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Sandia National Laboratories

Expansion Planning Tool Development & Analysis for Energy Storage & Decarbonization with the Public Service Company of New Mexico

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Project Motivation

Collaborate with the Public Service Company of New Mexico (PNM) on their integrated resource plan (IRP) process by independently evaluating least-cost investment portfolios that meet the Energy Transition Act (ETA) requirements and evaluate the system's future energy storage requirements.

Project Objectives

Planning Framework Development

- Develop planning framework to evaluate energy storage technologies to meet decarbonization and renewable energy goals

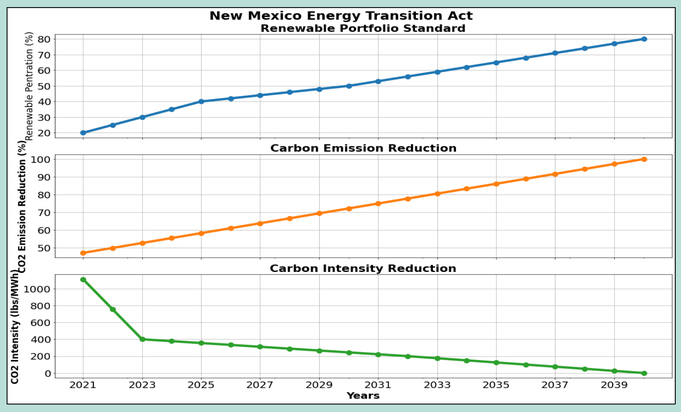
Data & Tool Development

- Wind and Solar resource potential and ramp rate characterization in New Mexico
- Long-term power system expansion planning models
- Production cost models
- Resource adequacy
- Resilience analysis

New Mexico Energy Transition Act

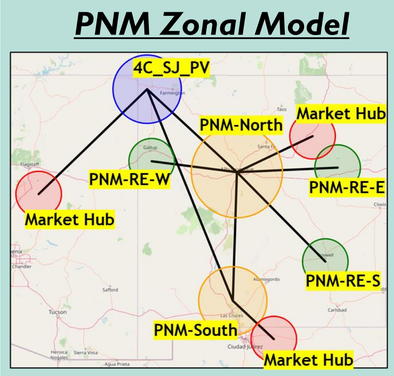
Key components of the NM ETA [1]:

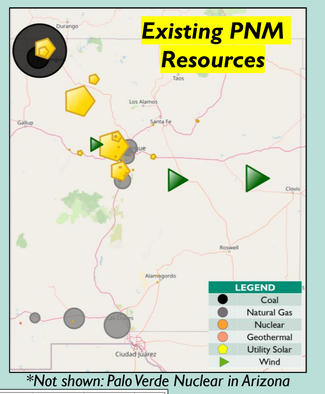
- Transition away from coal-fired generation to lower carbon resources
- Increase the state's renewable portfolio standard (RPS):
  - 50% by 2030
  - 80% by 2040
- Emission-free generation portfolio by 2045
  - PNM has promised to meet this goal by 2040



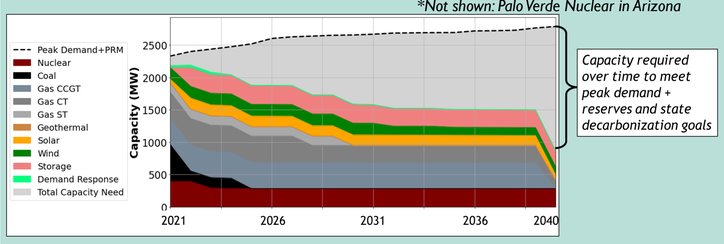
PNM Power System

PNM Zonal Model





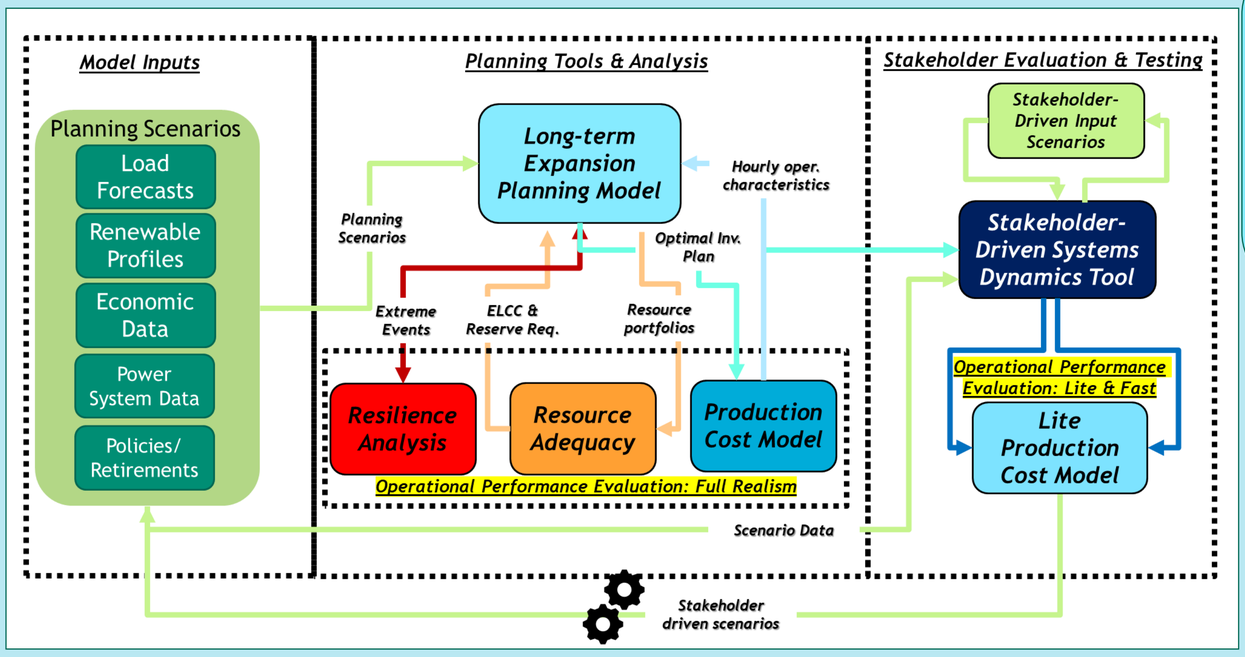
**Not shown: Palo Verde Nuclear in Arizona*



Stackplot of existing PNM generation with upcoming retirements and future resource capacity needs with forecasted peak demand. Data extracted from [1].

Proposed Planning Framework & Tool Development

Current efforts include developing framework to identify how planning should be coordinated effectively to meet decarbonization goals and to enhance decision making process about future resource mix.



Summary of ongoing tool development

Long-term Expansion Planning Model

Seeks to identify least cost resource and transmission investments over long-term planning horizon (20yrs). Temporal and spatial scopes are often aggregated to reduce computational complexity.

min NPV(Investment + Operational Costs)

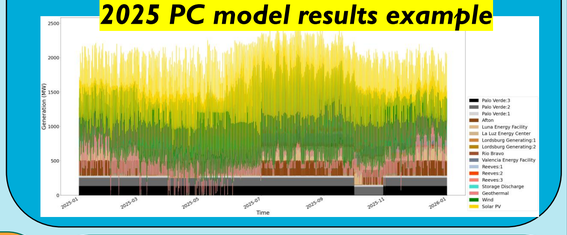
Planning horizon: Y1, Y5, Y10, Y15, Y20

Subject to:
- Power balance (w/forecasted load)
- Wind/PV power performance
  - Using site-specific wind and solar data
- ES constraints (charge, discharge, SOC)
- Planning reserve margin
- Policy constraints (RPS, CO2,water use)
- Transmission constraints
  - DC Power flow
  - Transportation (Pipes & bubbles)

Production Cost Model

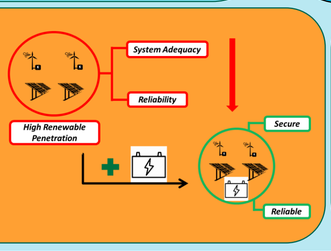
Provides hourly production of future system and models energy storage technologies at a higher fidelity

2025 PC model results example



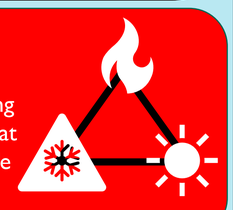
Resource Adequacy

Ensures that the resource mix determined by the IRP module guarantees reliable power generation and tracks dynamic changes in the state-of-charge of the energy storage devices.



Resilience Analysis

Incorporate extreme conditions into the planning process (Ex: ice storms, heat waves, wildfires) to provide feedback to expansion planning model

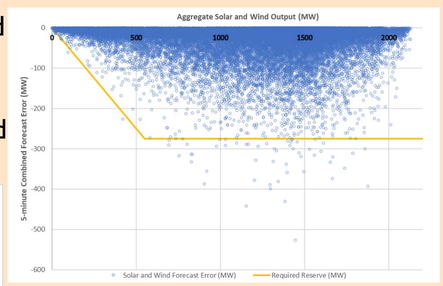


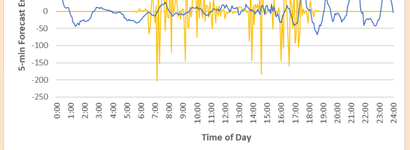
Stakeholder-Driven Systems Dynamics Tool

Incorporate stakeholder feedback and additional scenarios to evaluate various investment portfolios. Identifies potential sensitivities to incorporate in planning process. This work is in coordination with "*Systems Dynamics Modeling for Regulators*" project led by Howard Passell.

Variable Generation Forecast Error and Required Regulating Reserves

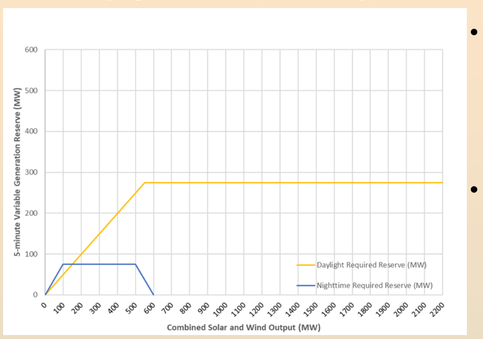
- 5-minute data for solar and wind used
- Forecast error for each 5-min period in the year was calculated
- Full analysis provided in [2]





Plotting the forecast error of each 5-min period allows one to draw a curve that contains 99.9% of all shortfalls within it

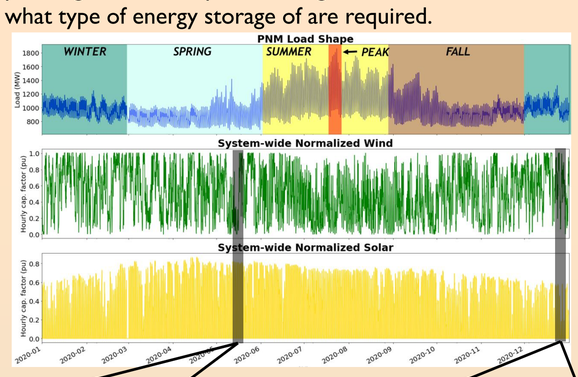
- A reserve requirement curve for daylight hours (solar + wind), and for non-daylight hours (wind only) is obtained

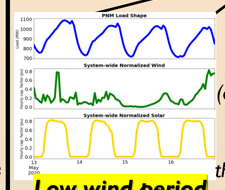


- Analysis provides insight into planning process by establishing the amount of reserves required and identifying tight margin events in a high renewable system.
- Ongoing work lies in implementing a resource adequacy model to ensure reliable generation for the future resource mixes.

Energy Storage Modeling in Planning Tools

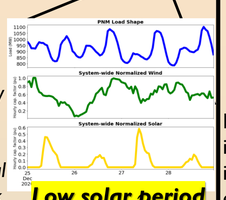
- Current expansion planning tools do not capture the full operational benefit of energy storage technologies due to the aggregation of temporal scales. Time buckets are typically created based on load by season and time of day.
- Temporal and spatial scope has an impact on the investment decisions of energy storage technologies. Including times when there is inadequate renewable energy available into planning models will provide insight into how much and what type of energy storage of are required.





Low wind period

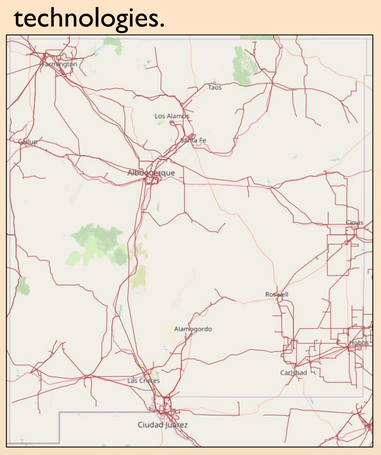
Additional energy storage (capacity and duration) may be needed to maintain system adequacy during these times which traditional planning tools may overlook these periods.



Low solar period

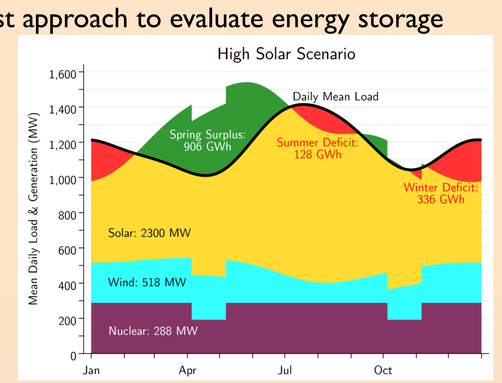
Future Work & Research Gaps to Address

- Incorporate transmission system and identify potential transmission investments and regional diversity of wind and solar.
- Evaluate long-duration energy storage technologies by incorporating various time scales into the planning models.
- Explore options how to better coordinate tools that are under development to identify the best approach to evaluate energy storage technologies.



Transmission system in New Mexico [3]

Incorporating transmission constraints and investments in current models will provide insights into the tradeoffs of investing in energy storage technologies and transmission projects.



Illustrative plot of seasonal variation of PNM's future system to highlight potential for long duration energy storage

Acknowledgements

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[1] Public Service Company of New Mexico (PNM), "PNM 2020-2040 Integrated Resource Plan", https://www.pnmforwardtogether.com/irp, January 29, 2021
[2] J. F. Ellison, C.J. Newlun, A.G. Benson, "An Analysis of PNM's Renewable Reserve Requirements to Meet New Mexico's Decarbonization Goals", SAND Report, Albuquerque, NM, 2022.
[3] U.S. Department of Homeland Security "Homeland Infrastructure Foundation-Level Data (HIFLD) Electric Power Transmission Lines", https://hifld-geoplatform.opendata.arcgis.com/datasets/electric-power-transmission-lines, 2022

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