Decarbonization and Storage Modeling with New Mexico

US DOE Office of Electricity
Storage R&D Program

PRESENTED BY

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Core Motivation

- Today, we are faced with a host of issues that challenge even the most well-tuned mind's eye:
  - Resilience to evolving hazards
  - Multi-sector decarbonization
  - Historic inequities
- Energy storage appears to be at the heart of the solution space for all of these issues – but differences in projections remain stark
- Stakeholders spend time coming up to speed on the technology landscape, forming their own mental models of the system, and often arguing over details that will **ultimately not matter**

Electric Utilities

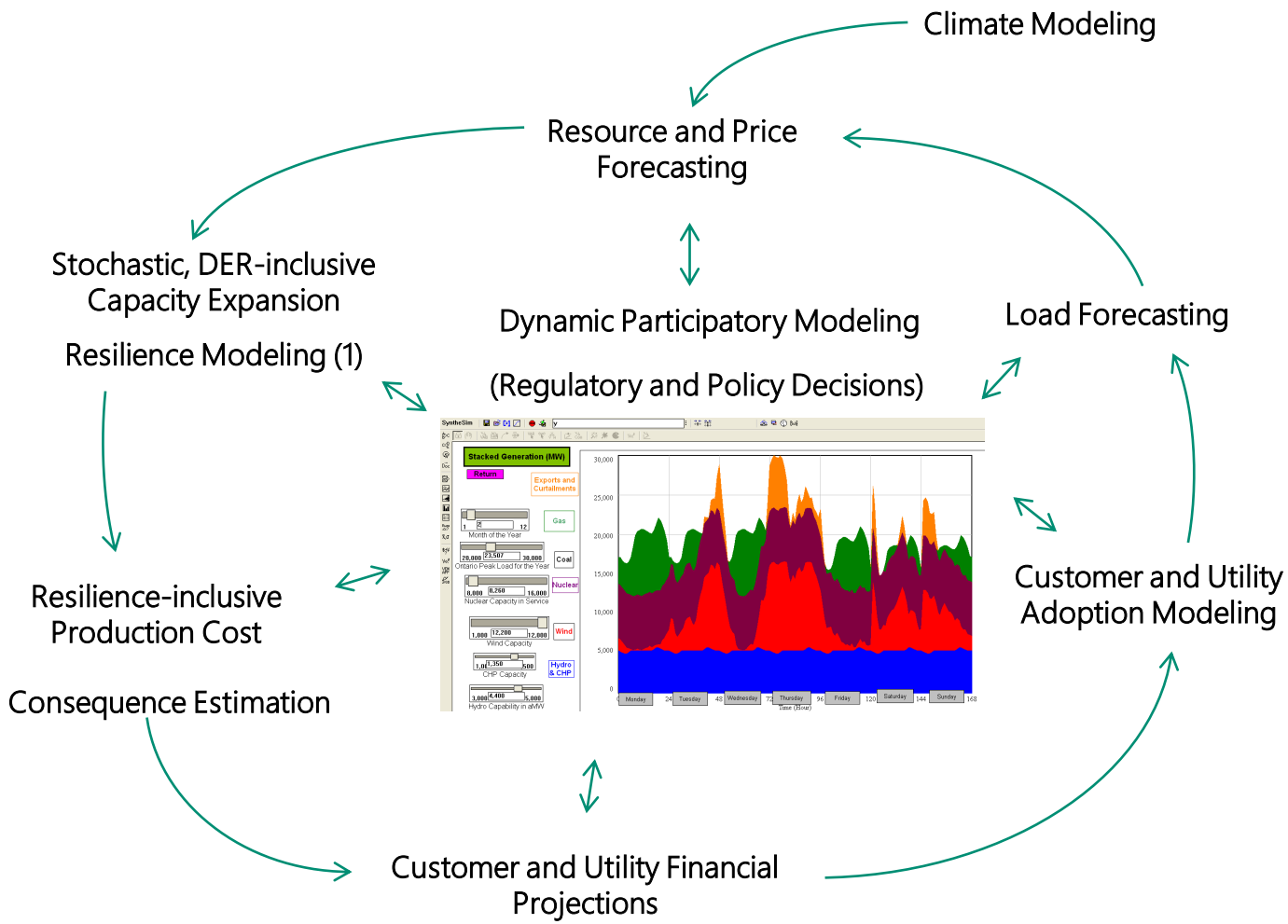
State + Federal Agencies

PUCs

Local Government

Vision

- We set out to build a model that can exist as a **forum** for various stakeholders to test and evolve their mental models
- Focus on structural complexity over categorical complexity – model the key causal influences that matter most, sacrificing precision in favor of dynamic realism
- Reach out to more detailed/sophisticated models to tune individual components of this dynamic "mega model"



Using sophisticated modeling techniques, the outer loop is incredibly time-consuming. We can model this same feedback mechanism much more rapidly.

Participatory System Dynamics Modeling

- Stakeholders become immersed in model development at high frequency
- Key performance indicators (metrics) are included that reflect the goals of all stakeholders
- Models run extremely fast, to enhance interaction

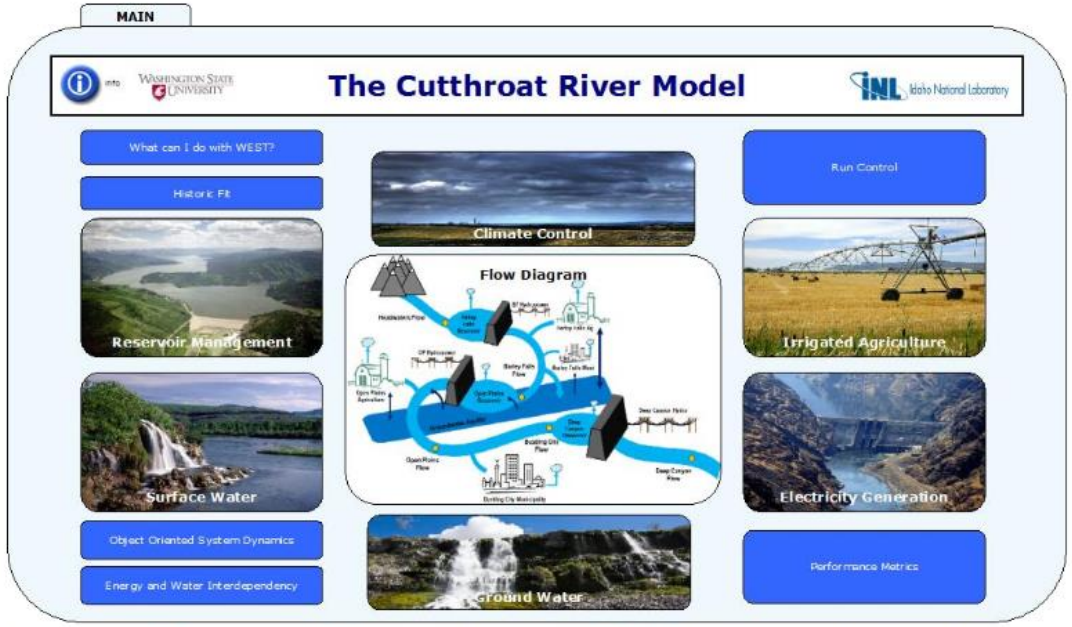
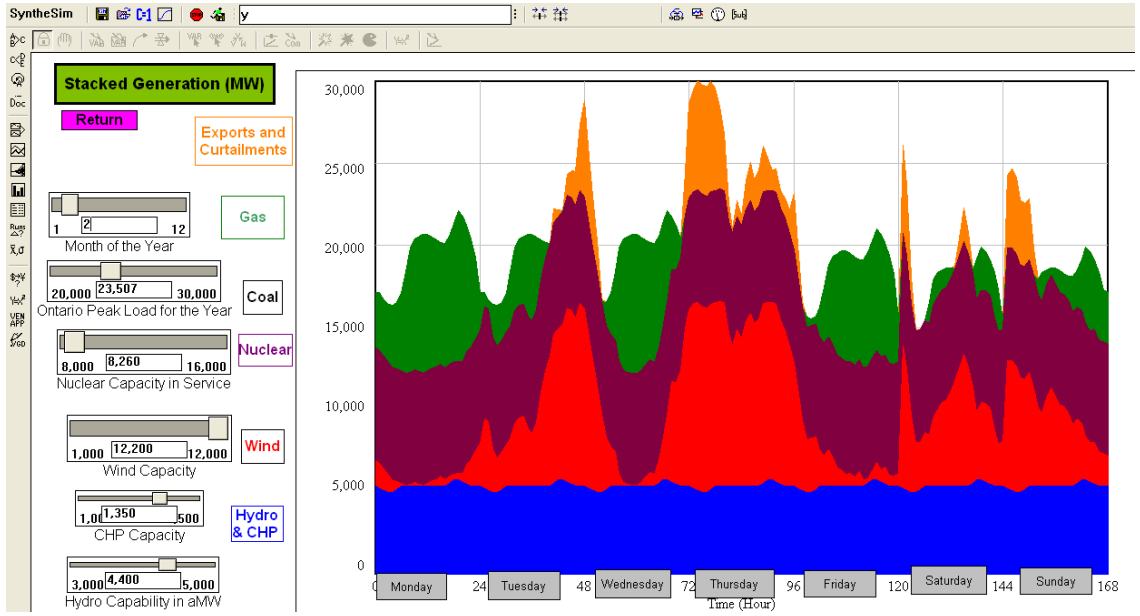


Figure 1.11. Introductory screen for the Cutthroat River Model, which is the WEST model of the Snake River Basin. Each rounded rectangle is a link to a specific sector of the model interface.



Stave, K. (2010) Participatory System Dynamics Modeling for Sustainable Environmental Management: https://www.researchgate.net/publication/46295172_Participatory_System_Dynamics_Modeling_for_Sustainable_Environmental_Management_Observations_from_Four_Cases
Beall, A, et al. (2011) Sustainable Water Resource management and Participatory System dynamics. Case Study: Developing the Palouse Basin Participatory Model. Sustainability, 2011, 3. https://aquadoc.typepad.com/files/beall-et-al.-palouse-basin.pdf

Partnership

- We have partnered with stakeholders in our home state of NM:
  - New Mexico Public Regulation Commission
  - Energy Minerals and Natural Resources Department (state energy office)
  - Public Service Company of New Mexico (PNM)
  - Additional stakeholders intended for year 2
- Twice monthly meetings focus on the participatory modeling process
- Ultimate transition partner is the National Association of Regulatory Utility Commissioners (NARUC) and all states wrestling with these issues
- Driving legislation: Energy Transition Act
  - 100% carbon neutral by 2045
  - Measures for lessening the impacts of coal retirements to local communities

PNM®

NEW MEXICO emnrd Energy, Minerals and Natural Resources Department

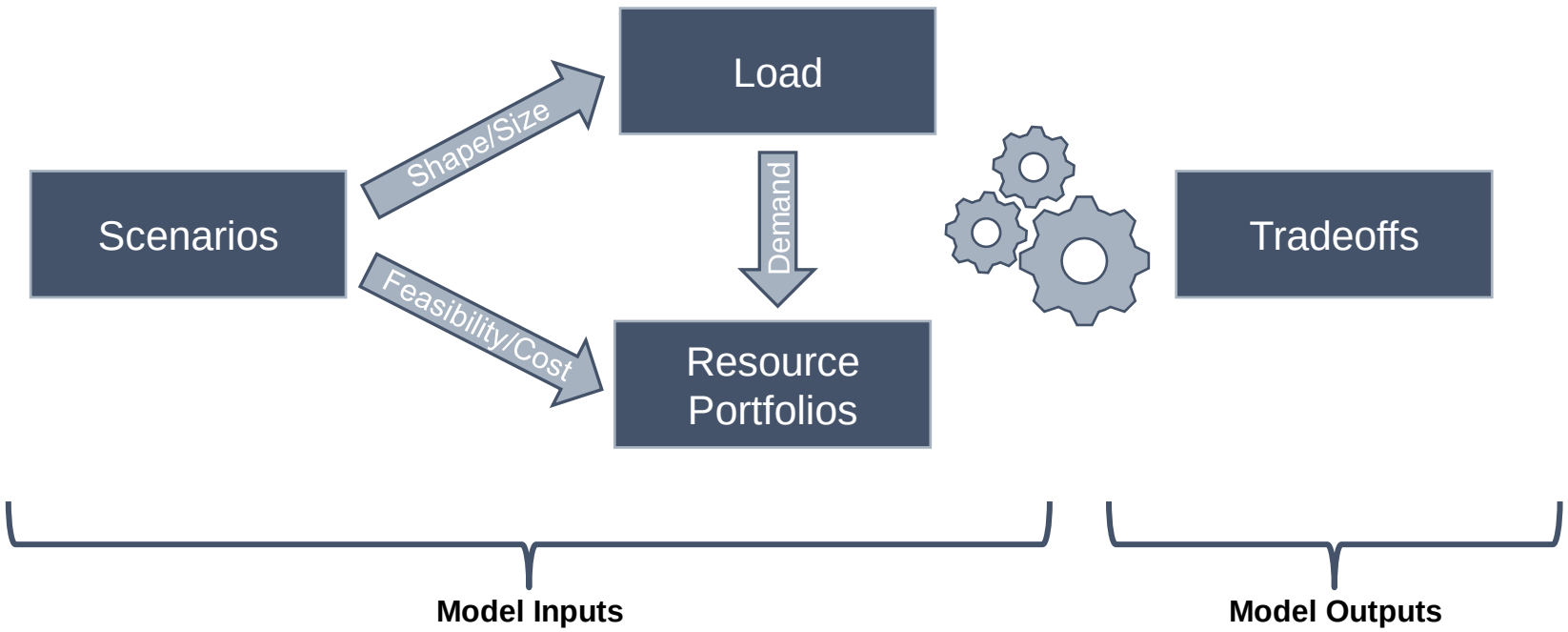
GREAT SEAL OF THE STATE OF NEW MEXICO 1912

Definitions / Terminology and Variables

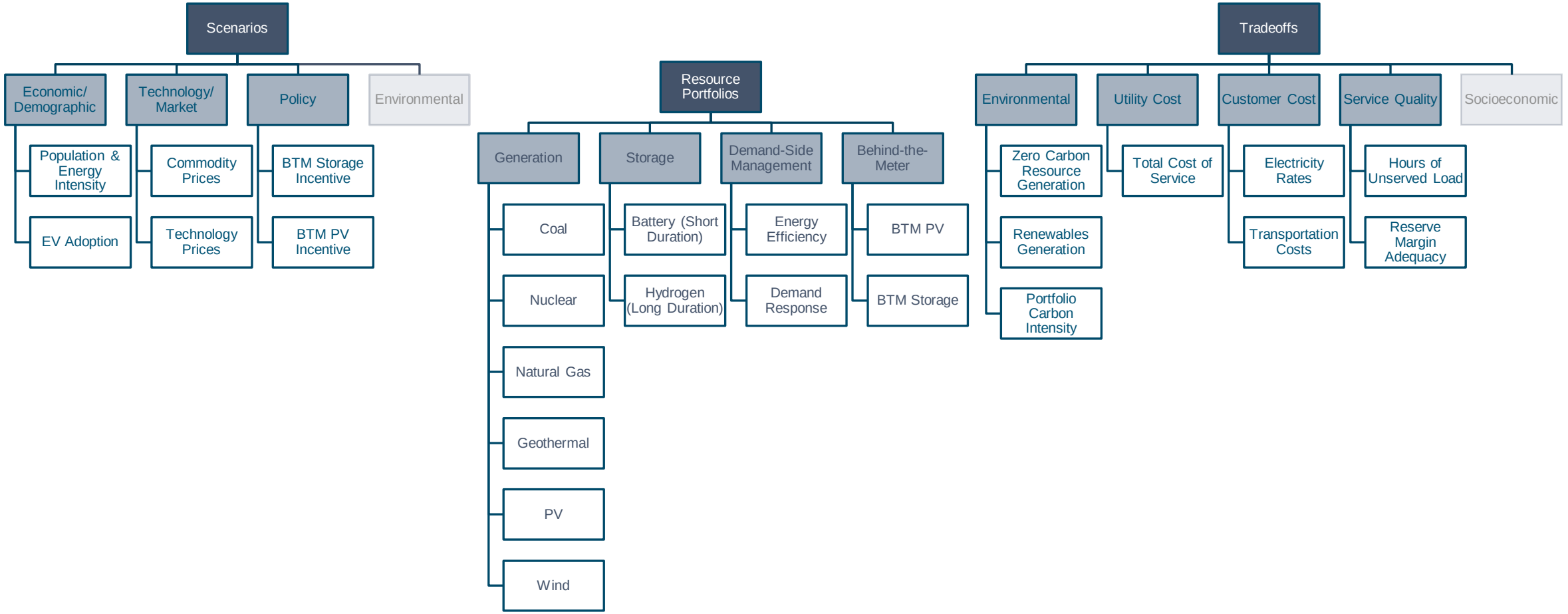
- Resource portfolios: Combinations of resources used to meet projected load profiles over the planning horizon (2020-2045)
- Scenarios: Represent key uncertainties via combinations of assumptions about future conditions
- Tradeoffs: Output metrics associated with alternative resource portfolios

		Categories	Model Variables
Model Inputs	Resource Portfolios	Generation	Coal
			Nuclear
			Natural Gas
			Geothermal
			Photovoltaics
			Wind
		Storage	Battery Short Duration
			Battery Long Duration
			Other Long Duration
		Demand-Side Management	Energy Efficiency
			Demand Response
		Behind-the-Meter	BTM Photovoltaics
			BTM Battery Storage
	Uncertainties	Economic/ Demographic	Load Growth
		Technology/Market	Commodity Prices
			Technology Prices
		Policy	BTM Storage Incentive
			BTM Photovoltaic Incentive
		Environmental	n/a
Model Outputs	Tradeoffs	Environmental	Zero Carbon Resource Generation
			Renewables Generation
			Portfolio Carbon Intensity
		Utility Cost	Total Cost of Service
		Customer Cost	Residential Rates
			Commercial Rates
			Industrial Rates
		Service Quality	Hours of Unserved Load (Reliability)
			Reserve Margin Adequacy (Reliability)
		Socioeconomic	n/a

Model Schematic (level 1)

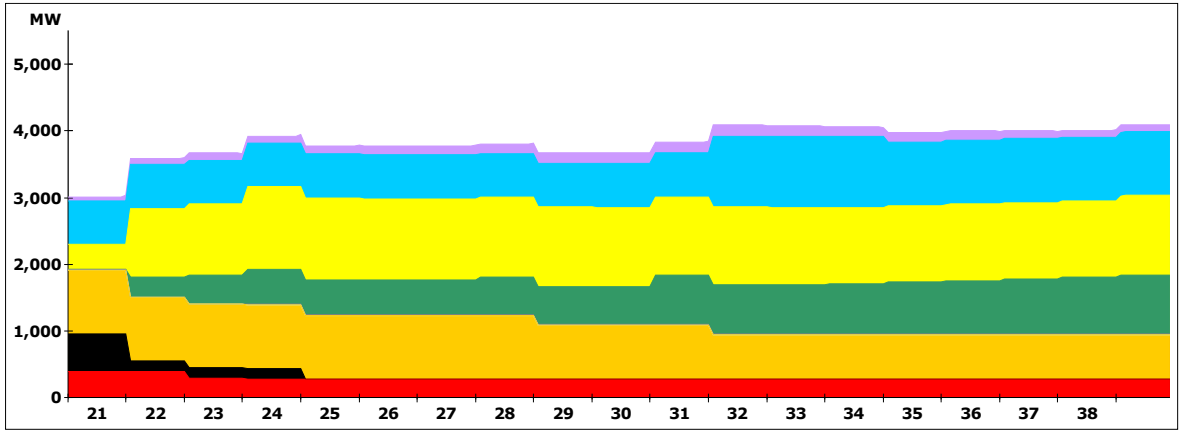


Model Schematic (level 3)

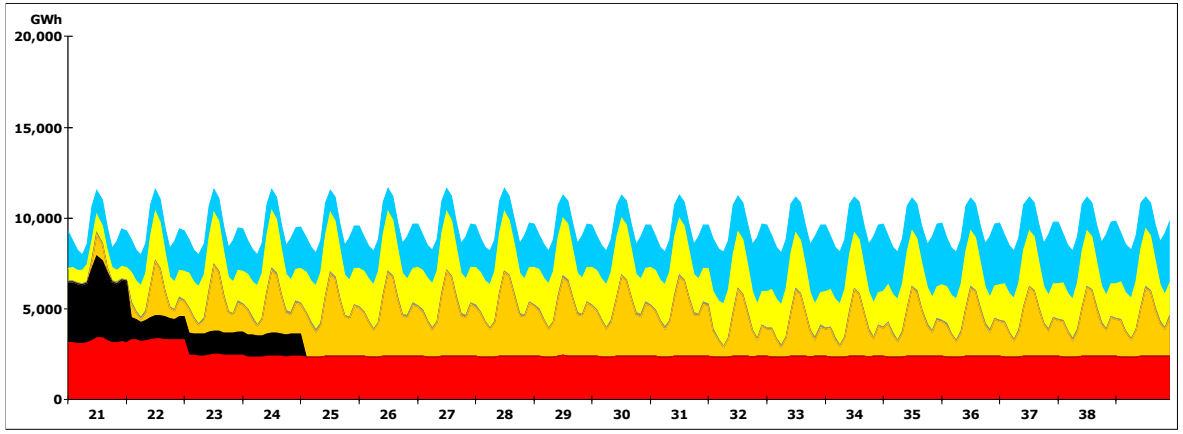


Model Preliminary Results

Annual Capacity (MW)

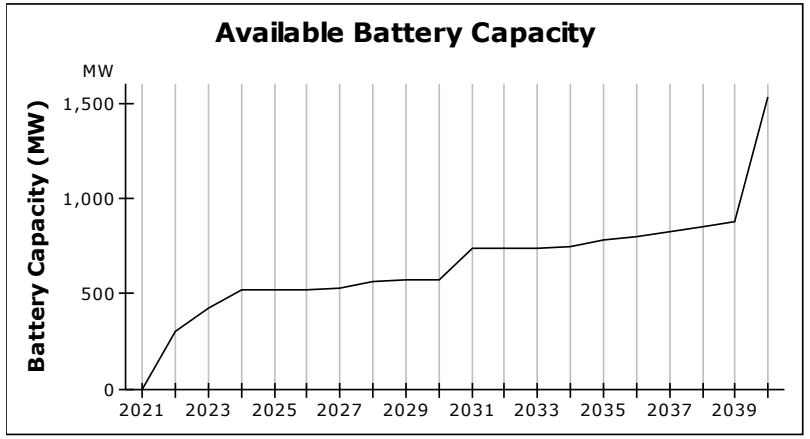


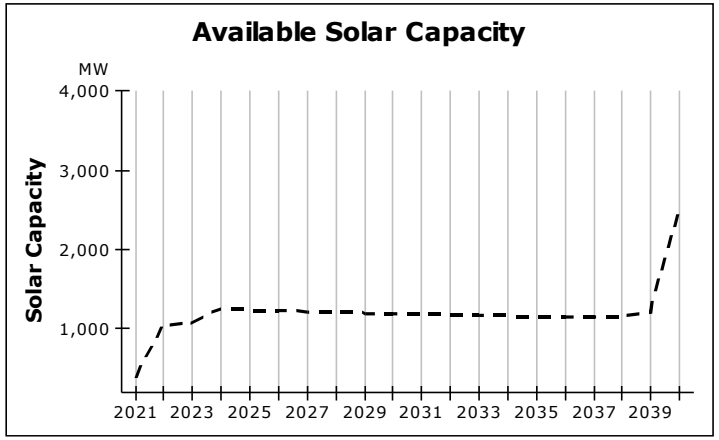
Monthly Generation (GWh)



	Nuclear		Coal		Natural Gas		Hydrogen		Geothermal
	Solar		Wind		Battery		Pumped Hydro		DSM

- Run time < 5 seconds
- Currently calibrating and validating to PNM IRP scenarios:
  - Base case = Current trends and policy, technology neutral
  - High EV penetration
  - Low EV penetration





Insights and directions

- Stakeholders have remarked at the **sheer amount of PV and battery storage constructed in 2040** (voluntary target for 0 emissions by PNM)
  - What are the financial pitfalls of such a large build-out in one year? Is it even possible?
- Hypothesis – if that build-out increases cost of service, and we have to significantly increase rates, **how will we support EV adoption, building electrification, and other deep decarb efforts?**
  - Will our deep decarbonization goals be achieved without additional policy?

- End CY 2021:
  - Successful calibration and validation to PNM integrated resource plan results
  - Exploration of high EV penetrations and long-duration battery storage options
  - Reveal cost/reliability/emissions tradeoffs with alternative resource portfolios

- Sept 2022:
  - Additional tradeoff metrics (resilience, rate impacts, jobs)
  - Additional spatial resolution (multi-node model)
  - Additional storage technology considerations
  - TOU rate mechanism, greater behind the meter detail
  - Expansion to all NM (includes several cooperative utilities)
  - Feedback from other states and NARUC

Thank You!

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