



THE MOONSHOT 100% CLEAN ELECTRICITY STUDY

ASSESSING THE TRADEOFFS AMONG CLEAN PORTFOLIOS WITH A PNM CASE STUDY

AUGUST 2023

FACT SHEET

WHAT ARE THE CHALLENGES THE REPORT RESPONDS TO?

Although several states, including New Mexico, have set 100% clean electricity targets, few have evaluated future power systems that reach those targets. Analyzing 100% clean energy portfolios will give policymakers the necessary information to develop a roadmap to achieve these goals. We selected New Mexico and the Public Service Company of New Mexico (PNM) utility as a case study, but with the intention that the findings can bring value for other jurisdictions.

IS IT POSSIBLE TO RELIABLY AND AFFORDABLY MEET A 100% CLEAN TARGET?

Our study shows that under the conditions analyzed, including varying levels of electrification, that it is possible to reliably meet a 100% clean electricity target. We demonstrate this result by assessing multiple portfolios with different combinations of clean resources. The study included a probabilistic resource adequacy analysis that considers a wide range of potential weather conditions and the interactions of PNM with the rest of the West.

While the study quantified the costs of different clean electricity portfolios, it did not seek to compare the total societal benefits and costs of achieving a 100% clean electricity grid, or identify the “least cost portfolio.” Future costs of emerging technologies, such as hydrogen fueled thermal

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generation or long duration storage resources, and clean resources that have not yet reached high penetration (such as geothermal energy) are highly uncertain, and complicate the calculation of the incremental cost of meeting the “last mile” of decarbonization. As these technologies become more commercially mature, planners can assess the costs and benefits between such technologies.

WHAT ARE THE KEY FINDINGS OF THE STUDY?

- **FINDING 1.** There are multiple pathways towards achieving a 100% clean electricity target while maintaining a reliable and economical electricity system.
- **FINDING 2.** Deploy, deploy, deploy: wind, solar, and battery storage are key components of any plan to decarbonize the power system.
- **FINDING 3.** The “last mile” to achieving 100% clean is uncertain in terms of the cost-optimal resource mix, but clean firm resources are beneficial for the last 5-10% of energy.
- **FINDING 4.** Resource adequacy needs are increasingly driven by energy constraints, not just capacity.
- **FINDING 5.** PNM should not go it alone—regional planning and coordination are critical for efficient reliability.
- **FINDING 6.** Electrification will require significantly more resources but does not fundamentally change the portfolio. However, weather dependent, end-use load forecasts are essential to understand the reliability impacts of electrification, and also, to identify load flexibility opportunities.
- **FINDING 7.** Reliability risks are shifting—with high levels of electrification, summer peak demand will not remain the largest challenge.
- **FINDING 8.** Cost, land use, and water requirements for PNM’s energy transition are manageable.

WHAT DO POLICY MAKERS AND REGULATORS NEED TO ACCOMPLISH IN THE NEAR TERM IN ORDER TO MEET 100% CLEAN TARGETS?

The study shows that wind, solar, and battery storage are the lowest cost options for achieving the majority of decarbonization across the electric power system for PNM. The Inflation Reduction Act affords a unique opportunity for utilities, especially in regions like New Mexico. The state not only has high quality wind and solar resources and available land, but also a large share of energy communities eligible for Inflation Reduction Act credits. We estimate between 1700 and 2200 MW of new wind, solar, and storage capacity are needed under baseline load assumptions and 2800-3800 MW for high electrification scenarios. That equates to roughly 650-1400 MW of solar, 50-1450 MW of wind, and 750-1750 MW of battery energy storage as the foundation of a 100% clean system, depending on the particular portfolio.

But the development of these resources will need to be accelerated to meet 100% clean electricity targets. Policy makers and regulators should develop land use, transmission, and utility-offtake policies that allow for accelerated renewable and storage development in New Mexico.

Policy makers and regulators also play an important role in regional coordination and planning. The study showed the importance of the broader West power system to meeting PNM's local reliability requirement. Policies and regulations can help promote and enable resource sharing via bilateral contracts, joining a regional resource adequacy program, or through an ISO/RTO.

It is worth noting that New Mexico has a unique advantage with respect to IRA credits. Roughly 80% of New Mexico qualifies for credits that are available to energy communities, with additional credits available for Native American land. We did not look at the economic development opportunities in this study (our study mainly factored in IRA in terms of the cost inputs to the modeling), but policy actions should leverage the IRA and other programs to maximize economic and social development objectives for New Mexico.

ARE NEW TECHNOLOGIES NEEDED TO MEET 100% CLEAN TARGETS?

Not necessarily. While the study showed that clean firm resources—such as hydrogen combustion turbines, geothermal, thermal resources with carbon capture and sequestration, small modular nuclear, or multi-day storage—are valuable to PNM and the rest of the West during times of low wind and solar production or extended peak demand periods, they may not be necessary if regional coordination is increased. Similar reliability benefits can arise through regional coordination and upsizing of wind, solar, and storage resources, especially if capacity expansion decisions are coordinated across the region. There are cost and reliability tradeoffs between these three options, along with regulatory risks—including asymmetry in clean electricity goals across different states, and market uncertainty.

There are multiple options to meeting 100% clean electricity targets, but there are no free lunches. The most important aspect to reaching 100% clean electricity in a reliable manner is to start now using the commercially mature technology available today. Deployment of wind, solar, and storage are least cost, least regrets, options for any future 100% clean electricity grid.

IN WHAT WAYS DOES JOINING A REGIONAL MARKET HELP TO MEET 100% CLEAN TARGETS?

Joining a regional market would allow PNM's ratepayers to benefit from geographic diversity in wind and solar, as well as demand. While multi-day low wind, solar, and high peak demand events can challenge reliability in a future power system, their impacts are mitigated considerably across a wider footprint. This would result in a lower capacity requirement for the entire region. In PNM for example, our analysis estimates that the expected loss of load will increase from roughly 0.1 days/year to 14 days per year without access to West-wide interchange unless PNM significantly increases its own firm capacity supply.

Joining a regional market would also fully leverage the existing transmission network. This would increase opportunities to access low-cost renewable energy across the region, market excess New Mexico energy to neighboring markets, enable new transmission planning development, support

better resiliency through coordinated transmission strategy, and support interconnection of new resources. Finally, a regional market could accelerate investment in clean energy resources by further opening opportunities for merchant wind and solar development in the region.

WHAT ARE THE LAND AND WATER USE IMPLICATIONS OF BUILDING SIGNIFICANT AMOUNTS OF RENEWABLE GENERATION AND POTENTIALLY RELYING ON HYDROGEN FUELED THERMAL GENERATION?

While the buildout of solar and wind resources will require large amounts of land, the total land use requirement is manageable and reasonable. The total land use represents less than 0.2 to 0.3% of New Mexico's total land area (approximately one-quarter to a third the area of Curry County), even when assuming high levels of electrification of buildings and transportation. While the total land needs for wind and solar projects are minimal, community acceptance, siting, and zoning rules are important considerations for future development.

In addition, given the high quality wind and solar resource and the prevalence of energy communities that qualify for IRA bonus credits, New Mexico will see large demand for renewable projects sited within the state to support neighboring states and regional decarbonization plans. As a result, land use considerations may be small for PNM's local needs but could increase due to the larger regional need for clean electricity.

Water requirements are an important consideration for the Desert Southwest. However, because the water consumption associated with natural gas and coal generation are absent in our modeled future 100% clean system, the water use associated with hydrogen production for a 100% clean power system is roughly 4-6% of PNM's current water needs.

ARE THE FINDINGS UNIQUE TO PNM AND NEW MEXICO OR CAN THEY BE REPRESENTATIVE OF THE CHALLENGES AND NEEDS OF OTHER REGIONS?

While we selected New Mexico and the Public Service Company of New Mexico (PNM) utility as a case study, most of the findings are applicable to other jurisdictions. Some regions may not have strong resource potential for both wind and solar in their territory—but economical clean portfolios will inevitably include one or both of these resources. In addition, the finding that regional coordination is important to reliability is true for any jurisdiction. The benefits of clean firm resources are also broadly applicable. While each region will have a different portfolio of clean resources, achieving a 100% clean electricity grid is technically feasible—the policy choices will ultimately depend on weighing the risks, costs, and benefits of the three core pathways utilizing emerging resources, regional coordination and upsizing solar, wind and batteries.