Executive Summary

In 2019, New Mexico passed the Energy Transition Act (ETA), one of the most ambitious pieces of clean-energy legislation in the United States. The centerpiece of the ETA is the renewable portfolio standard (RPS), requiring an increasing share of electricity sold by the state's investor-owned utilities (IOUs) and rural electric distribution cooperatives (REDCs) to come from zero-carbon-emitting sources, reaching a 100 percent zero-emission electricity requirement by 2045. The state's IOUs and REDCs appear on track to meet the ETA's interim targets. Despite these achievements, challenges remain in reaching the 2045 goal of 100 percent zero-emissions electricity while maintaining reliability and affordability.

Achieving higher clean-electricity targets will likely require deploying technologies not yet widely used. These include investments in long-duration energy storage (LDES) technologies and other sources of dispatchable zero-emissions generation, such as geothermal energy, small modular nuclear reactors, and fossil-fuel generation with carbon capture and storage (CCS). As these technologies develop to prove scalability and reduce costs, it is likely that ensuring reliable and affordable power in the state will require maintaining existing natural gas generation and, given the age of the existing fleet and load growth expectations, approval of new gas plants.

Reaching the ETA goals will also require investments beyond generation assets. Enhanced transmission infrastructure, both intra- and inter-regionally, is also crucial for integrating renewable energy and ensuring reliability. Additionally, increased demand responsiveness and energy efficiency will make achieving the RPS more cost-effective.

The state can help meet these challenges in several ways. First, by providing financial and regulatory support for the development and deployment of LDES and nascent zero-emission generation technologies, regulators can ensure a stable and reliable energy supply with little to no emissions. At the same time, regulators will likely need to provide incentives to keep existing natural gas fleets viable over the coming decade. Second, the state can streamline the permitting process for new transmission projects, take leadership roles in developing inter-regional transmission projects, and work with federal agencies to secure funding for this critical infrastructure. Third, implementing innovative rate structures and energy efficiency programs will help manage demand and reduce overall energy consumption. Fourth, investing in workforce development programs will ensure that the state has the skilled labor necessary to build and maintain new energy infrastructure, as well as to compete for the growing green manufacturing sector. Fifth, by exploring the formation of an RTO/ISO and supporting REDCs in transitioning to renewable energy sources, New Mexico can enhance grid reliability and efficiency, positioning itself as a leader in the clean energy transition. Finally, by taking these steps the state can ensure its reliable clean energy future while providing economic development opportunities for other industries in the state.

I. Introduction

In 2019, New Mexico passed Senate Bill 489, commonly referred to as the Energy Transition Act (ETA), putting into law one of the most ambitious pieces of clean electricity legislation in the US. The central goal of this legislation is to have New Mexico customers consuming all their electricity from CO2-emissions-free sources by 2045. As detailed below, while New Mexico may be able to meet its near-term goals on this energy transition path relatively easily, reaching the end goal of emissions-free electricity, while still maintaining reliable and affordable power, will present yet unresolved challenges.

In this paper, I draw on the extensive academic and grey literatures regarding energy transitions to give an overview of some of the challenges and opportunities the ETA presents to New Mexico. This discussion includes technological considerations regarding generation, as well as issues around transmission expansion, demand-side management, incentives for utilities and co-ops, and workforce development. The paper concludes with some general policy recommendations to be considered in an effort to efficiently and productively reach the ETA goals.

II. Background and Current Status

The centerpiece of the ETA is the renewable portfolio standard (RPS), which mandates that an increasing share of electricity sold by the state's investor-owned utilities (IOUs) and rural electric distribution cooperatives (REDCs) must come from zero-carbon-emitting resources. This RPS program reaches a critical milestone at the beginning of 2025 as it requires IOUs and REDCs to have renewable-electricity shares at 40 percent of their respective electricity sales.[1] Relative to the 2020 renewable energy share requirements, the 2025 renewable energy target constitutes a doubling for IOUs and a quadrupling for REDCs.

Remarkably, the state's IOUs and REDCs appear well positioned to meet the 2025 renewable-electricity-share target. Public Service Company of New Mexico (PNM) and Southwestern Public Service Company (SPS) both report having more Renewable Energy Credits (RECs) than needed for compliance. This is due to a combination of banked RECs from previous over-compliance and ongoing REC generation through power purchase agreements (PPAs) and utility-owned renewable energy assets. El Paso Electric (EPE) was non-compliant with the RPS targets in recent years but has agreed to meet its renewable energy obligations through borrowing from expected future over-compliance. The REDCs, with the exception of Kit Carson Electric Cooperative (KCEC), almost entirely meet their customers' electricity demand through power produced from one of two generation and transmission associations (G&Ts), Western Farmers Cooperative (Western

[1] "Renewable" electricity, as defined by SB 489, is electricity generated from wind, solar, geothermal, fuel cells, some biomass, and newer (in service after July 1, 2007) hydropower generating facilities.

Farmers) and Tri-State Generation & Transmission (Tri-State).[2] Both G&Ts "have expressed confidence" that they will be able to meet the 2025 target (Gillespie, O'Donnell and Tidwell 2024).

Going forward, IOUs are required to reach renewable energy shares of 50 percent by 2030 and 80 percent by 2040. By 2045, IOUs are required to meet 100 percent of electricity sales with "zero-carbon" generation.[3] REDCs have slightly less stringent targets, needing to reach 50 percent renewable energy by 2030 and meet 80 percent of electricity sales with zero-carbon electricity by 2050. At the same time, the state's Energy, Minerals, and Natural Resources Department predicts electricity sales in New Mexico to grow by over 40 percent from 2023 through 2040 (Rogers 2024).

Meeting the future RPS targets for both IOUs and REDCs will, thus, require unprecedented growth in renewable and other zero-carbon electricity generating sources. Though given cost declines in renewable energy, particularly wind and solar, and energy storage, along with the numerous and substantial Federal subsidies included in the recently passed Inflation Reduction Act (IRA) and Infrastructure Investment and Jobs Act (IIJA), these additions of zero-carbon generation source may well be economically prudent. That written, there is a role for State and State policies, in conjunction with efforts from the IOUs, REDCs, G&Ts, and public and private actors, in helping to make this energy transition feasible while maintaining power reliability and affordability. The remainder of this paper will discuss several of the areas that will likely need to be addressed to help facilitate and efficient and equitable transition and points where State department policies may be needed to further aid the transition.

III. Near-term Technologies - Wind, Solar, and Short-duration Storage

In 2023, over 45 percent of the utility-scale electricity generation from sources within New Mexico came from renewable generation (17,484 GWh out of a total of 38,539 GWh).[4] This is a far higher percentage than the nation as a whole, which derived only about 21 percent of total generation from renewables (inclusive of hydropower), and up dramatically from a decade ago when New Mexico generated just 7-8 percent of its electricity from renewable sources. The vast majority of the state's renewable generation comes from wind power (about 85 percent of 2023's renewable generation), with solar providing almost all of the rest.

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[2] KCEC orchestrated a buyout from its electricity purchase agreement with Tri-State in 2016. This effort was motivated, in part, by KCEC's desire to increase the share of electricity it receives from renewables (Rogan 2016). Resultingly, KCEC appears to be well beyond the 2025 40-percent renewable energy target.
[3] "Zero-carbon" generation, as defined by SB 489, is from any generating resource that emits no carbon dioxide into the atmosphere as a result of electricity production.
[4] These values are based off of the Energy Information Agency's (EIA) form 923 data and summarized at https://www.eia.gov/electricity/data/browser/#/topic/0?agg=2. Note, however, generation from within-state resources does not necessarily represent the mix of generation sold to the final customers in New Mexico due to electricity sales that send power into and out of the state.

Going forward, wind and solar will remain the dominant forms of renewable energy production in the state.. Indeed, the integrated resource plant (IRP) of PNM, the state's largest utility in terms of volume sold and customers served, has enough contracted and approved solar capacity to more than double their 2023 capacity within the next 2 to 3 years and their "most cost-effective portfolio" modeling scenario indicates solar will be PNM's single-largest generating source by 2027 (Public Service Company of New Mexico 2023). SPS, on the other hand, forecasts wind to be the largest contributor to their portfolio by 2028 and to be particularly wind-heavy as they progress to their 2045 target of 100% carbon-free electricity sales (Southwestern Public Service Company 2023).

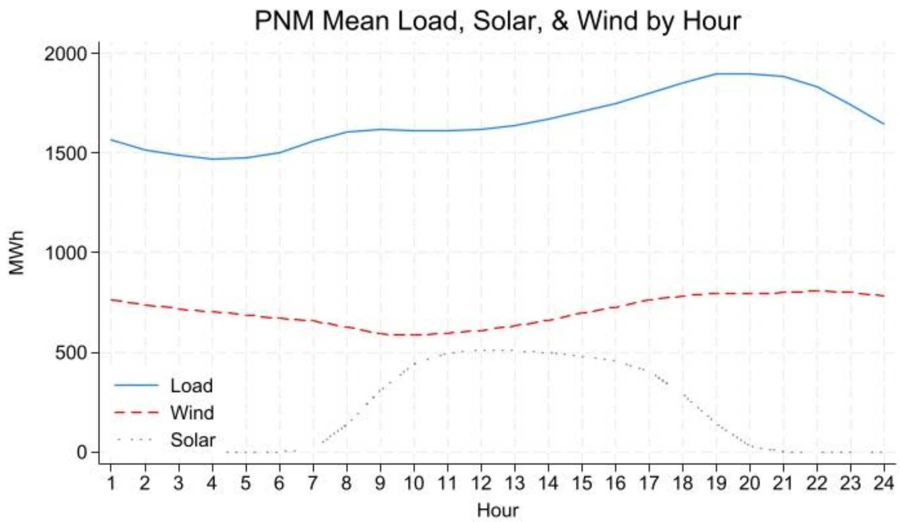
The rise in wind and solar can be explained by several factors. First, New Mexico has extraordinary wind and solar generation potential. Second, costs, particularly for solar panels, have declined significantly over the past decade, though supply chain issues, inflationary pressure, and trade disputes with China threaten this continued decline in costs. Finally, the IRA increased the potential, and changed the form of, subsidies for both solar and wind generation. More specifically, prior to the passage of the IRA, solar generators were eligible for only the investment tax credit (ITC), which covered roughly 30 percent of capital costs. Under the IRA, the ITC can cover as much as 70 percent of investment costs. In addition, the IRA allows solar generators, along with wind generators, to opt for a per MWh production subsidy, via a production tax credit (PTC) that can be as much as $33/MWh, instead of the ITC. Solar projects in New Mexico are well positioned to capture these maximum PTC/ITC values because virtually all of the state falls under the Department of Energy's (DOE) "energy community" classification and there is opportunity to have solar projects serve low-income and/or tribal communities.[5]

While a wind and solar-dominated electricity generation sector has some clear economic advantages, relying on these variable renewable energy (VRE) sources alone faces challenges given their non-dispatchability. This is obvious from an intra-day perspective – solar generators provide no electricity at night and diurnal wind patterns in the mid-continent tend to have wind speeds that are higher at night and lower during mid-day. One can see this in Figure 1 with the plots of the mean hourly load (demand), wind, and solar generation over 1/1/2022-8/25/2024 for PNM. While there is some complementarity in wind and solar in meeting demand for PNM (i.e. as wind decreases solar increases and vice versa), neither diurnal pattern alone is well matched with typical load patterns. Additionally, Figure 2 plots the hourly ratio of wind plus solar generation to load for PNM during the month of April, a month where wind and solar historically cover the

[5] The base ITC under the IRA is 30 percent of capital expenditure. The ITC can reach a maximum of 50 percent if: a) the project is built in a DOE-defined "energy community" (+10%), b) the project's components meet IRA-defined domestic content rules (+10%), and c) the project financially benefits low-income or tribal communities (+20%). A map of DOE-listed energy communities can be found at https://arcgis.netl.doe.gov/portal/apps/experiencebuilder/experience/?id=a2ce47d4721a477a8701bd0e08495e1d.

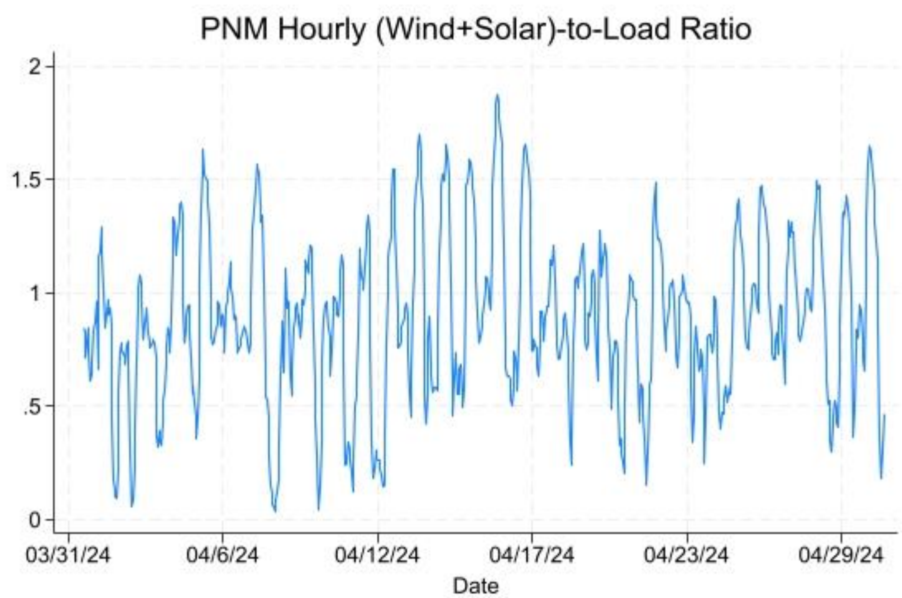
highest share of load, in 2024. Here one can see that while there are hours where wind and solar generate more than load, there is high volatility in the ratio, moving from generation surpluses to significant deficits happening numerous times in the matter of 2-4 hours.

Figure 1:



Source: Authors calculations derived from EIA 930 Data

Figure 2



Source: Authors calculations derived from EIA 930 Data

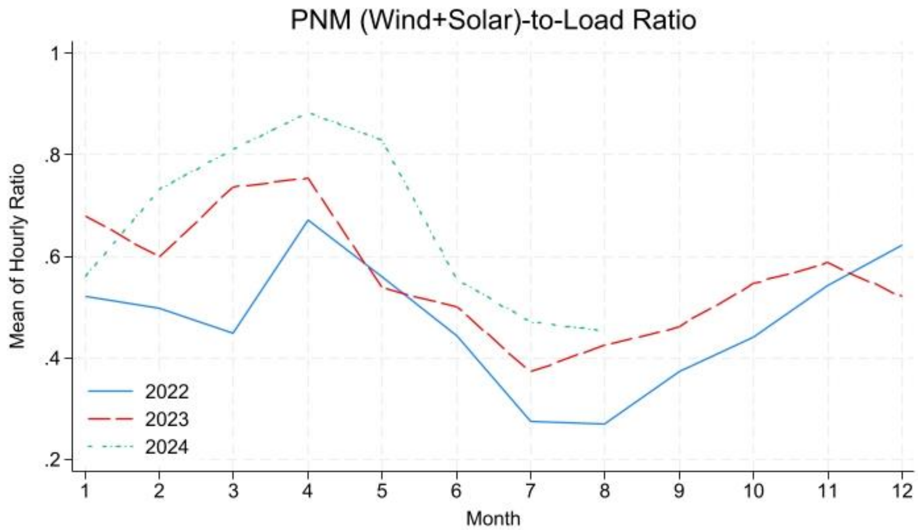
Short-duration battery storage is well suited to handle this intra-day variation. The IRA provides, for the first time, an ITC for standalone energy storage, with a base of 30 percent of capital costs and up to 70 percent. The increase in VRE and IRA-based subsidies, along with falling battery costs, has led to a massive expansion of battery storage. Nationwide capacity is set to nearly double with 2024 installations (14.3 GW to be added in 2024, with 15.5 GW existing at the beginning of the year). New Mexico is following these trends with 238 MW of battery capacity installed by 2023, but with 485 MW proposed according to the EIA 860 2023 early release data. Likewise, PNM's most cost-effective portfolio calls from going to very little storage by the end of 2023 to around 1000MW of capacity by 2027 and 2000MW by 2042. SPS's most cost-effective planning scenario, when constrained to existing technologies and ETA goals, similarly sees dramatic rises in storage capacity, going from essentially none now to about 2000MW by 2030.

IV. The Last Mile – Long-Duration Storage and Dispatchable Zero-Emissions Technologies

VRE's do not just exhibit variation in the intra-day context, they also exhibit day-to-day, seasonal, and year-over-year variability. Figure 3 provides some supporting evidence of this point. This figure plots the average monthly values of the hourly sum of wind and solar generation divided by hourly load for PNM over the years 2022-2024. The figure shows clear seasonal patterns in the wind+solar-to-load ratio. Wind and solar fall well short of load on average in the summer months but cover a higher share of load in the fall and spring. Additionally, despite continued annual additions to wind and solar capacity in PNM, there are months where the previous year's wind+solar-to-load ratio is higher than that for the subsequent year. This indicates year-to-year fluctuations in wind+solar production and/or loads that can significantly impact the relative availability of these VRE resources.

For these cases where VRE production surplus and shortfalls are separated by several days, months, or even years, battery storage is not well suited to temporally redistribute electricity. As the state's energy mix becomes more and more dependent on these VRE sources on its path to 100 percent clean electricity, long-duration energy storage (LDES) technologies and/or dispatchable zero-emission sources will be required to ensure reliable power.

Figure 3



Source: Authors calculations derived from EIA 930 Data

LDES technologies generally are defined as those that can shift power by 10 or more hours (Scott, et al. 2023). There are many different technologies that can provide these LDES services, broadly classified into thermal (e.g. stored heat via molten salts), mechanical (e.g. compressed air and pump hydro), electrochemical (e.g. electrochemical flow batteries), or chemical technologies (e.g. hydrogen). Many of these technologies are well suited for providing storage of a few days (LDES Council, McKinsey & Company 2021). Which of these inter-day to multi-day storage technologies is best suited for New Mexico remains to be seen as many are still in demonstration and pilot phases. There is financial support for the development of these technologies provided IRA and IIJA, with the hopes that grants from these bills will help push down the costs by the time energy systems are primarily reliant on VRE sources. It remains to be seen if these efforts will be successful and so a role for the state likely remains. More specifically, can provide support to universities and other research entities to develop these technologies, as well as supporting public-private partnerships to aid in the deployment of these new technologies.

Hydrogen (H2) is emerging as potential source for seasonal LDES, where excess electricity from VREs is used in electrolyzers to split water into hydrogen and oxygen. The hydrogen is then used to generate electricity via hydrogen fuel cells or possibly being burned, possibly with some mix of natural gas, in boilers of thermal electricity generators. This so-called “green hydrogen” production qualifies for a production subsidy of up to $3/kg-H2, which is equal to approximately 60 percent of recent green hydrogen production cost estimates (Fell, Holland and Yates 2024). New Mexico has already taken action to jumpstart hydrogen production in the state. The BayoGaaS Hydrogen Hub, a partnership BayoTech and the New Mexico Gas Company and leveraging technology created at Sandia National Lab, is a pilot program currently producing hydrogen that blends with natural gas and is used for home heating. Executive Order 2022-013 calls on several state departments to support the development of the clean hydrogen economy. The state also entered the Western Interstate Hydrogen Hub Coalition (WISHH) to apply for funding under the DOE's Regional Clean Hydrogen Hubs program.

However, some challenges with the widespread use of H2 remain. First, the WISHH program was not selected by DOE as one of the hydrogen hubs they will fund. Second, green hydrogen production requires about 5-8 gallons of water per kg of H2 or approximately 149 – 238 gallons per MWh of electricity from hydrogen (Ramirez, et al. 2023). While this would not constitute a large amount of water even if thousands of MWh's of electricity storage from hydrogen is required, it may be difficult in such a water-scarce state to secure these water rights. Third, guidance from U.S. Treasury regarding qualifications for the H2 subsidy indicates that H2 producers will have to procure zero-emissions electricity from generators that is local, time-matching the H2 consumption, and comes from generators that are "additional" (i.e. generators who are generating power for H2 producers that otherwise would not have been generated). These requirements may make projects uneconomic for many H2 producers. Finally, additional infrastructure will be needed to transport and/or store the H2. Beyond the costs of the physical assets needed to transport/store, this infrastructure will likely have to pass the same regulatory and permitting thicket that has hampered other energy infrastructure investments. Streamlining these regulatory processes at multiple levels of government will be required for timely deployment.

Beyond utilizing VREs with expanded storage and transmission (discussed below), clean energy goals can also be met by using other, more dispatchable, zero-emission sources. Geothermal energy may serve a role in the state's clean energy future. New Mexico already has a small geothermal plant (Lightning Dock, 14.5 MW capacity), has considerable geothermal resources in the central and southern parts the state, and was an early adopter of state-level policy with the 2016 Geothermal Resource Development Act. Geothermal power plants will also be eligible for either PTC or ITC under the IRA and the IIJA provides competitive grant opportunities for pilot geothermal energy demonstration projects.

Small modular reactors (SMR) are another source of zero-emissions power generation, harnessing advances in nuclear power, that is heavily supported under the IRA and IIJA. The DOE recently announced a notice of intent to fund up to $900 million to support the initial U.S. deployments of SMR technologies. In addition, beginning in 2025, the ITC and PTC subsidies initially made available to wind and solar generation become technology neutral, meaning other non-emitting generation sources, including nuclear generation, are eligible for these credits. As New Mexico has among the largest reserves of uranium in the country, SMRs may be a viable part of the state's clean energy portfolio, providing dispatchable power and alleviating some of the need for LDES. However, nuclear waste remains an issue. Recent research suggests waste from SMRs may be substantially more than traditional light water reactors (Krall, Macfarlane and Ewing 2022).

Using traditional thermal generators with combined carbon capture, utilization, and storage (CCUS) may also provide an opportunity for the state to meet its 100 percent zero-emissions electricity production goals while still providing dispatchability. The IRA offers an appealing extension and set of enhancements to the existing 45Q tax credit system. Notably, the IRA increases the per-ton-CO2-capture subsidies from $35 to $60 for captured CO2 used in enhanced oil recovery (EOR) and from $50 to $85 for non-EOR sequestered CO2. The IRA also dramatically reduced the quantity of CO2 that must be captured to be eligible for the credit and for more flexibility in the transferability of the tax credit, including some direct pay options (Goddard 2023). That written, CCUS has thus far failed to take a foothold beyond a few demonstration projects in the US. Thus, while New Mexico is well-poised to take advantage of EOR-based subsidies given the oil and gas activities in the Permian, CCUS is still in many respects in a developmental stage and uncertainty regarding deployment of CCUS plants remains. For example, New Mexico Tech was awarded a DOE grant, funded under the IIJA, to perform a site characterization study of three storage sites within San Juan Basin to facilitate storage of carbon emissions from the Four Corners power plant. Given this is a characterization study, it is clear that actually implementing a CO2 storage system for Four Corners would likely be many years from now, if deemed feasible at all.

The primary concern with relying upon some set of these LDES or more dispatchable low- to zero-emissions technologies is that many of these technologies are not currently in widespread use so costs and scalability remains quite uncertain. For example, the OECD Nuclear Energy Agency reports only three operating SMRs globally, while nationally there is only 116 MW of hydrogen electrolyzer capacity (Hubert and Arjona 2024), 16 commercial-scale CCUS projects (Anchondo 2024), and geothermal plants produce less than 0.5% of total US electricity.[6]. As a result, while the studies examining pathways to zero-emissions energy share many general features (i.e. build more wind/solar/batteries, deploy some LDES and dispatchable low-emission capacity), the levels of these deployments across technologies varies across studies (Bistline 2021). Additionally, from a practical and regulatory standpoint, there are challenges with progressing nascent-technology projects. First, at the planning stage, there is difficulty assessing the value of these newer technologies within an IRP context give the uncertainty in performance and costs. Request for Information are often used by utilities to just gain a sense of what the

[6] Geothermal production data is based on the author's calculations using data from EIA' electricity browser at https://www.eia.gov/electricity/data/browser/.

technological landscape looks like and what the potential cost range may be.[7] At the implementation stage, compliance under the state's RPS requires utilities to select resources through a competitive procurement process. This would require these nascent technologies to that fall not only below the "reasonable cost threshold" ($60/MWh plus inflation adders), but also be below bids submitted by more established zero-emission sources (i.e. wind and solar). Given the long lead-time of many of these technologies, it may be many years before they are able to submit competitive bids and then actually be constructed.

In light of these uncertainties, more recent modeling results highlight the need to maintain existing natural gas generation to both further reduce coal-fired generation and provide grid balancing support to VRE's (Bistline and Young 2022). The role of natural gas generation in the energy transition is also evolving given the sustained low natural gas prices and increasing financing costs. For example, the net-zero-emissions by 2050 pathway analysis by Princeton's REPEAT Lab in 2023 (Jenkins, Schivley, et al. 2023) showed natural gas generation without CCUS declining from 2024 – 2035, while its 2024 update to the analysis (Jenkins, Farbes and Jones 2024) shows increasing natural gas generation and capacity over the 2024-2035 period.

The need to develop and deploy LDES and/or low-emission dispatchable technologies has become all the more pressing given recent updates to electricity demand forecasts.[8] Given this, it remains likely that New Mexico will need its existing natural gas generation capacity over the coming decade. In addition, of the state's existing gas capacity about 18% is slated to retire in the coming decade and over 30% of the capacity is already 25 years or older. Thus, just maintaining the existing MWs of existing capacity will require approval of new gas generation.[9] What remains to be seen is if sufficient advancements will be made to LDES, CCUS, and other dispatchable zero-emission sources such that the state's IOUs and REDCs can meet its 2045 clean electricity goals in a manner that satisfies the ETA's mandate to "maintain and protect the safety, reliable operation and balancing of loads and resources on the electric system" and "prevent unreasonable impacts to customer electricity bills."

V. Transmission

While VRE, complementing energy storage, and/or dispatchable zero-emissions generators will clearly be needed to reach the ETA's clean energy targets, physically incorporating these resources in a way that ensures reliability and maximizes the value of these resources will require

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[7] Both SPS and PNM have recently issued RFIs for long-duration storage and other long-lead time emerging dispatchable resources.
[8] For example, Wilson and Zimmerman (2023) find that grid planners' forecasts of 5-year load growth went from 2.6% in 2022 to 4.7% in 2023. They found this load growth adjustment was particularly large in the Southwest region. Furthermore, they found this demand growth is driven largely by updates in power needed for data centers and other industrial users.
[9] These calculations are based on data reported in the EIA's 860m report for July 2024.

transmission upgrades and expansion. New Mexico is, of course, not alone in this need for expanded transmission. The DOE's transmission needs study indicates that the US will need a 64 percent increase in within-region transmission and a 114 percent increase in interregional transfer capacity by 2035, under a moderate load growth and high clean energy deployment scenario (United States Department of Energy 2023). Likewise, Princeton University REPEAT Lab's analysis of the IRA suggest that the law, along with other incentives in place, will drive U.S. greenhouse gas emissions to about 40 percent below 2005 levels by 2035 (Jenkins, Schivley, et al. 2023), but this value is contingent on electricity transmission networks growing at an annual rate that is more than double what it has been over the last decade (J. D. Jenkins, J. Farbes, et al. 2022).[10]

Department of Energy (2023) notes the primary reasons for transmission expansion in the Southwest region is to alleviate unscheduled flows, particularly between northern New Mexico and Southern Colorado, and to alleviate transfer capacity limits to Texas (both Southwest Power Pool and ERCOT components of Texas).[11] Indeed, the study finds a need for a 41 percent increase in transmission capacity between the Mountain region (primarily consisting of Colorado, Utah, Nevada, Wyoming) and the Southwest and a 914 percent increase in the transfer capacity between the Southwest and Plains region, which is largely made up of the Southwest Power Pool region including parts of eastern New Mexico and north Texas. Beyond congestion and unscheduled flow alleviation, building in these corridors was also cited as needed to provide greater reliability and resiliency in the face of the increasing likelihood of extreme weather events and wildfires.

As a result of these identified needs, DOE recently announced that two of the 10 National Interest Electric Transmission Corridors (NIETC) that have been proposed have portions in New Mexico. The Mountain-Plains-Southwest NIETC would increase transmission from Colorado to New Mexico and include portions of Texas.[12] The Plains-Southwest corridor runs from central New Mexico to southwest Kansas, cutting across northern Texas and the panhandle of Oklahoma. Designation as an NIETC opens federal funding and financing under the IIJA and IRA. It also

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[10] The study finds an average 2.3 percent annual growth rate of high voltage transmission capacity is needed to reach the approximate 40 percent emissions reduction value by 2035. Over the last decade, average annual growth, measured in GW-miles, of the U.S. high-voltage transmission capacity has been about 1 percent. At a 1 percent transmission growth rate, the study finds the IRA will deliver emission reductions (relative to 2005 levels) of about 30 percent, which is only slightly more emission reductions than the scenario with no IRA (27 percent emission reductions).

[11] The U.S. electricity grid is divided into three major regions: the eastern interconnection, the western interconnection, and the Texas interconnected system. While there can, and often is, congestion of power flows within these regions, transfer of power across the major interconnections is relatively even more limited.

[12] More specifically, the Mountains-Plains-Southwest corridor is proposed to from southern Colorado along the eastern part of New Mexico/northern Texas, which is in the DOE's Plains planning region, ending in south-central New Mexico, which is in the Southwest region. See https://www.energy.gov/gdo/national-interest-electric-transmission-corridor-designation-process for details.

increases the Federal Energy Regulatory Commission's (FERC) permitting authority in cases where states lack authority or have failed to move on applications to site a line (Howland 2024).

In addition to the need for interregional transmission, Southwest regional transmission, particularly in New Mexico, will need to grow to accommodate growing loads and dramatic increases in renewable generation. Indeed, according to data compiled by researchers at Lawrence Berkeley National Lab, New Mexico ranked ninth among all states in terms of capacity of active projects in the interconnection queue as of the end of 2023 (Rand, et al. 2024). An expanded Southwest transmission network, coupled with grid upgrades, will help facilitate these generation resources waiting for interconnections.

While the need for expanded transmission is apparent for both New Mexico and the nation as a whole, there are several barriers to building this infrastructure. Davis, Hausman and Rose (2023) note five issues in particular. First, historically, the US electricity grid a fragmented system of largely disconnected utilities that built relatively local transmission networks to connect their generating plants with load centers. The system was not designed with the need to connect and coordinate generation and load across large (interstate) regions. The rise of Independent System Operators (ISOs)/Regional Transmission Organizatons (RTOs), organizations that facilitate wholesale electricity markets across larger geographic regions and oversee transmission planning and investment decisions, help rectify some of these utility-siloing issues. However, there are still over 50 balancing authorities, system operators responsible for managing the power flows and operating criteria for the synchronized networks to which they are connected, for the contiguous U.S.[13]

Second, transmission creates winners and losers as more transmission effectively moves power from low-cost production areas to higher-cost production areas. As a result, ratepayers in renewables-rich regions, which typically have low costs of electricity production, may oppose transmission for fear that their cheap renewable power will be exported. Likewise, those owning generating resources in higher-cost regions may oppose more transmission that could facilitate the importing of cheaper power. This is more than a hypothetical. For example, the proposed New England Clean Energy Connect transmission project, which would have facilitated imports from low-cost Canadian hydropower plants into Massachusetts (ISO-New England), was upended by an anti-transmission ballot initiative in Maine. That initiative was heavily funded by owners of generating assets in ISO-New England (Iaconangelo 2021).

Third, there are construction cost and cost-allocation issues. Davis, Hausman, and Rose (2023) note that transmission lines are costly, in the millions of dollars per mile range, and, unlike renewables and batteries, there is no evidence these costs have declined over time. In addition, even if the financing for a line is possible, allocating costs to the line beneficiaries is not a simple task. Given the interconnectedness of regional networks, new transmission lines can provide

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[13] See https://www.eia.gov/electricity/gridmonitor/dashboard/electric_overview/US48/US48 for a map of these balancing authority regions.

congestion and reliability benefits to more than those directly connecting to the line. This makes transmission lines somewhat like a public good and, thus, opens the door for free-riding, resulting in an under-provision of the good.

Additionally, there are many local siting and permitting challenges, along with opposition from landowners, that need to be overcome to begin construction. Transmission builders must gain authorization from many federal, state, and local authorities, as well as need to negotiate with landowners over access rights and easement payments. All of these approvals are time-consuming and costly. An example of this action can be seen in the Grain Belt Express transmission line that is to deliver power from western Kansas to Illinois. The project was delayed by Missouri agricultural groups and politicians, finally gaining approval from the state's Public Service Commission after the project's plans were altered such that Missouri would receive more power from the line and that future lines would grant greater easement payments to affected landowners (Kite 2023).

Some of these issues are being addressed at the federal level and by actions at the state level in New Mexico. At the federal level, FERC recently announced Order 1920, which addresses various aspects of long-term regional planning, inter-regional transmission planning, and cost-allocation issues. Some of the highlights of Order 1920 include necessitating transmission operators to produce 20-year regional transmission plans (up from standard 10-year plans), requiring transmission developers to have a six-month "engagement period" with relevant state entities for the purpose of developing a cost-allocation method and requiring transmission providers to share more information with interregional transmission coordinating bodies and identify interregional projects that may more efficiently meet a region's long-term needs than regional projects alone.

At the state level, New Mexico has taken several steps to better facilitate transmission and general grid modernization. Importantly, the state established the Renewable Energy Transmission Authority (RETA) in 2007. RETA is unique to many states in that it has transmission siting authority, bond-issuing capabilities, and requirements that RETA-sponsored projects be powered by certain levels of renewable energy. RETA has sponsored two completed major transmission projects, with several more in development, including three multi-100-mile-long proposed transmission lines that will better connect the state with western U.S. energy markets. The state also passed the Energy Grid Modernization Roadmap Act in 2020, which helps support stakeholder convening efforts and grid modernization pilot projects. The PRC also updated interconnection rules in 2022 which significantly modernized the process of interconnection for distributed energy resources.

VI. An Alternative to Large Infrastructure - Demand Side Conservation and Responsiveness

While there is a clear need to add zero-emissions generation sources, energy storage, and transmission assets in order to meet the objectives of the ETA, demand-side interventions can also play a critical role. Demand-side interventions can broadly be classified into demand responsiveness and energy efficiency. Demand responsiveness encourages consumers to alter consumption patterns in ways that discourage energy consumption during high-cost/high-demand periods and move consumption to periods of low-cost/low-demand. Energy efficiency can lower overall energy needs while retaining the same energy services. Both increased demand responsiveness and energy efficiency can reduce the need for energy generation capacity, storage, and transmission.

Economically efficient electricity consumption, which maximizes the difference between consumer welfare and full production costs, requires consumers (and producers) to face prices that reflect the true marginal cost of supply (Borenstein and Bushnell 2022). With greater reliance on VREs, the marginal cost of electricity is likely to be much more volatile (Mallapragadaa, et al. 2021). However, electricity consumers rarely see prices that reflect the contemporaneous marginal cost of production. Rather, electricity consumers often face flat, tiered (increasing as consumption increases), or possibly time-of-use (varying by time of day) pricing. Realistically, in the near term, implementing a pricing regime that is fully reflective of contemporaneous marginal costs is infeasible. That written, there are numerous papers in the economics literature that show consumers are responsive to high price signals (e.g. Jessoe and Rapson (2014), Fowlie, Wolfram, et al. (2021), Guo (2023)), which can be valuable in shaving peak loads. Reducing peak loads is key to reducing needs for high-cost, quick-responding supply sources, electricity storage, and/or expanded transmission and distribution.

Another form of incentive-based demand response that has been employed by many utilities, including PNM, is to pay consumers a flat fee to cede control of some energy consuming device(s) to the utility that may curtail energy consumption of that device during peak demand periods. These programs are relatively understudied from an academic perspective, so without further experimentation, it is difficult to judge the relative efficiency and effectiveness of these types of programs relative to dynamic pricing programs. That is, we simply do not know the shape of the curtailable load supply curve and thus cannot judge the cost-effectiveness of expanding these programs.

Energy efficiency has also been promoted as a cost-effective way to lower electricity consumption and reduce the need for energy production infrastructure. However, several studies have shown that energy efficiency updates and energy-related building codes may not provide as much energy savings as engineering estimates suggest they should (e.g. Levinson (2016), Fowlie, Greenstone and Wolfram (2018)). Recent research suggests that more targeted energy efficiency programs, where investments are made using ex-ante predictions of potential energy savings, can greatly improve the energy reductions achieved through efficiency upgrades (Gerarden and Yang (2023), Christensen, et al. (2024)). In addition, research has highlighted that training of the energy efficiency installers matters and may explain about 40 percent of the difference between engineering estimates of energy savings through efficiency upgrades and observed savings (Christensen et al. 2023). This work highlights the need for a well-targeted energy efficiency program, combined with a highly trained workforce, to make energy efficiency programs deliver true energy savings.

VII. Market-based Solutions - Electricity Market Participation

The electricity system in the U.S. can crudely be divided into those areas that belong to RTO/ISO regions and those that do not. In the RTO/ISO regions, a system operator oversees wholesale energy markets and accompanying markets to provide reliability and resource adequacy services. The RTO/ISO also oversees transmission planning across the market area. In the non-ISO/RTO regions, system operations are more directly controlled by the local utility. New Mexico is unique in that SPS in the eastern portion of the state belongs to the Southwest Power Pool (SPP) RTO. Providers in the western half of the state does not formally belong to an RTO. However, PNM and EPE participate in the Western Energy Imbalance Market (EIM) and Tri-State participates in SPP's Western Energy Imbalance Service (WEIS), both of which provide a spot market for wholesale electricity.

The academic literature shows numerous benefits, including increased efficiency and fuel-cost savings for fossil fuel plants (Fabrizio, Rose and Wolfram (2007), Cicala (2015), Chan, et al. (2017)) and gains from trade through reduced use of uneconomic (e.g. out-of-merit-order) plants (Cicala, 2022). More locally, a recent analysis suggests that an RTO consisting of 11 western states (MT, WY, CO, NM, AZ, UT, ID, WA, OR, NV, CA) could collectively produce $1.5 billion in electricity cost savings by 2030 (Energy Strategies, LLC, and Peterson & Associates 2022). Additionally, the bulk of the renewable generation in the U.S. is in ISO/RTO regions. This is in part a geographic coincidence (i.e. it is windy in the mid-continent and ISOs/RTOs are there too), but ISOs/RTOs may also help facilitate renewables by being able to spread the low-cost energy across a wider geographic range (Muro, Rothwell and Saha 2011) and allow greater ease of integration (Hogan 2010).

Despite the numerous documented benefits of ISO/RTO participation, there are many challenges to their creation. To realize the benefits of the ISO/RTO model, there would need to be sufficient participation across the numerous western balancing authorities. Creating such a coalition would likely be time-consuming and costly. Another challenge would be determining a compensation package for existing transmission operators if they were to cede more control of their networks to an ISO/RTO. These costs, and likely many others, would have to be balanced against the relative ease of more deeply integrating and expanding the services of the EIM and WEIS.

VIII. Additional Considerations

REDCs

The IRA provides many incentives to REDCs with respect to clean energy and energy efficiency. Of particular note, REDCs are eligible for direct-pay from PTC/ITC eligible assets. This direct-pay option means that the REDCs can directly receive cash payments for tax credits without relying on a tax-equity partner, as was needed pre-IRA to monetize the credits. The IRA also expanded

USDA's Rural Energy for America Program which supports grants for clean energy infrastructure and energy efficiency projects. This support could provide direct benefits to REDC customers and further help the state achieve its ETA goals.

However, there are challenges that REDCs face in maximizing the benefits of the IRA. As noted, with the exception of KCEC, the state's REDCs are constrained in their ability to pursue clean energy alternatives due to their energy service contracts with their respective G&T Associations. While alternatives to their legacy energy contracts may be cost-effective, up-front contract-exit fees may be too exorbitant for many REDCs.[14]

Competition for the IRA-backed clean-energy/energy-efficiency funding is also extremely high. For example, USDA reports that in the first year of the IRA its Powering Affordable Clean Energy Program (PACE), for which $1 billion in funding was made available, received over $7.6 billion in applications. Given the limited staff of many of the state's REDCs, going after and securing funds through the IRA will be no small feat.

Workforce and Economic Development

Reaching the ETA goals, even in the most cost-effective manner, requires the deployment of a considerable amount of physical capital. This can provide a significant regional development boost.[15] A high-skilled workforce will be essential to deploying this infrastructure in a timely and technically competent manner. Indeed, research suggests that green jobs require higher math and science skills and generally higher levels of education, work experience, and job training than other occupations (Consoli, Marin and Marzucchi (2016), Kochhar (2020), Curtis and Marinescu (2023)). In addition, Popp et al. (2020) found that job creation under green-related America Reinvestment and Recovery Act spending was greater in areas with high pre-existing levels of green skills. Thus, for the state to take advantage of the ETA and IRA/IIJA funding from a local economic development perspective, workforce development is key.

The ETA itself has several apprenticeship requirements and, importantly, re-training provisions for displaced workers from legacy energy producers. The IRA similarly offers higher PTC/ITC values for projects that meet certain apprenticeship requirements and the IIJA has more than 70 programs that allow or encourage workforce development activities (Ross 2024).[16] Additionally, 54 programs across the IIJA and IRA, with funding around $75 billion, emphasize or allow green workforce development activities (Kane, Tomer and Singer 2023). However, this money has many

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[14] KCEC paid Tri-state $37 million in 2016 to exit its energy contract. Exit fees will be considerably more for larger REDCs. For example, the Colorado distribution cooperatives United Power and Delta-Montrose paid $627 million in 2024 and 136.5 million in 2020, respectively, to exit their contracts with Tri-state.

[15] For example, Gilbert et al. (2023) find that the employment benefits of wind generators are primarily captured by those workers living within 20 miles of the given generator.

[16] Meeting apprenticeship requirements also enhances the IRA-created tax credits for the Energy Efficient Commercial Buildings Deduction, Advanced Energy Project Credit, and Alternative Fuel Refueling Property Credit programs.

possible awardees, across many different sub-programs of the acts, with different application requirements, deadlines, and reporting procedures.

The challenge for the state is to provide systems and long-term workforce development strategies to help maximize the local benefits of these federal funding opportunities and ETA-related infrastructure deployment. Based on 2023 Bureau of Labor Statistics data (https://www.bls.gov/lau/ex14tables.htm), New Mexico has the fourth highest unemployment rate for the 25-34 age group (5.2%). Given clean energy jobs employ a higher share of workers under the age of 30 than the national workforce average (U.S. Department of Energy 2024), the ETA and IRA provide an opportunity to expand the state's workforce among a cohort needing additional employment options. Again, however, this hinges on the ability to have a well-trained workforce. It is also worth noting that while clean energy related infrastructure jobs are growing in New Mexico, the state currently employs more in the oil and gas sector than those working in wind, solar, energy efficiency, and transmission/distribution jobs combined (U.S. Department of Energy 2024). Thus, the oil and gas sector remains a vital component of the New Mexico labor market.

IX. Beyond providing employment opportunities for the actual deployment of energy infrastructure, the ETA can possibly be a catalyst for more innovation and economic development. This is an application of the "Porter Hypothesis" (Porter and van der Linde 1995), wherein regions adopting strict environmental regulations spur innovation in green technologies and eventually increase the competitiveness of local firms. Empirically, there is some evidence at the national level that environmental regulation does spur green innovation (Zhang, et al. 2024). There is also correlational evidence in the U.S. that the adoption of an RPS is positively associated with number of green businesses (Yi 2014). On top of this, the IRA and IIJA provide substantial incentives to develop domestic manufacturing of clean-energy related technologies, leading to around $89 billion in clean-energy manufacturing investments nationally over the last two years (Rhodium Group-MIT/CEEPR 2024). Again, having a well-trained workforce that can contribute to this advanced manufacturing sector, along with creating a business environment that is welcoming to the innovative technologies on the horizon, will be key for the state to take advantage of the federal and state policies spurring the clean energy sector.

Policy Recommendations

The passage of the ETA firmly secures New Mexico as a leader in the clean energy transition. Admirably, the state has also progressed a series of policies to support the achievement of the ambitious clean energy targets set forth in the ETA. That written, there are still several actions that State policymakers and industry leaders can take to further meet the ETA goals in an efficient manner.

1. As the state moves toward progressively higher zero-emissions targets, the electricity system will become more reliant on VREs, requiring solutions to deal with energy-to-load surpluses and shortages. In the near term, the issue appears readily addressable with increased battery storage. As these surplus/shortage periods increase in duration, options for ensuring reliable power remain less certain. LDES and dispatchable zero-emissions sources are likely part of the solution. While the IRA and IJJA provide funding opportunities to progress these technologies, there is a role for the state in aiding efforts to secure this government funding and promoting public-private partnerships to deploy new technologies. There will also be a need to maintain the existing natural gas generation capacity, which would require permitting new gas capacity, for the coming decade to ensure reliable and low-cost electricity as these LDES/dispatchable-zero-emission-generators move down the cost curve and demonstrate scalability.
2. Transmission remains a major sticking point for New Mexico and the nation as a whole. The DOE has identified a great need for New Mexico for interconnectivity beyond the state's borders. To that end, there is an opportunity for New Mexico to take a leadership role in convening regional and inter-regional transmission planning. This is particularly clear given that the state straddles interconnects with the west part belonging to WECC and portion of the east belonging to SPP, which is a part of the eastern interconnect, and its proximity to ERCOT. To maximize the value of its renewable resources and ensure greater reliability and resiliency, the state should strive to increase connectivity to other parts of the West, Plains, and ERCOT.
3. Demand-side interventions will be key to achieving the ETA goals efficiently. State regulators should work with IOUs and REDCs to form innovative electricity pricing strategies, enabling more responsive demand. Similarly, regulators should encourage electricity providers to use more data-driven methods of identifying residential, commercial, and industrial users for energy efficiency upgrades.
4. The economics literature has shown that there are numerous benefits from participation in electricity wholesale markets. In addition, the ISO/RTO model provides a more unified approach to planning transmission needs over a large market area. To this end, the state has a role to play in exploring the ISO/RTO options for its utilities or at least toward pushing more involvement in the western energy imbalance market and day-ahead market.
5. REDCs play a critical role in providing power to the state's rural communities. However, with the exception of KCEC, the energy mix that REDCs receive is largely dictated by their contracted G&T associations. As the KCEC experience has shown, exiting these contracts has large upfront costs, but potentially has long-term benefits. There is a role for the state in helping REDCs explore alternatives to their legacy providers and, possibly, financing options for exiting their energy-provision contracts should alternatives prove more cost-

effective. The state can also play a role in helping personnel-constrained REDCs go after and secure the billions in clean energy and energy efficiency incentives offered to REDCs under the IRA/IIJA.

6. A well-trained workforce is essential to carry out the investments needed for energy supply, transmission, and energy efficiency improvements. Additionally, developing a skilled workforce capable of filling the rapidly increasing number of clean energy manufacturing jobs nationwide will be crucial in attracting and retaining these businesses. While the state has already put in motion several actions to train new hires and help retrain workers formerly employed at legacy energy sources, there is a plethora of funding opportunities to enhance these training programs, particularly through the provisions in the IRA/IIJA. The state has a role to play in coordinating efforts to maximize its share of the unprecedented federal funding opportunity, as well as continuing the funding of education centers (e.g. universities and community colleges).

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