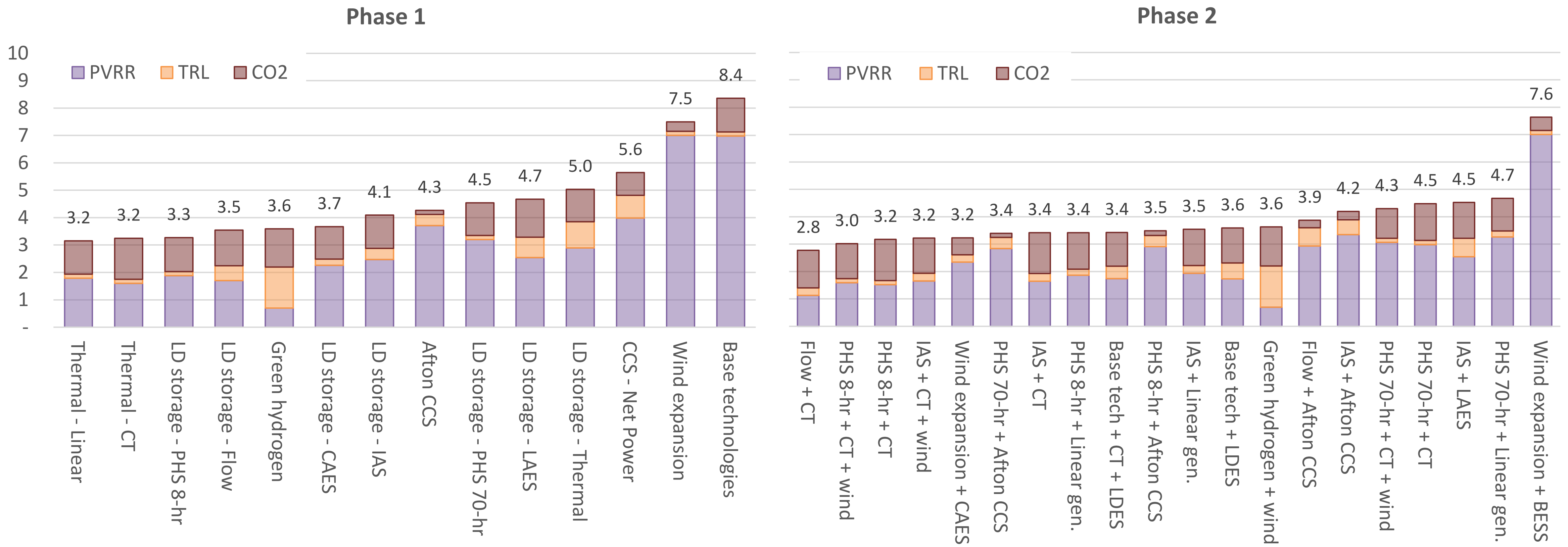
SCORED PORTFOLIOS USING PRELIMINARY PNM CRITERIA AND WEIGHTING SCHEME

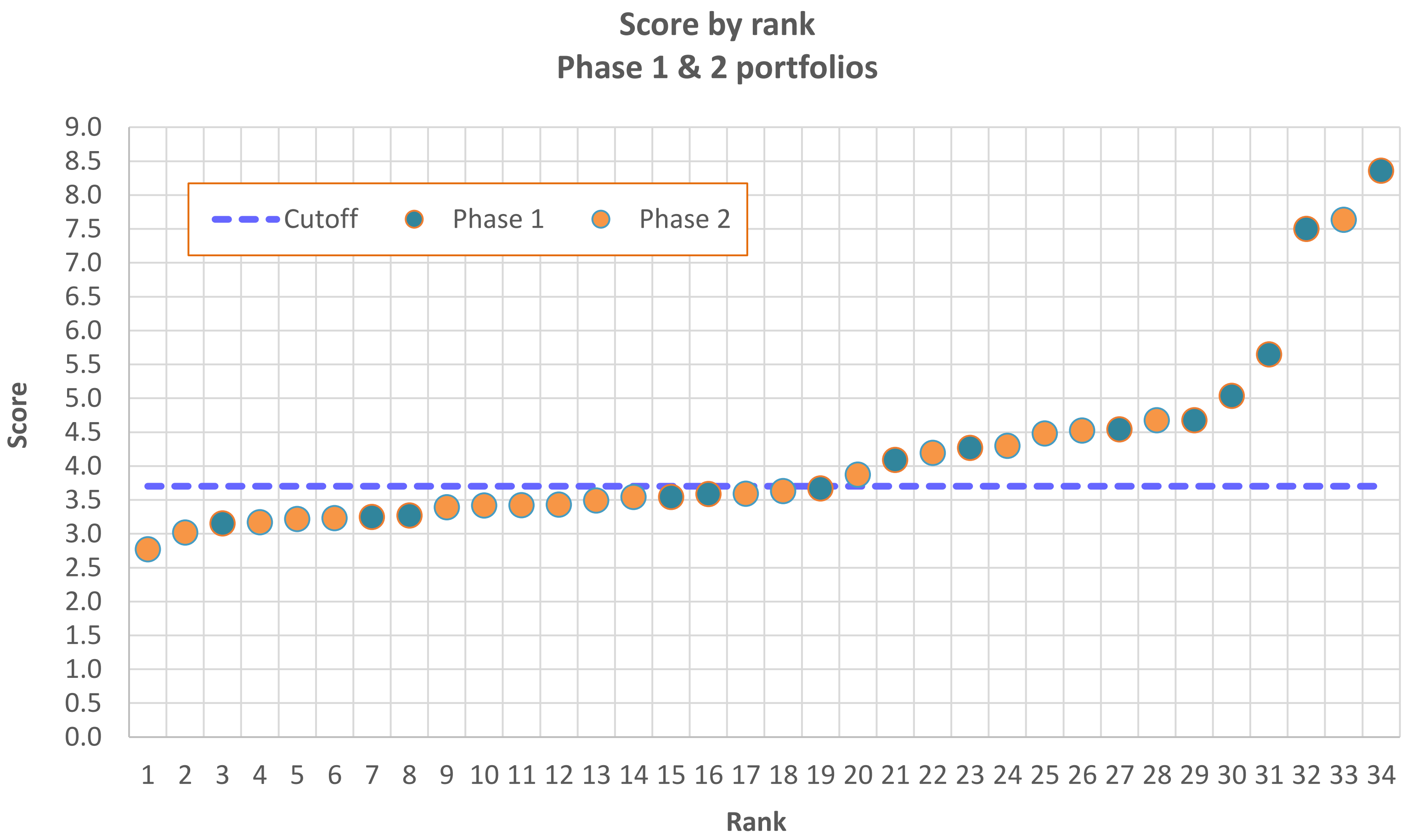
Total score breakdown by weighted component



All portfolios required to meet reliability, RPS, and carbon-intensity targets

PHASES 1-2 INFORM PHASE 3 TECHNOLOGY SELECTION

- Portfolio scores across Phases 1-2 indicate a "cutoff point"
- All unique technologies included in portfolios below the cutoff point will be included in Phase 3 modeling
- Phase 3 modeling will focus on "kitchen sink" scenarios in which EnCompass can select from a wide array of technologies selected from Phases 1-2
- Results from Phases 1-2 will help to contextualize results from Phase 3, and provide good comparison points



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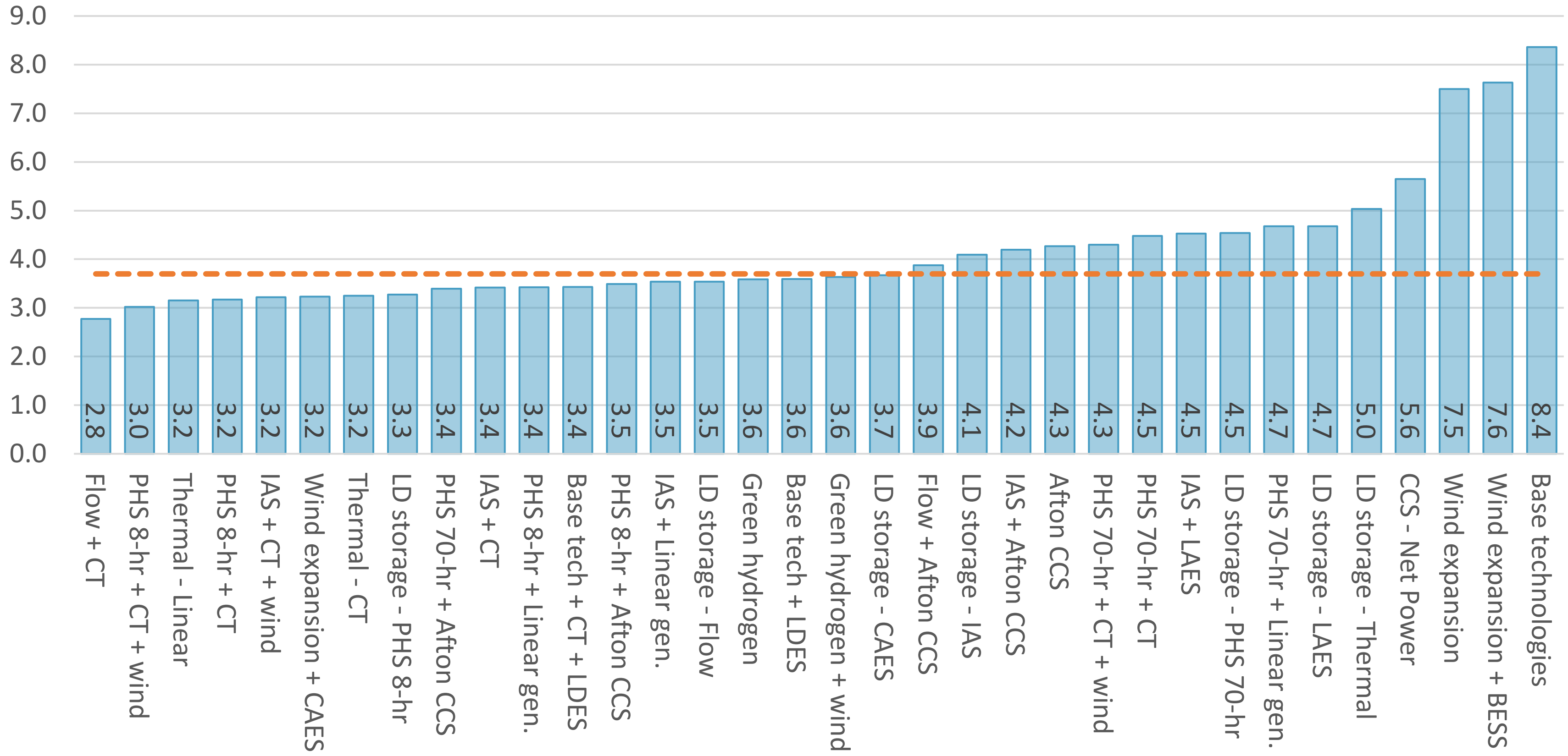
PHASE 3 TECHNOLOGY SELECTION

Total score for all scenarios



Unique technologies selected for Phase 3 modeling:

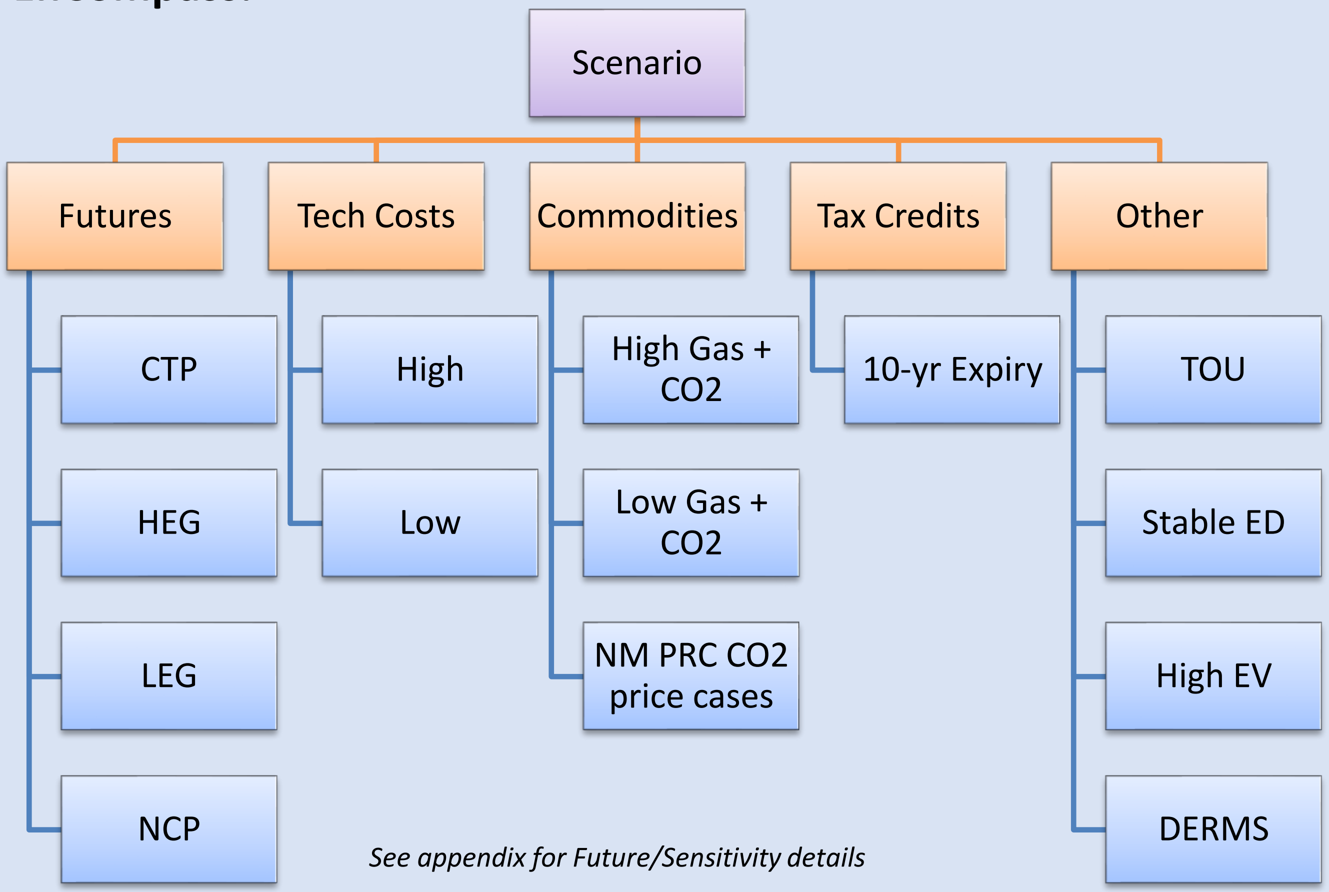
- CAES
- Flow battery
- PHS (8-hr & 70-hr)
- IAS
- CT
- Linear generator
- Wind expansion
- Afton CCS (Afton retrofit)
- Green hydrogen

FIVE SCENARIOS FOR PHASE 3 MODELING

Base technologies only	Base technologies + CTs	Base technologies + all LDES *(stakeholder scenario)*	Base technologies + CTs + all LDES	Phase 1-2 technologies
Resource options • Solar • Wind • 4-hr storage • EE/DR	**Resource options** • Solar • Wind • 4-hr storage • EE/DR • CT	**Resource options** • Solar • Wind • 4-hr storage • EE/DR • CAES • Flow battery • PHS 70-hr • PHS 8-hr • IAS • LAES • Thermal storage	**Resource options** • Solar • Wind • 4-hr storage • EE/DR • CAES • Flow battery • PHS 70-hr • PHS 8-hr • IAS • LAES • Thermal storage • CT	**Resource options** • Solar • Wind • 4-hr storage • EE/DR • CAES • Flow battery • PHS 8-hr • PHS 70-hr • IAS • CT • Linear generator • Wind exp. • Afton CCS • Green hydrogen

PHASE 3 MODELING

EnCompass:



See appendix for Future/Sensitivity details

SERVM:

CT&P case run for each scenario to determine:

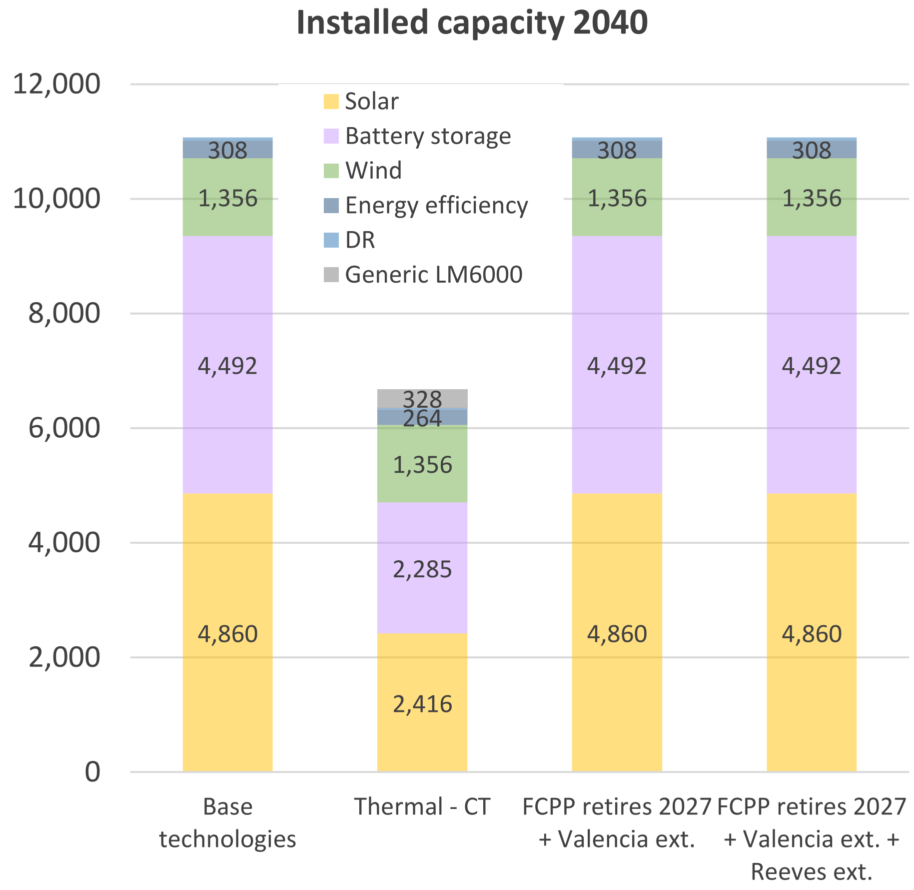
- LOLE meets ~0.1 target
- EUE for portfolio

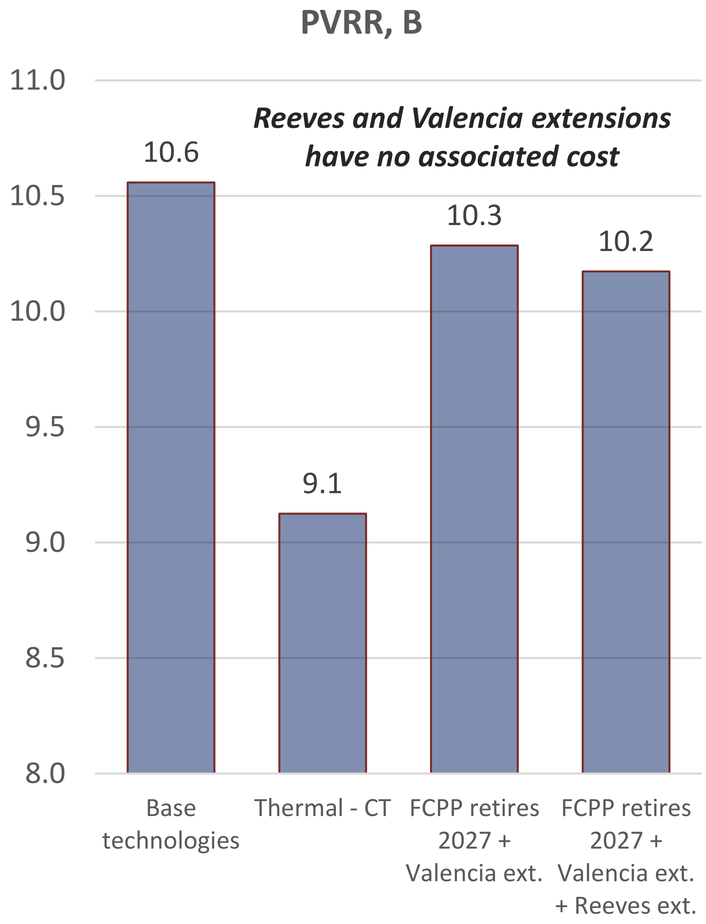
NEXT STEPS: PHASE 3 EVALUATION WILL ANALYZE PORTFOLIO PERFORMANCE ACROSS A VARIETY OF SENSITIVITIES

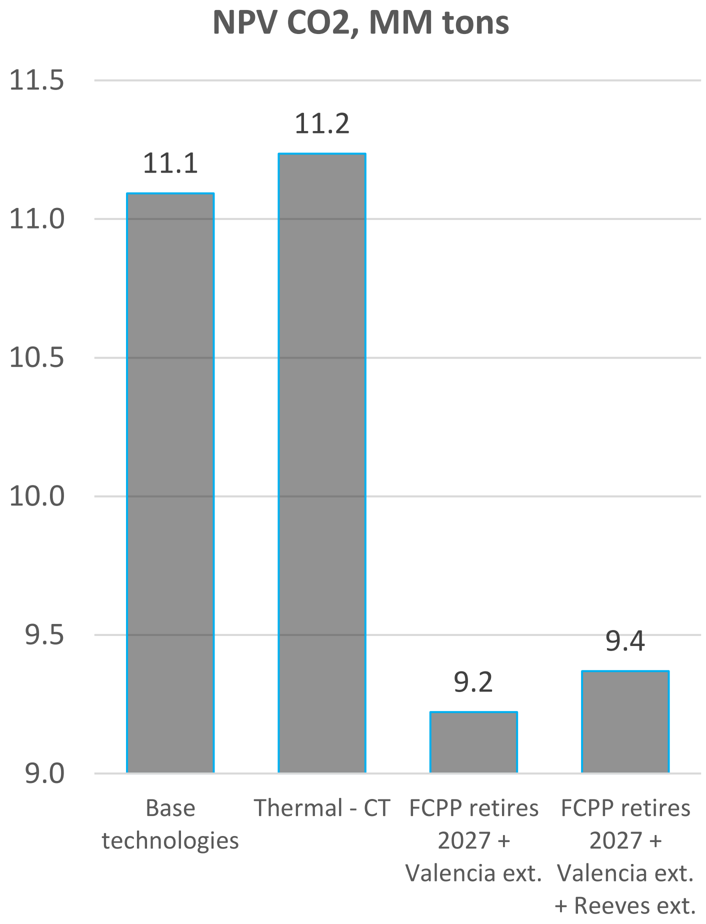
- Use all information gathered in Phase 3 to determine MCEPs:
  - Compare metrics across portfolios – NPV of Cost, CO2, TRL
  - Evaluate which technologies are consistently included across sensitivities (applies to "kitchen sink" cases)
  - Analyze reliability results from SERVM runs (CT&P)
    - Scenario meets ~0.1 LOLE target
    - Compare EUE across scenarios

STAKEHOLDER MODELING RUN REQUESTS: MODELING RESULTS

STAKEHOLDER-REQUESTED SCENARIOS: FOUR CORNERS ABANDONMENT SENSITIVITIES

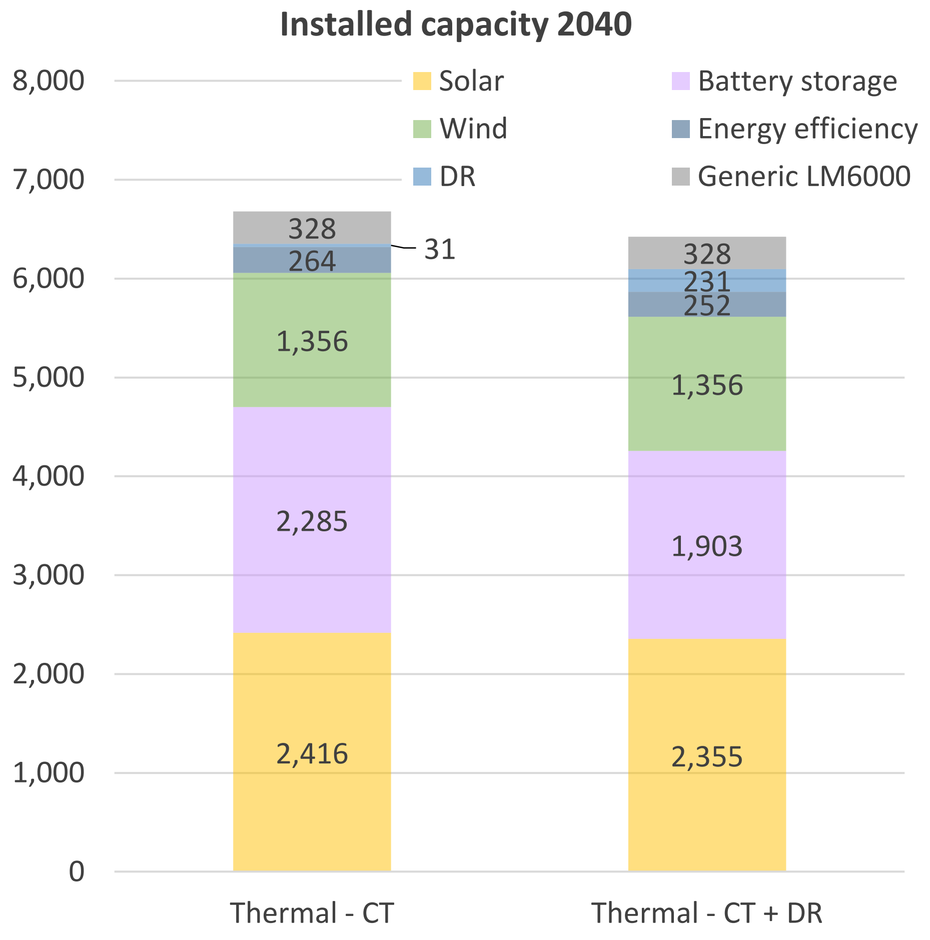


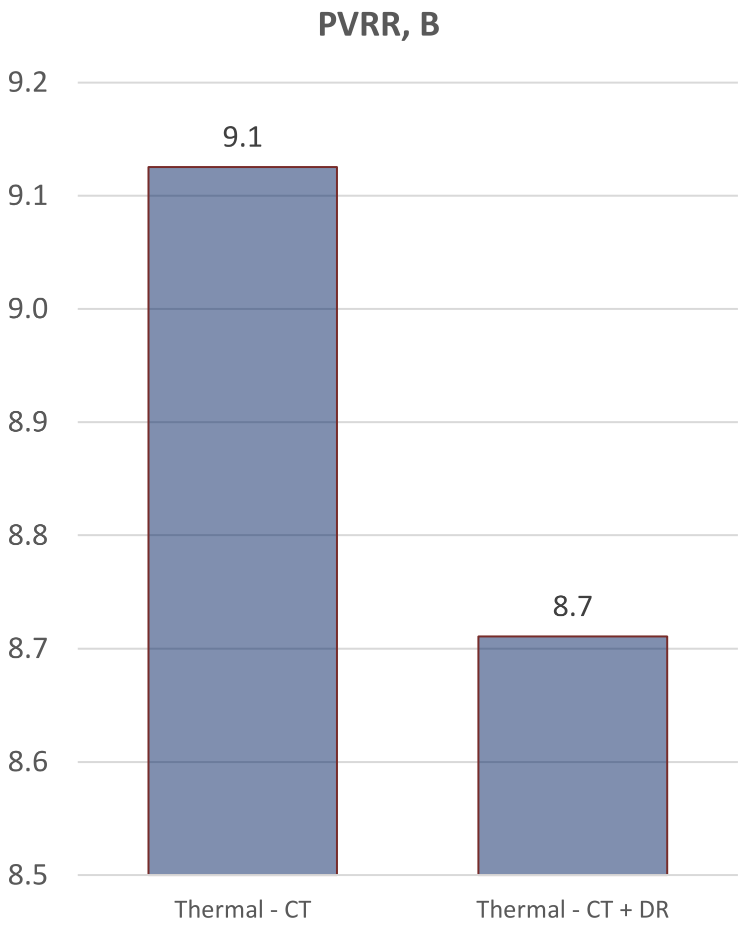


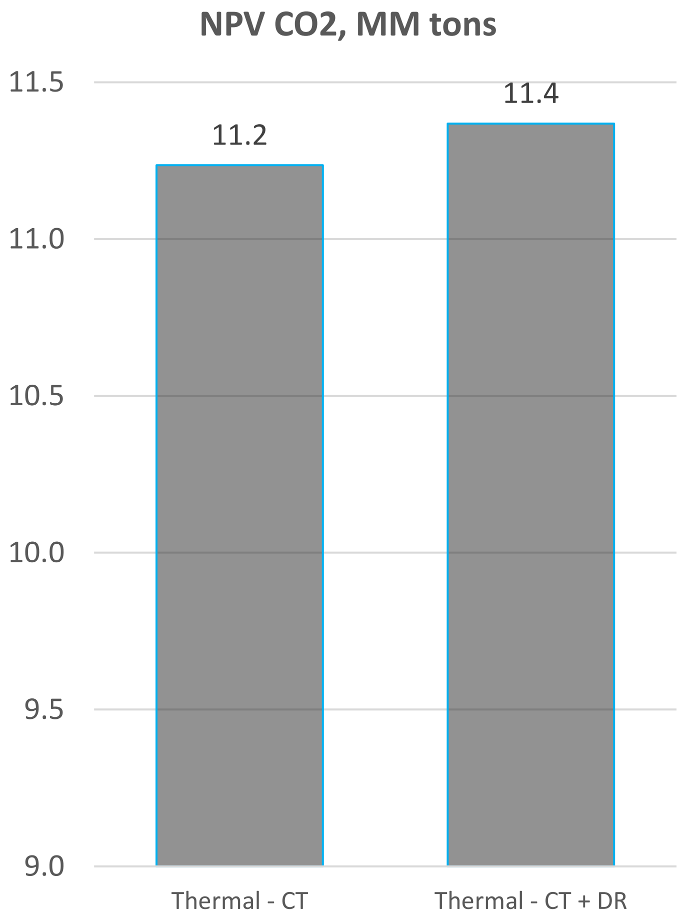


Preliminary results

STAKEHOLDER-REQUESTED SCENARIOS: INCREASED DEMAND RESPONSE







PNM'S INITIAL OBSERVATIONS & NEXT STEPS

Observations

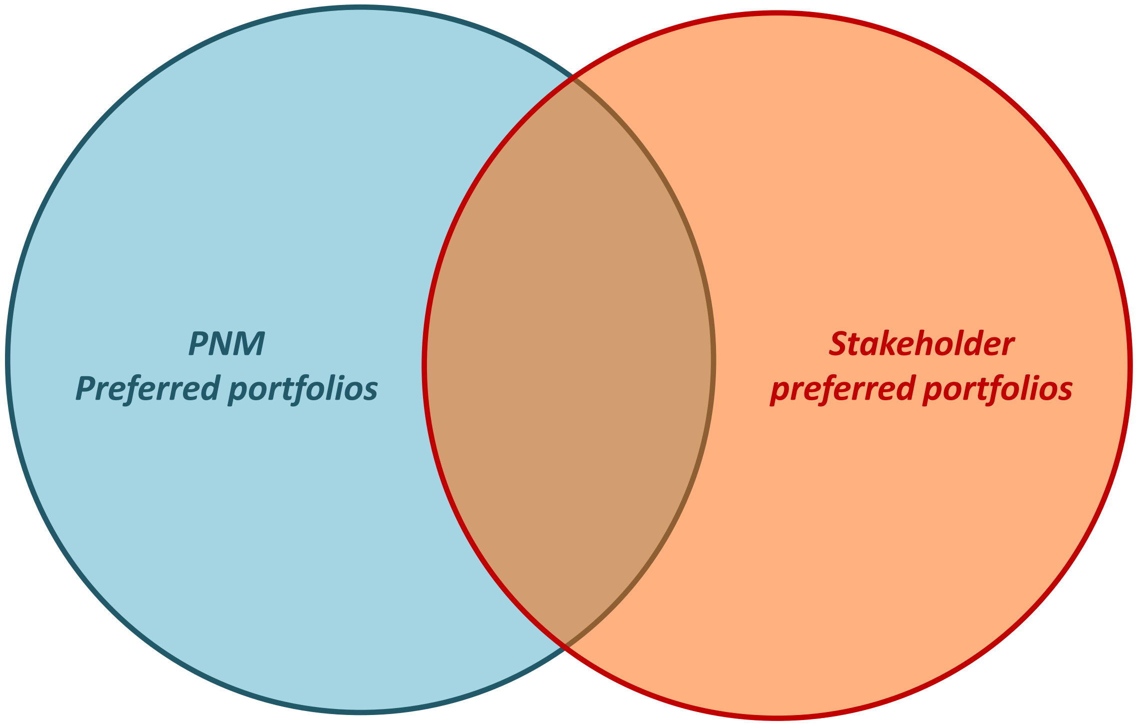
- Lowest-cost portfolios include dispatchable technologies and long-duration storage
- Technology combinations provide lower-cost alternatives to single-technology scenarios
- Base technologies results in a very high level of builds – which translates to high cost
- Portfolios with wind and/or carbon capture technologies have the lowest carbon emissions
- Wind helps to decarbonize the system and is included in all portfolios; however, earlier transmission expansion alone doesn't drive significant cost savings
- Portfolios with TRLs below 9 represent some technology risk; we recognize the importance of due diligence around technology risks given our carbon-free target
- Unserved energy under extreme weather cases is lowest for portfolios with dispatchable resources

Next Steps

- Continue to refine modeling approaches
- Examine robustness of initial observations against key futures and sensitivities (Phase 3)
- Explore implications of technology cost uncertainty upon results that rely heavily on emerging technologies (Phase 3)
- Conduct reliability modeling of most promising portfolio options (SERVM in Phase 3)
- Compare quantitative and qualitative metrics for Phase 3 portfolios to inform best path forward for Most Cost-Effective Portfolio

PORTFOLIO SCORING SYSTEM

- PNM proposes that stakeholders evaluate modeled portfolios using the same methodology as PNM, but with their own criteria and weighting scheme for portfolio scoring
- PNM suggests that stakeholders determine their evaluation criteria, and for each criterion, a metric for measurement and an associated weight
- These can then be to determine an overall portfolio score for each portfolio modeled
- Once stakeholders have a list of preferred portfolios based on their criteria and weighting scheme, preferred portfolios can be compared



APPENDIX

2023 IRP CORE FUTURES

Key assumption	Current Trends & Policy	High Economic Growth	Low Economic Growth	National Carbon Policy (Carbon-free by 2035)
Load forecast	Mid	High	Low	High
BTM PV forecast	Mid	High	Low	High
EV adoption forecast	Mid	High	Low	High
Building Electrification Forecast	Mid	Mid	Mid	High
Economic development	Limited	Stable	Limited	Stable
Gas price forecast	Mid	Mid	Low	High
Carbon price forecast	Mid	Mid	Mid	High
Technology cost forecast	Mid	Mid	Mid	Low

2023 IRP SENSITIVITIES

	Sensitivity	Load forecast	Economic Development	BTM PV forecast	EV adoption forecast	Building electrification	Gas price forecast	CO2 price forecast	Technology costs	IRA tax credits & incentives
Load	High load	**High**	Limited ED	Mid	Mid	Mid	Mid	Mid	Mid	Extended
Load	Strong ED growth	Mid	**Stable**	Mid	Mid	Mid	Mid	Mid	Mid	Extended
Load	Very strong ED growth	Mid	**Stable**	Mid	Mid	Mid	Mid	Mid	Mid	Extended
Load	Extreme weather	**P90 hot/cold**	Limited ED	Mid	Mid	Mid	Mid	Mid	Mid	Extended
Load	Low load	**Low**	Limited ED	Mid	Mid	Mid	Mid	Mid	Mid	Extended
Load	TOU pricing	**TOU shaping**	Limited ED	Mid	Mid	Mid	Mid	Mid	Mid	Extended
BTM	High BTM PV	Mid	Limited ED	**High**	Mid	Mid	Mid	Mid	Mid	Extended
BTM	Low BTM PV	Mid	Limited ED	**Low**	Mid	Mid	Mid	Mid	Mid	Extended
BTM	No BTM PV	Mid	Limited ED	**Zero**	Mid	Mid	Mid	Mid	Mid	Extended
BTM	High EV adoption	Mid	Limited ED	Mid	**High**	Mid	Mid	Mid	Mid	Extended
BTM	Low EV adoption	Mid	Limited ED	Mid	**Low**	Mid	Mid	Mid	Mid	Extended
BTM	High building electrification	Mid	Limited ED	Mid	Mid	**High**	Mid	Mid	Mid	Extended
BTM	DERMS	Mid	Limited ED	**High**	**High**	Mid	Mid	Mid	Mid	Extended
Gas price	High gas price	Mid	Limited ED	Mid	Mid	Mid	**High**	Mid	Mid	Extended
Gas price	Low gas price	Mid	Limited ED	Mid	Mid	Mid	**Low**	Mid	Mid	Extended
Carbon price	IRP rule \$40 CO2 price	Mid	Limited ED	Mid	Mid	Mid	Mid	**\$40/ton**	Mid	Extended
Carbon price	IRP rule \$20 CO2 price	Mid	Limited ED	Mid	Mid	Mid	Mid	**\$20/ton**	Mid	Extended
Carbon price	IRP rule \$8 CO2 price	Mid	Limited ED	Mid	Mid	Mid	Mid	**\$8/ton**	Mid	Extended
Carbon price	PNM high CO2 price	Mid	Limited ED	Mid	Mid	Mid	Mid	**High**	Mid	Extended
Carbon price	PNM mid CO2 price	Mid	Limited ED	Mid	Mid	Mid	Mid	Mid	Mid	Extended
Carbon price	PNM low CO2 price	Mid	Limited ED	Mid	Mid	Mid	Mid	**Low**	Mid	Extended
Technology costs	Fast technology advancement	Mid	Limited ED	Mid	Mid	Mid	Mid	Mid	**Low**	Extended
Technology costs	Slow technology advancement	Mid	Limited ED	Mid	Mid	Mid	Mid	Mid	**High**	Extended
Technology costs	IRA tax credits expire	Mid	Limited ED	Mid	Mid	Mid	Mid	Mid	Mid	**Expire 2032-2034**

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