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

2024 capacity

- Storage: 620
- Solar: 1,477
- Wind: 658
- Natural Gas: 987
- Coal: 200 MW

- 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

Installed capacity, MW

- Nuclear: 288 MW share of Palo Verde
- 2024 year-end: 4,241 MW
- 2023 year-end: 3,111 MW

- Coal: 200 MW
- Natural gas: 987 MW
- Wind: 658 MW
- Solar: 1,477 MW
- Storage: 620 MW
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 2028-2023 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

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

- 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

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

- 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
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 firm capacity basis

CARBON EMISSIONS (SCORE COMPONENT)

- Measured as NPV of total carbon emissions across study period (10% discount factor)
- Comparison of carbon emissions associated with scenario-specific combination of technologies
- Earlier abatement improves CO2 metric
PORTFOLIOS RANKED BY UNSERVED ENERGY UNDER EXTREME WEATHER LOAD CASE

2040 unserved energy under extreme weather load case, MWh

Phase 1

- Base technologies
- LD storage - Thermal
- Thermal - CT
- Thermal - Linear
- Wind expansion
- Afton CCS
- LD storage - PHS 70-hr
- LD storage - Flow
- CCS - Net Power
- Green hydrogen
- LD storage - LAES
- LD storage - IAS

Phase 2

- PHS 70-hr + CT + wind
- PHS 8-hr + Afton CCS
- IAS + CT
- IAS + Afton CCS
- Wind expansion + BESS
- Flow + Afton CCS
- Base tech + CT + LDES
- PHS 8-hr + CT
- Wind expansion + wind
- Green hydrogen + wind
- Base tech + IAS

1,000 MWh = 0.01% of annual load in 2025
PUTTING UNSERVED ENERGY IN CONTEXT: 2040 RESULTS FROM 0.1 LOLE CASE (BASE TECHNOLOGIES ONLY)

Preliminary results

2040 peak February load by weather year, MW

2011 was an extreme weather year – in this 2040 case, EUE is concentrated in February

2040 EUE across 10 simulations by weather year, MWh

On average across SERVM simulations, the 2011 weather year produced ~500 MWh of unserved energy; while there is a low probability of occurrence, this level of unserved energy falls within the range of possibilities for a reliable system

Maximum 2040 unserved energy across EnCompas extreme weather case
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*
PORTFOLIOS RANKED BY PRESENT VALUE OF REVENUE REQUIREMENT

Present value of Revenue Requirement, $B

Phase 1

- Green hydrogen
- Thermal - CT
- LD storage - Flow
- Thermal - Linear
- LD storage - PHS 8-hr
- LD storage - CAES
- LD storage - IAS
- LD storage - LAES
- LD storage - Thermal
- Afton CCS
- CCS - Net Power
- Base technologies
- Wind expansion
- Afton CCS
- CCS - Net Power
- Wind expansion

Phase 2

- Green hydrogen + wind
- Flow + CT
- PHS 8-hr + CT
- IAS + CT
- IAS + Linear gen.
- PHS 8-hr + Linear gen.
- Base tech + CT + LDES
- Base tech + LDES
- Wind expansion + CAES
- PHS 70-hr + Afton CCS
- IAS + LAES
- PHS 8-hr + LAES
- PHS 8-hr + Afton CCS
- Flow + Afton CCS
- PHS 70-hr + CT
- PHS 70-hr + Linear gen.
- IAS + Afton CCS
- Wind expansion + BESS

PRELIMINARY RESULTS
PORTFOLIOS RANKED BY WEIGHTED AVERAGE TECHNOLOGY READINESS LEVEL

Weighted average TRL (based on firm capacity in 2032)

Phase 1

Phase 2
PORTFOLIOS RANKED BY TOTAL CARBON EMISSIONS 2023-2042

NPV of carbon emissions 2023-2042, MM tons*

Phase 1

Afton CCS: 10.5
Wind expansion: 10.6
CCS - Net Power: 11.1
LD storage - CAES: 11.1
LD storage - Thermal: 11.1
Thermal - linear: 11.1
Base technologies: 11.1
LD storage - PHS 70-hr: 11.2
LD storage - Flow: 11.2
LD storage - LAES: 11.2
Green hydrogen: 11.2
Thermal - CT: 11.5

Phase 2

PHS 70-hr + Afton CCS: 10.0
Flow + Afton CCS: 10.5
IAS + Afton CCS: 11.0
Wind expansion + CAES: 10.5
Wind expansion + CAES + PHS 70-hr + CT + wind: 11.0
Base tech + LD, PHS 70-hr + CT + wind: 11.0
IAS + LD, PHS 70-hr + CT + wind: 11.1
IAS + LAES: 11.1
IAS + Linear gen.: 11.1
IAS + Linear gen.: 11.1
IAS + Linear gen.: 11.1
SBE + Linear gen.: 11.1
IA + Linear gen.: 11.2
IA + Linear gen.: 11.2
IA + Linear gen.: 11.2
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IA + Linear gen.: 11.2

* 10% discount rate used for NPV calculation
SCORED PORTFOLIOS USING PRELIMINARY PNM CRITERIA AND WEIGHTING SCHEME

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

Preliminary results
**PHASE 3 TECHNOLOGY SELECTION**

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

<table>
<thead>
<tr>
<th>Base technologies only</th>
<th>Base technologies + CTs</th>
<th>Base technologies + all LDES (stakeholder scenario)</th>
<th>Base technologies + CTs + all LDES</th>
<th>Phase 1-2 technologies</th>
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<td>• Wind</td>
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<tr>
<td>• 4-hr storage</td>
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<td>• EE/DR</td>
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<td>• CT</td>
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</tbody>
</table>

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:

- Futures
  - CTP
  - HEG
  - LEG
  - NCP

- Tech Costs
  - High
  - Low

- Commodities
  - High Gas + CO2
  - Low Gas + CO2
  - NM PRC CO2 price cases

- Tax Credits
  - 10-yr Expiry

- Other
  - TOU
  - Stable ED
  - High EV
  - DERMS

See appendix for Future/Sensitivity details

SERVM:

CT&P case run for each scenario to determine:
- LOLE meets ~0.1 target
- EUE for portfolio

See appendix for Future/Sensitivity details
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

**Installed capacity 2040**

- **Solar**
- **Battery storage**
- **Wind**
- **Energy efficiency**
- **DR**
- **Generic LM6000**

**PVRR, B**

- **Reeves and Valencia extensions have no associated cost**

**NPV CO2, MM tons**

- Reeves and Valencia extensions have no associated cost
STAKEHOLDER-REQUESTED SCENARIOS: INCREASED DEMAND RESPONSE

**Preliminary results**

**Installed capacity 2040**

- **Thermal - CT**
  - Solar: 2,416
  - Wind: 264
  - Battery storage: 328
  - Energy efficiency: 231
  - Generic LM6000: 252
- **Thermal - CT + DR**
  - Solar: 2,355
  - Wind: 1,903
  - Battery storage: 328
  - Energy efficiency: 231
  - Generic LM6000: 252

**PVRR, B**

- **Thermal - CT**
  - 9.1
- **Thermal - CT + DR**
  - 8.7

**NPV CO2, MM tons**

- **Thermal - CT**
  - 11.2
- **Thermal - CT + DR**
  - 11.4
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

Preliminary results
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 used 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
## 2023 IRP Core Futures

<table>
<thead>
<tr>
<th>Key assumption</th>
<th>Current Trends &amp; Policy</th>
<th>High Economic Growth</th>
<th>Low Economic Growth</th>
<th>National Carbon Policy (Carbon-free by 2035)</th>
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<tbody>
<tr>
<td>Load forecast</td>
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## 2023 IRP Sensitivities

### Load

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<th>Load forecast</th>
<th>Economic Development</th>
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<th>CO2 price forecast</th>
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### BTM

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Load forecast</th>
<th>Economic Development</th>
<th>BTM PV forecast</th>
<th>EV adoption forecast</th>
<th>Building electrification</th>
<th>Gas price forecast</th>
<th>CO2 price forecast</th>
<th>Technology costs</th>
<th>IRA tax credits &amp; incentives</th>
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<tbody>
<tr>
<td>High BTM PV</td>
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<td>Low BTM PV</td>
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<td>High building electrification</td>
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<td>Limited ED</td>
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### Gas price

<table>
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<th>EV adoption forecast</th>
<th>Building electrification</th>
<th>Gas price forecast</th>
<th>CO2 price forecast</th>
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<th>IRA tax credits &amp; incentives</th>
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<td>Low gas price</td>
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### Carbon price

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<th>EV adoption forecast</th>
<th>Building electrification</th>
<th>Gas price forecast</th>
<th>CO2 price forecast</th>
<th>Technology costs</th>
<th>IRA tax credits &amp; incentives</th>
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<td>$8/ton</td>
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<td>PNM high CO2 price</td>
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<td>PNM mid CO2 price</td>
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<td>PNM low CO2 price</td>
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### Technology costs

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<th>EV adoption forecast</th>
<th>Building electrification</th>
<th>Gas price forecast</th>
<th>CO2 price forecast</th>
<th>Technology costs</th>
<th>IRA tax credits &amp; incentives</th>
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<td>Slow technology advancement</td>
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<td>IRA tax credits expire</td>
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<td>Mid</td>
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<td>Low</td>
<td>Expire 2032-2034</td>
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<td>0</td>
<td>Unproven Concept with no testing having been done</td>
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<td>3</td>
<td>You have an initial “offering”, stakeholders are interested</td>
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<td>Tested in intended environment with close to expected performance</td>
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<td>Operating in operational environment at pre-commercial scale</td>
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<tr>
<td>8</td>
<td>All technical processes and systems to support commercial activity at ready state</td>
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<td>Technology on “general availability” for all consumers</td>
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</tbody>
</table>
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