USE OF THE SAN JUAN GENERATING STATION TO DEVELOP METRICS TO COMPARE COAL FUELED POWER PLANT JOBS IMPACTS TO THOSE OF RENEWABLES

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For

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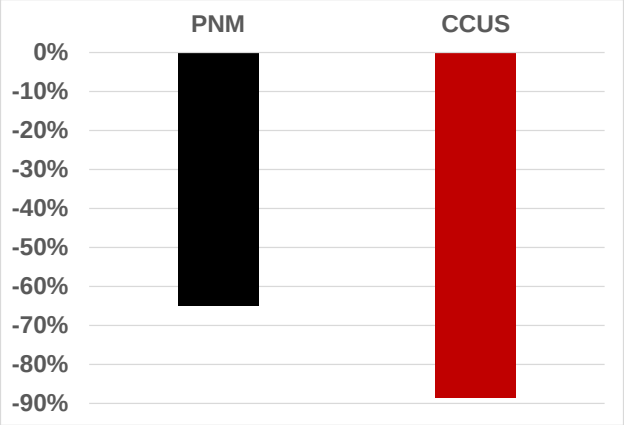
EXECUTIVE SUMMARY

Public Service of New Mexico (PNM) plans to close the San Juan Generating Station (SJGS) and San Juan Mine (SJM) in 2022, while the San Juan community and developer Enchant Energy plan to retrofit the SJGS with carbon capture, utilization, and storage (CCUS) and keep it and the SJM open. In place of the SJGS, PNM proposes to install 500 MW of photovoltaics (PV), 140 MW of wind, and 410 MW of batteries. This research had three major objectives: 1) Estimate the relative impacts of CCUS retrofit of the SJGS compared to its replacement by the PNM renewable energy (RE) scenario; 2) develop metrics that can be used to compare the jobs impacts of coal fueled power plants to those of renewable energy; 3) estimate the impacts on Native Americans of the two scenarios.

Relative Impacts

The CCUS scenario reduces CO_2 emissions by 37% more than the PNM scenario – Figure EX-1.

Figure EX-1: CO_2 Reductions Under Each Scenario

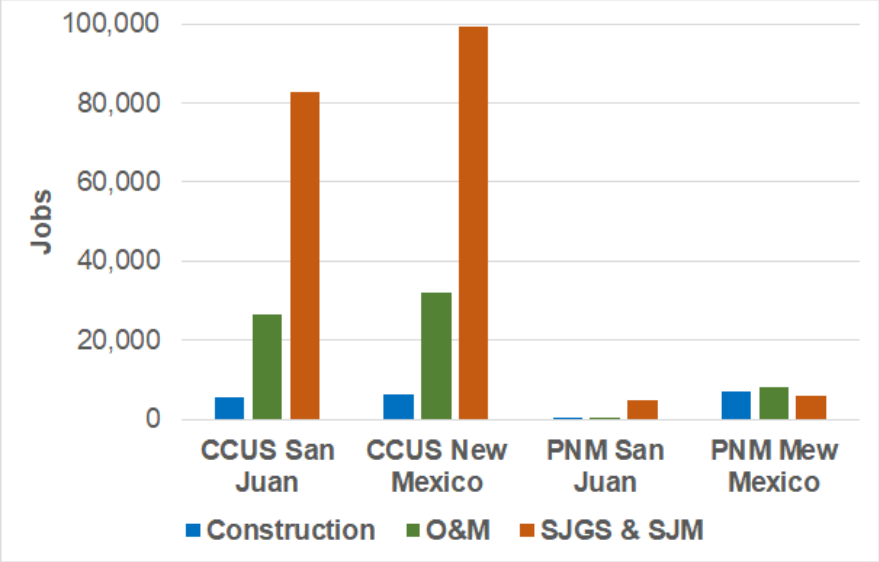


The CCUS scenario avoids economic harm and job losses to the San Juan area and New Mexico and creates large numbers of jobs. Figure EX-2 shows that the CCUS scenario creates significantly more jobs than the PNM scenario. In San Juan County: The CCUS Scenario creates 26 times as many construction jobs; the CCUS Scenario creates 92 times as many O&M jobs; the CCUS Scenario creates 17 times as SJGS and SJM jobs. In New Mexico, compared to the PNM scenario: The CCUS Scenario creates about the same number of construction jobs; the CCUS Scenario creates four times as many O&M jobs; the CCUS Scenario creates more than 16 times as many SJGS & SJM jobs. Over the long term, the CCUS scenario would ensure full employment in San Juan County whereas the PNM scenario would result in over 12% unemployment in the county.

Similar results hold true for the impacts on New Mexico – Figure EX-3: In 2021-2023, the CCUS scenario creates annually in New Mexico, on average, 814 more jobs than the PNM scenario – more than 20% more jobs each year; in 2024 and 2025, the CCUS scenario creates on average, 3,500 more jobs as the PNM scenario – 10 times as many

jobs each year; in years 2026 - 2055, the CCUS scenario creates annually in New Mexico, on average, 3,600 more jobs as the PNM scenario – 14 times as many jobs each year.

Figure EX-2: Total Jobs Created by the Two Scenarios, 2021-2055



<u>The two scenarios have very different impacts on San Juan area tax revenues</u> -- Figure EX-4: 1) Over 2021-2055, the CCUS scenario generates $1.33 billion in total local tax revenues compared to $160 million under the PNM scenario; 2) Over 2021-2055, the CCUS scenario generates $1.17 billion more in local tax revenues than the PNM scenario -- more than eight times as much.

Figure EX-3: Net Difference in Jobs Created Annually in New Mexico by the Two Scenarios

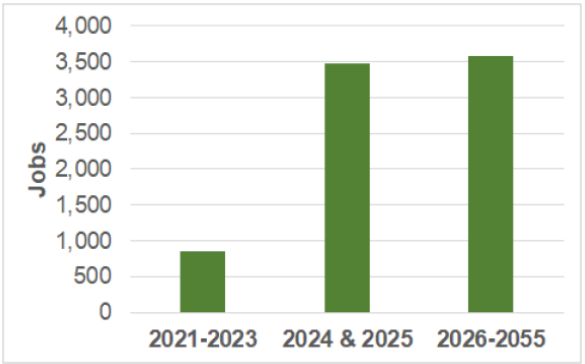
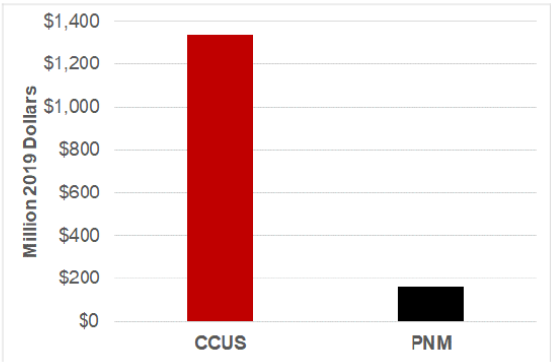


Figure EX-4: Total Local San Juan Tax Revenues, 2021-2025



<u>The CCUS scenario will greatly improve the local San Juan fiscal situation</u>. Since the SJGS and the SJM will not be prematurely retired, they will continue to generate real estate tax revenues and the jobs at the facilities will continue to generate local tax revenues. Under the PNM scenario this would not be the case. Further, the CCUS scenario will also increase San Juan tax revenues: 1) The SJGS and SJM jobs will be maintained and additional CCUS O&M jobs will be created; 2) not only will the SJGS continue in operation, but its assessed valuation will increase substantially.

The CCUS scenario will greatly benefit local schools -- Figures EX-5 and EX-6. The differing impacts of the two scenarios on the tax revenues for San Juan County, the Central Consolidated School District (CCSD), and the San Juan Community College (SJCC) are shown in these figures: 1) During years 2021-2023 of facilities' construction, the CCUS scenario contributes 28% of all tax revenues to the three jurisdictions and the PNM scenario contributes 13%; 2) In 2024 and 2025, when under the PNM scenario SJGS decommissioning is still occurring and severance, job training, and community assistance payments are being made, the PNM scenario contributes 5% of all tax revenues to the three jurisdictions and the CCUS scenario contributes 14%; 3) During years 2026-2055, the CCUS scenario contributes 14% of all tax revenues and the PNM scenario contributes less than 0.5%; 4) long term, the CCUS scenario would annually generate a substantial portion of the tax revenues of San Juan County, the CCSD, and the SJCC, whereas the PNM scenario would generate only a trivial share of the tax revenues; 5) long term, under the PNM scenario the three jurisdictions would have to raise, each year, an additional $35 - $40 million in tax revenues from other sources; 6) long term, under the PNM scenario, jurisdictions would have to raise a total of an additional $1.1 billion - $1.2 billion in tax revenues.

Figure EX-5: Impacts of the Scenarios on the Tax Revenues of San Juan County, the CCSD, and the SJCC

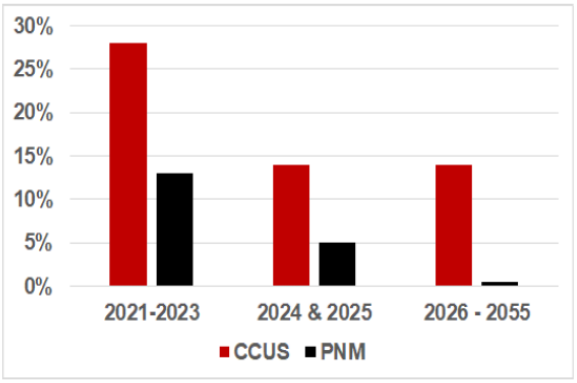
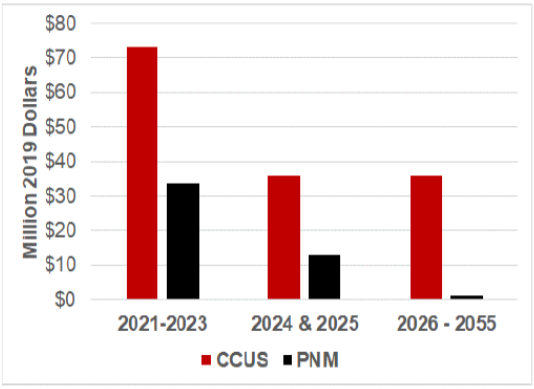


Figure EX-6: Average Annual San Juan Area Tax Revenue Impacts



The increased economic activity and jobs in the San Juan local community under the CCUS scenario will create increased earnings and tax revenues: 1) During the construction phase for the CCUS and the RE facilities, 2021-2023, the CCUS scenario generates over $73 million/yr. in local tax revenues and the PNM scenario generates less than $34 million/yr. Thus, in 2021-2023, the CCUS scenario generates each year more than twice the local tax revenues as does the PNM scenario. 2) In 2024 and 2025, the CCUS scenario generates $36 million/yr. in local tax revenues and the PNM scenario generates $13 million/yr. Thus, in 2024 and 2025, the CCUS scenario generates each year triple the local tax revenues as does the PNM scenario. 3) In 2026- 2055, the CCUS scenario generates $36 million/yr. in local tax revenues and the PNM scenario generates $1.1 million/yr. Thus, in 2026-2055, the CCUS scenario generates each year 33 times more in local tax revenues as does the PNM scenario.

Jobs Metrics

The CCUS scenario results in substantially more jobs/MW than the PNM scenario. Figure EX-7 summarizes the differences in jobs created/MW over 2021-2055 by the two scenarios. In terms of total jobs/MW over this period: 1) in San Juan, the CCUS scenario generates over 135 jobs/MW whereas the PNM scenario generates 5.2 jobs/MW – a 26-fold difference; 2) in New Mexico, the CCUS scenario generates over 162 jobs/MW whereas the PNM scenario generates 20 jobs/MW – an 8-fold difference. In terms of total jobs per MW over this period, excluding jobs from the SJGS and SJM: 1) In San Juan, the CCUS scenario generates 38 jobs/MW whereas the PNM scenario generates 0.48 jobs/MW – a 79X difference; 2) in New Mexico, the CCUS scenario generates 70.6 jobs/MW whereas the PNM scenario generates 10 jobs/MW – a 7-fold difference.

Figure EX-7: Comparison of Total Jobs Per MW, 2021-2055

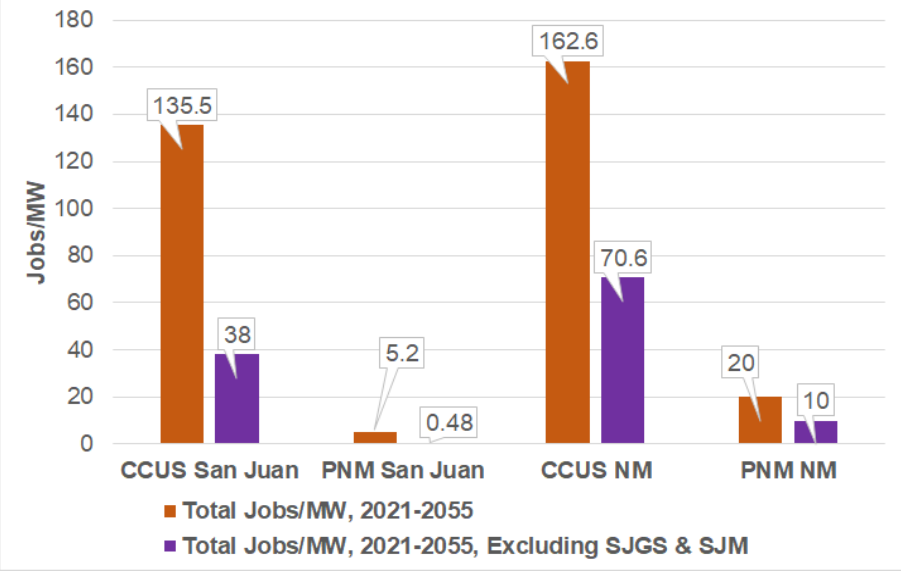


Figure EX-8 shows the differences in jobs/MW over 2021-2055 under the CCUS scenario and the PV portion of the PNM scenario: 1) In San Juan, the CCUS scenario generates over 135 jobs/MW whereas the PV portion of the PNM scenario generates 11.1 jobs/MW – a more than 12-fold difference; 2) in New Mexico, the CCUS scenario generates over 162 jobs/MW whereas the PV portion of the PNM scenario generates 18.4 jobs/MW – a 9-fold difference.

Figure EX-9 shows the differences in jobs/MW over 2021-2055 under the CCUS scenario and the wind portion of the PNM scenario: 1) In San Juan, the CCUS scenario generates over 135 jobs/MW whereas the wind portion of the PNM scenario generates 13.5 jobs/MW – a 10-fold difference; 2) in New Mexico, the CCUS scenario generates over 162 jobs/MW whereas the wind portion of the PNM scenario generates 16.5 jobs/MW – nearly a 10-fold difference.

Figure EX-8: Comparison of Total Jobs Per MW Under the CCUS Scenario and the Photovoltaics Portion of the PNM Scenario, 2021-2055

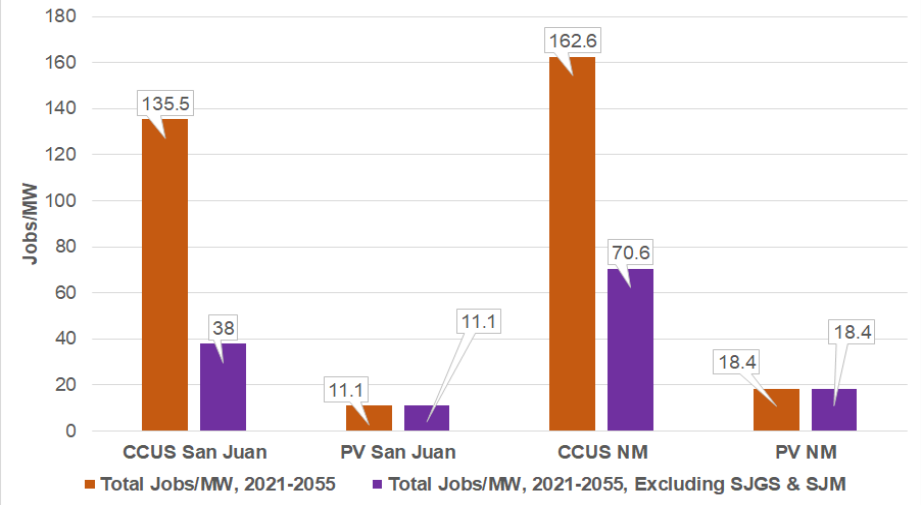
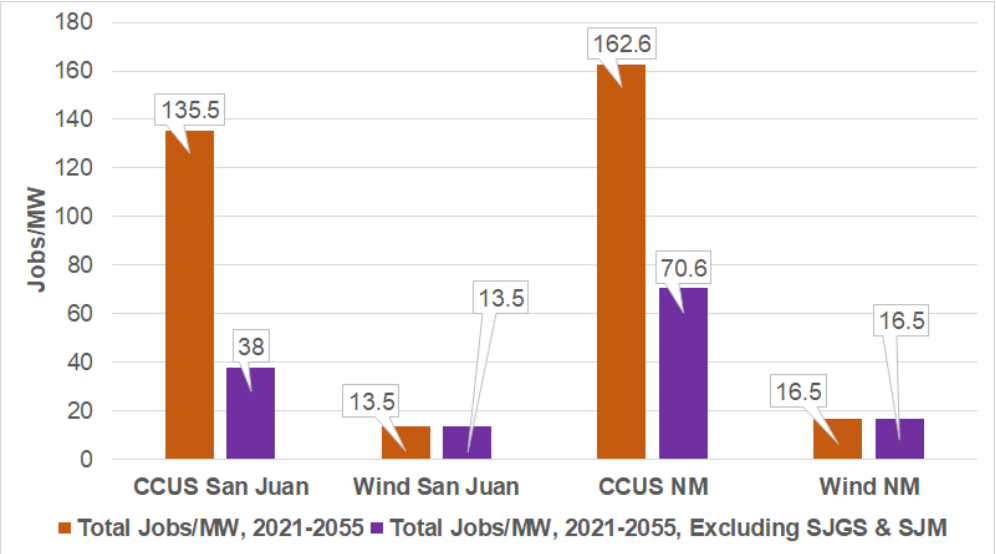


Figure EX-9: Comparison of Total Jobs Per MW Under the CCUS Scenario and the Wind Portion of the PNM Scenario, 2021-2055



In terms of total jobs/MW over this period, excluding jobs from the SJGS and the SJM: 1) In San Juan, the CCUS scenario generates 38 jobs/MW whereas the wind portion of the PNM scenario generates 13.5 jobs/MW; in New Mexico, the CCUS scenario generates 70.6 jobs/MW whereas the wind portion of the PNM scenario generates 16.5 jobs/MW.

Figure EX-10 shows the differences in jobs/MW over 2021-2055 under the CCUS scenario and the batteries portion of the PNM scenario: 1) In San Juan, the CCUS scenario generates over 135 jobs/MW whereas the batteries portion of the PNM scenario generates 8.6 jobs/MW – a 16-fold difference; 2) in New Mexico, the CCUS scenario generates 162 jobs/MW whereas the batteries portion of the PNM scenario generates 8.9 jobs/MW – an 18-fold difference. In terms of total jobs/MW over this period, excluding jobs from the SJGS and the SJM: 1) In San Juan, the CCUS scenario generates 38

jobs/MW whereas the batteries portion of the PNM scenario generates 8.6 jobs/MW; 2) in New Mexico, the CCUS scenario generates 70.6 jobs/MW whereas the batteries portion of the PNM scenario generates 8.9 jobs/MW – an 8-fold difference.

Figure EX-10: Comparison of Total Jobs Per MW Under the CCUS Scenario and the Batteries Portion of the PNM Scenario, 2021-2055

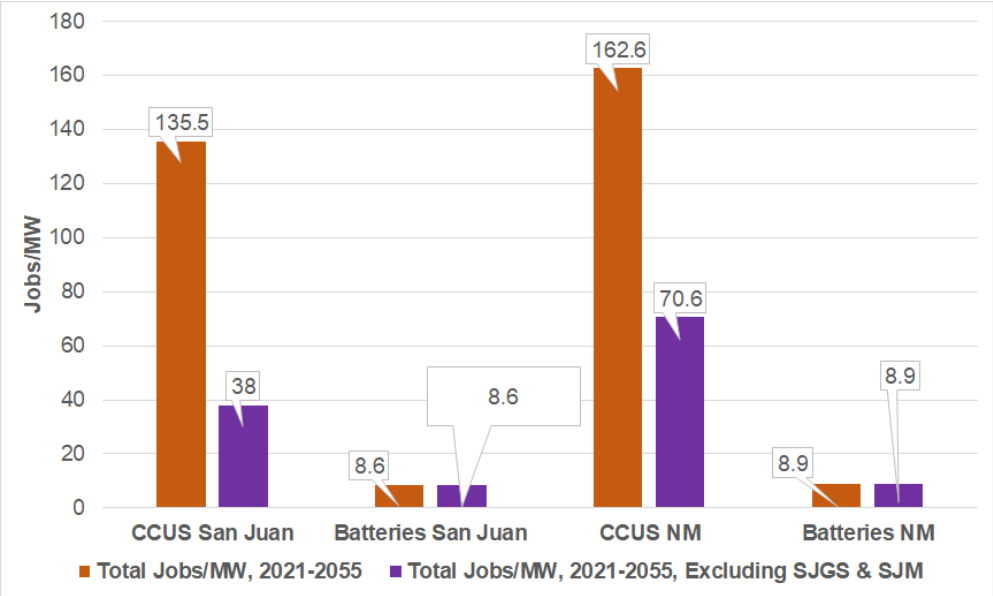
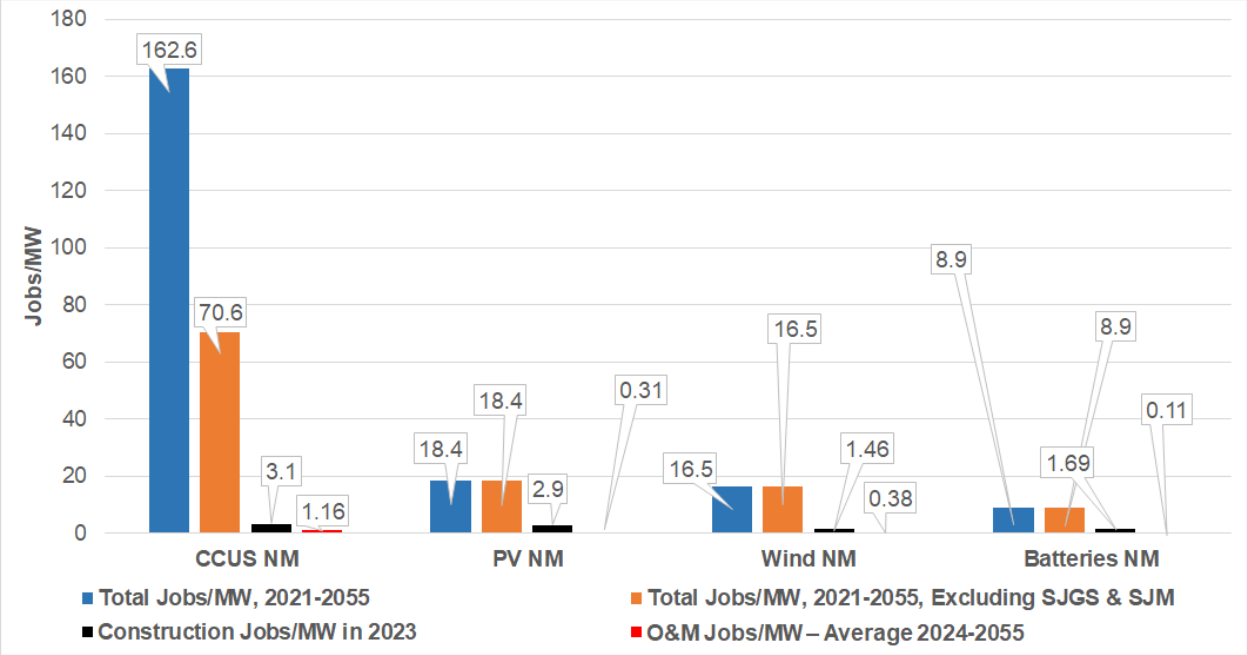


Figure EX-11 presents a summary comparison of jobs/MW in New Mexico under the CCUS scenario and the wind, photovoltaic, and batteries portions of the PNM scenario. In terms of total jobs/MW in New Mexico, 2021-2055, the CCUS scenario generates: 1) Nearly nine times as many jobs/MW as the photovoltaics portion of the PNM scenario; 2) nearly 10 times as many jobs/MW as the wind portion of the PNM scenario; 3) more than 19 times as many jobs/MW as the batteries portion of the PNM scenario. Figure EX-11 shows that in terms of total jobs/MW, 2021-2055, excluding jobs from SJGS and SJM, the CCUS scenario generates: 1) Nearly four times as many jobs/MW as the photovoltaics portion of the PNM scenario; 2) more than four times as many jobs/MW as the wind portion of the PNM scenario; 3) more than eight times as many jobs/MW as the batteries portion of the PNM scenario. Figure EX-11 shows that in terms of total jobs/MW generated by construction in 2023 – the year of maximum construction, the CCUS scenario generates: 1) 7% more jobs/MW as the PV portion of the PNM scenario; 2) more than twice as many jobs/MW as the wind portion of the PNM scenario; 3) nearly twice as many jobs/MW as the batteries portion of the PNM scenario. Figure EX-11 shows that in terms of O&M jobs/MW over 2024-2055, the CCUS scenario generates: 1) four times as many jobs/MW as the PV portion of the PNM scenario; 2) more than three times as many jobs/MW as the wind portion of the PNM scenario; 3) more than 10 times as many jobs as/MW the batteries portion of the PNM scenario

Figure EX-11: Comparison of Jobs Per MW in New Mexico Under the CCUS Scenario and the Wind, Photovoltaic, and Batteries Portions of the PNM Scenario



We thus conclude that, **irrespective of the comparison, the CCUS scenario generates substantially more jobs/MW than does the PNM option or any of the RE components of the PNM option – both in San Juan and in New Mexico**. There is no appropriate comparison in which the PNM scenario, or any of its RE components, generates more jobs/MW than does the CCUS scenario – in either San Juan or in New Mexico. This holds true whether we are measuring the jobs/MW created by each scenario, by each scenario excluding the jobs impacts of SJGS and SJM, the construction portions of the scenarios, or the O&M portions of the scenarios. Specifically, here we derived 68 individual comparisons. In two of these cases, the jobs/MW advantage of the CCUS option was between 4% and 7%. In all of the other 66 comparison cases the jobs/MW advantages of the CCUS option were huge – often orders of magnitude. Thus, the CCUS scenario will generate many more jobs/MW than the PNM scenario or the RE components of the PNM scenario – both in local San Juan and New Mexico.

Metric comparisons between the CCUS and PNM scenarios are complicated due to basic RE problems: 1) Since RE is intermittent and unreliable, metric comparisons with dispatchable coal plants are not valid; 2) required backup to RE, such as batteries, are inefficient, cost prohibitive, and unreliable; 3) the costs of RE technologies are vastly underestimated due to their inherent non-dispatchability and imbedded subsidies and mandates; 4) There are intractable problems with RE technologies such as wind that render them infeasible as large scale, dependable, dispatchable energy alternatives.

Impacts on Native Americans

"It is truly an injustice that this is happening in the United States of America." *Joe Seidenberg, Executive Director, Red Feather Development Group, commenting on the devastating economic impacts on Native Americans of coal facility closures in Arizona and New Mexico.*

The Hopi and Navajo suffer from extreme economic deprivation and poverty; both tribes are dependent on their abundant coal resources as the backbone of their local economies; both have been significantly impacted by the closure of the NGS and the Kayenta Mine and will be further impacted if SJGS and SJM close.

Closure of the SJM would result in a serious public health crisis for the Navajo and Hopis. Navajo and Hopi families have long relied on subsidized coal to heat their homes, but now must rely on the SJM after the Kayenta Mine closed in 2019. If the SJM closes, they will have no source of coal to heat their homes. This will result in significant hardship and health problems for Native Americans.

The CCUS scenario will provide many more jobs for Native Americans – primarily Navajos[1] -- than the PNM scenario. Figure EX-12 shows the average annual net differences in jobs created for San Juan Navajos between the CCUS scenario and the PNM scenario: 1) During the construction phases of the CCUS and the RE facilities, 2021-2023, the average annual net Navajo job gain under the CCUS scenario compared to the PNM scenario is 1,270 jobs; 2) in 2024 and 2025, when under the PNM scenario the SJGS and SJM are closed and are being decommissioned, the net average annual Navajo job gain under the CCUS scenario compared to the PNM scenario is 1,550 jobs; 3) During 2026 - 2055, when under the PNM scenario the SJGS and SJM are closed and decommissioning has been completed, the net average annual Navajo job gain under the CCUS scenario is 1,600 jobs/yr.; over 2021-2055, the CCUS scenario creates a net average of 1,560 more Navajo jobs/yr. than the PNM scenario

The CCUS scenario would result in enormous increases in wages and benefits for Navajos. Figure EX-13 shows the average annual net differences in wages and benefits created for San Juan Navajos between the CCUS scenario and the PNM scenario: 1) During the construction phases, 2021-2023, the average annual net Navajo wages and benefits gain under the CCUS scenario compared to the PNM scenario is $61.1 million/yr.; 2) in 2024 and 2025, the net average annual Navajo wages and benefits gain under the CCUS scenario is $74.5 million/yr.; 3) during 2026-2055, the net average annual Navajo wages and benefits gain under the CCUS scenario is $75.2 million; 4) over the period 2021-2055, the CCUS scenario creates a total of $2.6 billion more Navajo wages and benefits.

The economic alternatives proposed for Native Americans, such as tourism, native arts and crafts, RE projects, etc. are not promising. One of the few viable alternatives is a programs to train the skilled workforce required for the ongoing operation of SJGS with the planned CCUS and future carbon capture facilities.

[1]Relatively few Hopi work at the SJGS or SJM because it is 150 miles from the Hopi reservation.

Figure EX-12: Average Annual Net Job Differences For San Juan Navajos Between the Two Scenarios

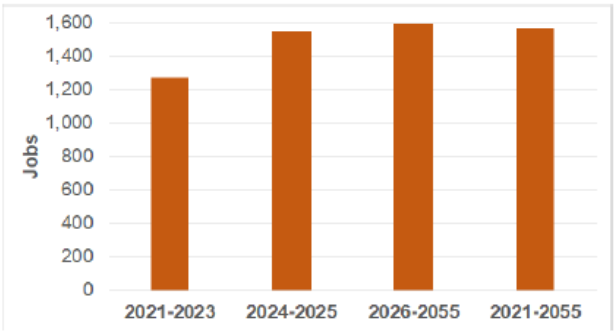
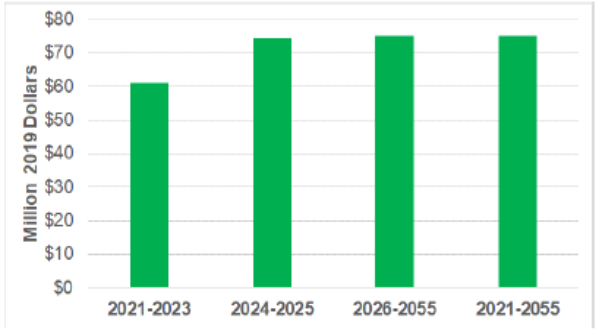


Figure EX-13: Average Annual Net Differences in Wages and Benefits Created For San Juan Navajos By the Two Scenarios



Basic Conclusions Concerning CCUS v Renewables

The basic conclusion derived here is that the CCUS retrofit scenario is greatly preferable to the PNM RE scenario: 1) It provides much greater economic and jobs benefits for San Juan and for New Mexico; 2) it produces greater CO_2 emissions reductions than the PNM scenario; 3) It preserves and expands San Juan tax revenues; 4) it represents the difference in San Juan between full employment and double-digit unemployment; 5) it preserves and expands well-paying jobs for Native Americans – in an area where there are few such jobs; 6) it preservers and expands revenues for Native American tribes – who have few other revenue sources; 7) it prevents a public health crisis for the Navajo and Hopi by retaining their supply of critically required coal for home heating; 8) on the basis of every job metric, including total jobs/MW, construction jobs/MW, and O&M jobs/MW, the CCUS scenario generates many more jobs per MW than the PNM scenario -- in both San Juan and in New Mexico.

If the SJGS closes, the implications for the San Juan area and for Native Americans are ominous: Their historically stable source of well-paying jobs and revenues will disappear. Thus, CCUS may be the key to San Juan's and New Mexico's future and can be a win-win. This report has documented the immense long term economic and job benefits that CCUS retrofits of the SJGS will have for the state and for local communities. The SJGS CCUS retrofit will establish San Juan and New Mexico as a world leader in the technology. This will pay large and increasing dividends to the San Juan area, to Native Americans, and to the state as CCUS becomes established as one of the dominant energy technologies of the 21st century.

I. INTRODUCTION: THE ISSUE

DOE is interested in development of metrics that can be used to compare the economic and jobs impacts of coal fueled power plants to those of renewable energy -- for example, "Jobs per MW." This could be used to assess the economic and job implications of replacing coal power generation with renewables. Accordingly, such a metric would be able to estimate the CAPEX and O&M jobs and other variables associated with replacing coal power plants with solar, wind, and other renewable energy (RE) technologies.

This is currently a relevant and controversial issue, and there is much debate over the relative economic and job impacts of renewables and fossil fuels. Further, many states and cities have legislated mandates to increase the share of renewables and to reduce or terminate electricity generation from coal power plants, and are in the process of implementing these mandates. At present:[2]

- 29 States and D.C. have a Renewable Portfolio Standard.
- Three states have a Clean Energy Standard.
- Eight states have renewable portfolio goals.
- Two states have clean energy goals.

In addition, distributed energy compensation policies exists in some form in 45 states, and 38 states have some form of net energy metering.[3] Net metering is another form of subsidy for renewables since excess renewable electricity is sold back to the utility at a price far higher than the cost of wholesale electricity. The utility is required to maintain power lines and maintain excess generating capacity to supply electricity if it is cloudy, is nighttime, or the wind is not blowing.

The issue is also both timely and pressing. For example, within the past year two of the largest U.S. coal power plants have been closed or scheduled for closing and are to be replaced largely by renewables: The Navajo Generating Station (NGS) in Arizona and the San Juan Generating Station (SJGS) in New Mexico.

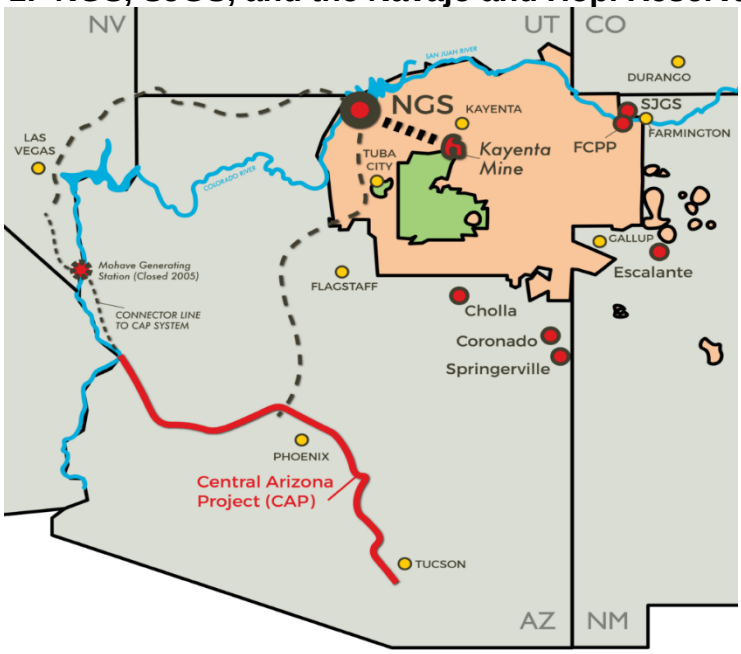
The NGS was a 2,250 MW coal plant located on the Navajo Nation, near Page, Arizona – Figure 1. The plant provided electric power to customers in Arizona, Nevada, and California and provided the power for pumping Colorado River water for the Central Arizona Project, supplying water to central and southern Arizona. In 2017, the utility operators of the power station voted to close the facility in 2019. In March 2019, the Navajo Nation ended efforts to buy the plant and continue running it after the lease expires, and in November 2019 the plant ceased commercial generation.[4] Closure of the

[2]"Renewable & Clean Energy Standards," https://s3.amazonaws.com/ncsolarcen-prod/wp-content/uploads/ 2019/07/RPS-CES-June2019.pdf.
[3]Solar Energy Industries Association, "Net Metering," https://www.seia.org/initiatives/net-metering.
[4]Katherine Locke, "Navajo Generating Station Shuts Down Permanently," *Navajo-Hopi Observer*, November 18, 2019.

NGS and the associated Kayenta coal mine was a devastating blow to the Navajos and the Hopis and resulted in the loss of:[5]

- Over 3,000 jobs.
- Over $500 million in Gross Navajo Nation Product.
- $240 million in labor income.
- A large portion of the local tax revenues.

Figure 1: NGS, SJGS, and the Navajo and Hopi Reservations*



*The Hopi Reservation, in Green, is surrounded by the Navajo Reservation, Peach colored.

Even more timely and controversial, Public Service Company of New Mexico (PNM) has proposed to close the 847 MW SJGS, and, effectively, the San Juan Mine (SJM) -- one of the largest underground coal mines in the world -- in 2022. The PNM Integrated Resource Plan (IRP), filed with the New Mexico Public Regulation Commission (NMPRC) in July 2017 presents a road map for PNM to eliminate all coal-fired generation by 2031.[6] Highlights of the IRP include the retirement of the remaining units at SJGS and the exit by PNM from its 13% participation in the Four Corners Power Plant when the existing coal-supply agreement expires in 2031. The plan includes significant solar and wind energy additions along with the potential for battery storage capacity as replacement power and to support load growth over the course of the 20-year planning horizon.[7]

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[5]Cindy Yurth, "2018: Year of Schism," *Navajo Times*, December 27, 2018; Ryan Randazzo and Noel Lyn Smith, "Navajo Nation Votes to End Efforts to Purchase Coal-Fired Power Plant, Sealing Its Fate," *Arizona Republic*, March 22, 2019.

[6]https://www.pnmforwardtogether.com/irp.

[7]Ibid. "Update on San Juan Generating Station and the New Mexico Public Regulation Commission Hearing," *Farmington Spotlight*, February 1, 2019.

The fate of the SJGS appeared sealed in 2018 when New Mexico regulators unanimously accepted PNM's IRP, which recommended closing SJGS in 2022 – 30 years ahead of schedule, and a complete exit from coal by 2031.[8] However, in February 2019 the city of Farmington, New Mexico, where the SJGS is located, announced that it had found a way to keep the plant operating using carbon capture, utilization, and storage (CCUS).[9] The city stated that it had reached an agreement with Acme Equities LLC to keep the plant open beyond 2022.[10] At present, the issue of the continued operation of SJGS and SJM is the subject of intense debate between environmentalists, renewable energy advocates, state and local government officials, and Native Americans – who operate the plant and the mine.[11] The SJGS is supplied with coal from the nearby San Juan underground mine. Efforts to keep SJGS open failed, and the final decision to close it was made in April 2020 at a contentious NMPRC meeting.[12] Nevertheless, Native Americans and the city of Farmington continue in their efforts to keep SJGS operating with CCUS.

The City of Farmington has been a minority owner of SJGS for four decades. Farmington will be the only remaining owner after 2022, and thereby has obtained the rights to market 100% of SJGS.[13] The city notes that over the past 10 years the owners of SJGS have invested over $600 million dollars in pollution control equipment. Combined with closing 2 of the 4 units, SJGS has achieved a 60% reduction in criteria pollutants, bringing the plant into compliance with President Obama's 2015 proposed Clean Power Plan (CPP). The remaining problem is CO_2 emissions, and SJGS generates approximately 2,000 pounds of CO_2/MWh. The installation of CCUS technology will reduce CO_2 emissions by 90% to an estimated 218 lbs. CO_2/MWh.[14]

SJGS was recently retrofitted with $635 million of pollution control equipment and, as noted, along with the closure of 2 of 4 units, brought the plant into compliance with the stringent emissions standards proposed in the CPP. In fact, SJGS has lowered its overall emissions by over 60% and is one of the cleanest and most technologically sound coal

[8]PNM Resources, Inc., "PNM Integrated Resources Plan Accepted; San Juan Generating Station Compliance Filing On Track," December 19, 2018; "Alternatives Study of the San Juan Generating Station," Public Service of New Mexico, SL-010117, Project No. 11278-018, prepared by Sargent and Lundy LLC, February 25, 2010.
[9]"City of Farmington Signs Initial Agreement to Continue Operations of San Juan Generating Station," *Farmington Spotlight*, February 24, 2019.
[10]Darrell Proctor, "Groups Reach Deal to Keep New Mexico Coal Plant Open," *POWER*, February 24, 2019.
[11]Hannah Grover, "Proposal to Study CCS Technology at San Juan Generating Station Rejected by Senate Panel," *Farmington Daily Times*, March 4, 2019; Morgan Lee, "New Mexico Lawmakers Seek Compromise on Coal, Clean Power," Associated Press, February 8, 2019.
[12]Liz Weber, "Utility Company's Bid to End Operations at San Juan Generating Station Approved," *Durango Herald*, April 3, 2020.
[13]"City of Farmington Advances to the Next Contractual Step to Keep San Juan Generating Station Open Past 2022," *Farmington Spotlight*, March 1, 2019.
[14]"Carbon Capture and Sequestration Proposal for San Juan Generating Station," prepared by Acme Equities LLC, February 2019.

plants in the U.S., and has several decades of functional life remaining. Further, even PNM admits that closing the SJGS will increase ratepayers' bills.[15]

Accordingly, the City of Farmington hired a Washington D.C. law firm that specializes in energy transactions to market the plant. Acme Equities LLC, a private New York-based hedge fund and real estate investment company that focuses on North American energy projects, was chosen after being vetted by the law firm. Acme was selected because of its interest in the project, its ability to successfully perform in the short timetable required, and because of its plan to install proven CCUS technology that would reduce CO_2 emissions by 90%, thereby allowing the plant to operate for decades to come.[16] Farmington entered into a Letter of Intent with Acme to negotiate a purchase agreement for the acquisition of SJGS. The next contractual step requires the signing of an Agency Agreement, followed by the completion of the ongoing negotiations for a formal Purchase Agreement. The new ownership agreement will allow SJGS and its associated SJM to continue to operate beyond 2022.[17]

The parties are advancing to the next contractual step by entering into an Agency Agreement whereby Acme obtains the authority to initiate discussions on behalf of the City of Farmington with the exiting owners for their interest in SJGS and to begin discussions with Westmoreland Mining LLC, owner of the SJM, for a new coal supply agreement.[18] According to the owners' agreement, all exiting owners have an obligation to negotiate in good faith and convey their interest in the plant at no cost.[19] Acme established a new company called Enchant Energy, which will retrofit the SJGS with CCUS technology.

SJGS may remain financially viable because the City of Farmington and the third party merchant operation have a different business model and different business concerns than PNM. They contend that SJGS is a lowest cost supplier of electricity and is economically viable with many years of useful life remaining. The revenue stream created by the sale of the captured CO_2 increases the economic viability, as well as creating significant new capital investment and additional employment in the community. IRS recently issued its long awaited guidance to help developers take advantage of CCUS tax credits, and this provides a crucial incentive for CCUS projects such as that being assessed for SJGS.[20]

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[15]Paul J. Gessing, "Transition to Renewables Shouldn't Cost Ratepayers," *Farmington Daily Times*, February 22, 2019.

[16]"Farmington City Manager Provides an Update and Status Report on the San Juan Generating Station Acquisition," *Farmington Spotlight*, March 1, 2019.

[17]"Win-Win Solution Found for San Juan Generating Station," City of Farmington, February 27, 2019.

[18]"City of Farmington Advances to the Next Contractual Step to Keep San Juan Generating Station Open Past 2022," op. cit.

[19]Kevin Robinson-Avila, "Details Scarce on Farmington's San Juan Talks, *Albuquerque Journal*, February 27, 2019.

[20]https://www.bloomberg.com/news/features/2020-06-11/carbon-capture-tool-against-climate-change-just-got-cheaper?srnd=green&sref=cihWxpXj&mc_cid=0932f6b16f&mc_eid=93d615f088

Acme estimates that SJGS with CCUS and a new coal contract can provide clean power at a 10% to 30% discount to solar, wind, or gas-fired electric power. CCUS will reduce SJGS CO_2 emissions by 90%, and to 25% below those from a combined wind/natural gas power plant. Acme estimates that the retrofit project can receive financing and grants from DOE. It also believes that the project can be financed by selling CO_2 to the oil industry and by monetizing the CCUS tax credits. It plans to build a new 20 mile CO_2 connector pipeline to the Permian Basin and to use the CO_2 for enhanced oil recovery (EOR) in oil fields in the Basin.[21]

Local government officials have thus been aggressively fighting for over three years to keep SJGS and SJM in operation.[22] They fear the devastating impact that the shutdown of the plant and the mine will have on the local economy, jobs, and economic development. They estimate that:[23]

- Job losses could total 1,600 or more.
- Local area earnings would be reduced by $120 million annually.
- Over $50 million in tax revenues would be lost annually.
- Hundreds of local families and businesses would be adversely affected.
- The property tax base of Central Consolidated Schools, San Juan College, and San Juan County will be greatly diminished.
- The Central Consolidated School District – where over 90% of the students are Native American and nearly 75% of the students are disadvantaged -- would lose 50% of its property tax revenues.

In this report, MISI conducts a case study which utilizes the SJGS as a representative coal plant and which models the scenario where it continues to operate beyond 2022. If SJGS, or any other coal power plant, is to continue to operate in New Mexico decades into the future, we must assume that CCUS will necessarily be part of the solution. Thus, MISI compares the economic and jobs effects of coal/CCUS with those from renewables. Specifically, MISI analyzes the scenario where SJGS is retrofit with CCUS and compares the economic and jobs impacts of this with those that would result from replacing SJGS with renewables. The renewables alternative adheres as closely as possible to the PNM IRP – which is still in the process of development. This allows MISI to develop for DOE generic metrics capable of comparing the job implications of replacing coal power generation utilizing CCUS with those resulting from renewables.

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[21]"Carbon Capture and Sequestration Proposal for San Juan Generating Station," op. cit.

[22]Rebecca Moss, "Four Corners Worries About Jobs as Coal-Fired Plants Power Down," The New Mexican, March 21, 2017; Danielle Nguyen, As Plant Faces Closure, New Mexico City Weighs Bet on Clean Coal Technology, The Bill Lane Center for the American West, June 26 2019; https://elementalreports.com/renewable-energy/2019/07/09/as-plant-faces-closure-city-in-four-corners-region-weighs-bet-on-clean-coal-technology/; Darrel Proctor, "City Backs Deal for CCS Technology to Save New Mexico Coal Plant," *Power*, August 19, 2019; Cindy Yurth, "PRC hearings: Northern Navajo's Economy Hangs in the Balance," Navajo Times, December 12, 2019; Hannah Grover, "How San Juan Generating Station Went From Powerhouse to Possible Closure," *Farmington Daily Times*, October 6, 2018.

[23]See Kelly O'Donnell, "Tax and Jobs Analysis of San Juan Generating Station Closure," O'Donnell Economics and Strategy, January 2019; Susan Montoya Bryan "Closing Generating Station Could Have Huge Economic Impacts," *Durango Herald*, September 30, 2018; Sally Burbridge, "San Juan Generating Station Closure Impacts," Four Corners Economic Development, March 2018.

The report is organized as follows:

- Chapter II describes the CCUS scenario and the PNM scenarios.
- Chapter III details the simulations conducted.
- Chapter IV describes the comparative results obtained from the simulations.
- Chapter V assesses the impacts on Native Americans.
- Chapter VI analyzes the jobs metrics per MW.
- Chapter VII contains the conclusions derived.

II. SAN JUAN GENERATING STATION SCENARIOS

MISI conducted a CCUS case study which utilized the SJGS as a representative coal plant and which modeled the scenario where it continues to operate beyond 2022. MISI assumed that all of the captured CO_2 is used for EOR. MISI estimated the likely economic and job impacts of CCUS retrofit of SJGS and compared these to the impacts of the PNM scenario that would close the SJGS and the SJM and provide replacement power with renewables and batteries. The major issue addressed here is the overall net economic and job impacts in San Juan County and in New Mexico, and the impacts on the local Native Americans, of installing CCUS technology on SGJS, especially as they compare to those resulting from the PNM IRP and the renewables/battery/storage option.

In conducting the impact assessment, MISI utilized data from various sources, including:

- Cost estimates for refitting SJGS with CCUS technology.
- The schedules for refitting SJGS.
- Cost estimates for the CO_2 pipeline that will be required.
- The schedules for the CO_2 pipeline that will be required.
- Estimates of the lengths and location of the CO_2 pipeline that will be required.
- CAPEX and fixed and variable O&M cost data for the coal CCUS retrofits.
- Pipeline assumptions (distance, CAPEX, fixed and variable O&M cost data, and expenditure schedules).
- Cost estimates for the PNM renewables and batteries proposed.
- O&M estimates for the PNM renewables and batteries proposed.
- Estimates for the decommissioning of the SJGS
- Estimates of the severance payments, job training assistance, and San Juan community assistance proposed by PNM.
- As available, other necessary parameters identified through discussions with DOE and NETL staff.

MISI estimated the likely economic and job impacts in San Juan County, in New Mexico, in the Navajo Nation, and the Hopi Tribe of the SGJS CCUS retrofits and the PNM scenario, including:

- Coal plant retrofit jobs.
- Pipeline-related jobs resulting from the coal CCUS retrofits.
- Retention of the SJGS and SJM jobs.
- Renewable jobs and battery jobs.

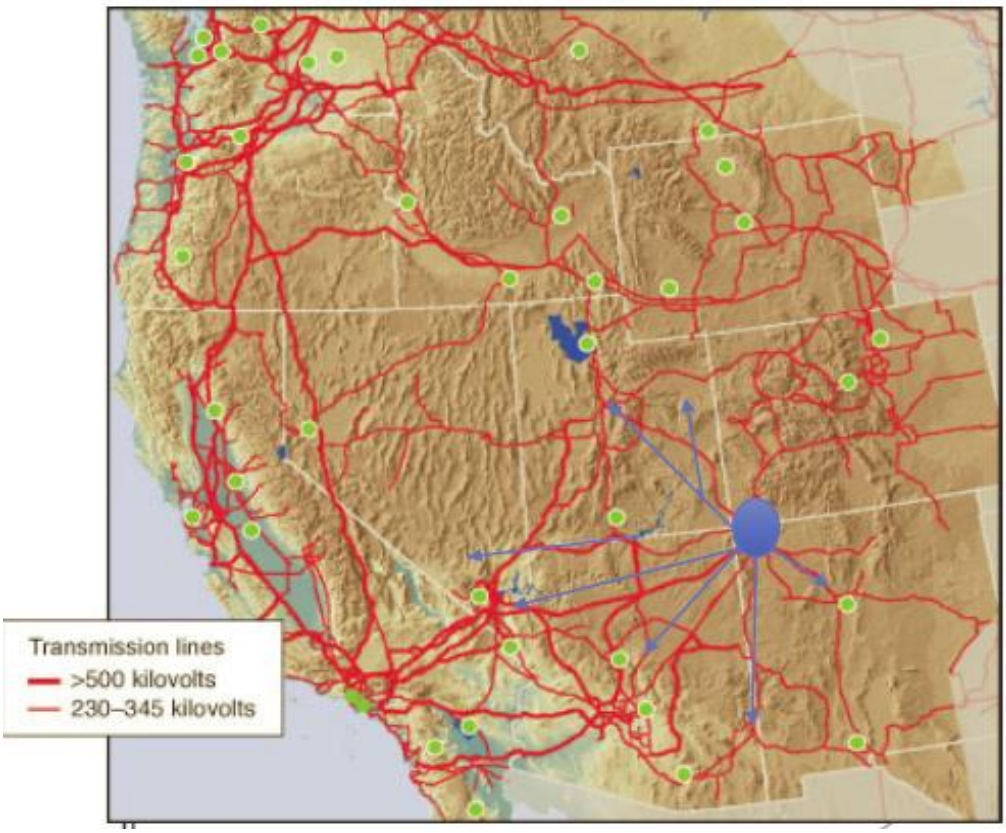
MISI analyzed the impacts of the scenario where SJGS is retrofit with CCUS and compared the economic and jobs impacts of this with those that would result from replacing SJGS with renewables – as specified in the New Mexico Energy Transition Act (ETA) and the PNM IRP.

II.A. The SJGS CCUS Retrofit Scenario

SJGS description:

- SJGS is an 847 MW (net) Coal-fired Electricity Generation Station in northwest New Mexico originally built in the 1970s, and expanded in the 1980s.
- The plant utilizes high BTU coal supplied by the adjacent San Juan coal mine, owned by Westmoreland Mining Holdings. Enchant Energy signed an MOU to extend the coal supply through 2035.
- SJGS is operated by PNM on behalf of PNM (66%), Tucson Electric Power (TEP) (20%), Farmington (5%), Los Alamos (4%), and United Associated Municipal Power System (UAMPS) (4%).
- The plant size was decreased from 1,828 MW (gross) in 2017 through shutdown of Units 2 & 3 in conjunction with installation of Selective Non-Catalytic Reduction (SNCR) equipment and settlement with the U.S. EPA.
- SJGS is the low cost generator with low NO_x/SO_x/Mercury/particulates emissions, but currently has significant CO_2 emissions.
- SJGS is located at the center of the Southwestern transmission grid, with connections to rest of New Mexico, Arizona, California, Colorado, Nevada, and Utah – Figure II-1.

Figure II-1
SJGS Location at the Center of the Southwestern Transmission Grid



Source: Enchant Energy.

As discussed, the closures of SJGS and the San Juan Mine are anticipated to result in a loss of, at least, over 1,600 jobs, $53 million annually in state and local tax revenues, and critical losses to the Central Consolidated School District (CCSD). In order to avoid these losses, and in accordance with the underlying Participation Agreement between the owners of SJGS, the City of Farmington conducted a nationwide search to market the opportunity to continue to operate SJGS. After evaluating a number of interested parties, the City of Farmington chose to work with Enchant Energy due to its proposal to utilize carbon capture equipment to continue operations at SJGS in compliance with the New Mexico ETA. With the closure of Navajo Generating Station, and the announced closures of the Four Corners and Escalante coal power plants, CCUS retrofit of SJGS is critical in minimizing an extreme negative economic impact to the Four Corners region.[24]

In partnership with the City of Farmington, Enchant Energy Corporation has obtained the right to acquire the 847 MW Coal-fired SJGS for $1.00, effective 6/30/2022 when the current owners exit the plant: 95% to Enchant, and 5% to City of Farmington municipal utility. PNM has applied to the NM PRC to abandon its portion of the plant with the ETA as part of that decision. Under the ETA, the plant would have to comply with a new CO_2 emissions intensity limit of 1,100 lbs. per MWh by January 1, 2023. SJGS currently has an intensity of 2,200 lbs. per MWh.

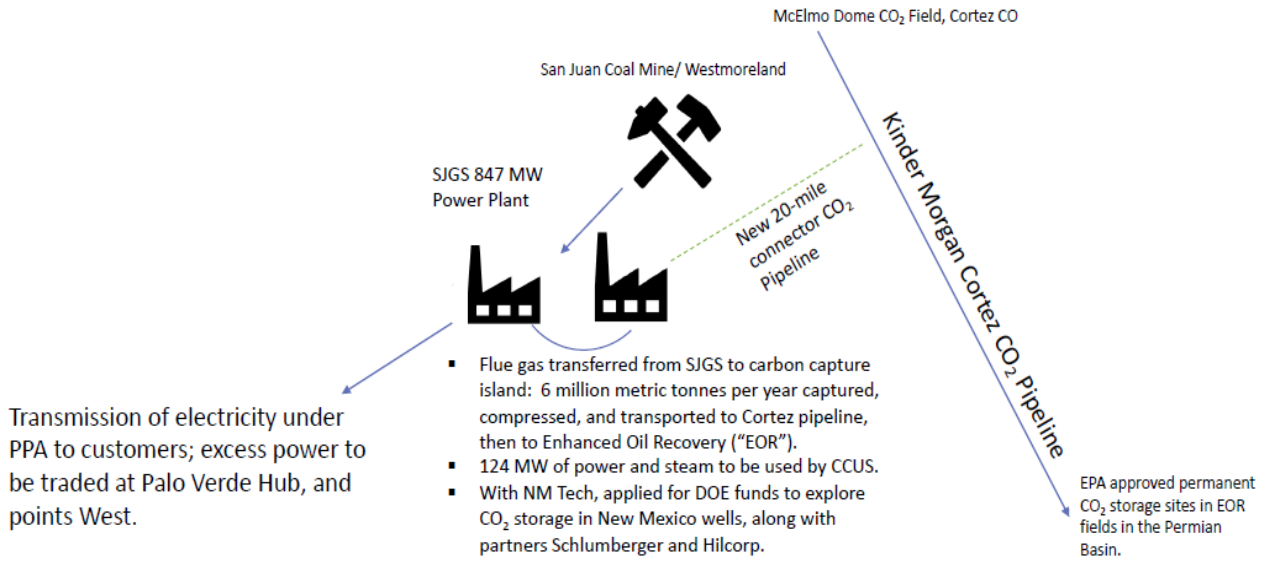
Farmington and Enchant Energy plan to retrofit the plant with proven, post-combustion CCUS technology that will lower the CO_2 emissions by up to 90% -- Figure II-2. The project does not require any state or local government subsidies. Post-CCUS, SJGS will have CO_2 emissions reduced to 247 lbs. per MWh – becoming Low Emissions Electricity (LEE). LEE produces 70% less CO_2 emissions than a typical, new combined-cycle gas turbine (CCGT), and 80% less emissions than a gas peaking plant. The project will provide $1.3 billion in private investment to the Four Corners/Farmington area during construction, financed through the monetization and forward sale of IRS Section 45Q tax credits. Notice to Proceed (NTP) and Commencement of Construction can occur in 2021, if PNM and all the other SJGS owners who pledged legally to exit by June 30, 2022 (the "Exiters") allow early CCUS site construction access north of Unit 3.

Enchant Energy Corporation and Farmington announced on December 10, 2019 that globally-leading companies have joined the Enchant Team:

- Mitsubishi Heavy Industries America (MHIA) is the carbon capture technology provider.
- Kiewit Power Constructors Co. (Kiewit)/Sargent & Lundy (S&L) will serve as the combined engineering, procurement, and construction (EPC) contractor.

[24]See "N.M. Braces For Economic Impact of Plant Shutdown," *Energywire*, July 24, 2020.

Figure II-2
Proposed Enchant SJGS CCUS Project



Source: Enchant Energy and Sargent & Lundy.

The San Juan Generating Station CCUS retrofit project will:

- Retrofit two coal-fired units with combined 847 MW (net) pre-CCUS capacity with one common (3-train) CCUS unit.
- Utilize Mitsubishi Heavy Industries' technology.
- Use existing auxiliary systems to reduce both project capital costs and the overall cost of capture.
- Capture and sell 6 million tons per year of CO_2 under contract with an investment-grade oil and gas company.
- Investigate potential for 100% utilization in New Mexico.
- Produce CO_2 sales that generate over $300 million per year in revenues and tax credits.
- Break ground in 2021 and be operational in 2023, if Exiters allow early construction start.

Sargent and Lundy estimates that cost of carbon capture at SJGS will range from $39.15 to $43.49 per ton – Table II-1.[25] This range supports the economic viability of the project. Carbon capture will decrease CO_2 emission intensity from 2,201 lbs./MWh to 249 lbs./MWh – Table II-2. Six million metric tons per year of CO_2 will be captured, which will

[25]Sargent & Lundy, "Enchant Energy San Juan Generating Station – Units 1 & 4 CO_2 Capture Pre-Feasibility Study," Project No. 13891-001, July 8, 2019. This analysis was reviewed and verified in "Preliminary Assessment of Post-Combustion Capture of Carbon Dioxide at the San Juan Generating Station: An Independent Assessment of a Pre-feasibility Study Conducted by Sargent & Lundy for Enchant Energy," Los Alamos National Laboratory, December 12, 2019.

provide 313 million standard cubic feet per day (MMSCFD) of pipeline-quality CO_2. S&L estimates the total capital cost of the project at approximately $1.3 billion – Table II-3.

Table II-1
Costs of CO_2 Capture

Description	Units	85% Capacity Factor	100% Capacity Factor
Total Project Cost	$	1,295,280,000	1,295,280,000
CCF		0.1243	0.1243
Annualized Capital Cost	$/yr	161,000,000	161,000,000
Annual O&M Cost	$/yr	99,939,000	115,389,000
Total Annual Cost	$/yr	260,939,000	276,389,000
CO_2 Captured	mmscfd	313	368
Annual CO_2 Captured	tonnes	6,000,000	7,060,000
Cost of Capture	**$/tonne[1]**	**43.49**	**39.15**

Note 1. Cost of capture reported as dollars per metric ton (equivalent to 2,240 lb).
Source: Sargent & Lundy

Table II-2
CO_2 Rates for SJGS

SJGS CO_2 Rates		Unit 1	Unit 4	Total Plant
Baseline Plant CO_2 Emissions Rate[1]	(lb/MWh_{gross})	2,165	2,236	2,201
Post-Project CO_2 Emission Rate	(lb/MWh_{gross})	243	254	249
Max Full Load Post-Project CO_2 Capture Rate	(lb/hr)	703,724	1,071,852	1,775,576
Post-Project CO_2 Capture Rate[2]	(mmscfd)	124	189	313
	(mmscfy)	45,200	68,845	114,045

Note 1. Data from the United States Environmental Protection Agency's (EPA) Air Market Program Database (AMPD) - Annual average for 2014-2018 – Total plant is estimated based on the average of Units 1 and 4.
Note 2. Values calculated assuming an annual average facility capacity factor of 85%.

Source: Sargent & Lundy.

After seven months of negotiations, in June 2020 Enchant Energy signed an agreement with Bank of America (BofA) to arrange the 45Q tax equity financing that Enchant will utilize to retrofit the SJGS with carbon capture technology.[26] The deal will help Enchant attract investors and finance the carbon capture retrofit. The 45Q tax credits are designed to accelerate development of CCUS in the U.S. If SJGS is successfully

[26]Hannah Grover, Enchant Energy Signs Deal With Bank of America in San Juan Generating Station Project," *Farmington Daily Times*, June 24, 2020.

retrofitted, its investors can receive $35 in tax credits for every ton of CO_2 that is captured and sold for enhanced oil recovery. If the CO_2 is pumped into an underground saline aquifer for permanent storage, the investors can receive $50 per ton in tax credits. The 45Q tax credit is similar to tax credits that helped develop the wind energy industry, which provides an additional sense of security for tax equity investors. Bank of America is a leader in tax equity financing, and its Renewable Energy Finance Team has been the number one tax equity investor in the U.S. since 2015, according to Bloomberg New Energy Finance.[27] Through 2019, BofA had invested approximately $9.4 billion in tax equity for renewable energy development.

Table II-3
Capital Cost Summary of CO_2 Capture System ($2019)

	Material / Equipment	Labor	Total
BOP Cost	**$ 110,360,000**	**$ 79,250,000**	**$ 189,610,000**
Civil / Sitework	*$ 4,020,000*	*$ 7,150,000*	*$ 11,170,000*
Mechanical /Equipment	*$ 31,370,000*	*$ 37,500,000*	*$ 68,870,000*
Structural / Ductwork	*$ 58,560,000*	*$ 24,770,000*	*$ 83,330,000*
I&C	*$ 5,630,000*	*$ 820,000*	*$ 6,450,000*
Electrical	*$ 14,780,000*	*$ 10,010,000*	*$ 24,790,000*
CO_2 Island Cost (Including Compression Island)	**$ 253,010,000**	**$ 309,230,000**	**$ 562,240,000**
Pipeline Cost (Furnished / Installed)			**$ 40,000,000**
Total Direct Capital Cost			*$ 796,850,000*
EPC Construction Overheads[1]			$ 119,530,000
Engineering[2]			$ 39,840,000
EPC Contingency			$ 159,370,000
EPC Risk Fee			$ 79,690,000
Total Indirect Costs			*$ 398,430,000*
Total EPC Cost			**$ 1,195,280,000**
Owner's Cost			**$ 100,000,000**
Total Project Cost[3]			**$ 1,295,280,000**

Note 1. Construction Overheads Includes:
Scaffolding, Overtime, Per Diem, Consumables, Sales Tax, Contractors Administration Fee, Contractor Profit
Note 2. Engineering Includes:
Engineering services, Field Support, Start-Up/Commissioning, SU/S Parts/Initial Fills
Note 3. Costs Exclude:
Escalation, AFUDC, Right of Way & Land Purchase, Insurance, Site Security

Source: Sargent & Lundy

The project will generate $2.6 billion of 45Q Tax Credits over 12 years, which covers twice the estimated project construction capital cost (CAPEX) of $1.3 billion. Sales of pipeline-quality CO_2 fully cover the annual operating costs of the CCUS, including the

[27] Ibid.

cost of power and steam used in the CCUS. At SJGS, the retrofit with CCUS will be separately financed, and will not increase the cost of generation for the power plant, which becomes separate from ratepayers' rate regulation in 2022 (Merchant Generation). CCUS will provide an anchor customer using 29% of output and paying for 29% of generation costs. SJGS will remain a low-cost power generator in the Southwest power market. Under Merchant Generation, there are no obligated power purchasers but California buyers are a likely destination for electricity.[28]

The S&L study demonstrated the financial viability of SJGS CCUS – Table II-4.

Table II-4
Financial Viability of SJGS CCUS

	85% Capacity Utilization
Cost of Capture	$ 43.39
45Q tax credit in 2026	$ 35.00
Value of pipeline quality CO2	$ 17.50
Total Revenue	$ 52.50
Coverage of cost of capture by revenues	121%

Source: Enchant Energy and Sargent & Lundy.

The major stakeholders in the project include:

- The City of Farmington
- The Central Consolidated School District
- Westmoreland – the San Juan Mine
- New Mexico Tech
- San Juan College
- San Juan County officials
- Union leaders and members

The SJGS project is advantageous for local residents and ratepayers. Continued operation of SJGS could mean reductions in ETA funds paid by PNM ratepayers to defray SJGS closure costs. The project will generate numerous direct jobs, direct contractor jobs, and indirect jobs. In addition, more than $50 million in state and annual local tax revenues are preserved by using CCUS to extend the life of the plant (which would otherwise close given New Mexico regulations for coal plants), preserve existing jobs, and promote new construction and O&M jobs for $1.3 billion+ carbon capture construction. Further, the project:

[28]Sargent & Lundy, op. cit.

- Preserves millions in tax and other revenues for CCSD.
- Expands educational and career pathways in carbon capture and related fields.
- Potentially expands tax revenues for education into the severance tax fund.
- Facilitates New Mexico becoming a national pioneer in CCUS and develops a skilled workforce to apply carbon capture technology in other high CO_2 emitting plants across the U.S.
- Ensures continued operation of SJGS, which means that Farmington ratepayers will not have to pay increased rates due to stranded costs and the need for replacement power due to closure.

The project is also a win for the environment and climate:

- It reduces New Mexico CO_2 emissions by estimated 6 million metric tons per year.
- Provides reliable, dispatchable power that emits 70% less CO_2 than the most-efficient natural gas plant.
- Carbon capture technology, which is the centerpiece of the DOE strategy to address climate change, will be advanced through its largest deployment to date at SJGS.

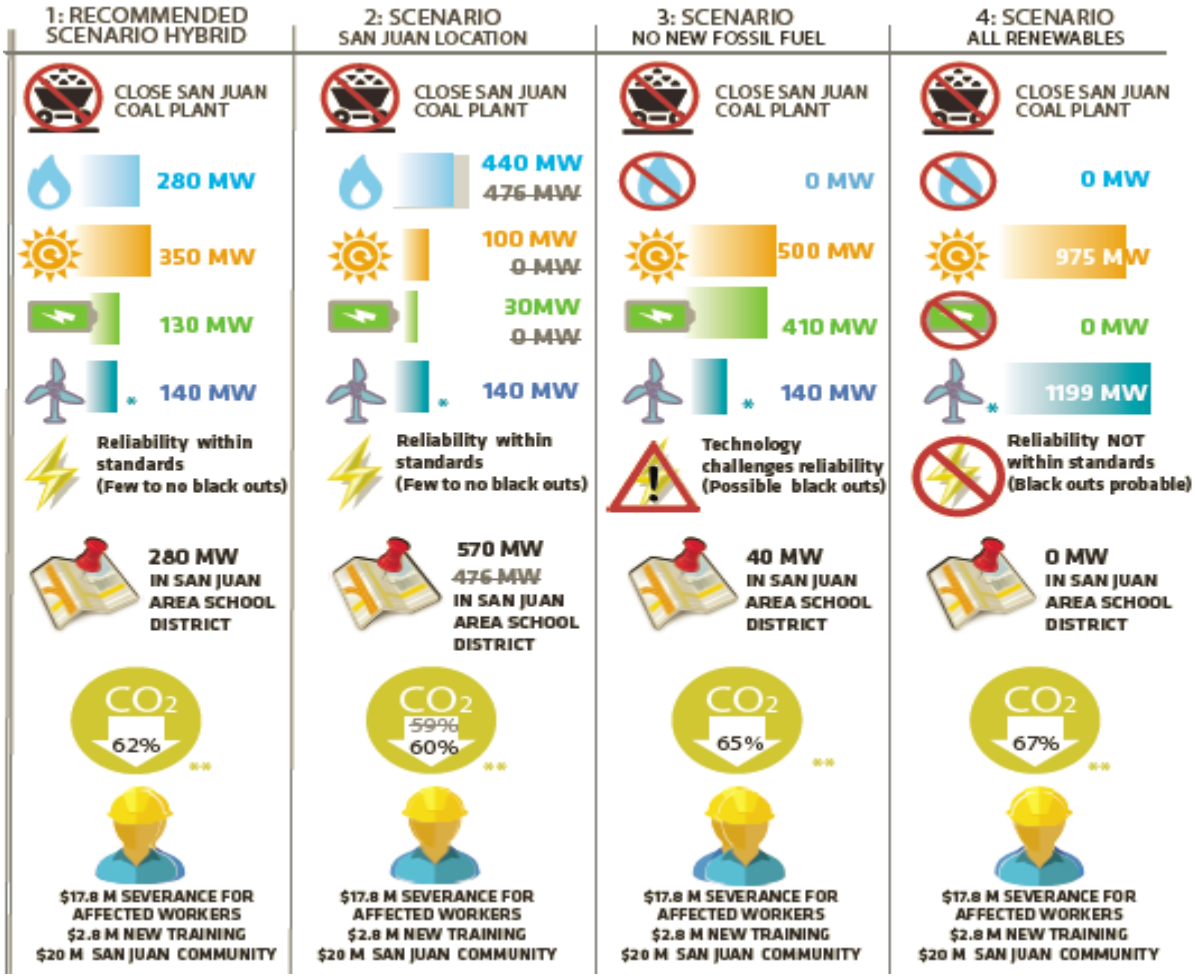
II.C. The PNM Renewable Scenario

PNM has proposed four scenarios for replacement of the SJGS – Figure II-3:[29]

- Scenarios 1 and 2 rely heavily on natural gas.
- Scenario 2 relies primarily on natural gas.
- Scenario 3 relies heavily on batteries and contains no natural gas.
- Scenario 4 relies solely on solar and wind.

[29]Public Service of New Mexico, *Integrated Resource Plan*, 2017-2036, July 3, 2017.

Figure II-3
Alternative SJGS Scenarios Proposed by PNM



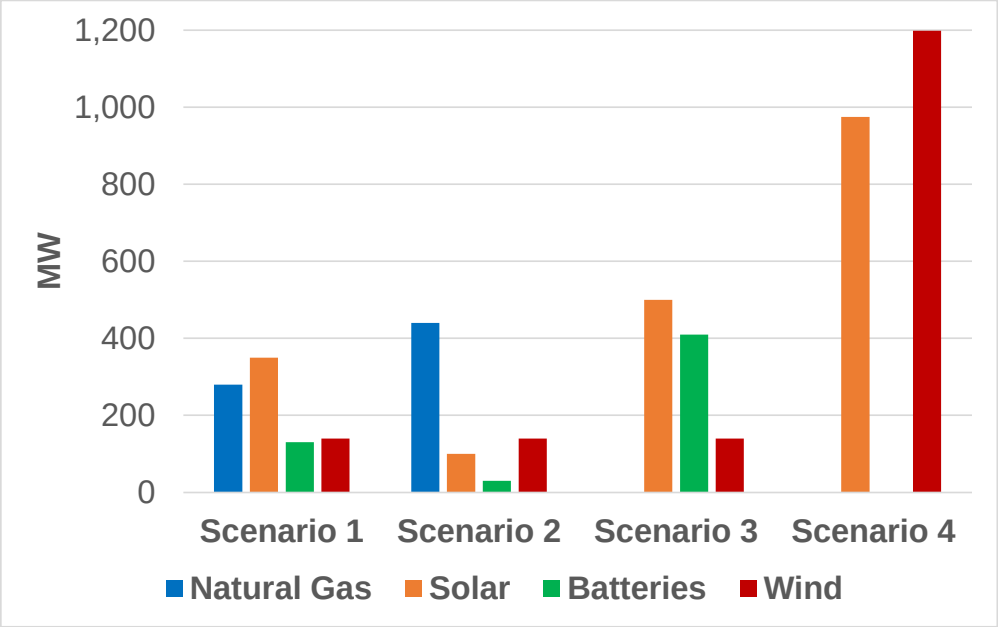
Source: Public Service of New Mexico.

Replacement generation resources shown above are proposed resources to replace Megawatts (MW) from the closure of the San Juan Generating Station, not the entire PNM generation portfolio.
*140 MW of wind resources pending approval in Renewable Portfolio Case and included in SJ modeling inputs.
**Carbon reductions based on 2005 levels in alignment with the Paris Agreement.

Figure II-4 shows the resource portfolios under each of the four PNM scenarios. It illustrates that:

- Scenarios 1 and 2 rely heavily on natural gas.
- Scenario 2 relies primarily on natural gas.
- Scenario 3 relies heavily on batteries and contains no natural gas.
- Scenario 4 relies solely on solar and wind and contains no batteries.

Figure II-4
Resource Portfolios Under Each PNM Scenario

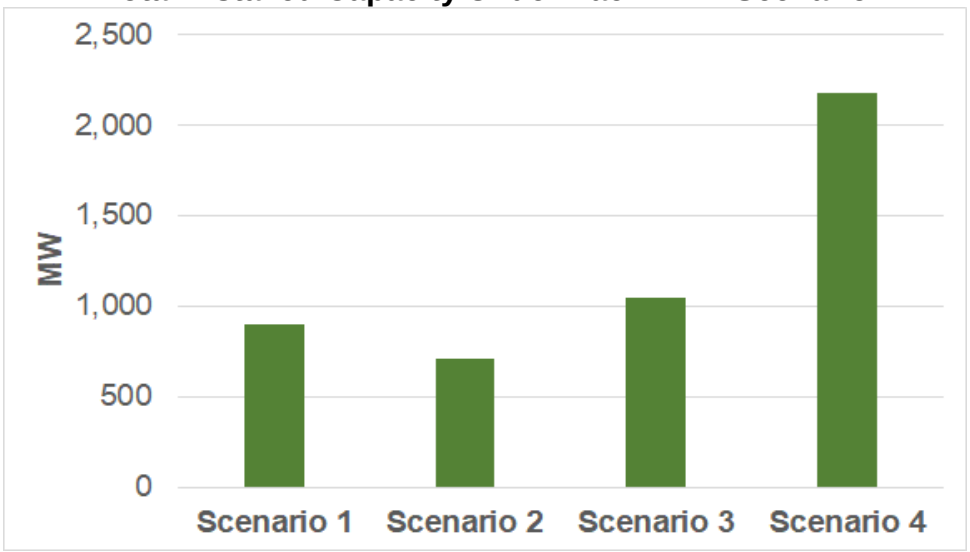


Source: Public Service of New Mexico.

Figure II-5 shows the total installed capacity under each PNM scenario. It indicates that the required capacities under each scenario differ significantly:

- Scenario 1 requires 27% more capacity than Scenario 2.
- Scenario 3 requires nearly 50% more capacity than Scenario 2.
- Scenario 4 requires more than three times as much capacity as Scenario 2.

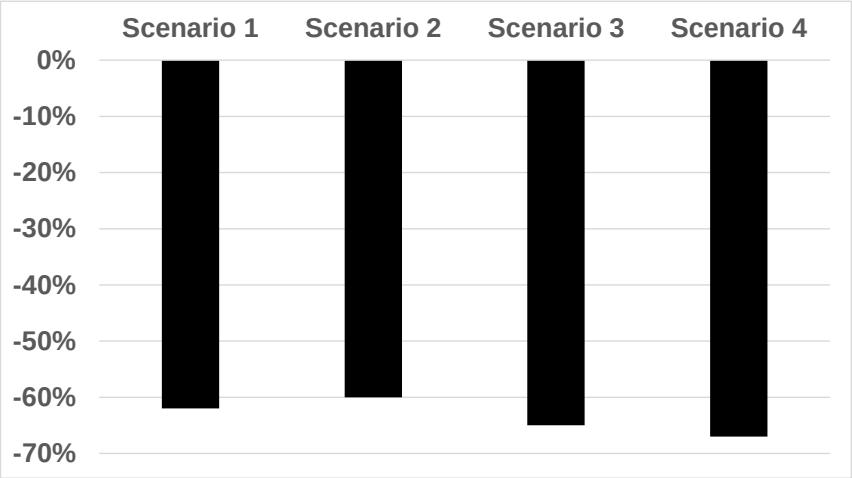
Figure II-5
Total Installed Capacity Under Each PNM Scenario



Source: Public Service of New Mexico.

Figure II-4 shows the estimated CO_2 reductions under each scenario. Interestingly, it illustrates that estimates of the CO_2 reductions under each scenario do not vary significantly and only range between reductions of 60% and 67%.

Figure II-4
CO_2 Reductions Under Each Scenario



Source: Public Service of New Mexico.

MISI compared the impacts of the SJGS retrofit against those of PNM scenario 3. The rationale for choosing this scenario is:

- Scenarios 1 and 2 rely heavily on natural gas, and are thus not fully "renewable energy" scenarios.
- Scenario 4 relies solely on solar and wind and contains no batteries. However, this scenario requires the building of nearly 2,200 MW of renewable capacity, which is more than 2.5 times the 847 MW capacity of SJGS. Further, PNM acknowledges that under this scenario reliability is not assured and blackouts are likely.
- Scenario 3 relies heavily on batteries and contains no natural gas and is thus a credible "renewable energy" scenario.
- Scenario 3 requires the building of 1,050 MW of capacity – 25% more than the 847 MW capacity of SJGS. However, due to the intermittency, unreliability, and non-dispatchability of wind and solar, excessive capacity and battery backup are required in any realistic renewable energy scenario. Further, even under this scenario PNM admits that reliability and blackouts will be a problem.
- A major purpose of this report is to provide metrics of the job impacts of the SJGS CCUS retrofit scenario compared to a viable renewable energy alternative. Scenario 3 provides this alternative.
- Scenario 3 reduces CO_2 emissions by 65% -- compared to reductions of 62% from Scenario 1, 60% from Scenario 2, and 67% from Scenario 4. It thus reduces CO_2 emissions by more than Scenarios 1 and 2, and nearly as much as Scenario 4.

MISI did not assess the impacts of the SJGS retrofit against those of PNM Scenario 1 – the PNM recommended "hybrid" scenario -- because it includes a large component of natural gas and is thus not a completely renewable energy scenario. Further, given New Mexico's current and impending restrictions on natural gas emissions,[30] it is not clear how feasible over the long term this scenario is. In addition, as noted, a major purpose of this research is to provide metrics comparing the impacts of SJGS CCUS retrofit option with an approximately equivalent renewable energy alternative. Further, on July 29, 2020, the New Mexico PRC disallowed Scenario 1 and mandated an all-renewables scenario very similar to PNM Scenario 3.[31]

Therefore, here MISI compares the job impacts and local San Juan tax revenue impacts of the SJGS CCUS retrofit scenario to those of PNM Scenario 3, which comprises:

- 500 MW of solar
- 140 MW of wind
- 410 MW of batteries
- No natural gas or other fossil fuels.
- Closure of the SJGS in 2022
- Closure of the San Juan mine in 2022
- SJGS decommissioning, 2023-25
- The provision by PNM of approximately $41 million in payments for severance, job training, and community assistance.

PNM Scenario 3 allocates only 40 MW total of RE and batteries in the local San Juan area. Therefore, under the PNM Scenario modeled here, MISI assumed that in the local San Juan area there would be installed:

- 14 MW of batteries
- 13 MW of wind
- 13 MW of central station PV

Under PNM Scenario, MISI assumed that all of the other renewables and batteries are installed elsewhere in New Mexico. Thus, MISI assumed that under the PNM scenario there would be installed in New Mexico outside of the San Juan area:

- 396 MW of batteries
- 127 MW of wind
- 487 MW of central station PV

MISI assumed that all of approximately $41 million in payments for severance, job training, and community assistance under the PNM scenario would accrue to the local San Juan area.

[30]See, for example, "N.M. Looks for 'Sweet Spot' In Crafting Methane Rules," *Climatewire*, July 23, 2020.
[31]"A 100% renewables portfolio was the only replacement option that fully satisfied the state's Energy Transition Act (ETA), passed last year, which requires the state to make an economically just transition to 100% carbon-free energy by 2045." Catherine Morehouse, "New Mexico Approves 100% Renewable Replacement For San Juan Coal Capacity," *Utility Dive*, July 30, 2020.

III. SIMULATIONS

III.A. MISI Conventions

MISI has conducted numerous analyses using assumptions and methodology similar to those utilized in the current study.[32]

III.A.1. Data Sources

MISI estimated the likely economic and direct and indirect job impacts in New Mexico and the San Juan area of the CCUS retrofit on the SJGS units 1 and 4. It was assumed that the plant will thus continue to operate through 2055. MISI estimated the job impacts on the local and New Mexico economies of:

- SJGS CCUS construction
- SJGS CCUS O&M
- CO_2 pipeline construction
- CO_2 pipeline O&M
- Continued operation of the SJGS
- Continued operation of the San Juan mine
- No provision by PNM of any funds for severance, job training, or community assistance.

[32]These related studies include the following: Management Information Services, Inc., "Assessment of the Jobs Impacts of CCUS Retrofit of Four Coal Power Plants in Wyoming," prepared for the U.S. Department of Energy, July 2020; Management Information Services, Inc. and Leonardo Technologies Inc., "Economic Impact Assessment of CCUS Retrofit of the Comanche Generating Station," prepared for the U.S. Department of Energy and the National Energy Technology Laboratory, June 2019; Management Information Services, Inc., "Estimates of the Jobs Likely to be Generated by the 2018 Enacted 45Q Legislation Compared to Those Likely From the 2017 Proposed CCUS Tax Credits," prepared for the National Energy Technology Laboratory, November 2018; Roger H. Bezdek, "The Economic and Job Benefits of U.S. Coal," presented at the American Coal Council 2018 Spring Coal Forum Clearwater Beach, Florida, March 8, 2018; Management Information Services, Inc., "Analyzing the Economic and Job Impacts of the DOE R&D Program and CCS Tax Credits," prepared for the National Energy Technology Laboratory, DOE contract DE-FE 0025912, January 2018; Management Information Services, Inc., "Analyzing and Estimating the Economic and Job Benefits of U.S. Coal," prepared for the U.S. Department of Energy, September 2017; Management Information Services, Inc., "Employment Impact Analysis of Coal Carbon Capture and Sequestration Retrofits," prepared for National Energy Technology Laboratory, August 2015; Roger H. Bezdek and Robert M. Wendling, "The Return on Investment of the Clean Coal Technology Program in the USA," *Energy Policy*, March 2013, Vol. 54, pp. 104-112; Management Information Services, Inc., "Estimates of The Jobs and Economic Benefits Resulting From the Capacity Build-Out and Oil Production Associated With the FE Technologies/EOR Market Snapshot, 2020-2100," prepared for the National Energy Technology Laboratory, September 2012; Roger H. Bezdek "Economic, Employment, and Energy Stimulus From Clean Coal Technology Deployment," chapter 2 in *Harnessing Coal's Carbon Content to Advance the Economy, Environment, and Energy Security*, National Coal Council, Washington, D.C., June 2012; Roger H. Bezdek and Robert M. Wendling, "Economic, Environmental, and Job Impacts of Increased Efficiency in Existing Coal-Fired Power Plants," *Journal of Fusion Energy*, 2012; Roger H. Bezdek and Robert M. Wendling, "Costs and Benefits of U.S. Government Investments in Clean Coal Technology: Implications For Europe," presented at GeoDarmstadt 2010 – 8th European Coal Conference, Darmstadt, Germany, October 2010. Also, see http://misi-net.com/.

MISI estimated the likely economic and direct and indirect job impacts in New Mexico and the San Juan area of PNM Scenario 3 which contains no fossil fuels and comprises:

- 500 MW of solar
- 140 MW of wind
- 410 MW of batteries
- No natural gas or other fossil fuels.
- Closure of the SJGS in 2022
- Closure of the San Juan mine in 2022
- The provision by PNM of approximately $41 million in payments for severance, job training, and community assistance.

In conducting the impact assessment, MISI utilized CCUS and related data provided by DOE, NETL, Leonardo Technologies Inc. (LTI), and other regional stakeholders. These data included:

- CAPEX and fixed and variable O&M cost data for the SJGS CCUS retrofit.
- The schedule for the CCUS retrofit.
- Cost estimates for the CO_2 pipeline that will be required.
- The schedule for the CO_2 pipeline that will be required.
- CAPEX and fixed and variable O&M cost data for the CO_2 pipeline.
- Estimates of the length and location of the CO_2 pipeline.
- Cost estimates for the PNM renewables and batteries proposed – 500 MW of wind, 140 and 410 MW of batteries.
- O&M estimates for the PNM renewables and batteries proposed – 500 MW of wind, 140 and 410 MW of batteries.
- Estimates for the decommissioning of the SJGS
- Estimates of the severance payments, job training assistance, and San Juan community assistance proposed by PNM.
- As available, other necessary parameters identified through discussions with DOE, LTI, and other regional stakeholders.

III.A.2. Constant Dollar Data

The only meaningful way to compare and analyze historical and forecast economic data over a long period is to use constant dollar data. Obviously, it would be misleading to equate a dollar expended in 2020 with one forecast to be spent in 2040 or 2055, since the price level in the latter years will likely be much higher than that of the former year. Aside from the general distortions, use of current dollar data in the analysis would, for example, seriously undercount expenditures early in the forecast period relative to those later in the forecast period. Therefore, throughout this report, the constant dollar estimates given are stated in constant 2019 dollars. The base year dollar used was 2019 dollars, and estimates stated in nominal dollars or in other base year dollars were

converted, where necessary, to 2019 constant dollars using the BEA Implicit GDP Deflator series.[33]

We derived the constant 2019 dollar data (2019 = 1.00), using the GDP deflators to convert dollar values into 2019 base year estimates. It is preferable in an analysis such as the one conducted here to use the GDP deflators – implicit price deflators (IPD) – instead of the more widely known consumer price index (CPI) deflators.[34]

III.A.3. The Jobs Concept

The jobs issue is a key focus of this report. The "jobs" concept can be subject to misinterpretation and misuse, and it is thus important that it be carefully defined.[35] Specifically, the employment concept used is a full time equivalent (FTE) job in the U.S. An FTE job is defined as 2,080 hours worked in a year's time, and adjusts for part time and seasonal employment and for labor turnover. The FTE concept normalizes job creation among full time, part time, and seasonal employment. Thus, for example, two workers each working six months of the year would be counted as one FTE job. An FTE job is the standard job concept used in these types of analyses and allows meaningful comparisons over time and across jurisdictions because it consistently measures the input of labor in the production process.

Thus, a "job" created is defined as a job created for one person for one year, and 50,000 jobs created will refer to 50,000 persons employed for one year. It is correct to state that "over a ten year period 500,000 cumulative jobs are created" as long as it is

[33]U.S. Bureau of Economic Analysis, "GDP Price Deflator," https://www.bea.gov/data/prices-inflation/gdp-price-deflator.

[34]The IPD, compiled by the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce, is a by-product of the deflation of GDP, and is derived as the ratio of current-to-constant-dollar GDP (multiplied by 100). It is the weighted average of the detailed price indices used in the deflation of GDP, but they are combined using weights that reflect the composition of GDP in each period. Thus, changes in the implicit price deflator reflect not only changes in prices but also changes in the composition of GDP. It is issued quarterly by BEA. Conceptually, the IPD measures the general price level of all final goods and services (including government) produced during a specific period. Thus, the IPD is the only official index which attempts to measure overall price behavior of all goods and services in the nation. The CPI is restricted to a narrower universe. The implicit GDP deflators are the ones used in this study,

[35]For example, DOE has expended substantial resources on several annual versions of the *U.S. Energy and Employment Report* (USEER). The employment figures reported in the USEER are supposed to refer only to direct employment and not to indirect employment or induced employment. However, the report's employment figures do include some indirect jobs, although it is not clear how many. It is also not clear what "job" concept USEER utilized. There are repeated references to "employment," "workforce," "jobs," and "net jobs." However, these concepts are sometimes used interchangeably in a confusing manner. Further, the employment concept of a full time equivalent (FTE) job in the U.S. is the standard used in economic analyses and normalizes job creation among full time, part time, and seasonal employment. The USEER does not mention the FTE job concept. In addition, the methodologies used in the 2016 USEER, (which estimated 2015 employment) and the 2017 USEER (which estimated 2016 employment) are different. Thus, as noted in the 2017 USEER, "As a result, not all data points are directly comparable between 2016 and 2017." In other words, it is difficult to estimate employment trends between the two years. See *U.S. Energy and Employment Report,* https://www.energy.gov/downloads/2017-us-energy-and-employment-report.

specified that this refers to 50,000 persons, each employed annually for 10 years. These distinctions may sound technical, but they are critical to a proper interpretation of the results.

In estimating the impacts on the entire labor market, it is important to recognize that one lost or gained dollar of economic output or one lost or gained job is not the same as another. Each industry has backward linkages to economic sectors that provide the materials needed for the industry's output, and each industry also has forward linkages to the economic sectors where the industry's employees spend their income. Therefore, in addition to the jobs directly supported by an industry, a large number of indirect jobs may also be supported by that industry. The inclusion (or exclusion) of jobs and output in industries with strong backward and forward linkages to other economic sectors can cause indirect and induced impacts. Employment multipliers measure how the creation or destruction of output or employment in a particular industry translates into wider employment changes throughout the economy.[36]

Accordingly, MISI estimated the total (direct, indirect, and induced) jobs created by the CCUS retrofits and related expenditures: [37]

- Direct jobs are those created directly in the specific activity or process.
- Indirect jobs are those created throughout the required interindustry supply chain.
- Induced jobs are those created in supporting or peripheral activities.
- Total jobs are the sum or all of the jobs created.
- For simplicity, MISI will include induced jobs in the indirect category.

The total (direct, indirect, and induced) jobs concept is the accepted methodology widely used in studies of this nature and in the peer-reviewed literature.

In the analysis and forecasting, MISI followed the conventions in the U.S. Energy Information Administration's *Annual Energy Outlook 2020* (*AEO 2020*) and *Annual Energy Outlook 2019* (*AEO 2019*), and dollar estimates are expressed in terms of constant 2019 dollars.[38] The other standard conventions of the EIA AEO reports were also adhered to. In addition, the conventions of the required U.S. Bureau of Labor

[36]See, for example, "Understanding Multipliers," https://implanhelp.zendesk.com/hc/en-us/articles/115009505707-Understanding-Multipliers.

[37]The basic MISI methodology and model are documented in Management Information Services, Inc., *Development of Economic and Job Impacts Analysis Tool and Technology Deployment Scenario Analysis*, report prepared for the U.S. Department of Energy, National Energy Technology Laboratory, DOE/NETL-402/092509, September 2009. For applications, see Management Information Services, Inc. and Leonardo Technologies Inc., "Economic Impact Assessment of CCUS Retrofit of the Comanche Generating Station," prepared for the U.S. Department of Energy and the National Energy Technology Laboratory, June 2019; Roger Bezdek and Robert Wendling, "Economic, Environmental, and Job Impacts of Increased Efficiency in Existing Coal-Fired Power Plants," *Journal of Fusion Energy*, Volume 32, Number 2 (April 2013), pp. 215-220; Roger Bezdek, "Maximum Burden: The Electricity Price Increases From the Proposed EPA Utility MACT Will Act as a Regressive Tax on the Elderly," *Public Utilities Fortnightly*, December 2012; Roger H. Bezdek and Robert M. Wendling, "The Return on Investment of the Clean Coal Technology Program in the USA," *Energy Policy*, March 2013, Vol. 54, pp. 104-112.

[38]U.S. Energy Information Administration, *Annual Energy Outlook 2020*, January, 2020; U.S. Energy Information Administration, *Annual Energy Outlook 2019*, January 2019.

Statistics, U.S. Bureau of Economic Analysis, and U.S. Census Bureau data bases were followed.[39]

III.B. The CCUS Retrofit Scenario

The impacts of the CCUS Retrofit Scenario were estimated by MISI using methodology similar to that employed in other recent CCUS impact studies for DOE.[40]

III.B.1. Retrofit Plant Construction

As discussed, here CCUS retrofit of the SJGS was assessed. The retrofit total overnight capital cost of the CCUS retrofit was estimated to total $1.3 billion (2019 dollars).

Following Enchant's planned schedule, it was assumed that CCUS retrofit construction would begin in 2021 and be completed by the end of 2023, and that operations would begin in 2024. The construction schedule was developed from the NETL CCUS retrofit plant construction schedule and was estimated to be as shown in Table III-1.[41]

Table III-1
CCS Retrofit Plant Construction Schedule

Year 1	Year 2	Year 3
0.25	0.40	0.35

Source: Management Information Services, Inc. and U.S. National Energy Technology Laboratory.

The construction schedule in is given in Table III-2.

[39]See also U.S. Department of Commerce, Bureau of Economic Analysis, "Regional Economic Accounts, Gross Domestic Product," http://www.bea.gov/regional/index.htm; Melissa Thevenin and Jonathan Elliott, "Economic Impacts of the Construction Industry on the State of Colorado," Department of Construction Management, Colorado State University, January 2015; U.S. Energy Information Administration, "Colorado State Profile and Energy Estimates," http://www.eia.gov/state/?sid=CO.

[40]See Management Information Services, Inc., "Assessment of the Jobs Impacts of CCUS Retrofit of Four Coal Power Plants in Wyoming," op. cit.; Management Information Services, Inc. and Leonardo Technologies Inc., "Economic Impact Assessment of CCUS Retrofit of the Comanche Generating Station," op. cit.; Management Information Services, Inc., "Estimates of the Jobs Likely to be Generated by the 2018 Enacted 45Q Legislation Compared to Those Likely From the 2017 Proposed CCUS Tax Credits," op. cit.

[41]See Management Information Services, Inc., "Employment Impact Analysis of Coal Carbon Capture and Sequestration Retrofits," prepared for National Energy Technology Laboratory, August 2015.

Table III-2
CCUS Retrofit Plant Construction Expenditures
(Millions of 2019 dollars)

Plant	Year 1	Year 2	Year 3
SJGS 1 & 4	$325	$520	$455

Source: Management Information Services, Inc., U.S. National Energy Technology Laboratory, and Leonardo Technologies Inc.

The major CCUS retrofit plant construction metrics were:

- Retrofit of two coal-fired units with combined 847 MW (net) pre-CCUS capacity with one common (3-train) CCUS unit.
- Utilization of Mitsubishi Heavy Industries' technology.
- Utilization of an amine-based CO_2 removal process
- Economic life of 30 years

The preferred method of developing an estimate of the CCUS retrofit jobs would be a comprehensive modeling approach of the type previously conducted for NETL.[42] A final demand vector for CCUS retrofits would be constructed, and this vector could then be used with economic input-output analysis to estimate the total (direct and indirect) employment generated by the CCUS retrofit program. This would provide an estimate of the overall jobs impact. However, due to time and resource constraints, this type of detailed analysis was not possible for this project.

We thus had to estimate the number of jobs that would be created by the CCUS retrofit program using proxy data. We used two sources for these proxy data:

- National industry jobs estimates available from the federal government and other sources.
- Estimates of jobs impacts available from analytical studies of the employment effects of power plant expenditures.

The jobs impacts of the CCUS retrofit construction were thus estimated based on previous MISI research and on analysis of CCUS data and projects.[43]

[42]Management Information Services, Inc., *Economic and Employment Impacts of Increased Efficiency in Existing Coal-Fired Power Plants*, report prepared for the U.S. Department of Energy, National Energy Technology Laboratory, DOE/NETL-41817M4462, June 2009; Management Information Services, Inc., *Development of Economic and Job Impacts Analysis Tool and Technology Deployment Scenario Analysis*, op. cit.; and Management Information Services, Inc., "Employment Impact Analysis of Coal Carbon Capture and Sequestration Retrofits," prepared for National Energy Technology Laboratory, op. cit.

[43]See Management Information Services, Inc., "Assessment of the Jobs Impacts of CCUS Retrofit of Four Coal Power Plants in Wyoming," prepared for the U.S. Department of Energy, July 2020; Management Information Services, Inc. and Leonardo Technologies Inc., "Economic Impact Assessment of CCUS Retrofit of the Comanche Generating Station," op. cit.; Ernst & Young, "Estimated Economic and Fiscal Impacts of the Kemper County IGCC Project," report prepared for the Mississippi Development Authority, March 2009; "Petition of Mississippi Power Company For a Certificate of Public Convenience and Necessity Authorizing the Acquisition, Construction, and Operation of an Electric Generating Plant, Associated Transmission Facilities, Associated Gas Pipeline Facilities, Associated Rights-Of-Way, and Related Facilities In Kemper, Lauderdale, Clarke, and Jasper Counties, Mississippi," Final Order on Remand

It was also difficult to estimate the additional jobs that would be created by the ongoing operation and maintenance (O&M) of the plant that would result from the retrofit program, since there are few data on the number of permanent O&M jobs that would be created by such a retrofit program.[44] One estimate of the O&M jobs that would be required by the retrofit program is that of the average O&M jobs in existing and planned coal power plants, and we thus estimated the O&M jobs that would be required using the normalized average of O&M jobs in existing coal power plants.[45] We used a "micro" approach by examining the actual O&M permanent employees at a number of coal plants and a "macro" approach where we estimated the overall national average of O&M employees at U.S. coal power plants. Using an estimate of annual plant O&M

Granting a Certificate of Public Convenience and Necessity, Authorizing Application of Baseload Act, and Approving Prudent Pre-Construction Costs, Before The Mississippi Public Service Commission Mississippi Power Company Docket No. 2009-Ua-014 Ec-120-0097-00; Jeff Byrd, "Kemper Co. Looks to Implement Portera Plan," *The Meridian Star*, February 22, 2015; Jeff Byrd , "Mississippi Power Officials Tout Benefits of Kemper Plant," *The Meridian Star*, April 5, 2015; SaskPower, "SaskPower Boundary Dam Carbon Capture Project," https://www.saskpower.com/our-power-future/infrastructure-projects/carbon-capture-and-storage/boundary-dam-carbon-capture-project; Suzanne Goldenberg, "Canada Switches on World's First Carbon Capture Power Plant Boundary Dam Held up as First Commercial-Scale Ccs Plant and Proof That Coal-Burning is Compatible With Cutting Emissions," *The Guardian*, October 1, 2014; Jesse Jenkins, "Financing Mega-Scale Energy Projects: A Case Study of the Petra Nova Carbon Capture Project," prepared for the CEO Council for Sustainable Urbanization, October 2015; Sonal Patel, "Capturing Carbon and Seizing Innovation: Petra Nova is Power's Plant of the Year," *Power*, August 2017; "Public Direct Testimony of Ralph C. Smith on Behalf of Citizens Action Coalition of Indiana, Inc., Hoosier Chapter of the Sierra Club, Save the Valley, Inc., and Valley Watch, Inc.," in Verified Petition of Duke Energy Indiana, Inc. Seeking (1) Approval of an Ongoing Review Progress Report: Pursuant to Ind. Code 8-1-8.5 and 8-1-8.7 and (2) Authority to Reflect Costs: Incurred for the Edwardsport Integrated Gasification Combined Cycle Generating Facility ("IGCC Project") Cause No.43114-IGCC-12/13 Property Under Construction in its Rates and Authority to Recover Applicable Related Costs and Credits Through its Integrated Coal Gasification Combined Cycle Generating Facility Cost Recovery Adjustment, Standard Contract Rider No. 61 Pursuant to Ind. Code §§ 8-18-.8-11, December 15, 2014; "Petition of Mississippi Power Company For Finding of Prudence In Connection With the Kemper County Integrated Gasification Combined Cycle Generating Facility, Response to Surrebuttal Filing in Support of Prudence," Before the Mississippi Public Service Commission, Mississippi Power Company Docket No. 2013-Ua-189 Ec-120-0097-00; David Schlissel and Dennis Wamsted, "Holy Grail of Carbon Capture Continues to Elude Coal Industry," Institute for Energy Economics and Financial Analysis, November 2018; Roger H. Bezdek, "Economic, Employment, and Energy Stimulus From Clean Coal Technology Deployment," chapter 2 in *Harnessing Coal's Carbon Content to Advance the Economy, Environment, and Energy Security*, National Coal Council, Washington, D.C., June 2012; Management Information Services, Inc., "Analyzing the Economic and Job Impacts of the DOE R&D Program and CCS Tax Credits," prepared for the National Energy Technology Laboratory, DOE contract DE-FE 0025912, January 2018; Management Information Services, Inc., "Estimating the Economic and Job Benefits of NETL Coal R&D Programs," prepared for the National Energy Technology Laboratory, August 2017; Management Information Services, Inc., "Employment Impact Analysis of Coal Carbon Capture and Sequestration Retrofits," prepared for National Energy Technology Laboratory, August 2015; Management Information Services, Inc., *Literature Review of Employment Impact Studies of Power Generation Technologies*, report prepared for the U.S. Department of Energy, National Energy Technology Laboratory, DOE/NETL-41817M4462, April 2009; Management Information Services, Inc., "Analyzing and Estimating the Economic and Job Benefits of U.S. Coal," prepared for the U.S. Department of Energy, September 2017.

[44]Ibid.

[45]See the discussion in Management Information Services, Inc., "A Retrospective Analysis of the Costs, Impacts, and Benefits of the U.S. Department of Energy Coal R&D Program," prepared for the U.S. Department of Energy, May 2020.

expenditures and average salaries in NAICS code 2211121, fossil fuel electric power generation, we derived estimates of O&M employees.

MISI developed two estimates of the O&M jobs required. For the first, we used a "micro" approach by examining the actual O&M permanent employees at a number of coal plants. While the number of such employees per MW differed somewhat among different plants, it was usually in the range of about 0.15 to 0.20 per MW. For example:

- The Dave Johnston plant in Wyoming had about 0.21 permanent O&M employees per MW.
- The Karn Weadock plant in Michigan had about 0.19 permanent O&M employees per MW.
- The expanded Karn Weadock plant would have about 0.16 permanent O&M employees per MW.
- The Gorgas plant in Georgia had about 0.20 permanent O&M employees per MW.
- The Coal Creek plant in North Dakota had about 0.20 permanent O&M employees per MW.
- The Avon Lake plant in Ohio had about 0.15 permanent O&M employees per MW.
- The San Juan plant in New Mexico had about 0.22 permanent O&M employees per MW.
- The Eastlake plant in Ohio had about 0.13 permanent O&M employees per MW.
- The Comanche Generating station in Colorado had about 0.17 permanent O&M employees per MW.
- The planned Mesaba plant in Minnesota would have had about 0.17 permanent O&M employees per MW.
- The planned NRG plant in New York would have had about 0.15 permanent O&M employees per MW.
- Other plants usually had between about 0.10 and 0.20 permanent O&M employees per MW.

Thus, on the basis of these and other actual facilities, a 1,000 MW coal power plant would likely have about 100 to 200 permanent O&M employees.

To derive another estimate of the O&M jobs for a coal plant, we used a "macro" approach where we estimated the overall national average of O&M employees at U.S. coal power plants. Using an estimate of annual plant O&M expenditures and average salaries in NAICS code 2211121, fossil fuel electric power generation, we estimate that the average O&M employee per MW is about 0.15. Thus, according to this procedure, a 1,000 MW coal power plant would have about 150 permanent O&M employees.[46]

[46]EIA had estimated that the average 300 MW coal-fired power plant had 53 employees. This translates to about 0.18 permanent employees per MW.J. Alan Beamon and Thomas J. Leckey. "Trends in Power Plant Operating Costs," Energy Information Administration, EIA, 1999. NAICS is the North American Industrial Classification System

Thus, the estimate for coal plans of about 0.15 permanent O&M employees per MW seemed viable and, accordingly, here we used the estimate of approximately 0.15 permanent O&M employees per MW for coal power plants. As discussed earlier, the preferred method of developing an estimate of the total (direct plus indirect) jobs generated by the on-site O&M jobs would be a comprehensive modeling approach.[47] However, due to time and resource constraints, this type of detailed analysis was not possible for this project, and we had to use another methodology.

The two major economic and job impacts resulting from the coal plant CCUS retrofit program derive from the capital cost expenditures for the plants and from the ongoing O&M of the plants.[48]

III.B.2. CO_2 for EOR

In the CCUS retrofit scenario, MISI adhered to the Enchant plan and assumed that all of the CO_2 captured will be used for EOR in EPA approved permanent storage sites in EOR fields in the Permian Basin. It was thus assumed that the captured CO_2 will displace CO_2 from natural sources, and that therefor there will be no additional economic impact from EOR. The price assumptions for EOR were derived from *AEO 2020*.[49]

The major CO_2 capture system performance metrics were:

- Three year construction period
- 30 year operation beginning in 2024
- Retrofit of two coal-fired units with combined 847 MW (net) pre-CCUS capacity with one common (3-train) CCUS unit.
- Utilization of Mitsubishi Heavy Industries' technology.
- Amine-based CO_2 removal process.
- 85% capacity factor (pre-retrofit), 75% (post-retrofit).
- Heat rates obtained from EPA CEMS.
- 3-yr. construction, 30-yr. operation from 2024.

The CO_2 costs were inferred from the CO_2 valuation and volumes reported to COGCC every quarter.[50] WTI spot price data were aggregated to each quarter, and were sourced from EIA estimates. The correlation between the inferred CO_2 cost and the oil price is positive, but not of the same range as the purported 1-2% of the oil price.

[47]See Management Information Services, Inc., *Development of Economic and Job Impacts Analysis Tool and Technology Deployment Scenario Analysis*, report prepared for the U.S. Department of Energy, National Energy Technology Laboratory, DOE/NETL-402/092509, September 2009.
[48]See Angelos Kokkinos, "Looking at the Future of CCUS and Clean Coal Technologies," Western States Coal Strategies Forum, November 2019, Moab, Utah.
[49]U.S. Energy Information Administration, *Annual Energy Outlook 2018*, op. cit.
[50]Leonardo Technologies, Inc., op. cit.

III.B.3. CO_2 Pipelines

The CO_2 transportation cost estimation was consistent with estimates for oil and gas industry. The 45Q and EOR tax credits were assumed to be available through project lifetime, and 85% credit monetization was assumed. Oil prices were based on *AEO 2020* estimates, and CO_2 prices were based on data from the wellhead price of CO_2 extrapolated to *AEO 2020* projected crude prices.[51]

Following the Sargent and Lundy study, it was assumed that only one 20" pipeline will be needed for the CO_2 produced from SJGS. The CO_2 pipeline will be 20 miles in length to connect to the Kinder Morgan Cortez CO_2 pipeline.[52] MISI assumed that all costs are in the EIA Central region. Due to the short pipeline length, it was assumed that pipeline construction could be completed in one year.[53] For the pipeline costs we used the latest Federal tax rate.

The pipeline O&M costs are dependent on the length of pipeline, and were estimated on a per mile basis. Because this pipeline is less than 100 miles long, there is no requirement for additional pumps or compression stations.

The jobs impacts of this activity were estimated based on relevant published estimates of the economic and jobs impacts of pipeline construction and pipeline O&M and the economic and jobs profile of the oil and gas pipeline and related structures construction industry (NAICS 23712). The total CAPEX and job creation for pipeline construction in any given year is determined by the pipeline under construction and the relevant CAPEX for the pipeline. The jobs created by the pipeline deployment are the sum of the jobs created during the construction of the pipeline and the O&M jobs as the pipeline comes on line.

III.C. The PNM Renewable Scenario

As discussed, MISI compared the job impacts of the SJGS CCUS retrofit scenario to those of PNM Scenario 3, which comprises:

- 500 MW of solar
- 140 MW of wind
- 410 MW of batteries
- No natural gas or other fossil fuels.
- Closure of the SJGS in 2022
- Closure of the San Juan mine in 2022
- SJGS decommissioning completed in 2025
- The provision by PNM of approximately $41 million in payments for severance, job training, and community assistance.

[51]Simulations were conducted using the EIA Reference and High Oil Price scenarios.
[52]Sargent and Lundy, op. cit.
[53]For interstate pipelines a three year construction period would be assumed.

Under this scenario, the SJGS and the SJM both close in 2022. We assumed that both facilities would continue to operate through 12-31-2022, but not thereafter. Thus, under the PNM scenario, employment at SJGS and the SJM would continue without reduction through 2022, and terminate on 12-31-2022.

Estimation of the job impacts of the PNM scenario required estimating the net impacts of the job losses resulting from closure of the SJGS and the SJM and the jobs created by the photovoltaic, wind, and battery facilities – both in the San Juan local area and the state of New Mexico. Estimates of the jobs impacts of the SJGS and the SJM were available from the CCUS scenario. The jobs created by the PNM scenario were estimated separately from the construction and O&M jobs impacts of the photovoltaics facilities, the wind facilities, and the battery facilities.

The job impacts of the battery facilities have been analyzed much less than those of photovoltaics or wind, and were estimated on the basis of research conducted by NREL, the Solar Foundation, the Energy Storage Foundation, the New York Jobs Project, and other organizations.[54]

Unlike batteries, the job impacts and jobs potential of wind energy systems have been the subject of extensive research over the past two decades. Various advocacy organizations and researchers contend that wind energy is a large job creator, although the estimates vary widely according to the wind energy system analyzed, the time frame, the geographic area, and other factors. NREL has developed various Jobs and Economic Development (JEDI) models applicable to wind energy systems, and these have been widely used to assess potential jobs impacts of wind energy development.[55] However, published estimates of jobs created by construction and O&M of wind energy systems

[54]See, for example, Wesley Cole, and A. Will Frazier, *Cost Projections for Utility-Scale Battery Storage*, National Renewable Energy Laboratory, NREL/TP-6A20-73222, 2019; Lazard's Levelized Cost of Storage Analysis – Version 4.0," Lazard, November 2018; The Solar Foundation, "Solar + Storage Jobs Discussion Paper," Washington, D.C., 2016; Energy Storage Association, "35x25: A Vision For 2025," 2017; the New York Jobs Project, "A Guide to Creating Jobs in Energy Storage," December 2018; Ran Fu, Timothy Remo, and Robert Margolis, *2018 U.S. Utility-Scale Photovoltaics-Plus-Energy Storage System Costs Benchmark*, National Renewable Energy Laboratory, NREL/TP-6A20-71714, 2018.

[55]For descriptions of the JEDI model and its applications see L. Billman and D. Keyser, "Assessment of the Value, Impact, and Validity of the Jobs and Economic Development Impacts (JEDI) Suite of Models," Technical Report NREL/TP-6A20-56390, National Renewable Energy Laboratory, August 2013; Barry Friedman, Philip Jordan, and John Carrese, "Solar Installation Labor Market Analysis," Technical Report NREL/TP-6A20-49339, National Renewable Energy Laboratory, December 2011; C. Augustine, C. Johnson, and M. Goldberg, "Jobs and Economic Development Impact (JEDI) Model Geothermal User Reference Guide," NREL Report/Project Number: TP-6A20-55781, September 2012; Suzanne Tegen, "Wind Energy Workforce Development and Jobs," National Renewable Energy Laboratory, November 2016; National Renewable Energy Laboratory, "JEDI Photovoltaics," 2017, https://jedi.nrel.gov/; David Keyser, Francisco Flores-Espino, Caroline Uriarte, and Sadie Cox, "User Guide For The International Jobs and Economic Development Impacts Model," National Renewable Energy Laboratory, NREL/TP-6A20-67036, September 2016; Jinwon Bae and Sandy Dallerba, "The Economic Impact of a New Solar Power Plant in Arizona: Comparing the Input-Output Results Generated by JEDI vs. IMPLAN," *Regional Science Policy & Practice*, Volume 8, Numbers 1-2, March-June, 2016.

vary widely, even often for comparable systems and installations.[56] Here MISI estimated the construction and O&M job impacts of wind energy systems based on recent research on wind job impacts in the U.S. west and southwest, estimates based on the NREL JEDI models and related research, and estimates consistent with input-output models.

The job impacts and jobs potential of photovoltaics energy systems have also been the subject of extensive research over the past two decades, although not as much research as wind energy systems. Similarly, various advocacy organizations and researchers contend that photovoltaics energy is a large job creator, although the estimates vary widely according to the PV system analyzed, the time frame, the geographic area, and other factors.[57] NREL has developed various JEDI models

[56]See, for example, Luigi Aldieri, Jonas Grafström, Kristo_er Sundström, and Concetto Paolo Vinci, "Wind Power and Job Creation," *Sustainability*, 12, 45, 2020; Tyler Stehly and Philipp Beiter, *2018 Cost of Wind Energy Review*, National Renewable Energy Laboratory, NREL/TP-5000-74598, 2020; Tyler Comings, Spencer Fields, Kenji Takahashi, and Geoff Keith, "Employment Effects of Clean Energy Investments in Montana," Prepared for Montana Environmental Information Center and Sierra Club, June 5, 2014; Ashley J. Lawson, Molly F. Sherlock, Michaela D. Platzer, Corrie E. Clark, and Tadlock Cowan, "Solar Energy: Frequently Asked Questions," Congressional Research Service, January 27, 2020; Anelia Milbrandt, Donna Heimiller, and Paul Schwabe, "Techno-Economic Renewable Energy Potential on Tribal Lands," NREL/TP-6A20-70807, National Renewable Energy Laboratory, July 2018; Eric Lantz and Suzanne Tegen, "Jobs and Economic Development from New Transmission and Generation in Wyoming," Technical Report NREL/TP-6A20-50577, National Renewable Energy Laboratory, March 2011; Paul Dvorak, "How Many Jobs do Wind Farms Create?" Southern Wind Energy Association, April 12, 2016; Manish Ram, Arman Aghahosseini, and Christian Breyer, Job Creation During the Global Energy Transition Towards 100% Renewable Power System by 2050," *Technological Forecasting and Social Change*, July 2019; S. Reategui and S. Tegen, "Economic Development Impacts of Colorado's First 1000 Megawatts of Wind Energy," National Renewable Energy Laboratory, Presented at WINDPOWER 2008, Houston, Texas June 1-4, 2008; M. Wei, S. Patadia, and D. Kammen, "Putting Renewables and Energy Efficiency to Work: How Many Jobs Can the Clean Energy Industry Generate in the U.S.?" *Energy Policy*, Vol. 38, 2010, pp. 919-931; Ashley J. Lawson, Molly F. Sherlock, Michaela D. Platzer, Corrie E. Clark, and Tadlock Cowan, "Solar Energy: Frequently Asked Questions," Congressional Research Service, January 27, 2020; Manish Ram*, Arman Aghahosseini, Christian Breyer, "Job Creation During the Global Energy Transition Towards 100% Renewable Power System by 2050," *Technological Forecasting and Social Change*, July 2019; Environmental and Energy Study Institute, "Jobs from Renewable Energy and Energy Efficiency," October 2009; National Resources Defense Council, "Powering Jobs Growth With Green Energy," September 2019; Hillard G. Huntington, "Creating Jobs With 'Green' Power Sources," Energy Modeling Forum, Stanford University, April 2009.

[57]See U.S. Department of Energy, "SunShot Vision Study, February 2012; International Finance Corporation, "Utility-Scale Solar Photovoltaic Power Plants: A Project Developer's Guide, 2015; Electric Power Research Institute, "EPRI, Budgeting For Solar PV Plant Operations & Maintenance: Practices and Pricing, December 2015; The Solar Foundation, "10th Annual National Solar Jobs Census 2019," February 2020; "Investing in the Sun Economic and Environmental Benefits of Developing 1,000 Megawatts of Distributed Generation Solar in Colorado," Environment Colorado, 2011; International Renewable Energy Agency, "Renewable Energy and Jobs -- Annual Review 2017," Masdar City Abu Dhabi, United Arab Emirates, 2017; C. Roselund, "Make Solar Great Again", *PV Magazine*, November 22, 2016; R. Fu, "U.S. Solar Photovoltaic System Cost Benchmark," National Renewable Energy Laboratory, 2017; B. Eckhouse, "Solar Jobs Are Rising, Despite Trump's Tariffs," *Renewable Energy World*, April 11, 2018; L. Cameron and BVan Der Zwaan; "Employment Factors For Wind and Solar Energy Technologies: A Literature Review," *Renewable and Sustainable Energy Reviews*, Vol. 45, 2015, pp. 160-172; International Renewable Energy Agency, "Renewable Energy and Jobs -- Annual Review 2019," Masdar City Abu Dhabi, United Arab Emirates, 2019; "Solar Generation: Solar Electricity for Over One Billion People and Two Million Jobs by 2020," Greenpeace, 2006.

applicable to PV energy systems, and these have been used widely to assess potential jobs impacts of PV energy development.[58] However, as for wind, published estimates of jobs created by construction and O&M of wind energy systems vary widely, even often for comparable systems and installations.[59] Here MISI estimated the construction and O&M job impacts of PV energy systems based on recent research on PV job impacts in the U.S. west and southwest, estimates based on the NREL JEDI models and related research, and estimates consistent with input-output models.

On the other hand, researchers have questioned the purported economic and job development impacts of renewable energy systems, both in general and compared to other energy alternatives. Some research has even concluded that RE such as wind and PV energy systems are actually net job destroyers.[60] In addition, research has found that RE such as wind and solar increase electricity costs and rates, which tends to depress economic development and lead to job losses. Research has found a statistically significant relationship between the percent of RE penetration and electricity rates and econometric studies have determined that renewable portfolio standards increase electricity rates.[61]

[58]For descriptions of the JEDI model and its applications see L. Billman and D. Keyser, "Assessment of the Value, Impact, and Validity of the Jobs and Economic Development Impacts (JEDI) Suite of Models," Technical Report NREL/TP-6A20-56390, National Renewable Energy Laboratory, August 2013; Barry Friedman, Philip Jordan, and John Carrese, "Solar Installation Labor Market Analysis," Technical Report NREL/TP-6A20-49339, National Renewable Energy Laboratory, December 2011; C. Augustine, C. Johnson, and M. Goldberg, "Jobs and Economic Development Impact (JEDI) Model Geothermal User Reference Guide," NREL Report/Project Number: TP-6A20-55781, September 2012; Suzanne Tegen, "Wind Energy Workforce Development and Jobs," National Renewable Energy Laboratory, November 2016; National Renewable Energy Laboratory, "JEDI Photovoltaics," 2017, https://jedi.nrel.gov/; David Keyser, Francisco Flores-Espino, Caroline Uriarte, and Sadie Cox, "User Guide For The International Jobs and Economic Development Impacts Model," National Renewable Energy Laboratory, NREL/TP-6A20-67036, September 2016; Jinwon Bae and Sandy Dallerba, "The Economic Impact of a New Solar Power Plant in Arizona: Comparing the Input-Output Results Generated by JEDI vs. IMPLAN," *Regional Science Policy & Practice*, Volume 8, Numbers 1-2, March-June, 2016.

[59]See footnote 56**.**

[60]See, for example, Charles J. Cicchetti, "Inflated Numbers; Erroneous Conclusions: The Navigant Wind Jobs Report," National Center for Public Policy Research, the American Energy Alliance, March 2013; Robert Michaels and Robert P. Murphy, "Green Jobs: Fact or Fiction?" Institute for Energy Research, January 2009; Gabriel Calzada Álvarez, "Study of the Effects on Employment of Public Aid to Renewable Energy Sources," *Procesos De Mercado*, Volumen VII, Número 1, *Primavera*, 2010; https://www.aei.org/carpe-diem/inconvenient-energy-fact-it-takes-79-solar-workers-to-produce-same-amount-of-electric-power-as-one-coal-worker/; Norman Rogers, "Nevada's Renewable Energy Delusion," March 29, 2020, https://www.renewablefairytales.com/nevada-renewable-energy-delusions.html.

[61]See Michael Greenstone, and Ishan Nath, "Do Renewable Portfolio Standards Deliver?" Energy Policy Institute at the University of Chicago, Working Paper · No. 2019-62, May 9, 2019; Michael Shellenberger, "Yes, Solar and Wind Really do Increase Electricity Prices -- and For Inherently Physical Reasons," *Forbes*, April 25, 2018; David G. Tuerck, Paul Bachman, and Michael Head, "The Economic Impact of Wisconsin's Renewable Portfolio Standard," Wisconsin Policy Research Institute, March 2013, Vol. 26, No. 4; Gregory Upton and Brian Snyder, "Funding Renewable Energy: An Analysis of Renewable Portfolio Standards," *Energy Economics*, Vol. 66, 2017, pp. 205-216.

IV. COMPARATIVE RESULTS

IV.A. Impacts on CO_2 Emissions Reductions

The New Mexico ETA requires electric generating facilities in the state with an originally installed capacity exceeding 300 MW, to comply with a CO_2 emissions standard requiring emission of under 1,100 lb./MWh by January 1, 2023.[62] Installation of CCUS at SJGS will decrease CO_2 emissions by at least 90%, or approximately 6 million tons per year. More specifically, CCUS installation at SJGS would limit CO_2 emissions to 243 lb./MWh-gross and 254 lb./MWh-gross for Units 1 and 4 respectively, which is 77% below the emissions standard required by the ETA.[63]

SJGS is subject to federal and state regulations on emissions. As a result of the environmental upgrade completed in 2017, the plant is at present fully compliant with all limits required under a 2013 settlement agreement with the New Mexico Environmental Department and the U.S. EPA. SJGS had selective noncatalytic reduction (SNCR) technology installed for NO_x control on Units 1 and 4. The SNCR was determined to be the Best Available Retrofit Technology (BART) at the time of the settlement agreement. The installation of SNCR on the SJGS brought the plant into compliance with Section 113(g) of the Clean Air Act.[64]

The settlement agreement also resulted in a lower SO_2 permitted emission rate for Units 1 and 4 and the retirement of Units 2 and 3 by the end of 2017. The settlement agreement does not have an expiration or renewal date. With CCUS installed, SJGS will continue to be compliant with the terms of the 2013 settlement agreement. Installation of CCUS will not increase emissions of any controlled pollutants and, in addition to CO_2 reductions, will likely reduce facility emissions of particulate, SO2, NOx, ammonia and mercury.[65]

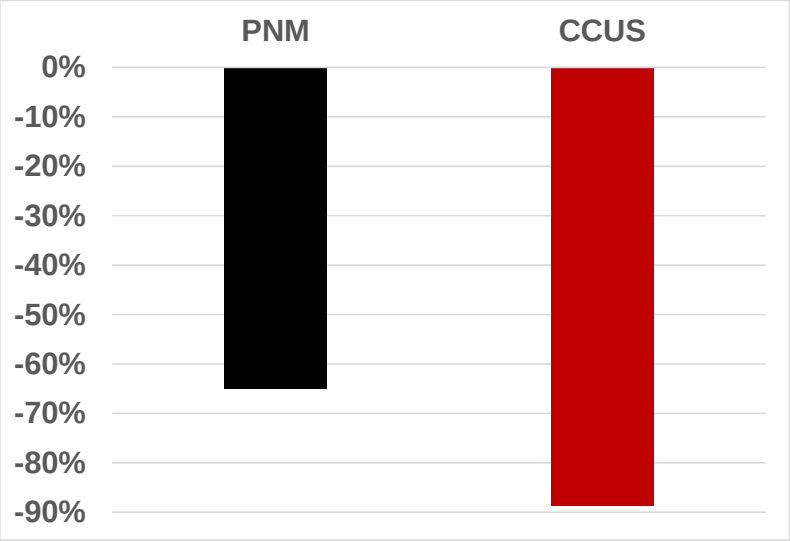
Figure IV-1 shows the estimated CO_2 emissions reductions under the CCUS scenario and the PNM scenario. It illustrates that:

- Under the PNM scenario, CO_2 emissions will be reduced about 65%
- Under the CCUS scenario, CO_2 emissions will be reduced nearly 89%

Thus, the CCUS scenario reduces CO_2 emissions by about 24% more than does the PNM scenario.

[62]"SB # 489: Energy Transition Act," https://350newmexico.org/bill/.
[63]Sargent and Lundy, op. cit.
[64]Ibid.
[65]Ibid.

Figure IV-1
CO_2 Reductions Under Each Scenario



Source: Sargent & Lundy and Public Service of New Mexico.

IV.B. Job Impacts

To compare the relative job impacts in the San Juan area and in New Mexico, MISI utilized employment and demographic data as of January 2020 – prior to the COVID-19 pandemic and its economic consequences.[66] The January 2020 demographic and labor force information for New Mexico and San Juan County[67] is summarized in Table IV-1. This table shows that in January 2020 for New Mexico:

- The population was 2.2 million.
- The labor force totaled 958,300.
- Employment totaled about 910,000.
- Unemployment totaled about 48,000.
- The unemployment rate was 5.0%.

It shows that in January 2020 for San Juan County:

- The population was 124,000.
- The labor force totaled 52,500.
- Employment totaled about 48,300.
- Unemployment totaled about 3,200.
- The unemployment rate was 6.2%.

[66]New Mexico Department of Workforce Solutions, https://www.dws.state.nm.us/LMI.
[67]The Farmington MSA comprises over 93% of the population of San Juan County. Further, 97% of San Juan Generating Station employees live in San Juan County, and 92% of San Juan Mine employees live in San Juan County. See Central Consolidated School District, "Understanding the Impacts Related to the San Juan Generating Station Closure," presentation to PSCOC Task Force, August 20, 2019.

Table IV-1
Basic Demographic and Labor Force Estimates for
San Juan County and New Mexico as of January 2020

	Population	Labor Force	Employed	Unemployed	Unemployment Rate
San Juan County	123,958	52,455	48,262	3,193	6.2%
New Mexico	2,097,000	958,293	910,393	47,900	5.0%

Source: New Mexico Department of Workforce Solutions.

The job impacts under the CCUS scenario derive from:

- CCUS Construction
- CCUS plant O&M
- Pipeline construction
- Pipeline O&M
- Continued operation of the SJGS
- Continued operation of the SJM

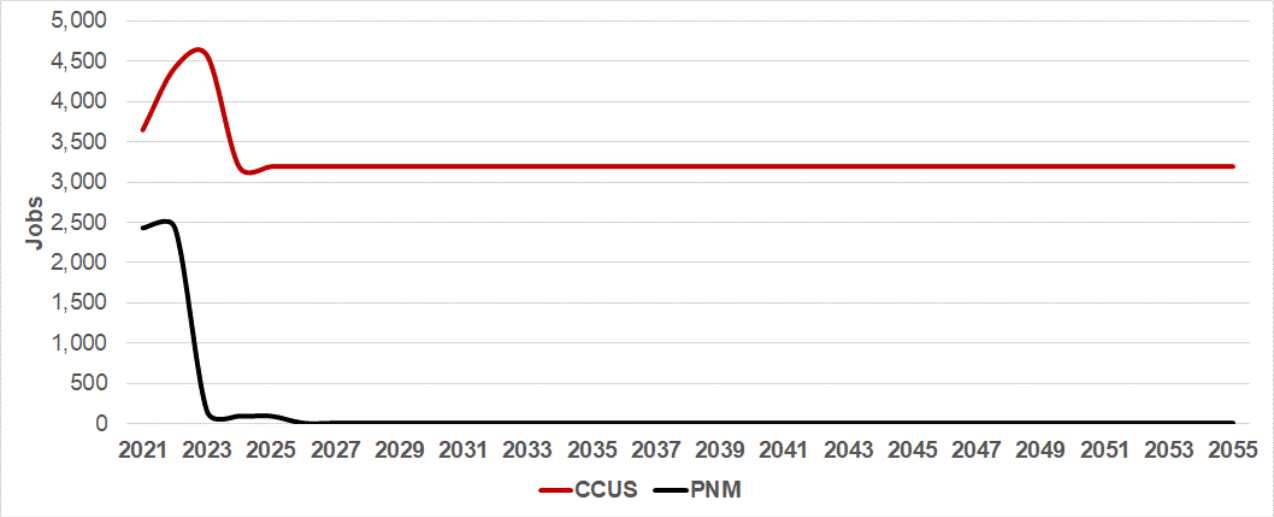
The job impacts from the PNM scenario derive from:

- PV plant construction
- PV plant O&M
- Wind turbine plant construction
- Wind turbine plant O&M
- Batter storage construction
- Batter storage O&M
- Continued operation of the SJGS through 2022
- Continued operation of the SJM through 2022
- Decommissioning of the SJGS

The job annual impacts 2021-2055 in San Juan County of the CCUS scenario and the PNM scenario are shown in Figure IV-1. This figure shows that in San Juan County:

- The CCUS scenario creates substantially more jobs every year than does the PNM scenario.
- During the CCUS construction phase, 2021-2023, the CCUS scenario creates an average of over 4,200 jobs annually compared to less than 1,600 jobs under the PNM.
- After 2022, job creation under the PNM scenario virtually ceases with the closing of SJGS and SJM.
- In 2024 and 2025, the CCUS scenario creates nearly 3,200 jobs annually compared to less than 100 jobs under the PNM scenario – most of the PNM jobs result from decommissioning SJGS.
- After 2025, the CCUS scenario creates nearly 3,200 jobs annually compared to about 10 jobs annually under the PNM scenario.

Figure IV-1
Comparative Annual Job Impacts in San Juan County
of the CCUS Scenario and the PNM Scenario



Source: Management Information Services, Inc.

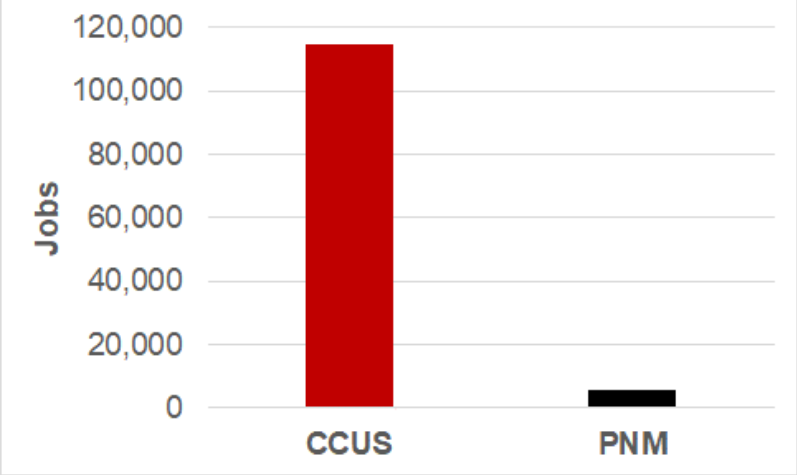
The two scenarios would have profoundly different impacts on the San Juan County labor force and employment. The "pre-COVID" number of unemployed was 3,193, whereas:

- In 2022, the CCUS scenario would create 40% more jobs as there were unemployed and nearly twice as many jobs as the PNM scenario.
- In 2023, the CCUS scenario will create 43% more jobs as there were unemployed and 30 times as many jobs as the PNM scenario.
- In 2024 and every year thereafter, the CCUS scenario will create about as many jobs as there are unemployed in San Juan County.
- By contrast, in 2023, 2024, and 2025, the PNM scenario creates less than 100 jobs annually and after 2026 less than 10 jobs annually.
- Over the long term the CCUS scenario creates, annually, 355 times as many jobs as the PNM scenario – about 3,100 more jobs every year.

Figure IV-2 shows the comparative cumulative job impacts in San Juan County of the CCUS scenario and the PNM scenario, 2021 – 2055. It illustrates that over the period 2021-2055:

- The CCUS scenario would create 115,000 jobs.
- The PNM scenario would create 5,500 jobs.
- The CCUS scenario would thus create more than 20 times as many jobs as the PNM scenario.
- After 2025, the PNM scenario creates virtually no jobs.

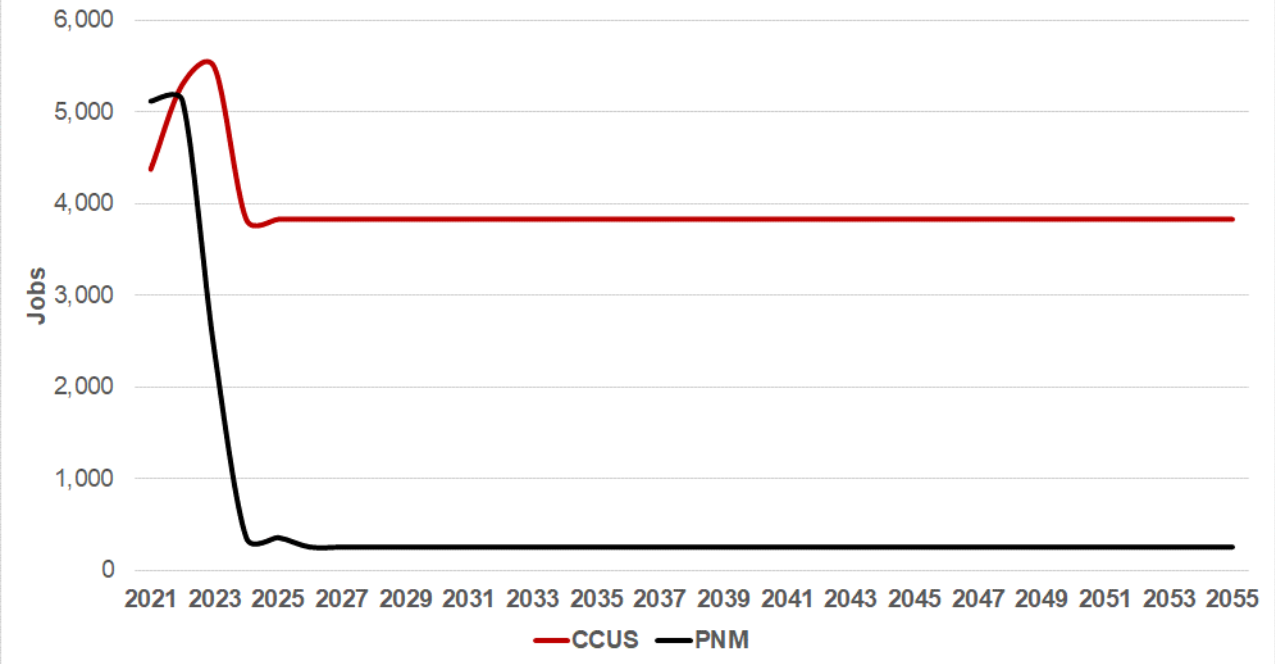
Figure IV-2
Comparative Cumulative Job Impacts in San Juan County of the CCUS Retrofit Scenario and the PNM Scenario, 2021 - 2055



Source: Management Information Services, Inc.

The job annual impacts 2021-2055 in New Mexico of the CCUS scenario and the PNM scenario are shown in Figure IV-3.

Figure IV-3
Comparative Annual Job Impacts in New Mexico of the CCUS Scenario and the PNM Scenario



Source: Management Information Services, Inc.

Figure IV-3 shows that in New Mexico:

- The CCUS scenario creates substantially more jobs every year than does the PNM scenario.
- During the CCUS construction phase, 2021-2023, the CCUS scenario creates an average of 5,100 jobs annually compared to 4,200 jobs under the PNM.
- After 2022, job creation under the PNM scenario declines drastically with the closing of SJGS and SJM.
- In 2023, 2024, and 2024, the CCUS scenario creates over 3,800 jobs annually compared to less about 360 jobs under the PNM scenario – nearly 30% of the PNM jobs result from decommissioning SJGS.
- After 2025, the CCUS scenario creates over 3,800 jobs annually compared to about 250 annually under the PNM scenario.

The two scenarios would have very different impacts on the New Mexico labor force and employment. The "pre-COVID" number of unemployed was 47,900, whereas:

- In 2023, the CCUS scenario would create about 12% as many jobs as there were unemployed and over twice as many jobs as the PNM scenario.
- In 2024 and every year thereafter, the CCUS scenario will create about 8% as many jobs as there are unemployed in New Mexico.
- By contrast, in 2024 and 2025, the PNM scenario creates less than 400 jobs annually and after 2026 less than 300 jobs annually.
- Over the long term the CCUS scenario creates, annually, 15 times as many jobs as the PNM scenario – about 3,600 more jobs every year.

Figure IV-4 shows the comparative cumulative job impacts in New Mexico of the CCUS scenario and the PNM scenario, 2021 – 2055. It illustrates that over the period 2021-2055:

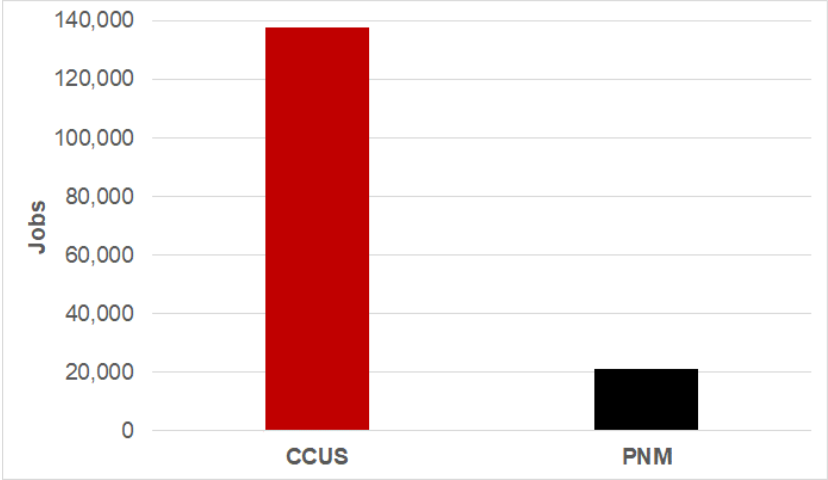
- The CCUS scenario would create 138,000 jobs.
- The PNM scenario would create 21,000 jobs.
- The CCUS scenario would thus create nearly seven times as many jobs as the PNM scenario.
- After 2025, the PNM scenario creates only about 250 jobs annually in New Mexico.

As noted, total employment in San Juan County in January 2020 was about 48,300 and the number of unemployed was about 3,200.[68] Thus, in 2023, the approximately 4,600 jobs created by the CCUS retrofits will comprise nearly ten percent of total San Juan County employment. In addition, as noted, the CCUS scenario will also avoid the job losses that would result from the closure of SJGS and SJM. Thus, after the CCUS retrofit construction is completed, permanent San Juan County employment resulting from the CCUS retrofit, the SJGS, and the SJM would be about 3,200 jobs – jobs that pay well above the San Juan average.[69] Further, San Juan County unemployment in January 2020 totaled about 3,200. Thus, the number of jobs created in San Juan County under the CCUS scenario will total more than 40% more than the number of unemployed in the

[68]New Mexico Department of Workforce Solutions, op. cit.
[69]Ibid. and https://www.payscale.com/research/US/Employer=San_Juan_County/Hourly_Rate.

county. After 2023, the number of jobs created by the CCUS scenario in San Juan County will total about the same number as the number of unemployed in the county.

Figure IV-4
Comparative Cumulative Job Impacts in New Mexico of the CCUS Retrofit Scenario and the PNM Scenario, 2021 - 2055

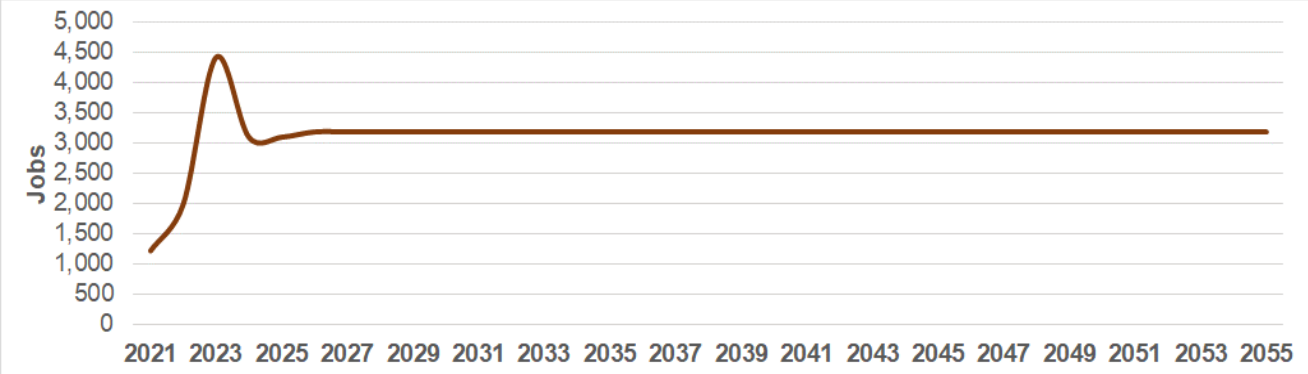


Source: Management Information Services, Inc.

This is illustrated graphically in Figure IV-5, which shows the net difference in jobs created annually in San Juan County by the CCUS scenario compared to the PNM scenario. It shows that:

- In 2021-2023, the CCUS generates between 1,200 and 4,400 more jobs each year than the PNM scenario
- In 2024 and 2025, the CCUS generates about 3,100 more jobs each year than the PNM scenario
- In 2026 – 2015, the CCUS generates about 3,200 more jobs each year than the PNM scenario

Figure IV-5
Net Difference in Jobs Created Annually in San Juan County by the CCUS Scenario Compared to the PNM Scenario



Source: Management Information Services, Inc.

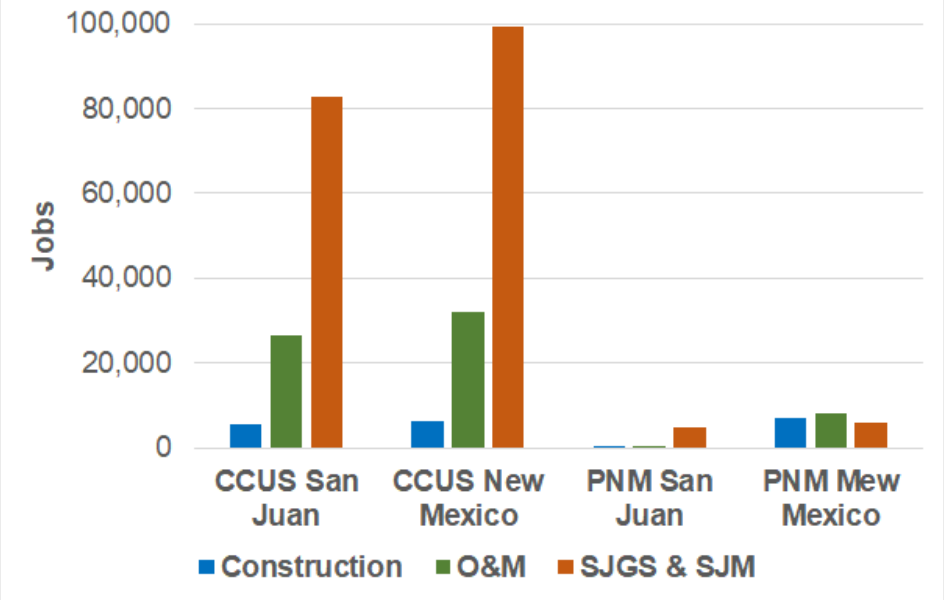
The CCUS scenario can achieve CO_2 emissions reductions significantly greater than those achieved under the PNM scenario, avoids economic harm and job loss to the San Juan area, and creates large numbers of jobs in the process. Figure IV-6 shows that the CCUS scenario creates significantly more jobs both in San Juan County and in New Mexico than does the PNM scenario. In San Juan County, compared to the PNM scenario:

- The CCUS Scenario creates 26 times as many construction jobs.
- The CCUS Scenario creates 92 times as many O&M jobs.
- The CCUS Scenario creates 17 times as many SJGS and SJM jobs.[70]

In New Mexico, compared to the PNM scenario:

- The CCUS Scenario creates about the same number of construction jobs.
- The CCUS Scenario creates four times as many O&M jobs.
- The CCUS Scenario creates more than 16 times as SJGS & SJM jobs.[71]

Figure IV-6
Total Jobs Created by the CCUS Scenario and the PNM Scenario, 2021-2055



Source: Management Information Services, Inc.

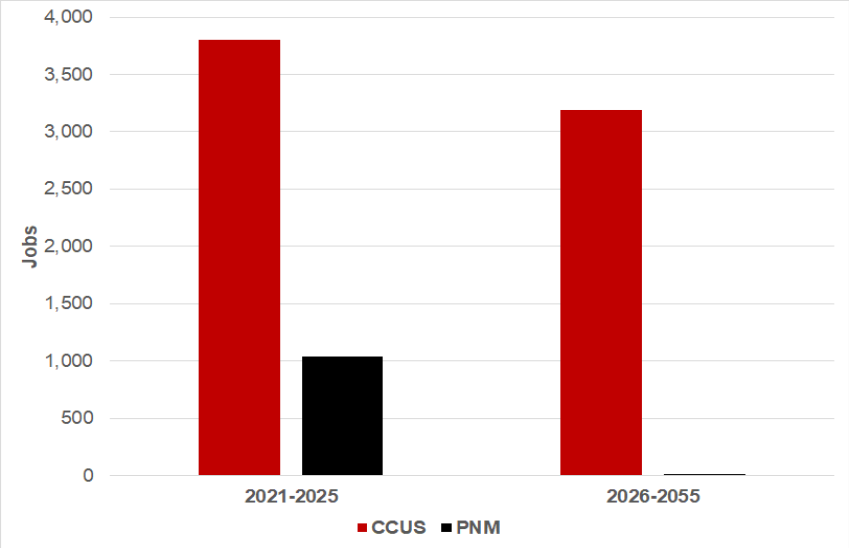
Figure IV-7 shows the time periods over which the jobs are created in San Juan County by the CCUS and the PNM scenarios. It demonstrates that the CCUS scenario creates more than 20 times as many jobs in San Juan County than the PNM scenario but, due to the construction and decommissioning schedules, most of the PNM jobs are created in those five years. Specifically, in San Juan County:

[70]SJGS decommissioning jobs included in the PNM total.
[71]SJGS decommissioning jobs included in the PNM total.

- In years 2021-2025, the CCUS scenario creates annually, on average, 3.7 times as many jobs as the PNM scenario.
- In years 2026-2055, the CCUS scenario creates annually, on average, 355 times as many jobs as the PNM scenario.

Thus, over the long term, the CCUS would ensure near full employment in San Juan County whereas the PNM scenario would result in over 12% unemployment in the county.

Figure IV-7
Average Number of Jobs Created in San Juan County

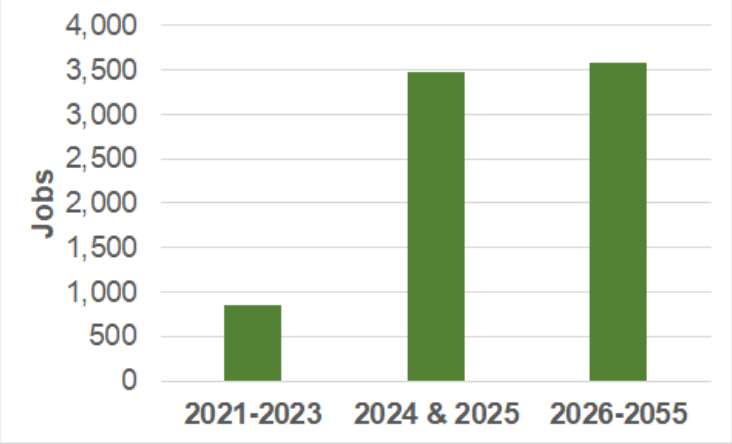


Source: Management Information Services, Inc.

Similar finding hold true for the impacts on the state of New Mexico – Figure IV-8:

- In years 2021-2023, the CCUS scenario creates annually in New Mexico, on average, 814 more jobs than the PNM scenario – more than 20% more jobs each year.
- In years 2024 and 2025, the CCUS scenario creates annually in New Mexico, on average, about 3,500 more jobs as the PNM scenario – about 10 times as many jobs each year.
- In years 2026 - 2055, the CCUS scenario creates annually in New Mexico, on average, about 3,600 more jobs as the PNM scenario – about 14 times as many jobs each year.

Figure IV-8
Net Difference in Jobs Created Annually in New Mexico by the CCUS Scenario Compared to the PNM Scenario



Source: Management Information Services, Inc.

IV.C. Impacts on Local Tax Revenues

The SJGS and the SJM are major tax generating facilities for the local San Juan area. The facilities provide substantial property taxes to local jurisdictions, including San Juan County, the Central Consolidated School District (CCSD), and the San Juan Community College (SJCC) – nearly $7 million annually to those three institutions alone. At least as significant, they provide thousands of well-paying direct and indirect jobs that generate substantial local tax revenues. Similarly, substantial local tax revenues will be generated by the CCUS retrofit construction and continuing O&M. Nevertheless, the most important contribution of the CCUS scenario to local tax revenues is the continued operation of the SJGS and the SJM.

The PNM scenario will also create local tax revenues via the construction and O&M of the renewables and batteries installed locally:

- 14 MW of batteries
- 13 MW of wind
- 13 MW of central station PV

As noted, MISI also assumed that all of approximately $41 million in payments for severance, job training, and community assistance under the PNM scenario would accrue to the local San Juan area. Nevertheless, the San Juan area local tax revenues would be much less under the PNM scenario than under the CCUS scenario, for three major reasons. First, the local installation of 40 MW of RE and batteries would represent only a small fraction of the assessed value of the CCUS retrofit facilities. Second, the number of local San Juan jobs under the PNM scenario would be only a small fraction of those generated under the CCUS scenario. Third, and most important, under the PNM scenario the SJGS and SJM would be closed, whereas under the CCUS scenario they would remain open – generating substantial direct and indirect local tax revenues.

The value of the new RE and CCUS facilities will be subject to property tax by San Juan County, the CCSD, and SJCC, and other local jurisdictions. Under New Mexico law, the taxable value of a property is equal to 33.33% of its assessed value.[72] In 2018, the San Juan County assessor estimated the taxable values of the SJGS and the SJM at $349.4 million and $25.2 million respectively, for a combined taxable value of $374.6 million.[73] San Juan County's total combined property tax rate is $24.28 per $1,000 taxable value -- 24.28 mils. MISI assumed that this tax rate would be applied to the new facilities constructed under the PNM scenario and the CCUS scenario.[74]

Direct and indirect local tax impacts will accrue during construction of the facilities under each scenario and annually thereafter during O&M. Direct and indirect local tax revenue impacts will be generated, and these include gross receipts, personal income, and property taxes paid by supply chain businesses, construction workers, O&M workers, contractors, employees of supply chain businesses, and workers in local induced company operations.

The two scenarios will have very different impacts on local San Juan area tax revenues. The major differences result from:

- The fate of the SJGS and the SJM and the tax revenues from these facilities.
- The total tax revenues generated by the jobs created – and the tax revenues lost when jobs are lost.
- The property tax revenues generated by the San Juan CCUS facilities and the San Juan renewable energy facilities.
- The tax revenues and equivalent payments generated by the combined severance, job training, and community assistance funds provided under the PNM scenario -- $40.6 million.

During the construction phase for the CCUS and the RE facilities, 2021-2023, tax revenues are generated in the CCUS scenario by the SJGS and SJM jobs, the CCUS construction jobs, and the tax revenues created by the operation of SJGS and SJM. During the construction phase for the RE facilities, 2021-2023, tax revenues are generated in the PNM scenario by the SJGS and SJM jobs through 2022, the RE and battery construction jobs, the decommissioning of SJGS beginning in 2023, and the tax revenues created by the continued operation of SJGS and SJM in 2021 and 2022.

In the years 2024 and 2025, the construction of all facilities has been completed. Tax revenues are generated in the CCUS scenario by the SJGS and SJM jobs, the CCUS O&M jobs, and the tax revenues created by the continued operation of SJGS, SJM, and CCUS retrofit facilities. In these two years, the tax revenues in the PNM scenario are generated by the tax revenues created by the operation of the RE and battery facilities,

[72]https://www.nmlegis.gov/handouts/RSTP%20092619%20Item%203%20O'Neill%20Prop%20Tax%20Summary%20History.pdf.
[73]San Juan County Assessor, https://www.sjcassessor.net
[74]San Juan County also levies a county local option of 0.014375 on transactions occurring in unincorporated areas. See O'Donnell, op. cit.

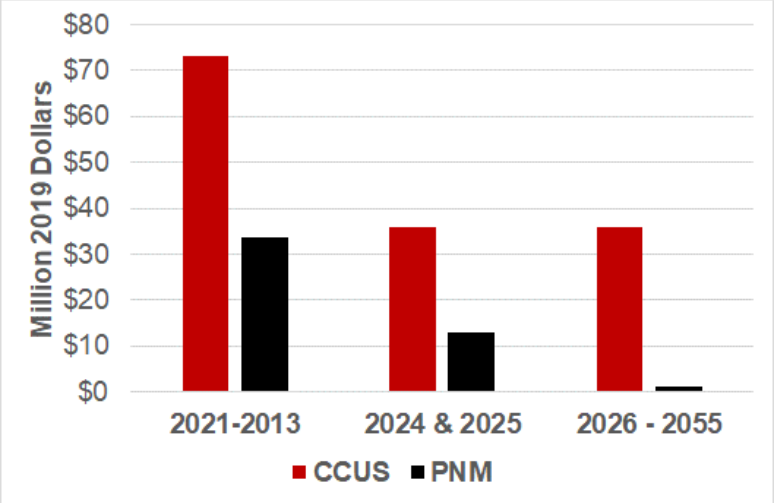
the RE and battery O&M jobs, the decommissioning of SJGS, and the tax revenues and equivalent payments created by the combined severance, job training, and community assistance funds provided under the PNM scenario.

In the years 2026 - 2055, tax revenues are generated in the CCUS scenario by the SJGS and SJM jobs, the CCUS O&M jobs, and the tax revenues created by the continued operation of the SJGS, the SJM, and the CCUS retrofit facilities. In these years, the tax revenues in the PNM scenario are generated by the tax revenues created by the operation of the RE and battery facilities.

The estimated local San Juan average annual tax revenue impacts under each scenario are shown in Figure IV-9. It is clear that the increased economic activity and jobs in the San Juan local community under the CCUS scenario will create increased earnings and tax revenues and much higher tax revenues than the PNM scenario:

- During the construction phase of the CCUS and the RE facilities, 2021-2023, the CCUS scenario generates over $73 million per year in local tax revenues and the PNM scenario generates less than $34 million per year in local tax revenues.
- Thus, in years 2021-2023, the CCUS scenario generates each year more than twice the local tax revenues as does the PNM scenario.
- In the years 2024 and 2025, the CCUS scenario generates about $36 million per year in local tax revenues and the PNM scenario generates about $13 million per year in local tax revenues.
- Thus, in years 2024-2025, the CCUS scenario generates each year nearly three times the local tax revenues as does the PNM scenario.
- In the years 2026- 2055, the CCUS scenario generates about $36 million per year in local tax revenues and the PNM scenario generates about $1.1 million per year in local tax revenues.
- Thus, in years 2026-2055, the CCUS scenario generates each year 33X more in local tax revenues as does the PNM scenario.

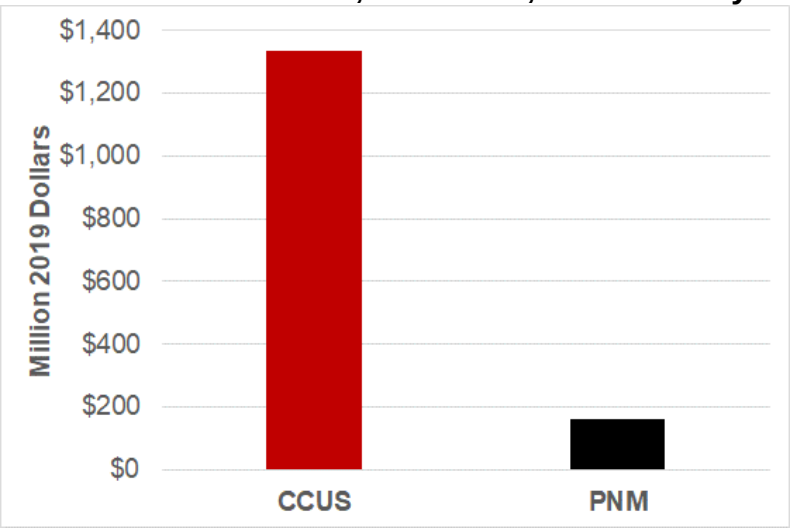
Figure IV-9
Average Annual San Juan Area Tax Revenue Impacts



Source: Management Information Services, Inc.

The total local tax revenues generated 2021-2055 under each scenario thus differ greatly, as illustrated in Figure IV-10.

Figure IV-10
Total Local San Juan Tax Revenues, 2021-2055, Generated by Each Scenario



Source: Management Information Services, Inc.

This figure shows that:

- Over the period 2021-2055, the CCUS scenario generates about $1.33 billion in total local tax revenues.
- Over the period 2021-2055, the PNM scenario generates about $160 million in total local tax revenues.
- Over the period 2021-2055, the CCUS scenario generates about $1.17 billion more in local tax revenues than the PNM scenario.
- Over the period 2021-2055, the CCUS scenario generates more than eight times as much local tax revenues than the PNM scenario.

The CCUS scenario will greatly improve the local San Juan fiscal situation. First, since the SJGS and the SJM will not be prematurely retired, they will continue to generate real estate tax revenues and the jobs at the facilities will also continue to generate local tax revenues. Under the PNM scenario this would not be the case, and, under the PNM scenario, the San Juan area would experience substantial tax revenue shortfalls beginning in 2023 when the SJGS and the SJM are retired and the associated jobs lost.

However, the CCUS scenario will also increase San Juan tax revenues starting in 2023 when construction is complete. First, jobs the SJGS and the SJM will be maintained and additional CCUS O&M jobs will be created. Second, not only will the SJGS continue in operation and maintain the plant's assessed valuation, but the assessed valuation – and thus real estate taxes -- will increase substantially. It is difficult to determine precisely the increased tax revenues that would accrue to the San Juan area from the CCUS

retrofits. However, based on the current assessed valuation of the SJGS, the real estate taxes it currently pays, the estimated cost of the CCUS retrofits, current San Juan real estate tax assessment protocols, and estimated tax and insurance payments, MISI estimates that the increased real estate taxes accruing to the local San Juan beginning area in 2023 would total over $10 million annually. These tax revenues would accrue every year for the life of the CCUS system, and would be an enormous beneficial windfall for San Juan. If taxes are assessed on construction work in progress (CWIP), the tax revenue increase for San Juan could begin as early as 2021.[75]

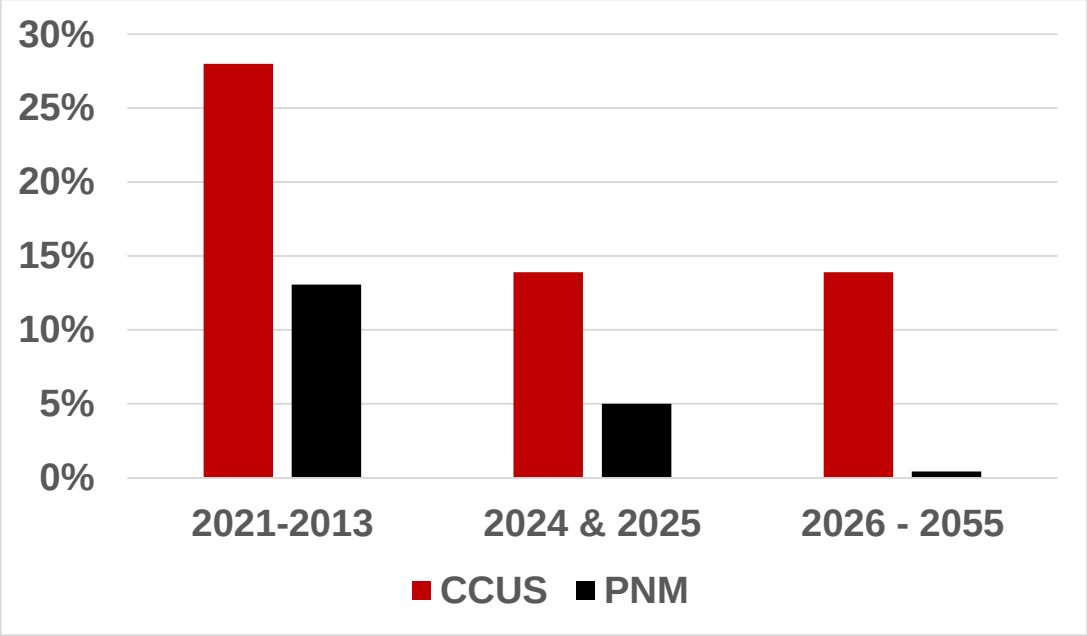
Figure IV-11 places the San Juan local area tax revenue impacts of the two scenarios into perspective. The differing impacts of the CCUS scenario and the PNM scenario on the total tax revenues from all sources for San Juan County, the Central Consolidated School District (CCSD), and the San Juan Community College (SJCC) are shown in Figure IV-11.[76] This figure illustrates that:

- During the years 2021-2023 of facilities' construction, the CCUS scenario contributes 28% of all tax revenues to the three jurisdictions and the PNM scenario contributes 13%.
- In 2024 and 2025, when under the PNM scenario decommissioning is still occurring and severance, job training, and community assistance payments are being made, the PNM scenario contributes 5% of all tax revenues to the three jurisdictions and the CCUS scenario contributes 14%.
- During the years 2026-2055, the CCUS scenario contributes 14% of all tax revenues to the three jurisdictions and the PNM scenario contributes less than 0.5%.
- Over the long term, the CCUS scenario would annually generate a substantial portion of the tax revenues of San Juan County, the CCSD, and the SJCC, whereas the PNM scenario would generate annually a trivial share of the tax revenues of the jurisdictions.
- Over the long term, under the PNM scenario San Juan County, the CCSD, and the SJCC would have to raise, each year, an additional $35 million to $40 million in tax revenues from other sources.
- Over the long term, under the PNM scenario San Juan County, the CCSD, and the SJCC would have to raise a total of an additional $1.1 billion to $1.2 billion in tax revenues from other sources.

[75]This is potentially a significant factor. For example, the Shoreham Nuclear Power Station in New York State was under construction during the 1970s and 1980s. Even though it never even opened, the taxes Shoreham paid for nearly two decades made the local school district one of the wealthiest in the U.S., and the Shoreham case was a landmark in litigation concerning property tax assessments of power facilities. MISI staff were deeply involved for years in the extensive litigation that resulted from the property tax assessment of the Shoreham plant. See Long Island Lighting Co. v. Assessor and Bd. of Assessment Review for Town of Brookhaven," 246 A.D.2d 156 (2d Dep't 1998).

[76]Based on the total estimated 2018 tax revenues for the three jurisdictions.

Figure IV-11
Impacts of the CCUS Scenario and the PNM Scenario on the Total Tax Revenues From All Sources of San Juan County, the CCSD, and the SJCC



Source: Management Information Services, Inc.

V. JOBS METRICS

V.A. Jobs Per MW

A major goal of this project is to estimate the jobs per MW created by the CCUS scenario compared to the jobs per MW created by the PNM renewable energy scenario, and to generalize the findings into estimates of jobs/MW for coal compared to renewables. These estimates can then be used to assess the economic and job implications of replacing coal power generation with renewables. Here, at least eight sets of options need to be compared:

- The jobs/MW created by the CCUS scenario compared to the PNM scenario – in the local San Juan area and in the state of New Mexico.
- The jobs/MW created by the CCUS scenario compared to the PNM scenario excluding the jobs impacts of the SJGS and the SJM – in the local San Juan area and in the state of New Mexico.
- The jobs/MW created by the construction activity in the CCUS scenario compared to the construction activity in the PNM scenario – in the local San Juan area and in the state of New Mexico.
- The/MW jobs created by the O&M operations in the CCUS scenario compared to the O&M operations in the PNM scenario – in the local San Juan area and in the state of New Mexico.

In addition, the jobs per MW of the CCUS scenario need to be compared to the jobs per MW of the individual RE components of the PNM scenario: Photovoltaics, wind, and batteries.

The jobs/MW created by the CCUS scenario compared to the PNM scenario indicate the jobs created by the CCUS scenarios compared to an "equivalent" RE scenario. The jobs and jobs/MW created in the local San Juan area are of obvious interest to policy makers and, especially, to residents of the local areas where the facilities will be constructed and operated. However, as has been discussed, most of the RE facilities in the PNM scenario are located outside of the San Juan area and we assumed that they are all located in the state of New Mexico. Thus, comparing the jobs impacts of the CCUS scenario and the PNM scenario in New Mexico presents an appropriate comparison of the total jobs/MW impact of each scenario. Finally, the CCUS scenario is for a coal plant of 847 MW and the PNM scenario contains RE and batteries totaling 1,050 MW. These have to be normalized to derive jobs/MW estimates.

The jobs/MW created by the CCUS scenario compared to the PNM scenario excluding the jobs impacts of the SJGS and the SJM is required to exclude the jobs impacts of the power station and the mine from both scenarios -- it also excludes the (relatively minor) jobs impacts of SJGS decommissioning. This allows us to compare the jobs impacts of only the CCUS facilities with only the RE facilities. Including the jobs impacts of the SJGS and the SJM obviously bias the results in favor of the CCUS scenario since under the PNM scenario both are closed in 2022. However, it must be noted that

one of the major economic and jobs benefits of the CCUS scenario is keeping both the SJGS and the SJM in operation.

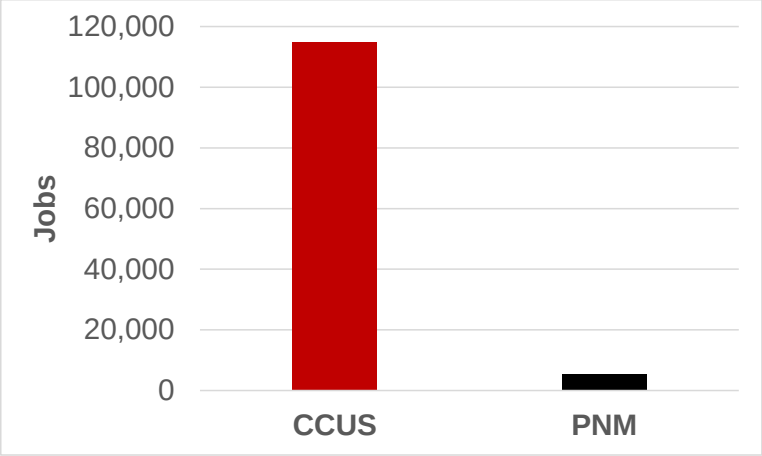
The jobs/MW created by the construction activity in the CCUS scenario compared to the construction activity in the PNM scenario are useful in comparing the relative jobs impacts of constructing the CCUS facilities and those of construction the RE and battery facilities. These jobs impacts, although limited to the three year construction period, are especially important in the local areas where the facilities are located.

Lastly, the jobs/MW created by the O&M operations in the CCUS scenario compared to the O&M operations in the PNM scenario are relevant to estimating the long term impacts of the facilities continuing operations over three decades. However, it must be again emphasized that one of the major economic and jobs benefits of the CCUS scenario is keeping both the SJGS and the SJM in operation.

Figure V-1 shows the comparative cumulative job impacts in San Juan County of the CCUS scenario and the PNM scenario, 2021 – 2055. It illustrates that over the period 2021-2055:

- The CCUS scenario would create 115,000 jobs.
- The PNM scenario would create 5,500 jobs.
- The CCUS scenario would thus create locally more than 20 times as many jobs as the PNM scenario.

Figure V-1
Comparative Cumulative Job Impacts in San Juan County of the CCUS Retrofit Scenario and the PNM Scenario, 2021 - 2055



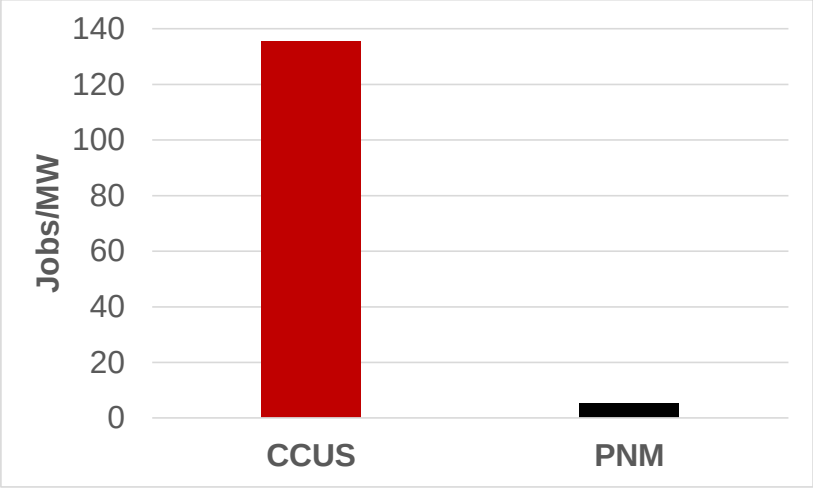
Source: Management Information Services, Inc.

Normalizing for the different MW in the CCUS scenario and the PNM scenario, Figure V-2 shows that in the local San Juan area, cumulatively over 2021 – 2055:

- The CCUS scenario generates over 136 jobs per MW
- The PNM scenario generates just over five jobs per MW

- Thus, the CCUS scenario generates 26 times as many jobs per MW as the PNM scenario.

Figure V-2
Comparative Cumulative Job Impacts/MW in San Juan County of the CCUS Retrofit Scenario and the PNM Scenario, 2021 - 2055



Source: Management Information Services, Inc.

Much of differential jobs impacts in Figures V-1 and V-2 arises from two factors: The jobs impacts of the continued operation of the SJGS and the SJM and the fact that most RE and battery facilities in the PNM scenario are outside of the local San Juan area.

Excluding the impacts of SJGS and SJM jobs, we have jobs generated in the CCUS scenario by:

- CCUS construction, 2021-2023
- CCUS O&M, 2024-2055
- Pipeline construction, 2023
- Pipeline O&M, 2024-2055

Excluding the impacts of SJGS and SJM jobs and the SJGS decommissioning, we have jobs generated in the PNM scenario by:

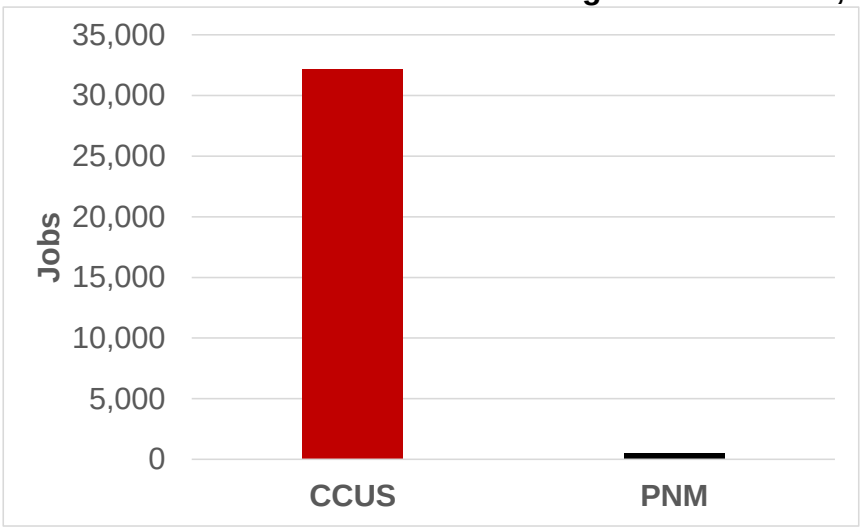
- PV construction, 2021-2023
- PV O&M, 2024-2055
- Wind construction, 2021-2023
- Wind O&M, 2024-2055
- Battery construction, 2021-2023
- Battery O&M, 2024-2055

Excluding the impacts of SJGS and SJM jobs, over the period 2021-2055 in the local San Juan area Figure V-3 shows total cumulative local San Juan jobs generated and illustrates that:

- The CCUS scenario generates about 32,150 jobs.

- The PNM scenario generates about 500 jobs.
- Thus, the CCUS scenario generates 64 times as many jobs as the PNM scenario.

Figure V-3
Total Local Cumulative San Juan Jobs Excluding SJGS and SJM, 2021-2055

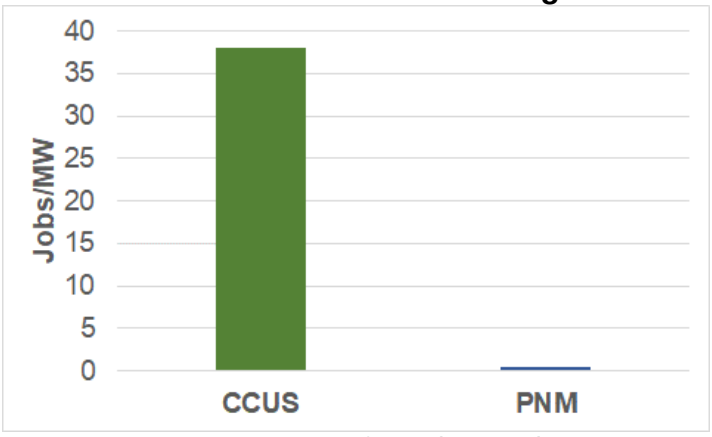


Source: Management Information Services, Inc.

Excluding the impacts of SJGS and SJM jobs, over the period 2021-2055 in the local San Juan area Figure V-4 shows total cumulative local San Juan jobs per MW generated and illustrates that:

- The CCUS scenario generates 38 jobs per MW
- The PNM scenario generates 0.48 jobs per MW
- Thus, per MW, the CCUS scenario generates nearly 80 times as many jobs per MW in the San Juan area as the PNM scenario.

Figure V-4
Total Local Cumulative San Juan Jobs/MW Excluding SJGS and SJM, 2021-2055



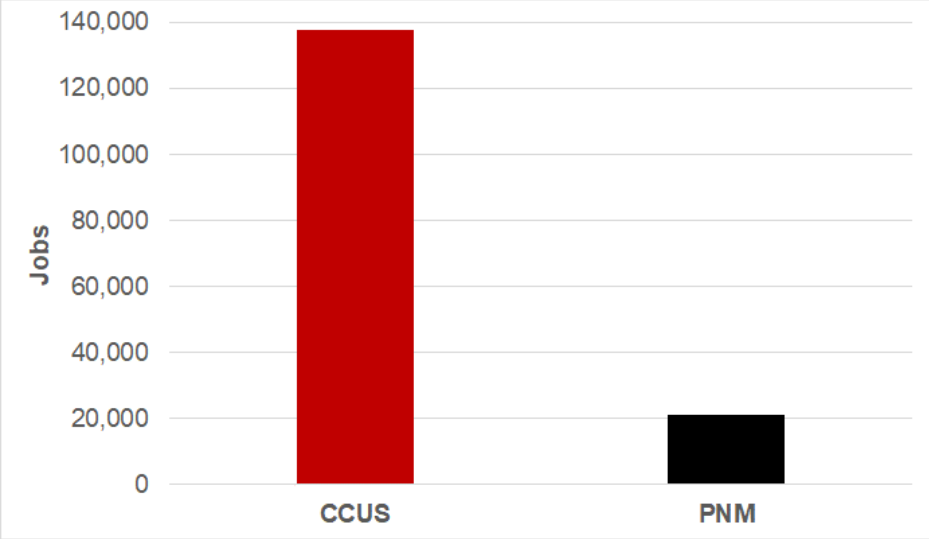
Source: Management Information Services, Inc.

To derive a more appropriate indication of the Jobs/MW of CCUS compared to RE it is necessary to estimate the jobs impacts in New Mexico since, as noted, most of the RE and battery facilities are located in the state but outside of the local San Juan area. Figure VI- shows the comparative cumulative job impacts in New Mexico of the CCUS scenario and the PNM scenario, 2021 – 2055. It illustrates that over the period 2021-2055 in New Mexico:

- The CCUS scenario would create 138,000 jobs.
- The PNM scenario would create 21,000 jobs.
- The CCUS scenario would thus create nearly seven times as many jobs as the PNM scenario.

Much of this differential arises from one factor: The jobs generated by the continued operation of the SJGS and the SJM.

Figure V-5
Comparative Cumulative Job Impacts in New Mexico of the CCUS Retrofit Scenario and the PNM Scenario, 2021 - 2055

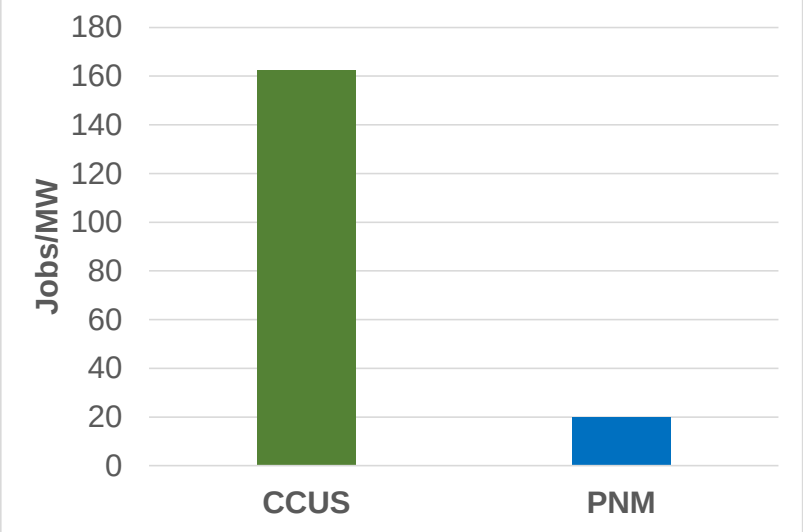


Source: Management Information Services, Inc.

Normalizing for the different MW in the CCUS scenario and the PNM scenario, Figure V-6 shows that in New Mexico, cumulatively over 2021 – 2055:

- The CCUS scenario generates 163 jobs per MW
- The PNM scenario generates 20 jobs per MW
- Thus, per MW, the CCUS scenario generates more than eight times as many jobs per MW in New Mexico as the PNM scenario.

Figure V-6
Comparative Cumulative Job Impacts/MW in New Mexico of the CCUS Retrofit Scenario and the PNM Scenario, 2021 - 2055

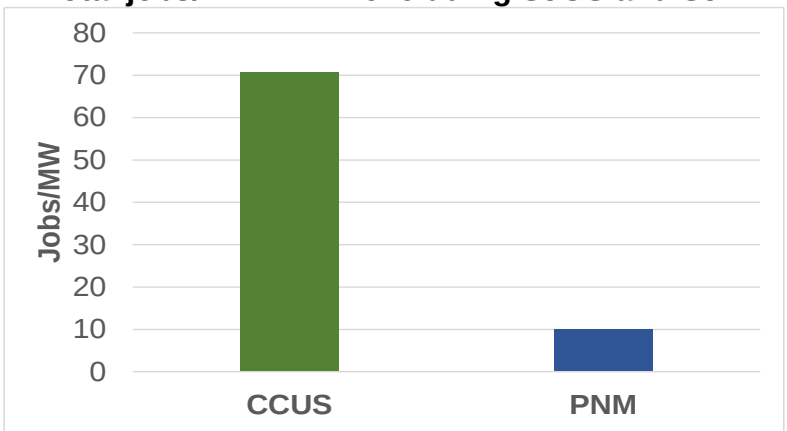


Source: Management Information Services, Inc.

Excluding the impacts of SJGS and SJM jobs, over the period 2021-2055 in New Mexico Figure V-7 shows total cumulative local San Juan jobs per MW generated and illustrates that:

- The CCUS scenario generates over 70 jobs per MW.
- The PNM scenario generates 10 jobs per MW.
- Thus, per MW, the CCUS scenario generates seven times as many jobs per MW in New Mexico as the PNM scenario.

Figure V-7
Total jobs/MW in NM excluding SJGS and SJM

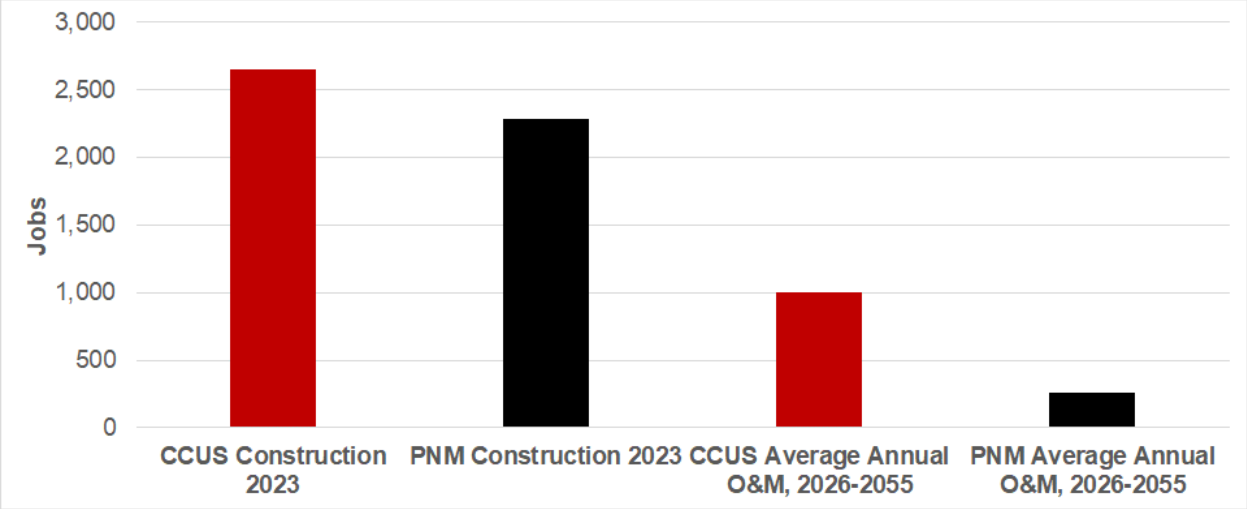


Source: Management Information Services, Inc.

We next consider the jobs impacts in New Mexico of the CCUS and the PNM scenarios excluding SJGS and SJM. Figure V-8 shows that in New Mexico, excluding the jobs impacts of SJGS and SJM, over the period 2021-2055:

- The CCUS scenario generates 2,655 construction jobs
- The CCUS scenario generates 1,000 O&M jobs
- The PNM scenario generates 2,285 construction jobs
- The PNM scenario generates 255 O&M jobs
- The CCUS scenario generates 16% more construction jobs than the PNM scenario.
- The CCUS scenario generates nearly four times as many O&M jobs as the PNM scenario.

Figure V-8
Comparative Cumulative Job Impacts in New Mexico of the Construction and O&M activities in CCUS Retrofit Scenario and the PNM Scenario, 2021 - 2055

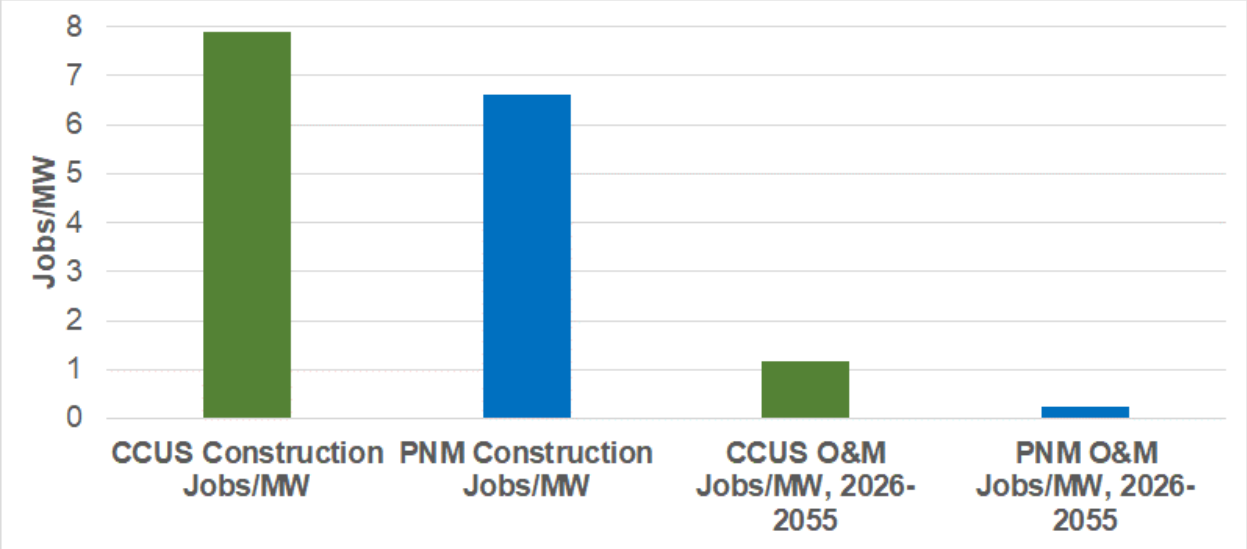


Source: Management Information Services, Inc.

Normalizing for the different MW in the CCUS scenario and the PNM scenario, Figure V-9 shows the jobs/MW impacts in New Mexico of the construction and O&M activities of the two scenarios over the period 2021-2055. It illustrates that:

- The CCUS scenario generates 7.9 jobs/MW in construction.
- The CCUS scenario generates 1.16 jobs/MW in O&M.
- The PNM scenario generates 6.6 jobs/MW in construction.
- The PNM scenario generates 0.24 jobs/MW in O&M.
- The CCUS scenario generates 20% more construction jobs/MW than the PNM scenario.
- The CCUS scenario generates nearly five times as many O&M jobs/MW as the PNM scenario.

Figure V-9
Jobs/MW in New Mexico: CCUS Scenario Compared to the PNM Scenario



Source: Management Information Services, Inc.

V.B. Assessment of Jobs Metrics

The PNM scenario includes substantial photovoltaics, wind, and battery components. It is useful to assess the jobs/MW created by the CCUS scenario compared to the jobs/MW created by each of the RE components of the PNM scenario. Accordingly, this section summarizes the differences in:

- The jobs/MW created by the CCUS scenario and the PNM scenario in the San Juan area and in New Mexico.
- The jobs/MW created by the CCUS scenario and the photovoltaics portion of the PNM scenario in the San Juan area and in New Mexico.
- The jobs/MW created by the CCUS scenario and the wind portion of the PNM scenario in the San Juan area and in New Mexico.
- The jobs/MW created by the CCUS scenario and the batteries portion of the PNM scenario in the San Juan area and in New Mexico.

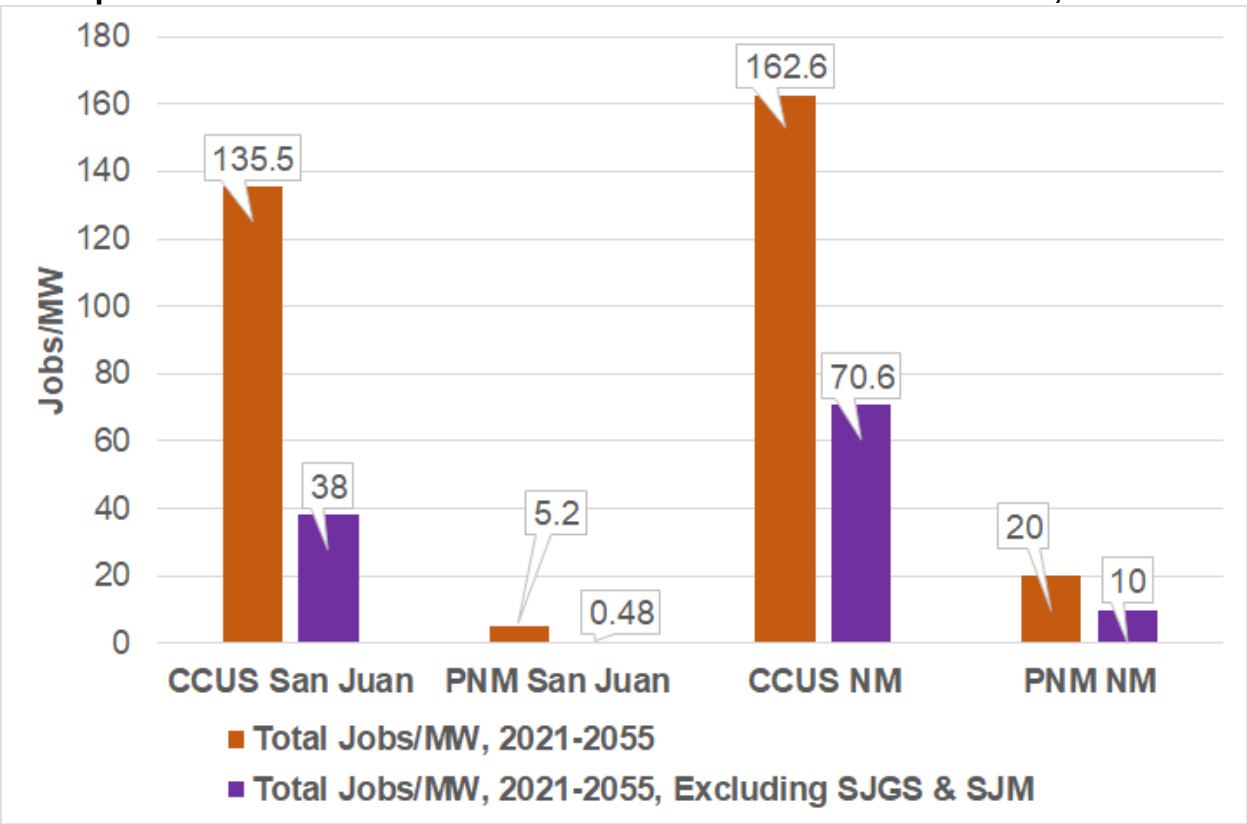
Figure V-10 summarizes the differences in jobs created per MW over the period 2021-2055 under the CCUS scenario and the PNM scenario in the San Juan area and in New Mexico. It illustrates stark differences. In terms of total jobs per MW over this period:

- In San Juan, the CCUS scenario generates over 135 jobs/MW whereas the PNM scenario generates 5.2 jobs/MW – a 26X difference.
- In New Mexico, the CCUS scenario generates over 162 jobs/MW whereas the PNM scenario generates 20 jobs/MW – a greater than 8X difference.

In terms of total jobs per MW over this period, excluding jobs from the SJGS and the SJM:

- In San Juan, the CCUS scenario generates 38 jobs/MW whereas the PNM scenario generates 0.48 jobs/MW – a 79X difference.
- In New Mexico, the CCUS scenario generates 70.6 jobs/MW whereas the PNM scenario generates 10 jobs/MW – a greater than 7X difference.

Figure V-10
Comparison of Total Jobs Per MW Under CCUS and PNM Scenarios, 2021-2055



Source: Management Information Services, Inc.

Figure V-11 shows the differences in jobs created per MW under the two scenarios by construction in 2023 – the year of maximum construction, and average O&M jobs over the period 2024-2055. It also illustrates striking differences. In terms of construction in 2023 jobs per MW in 2023:

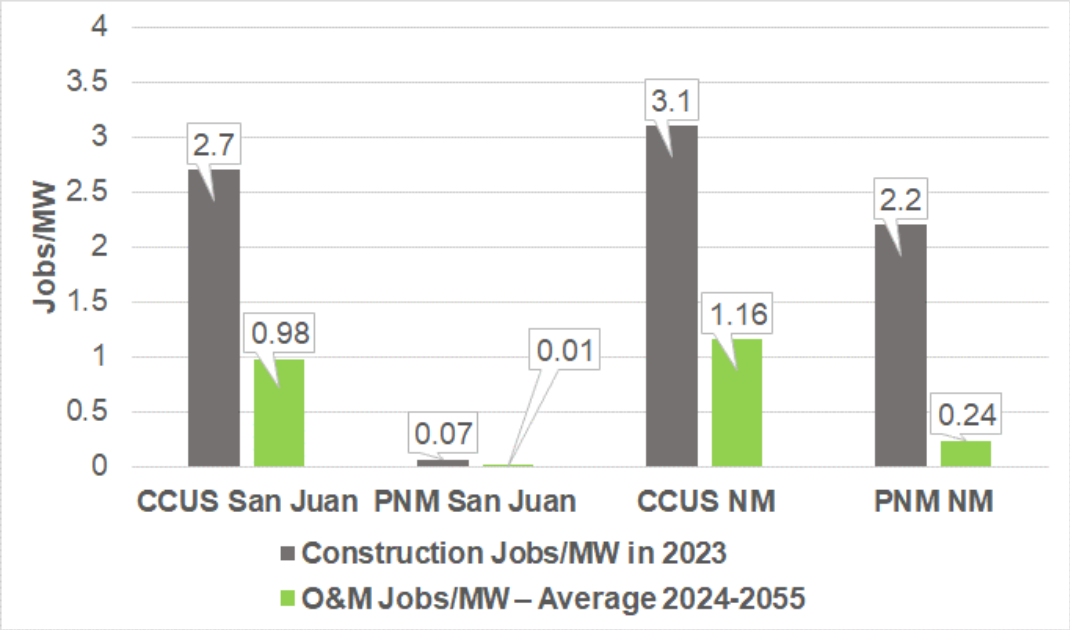
- In San Juan, the CCUS scenario generates 2.7 jobs/MW whereas the PNM scenario generates 0.07 jobs/MW – a 39X difference.
- In New Mexico, the CCUS scenario generates 3.1 jobs/MW whereas the PNM scenario generates 2.2 jobs/MW – a 1.4X difference.

In terms of average O&M jobs per MW over the period 2024-2055:

- In San Juan, the CCUS scenario generates 0.98 jobs/MW whereas the PNM scenario generates 0.01 jobs/MW – a 98X difference.

- In New Mexico, the CCUS scenario generates 1.16 jobs/MW whereas the PNM scenario generates 0.24 jobs/MW – a nearly 5X difference.

Figure V-11
Comparison of Construction and O&M Jobs
Per MW Under CCUS and PNM Scenarios



Source: Management Information Services, Inc.

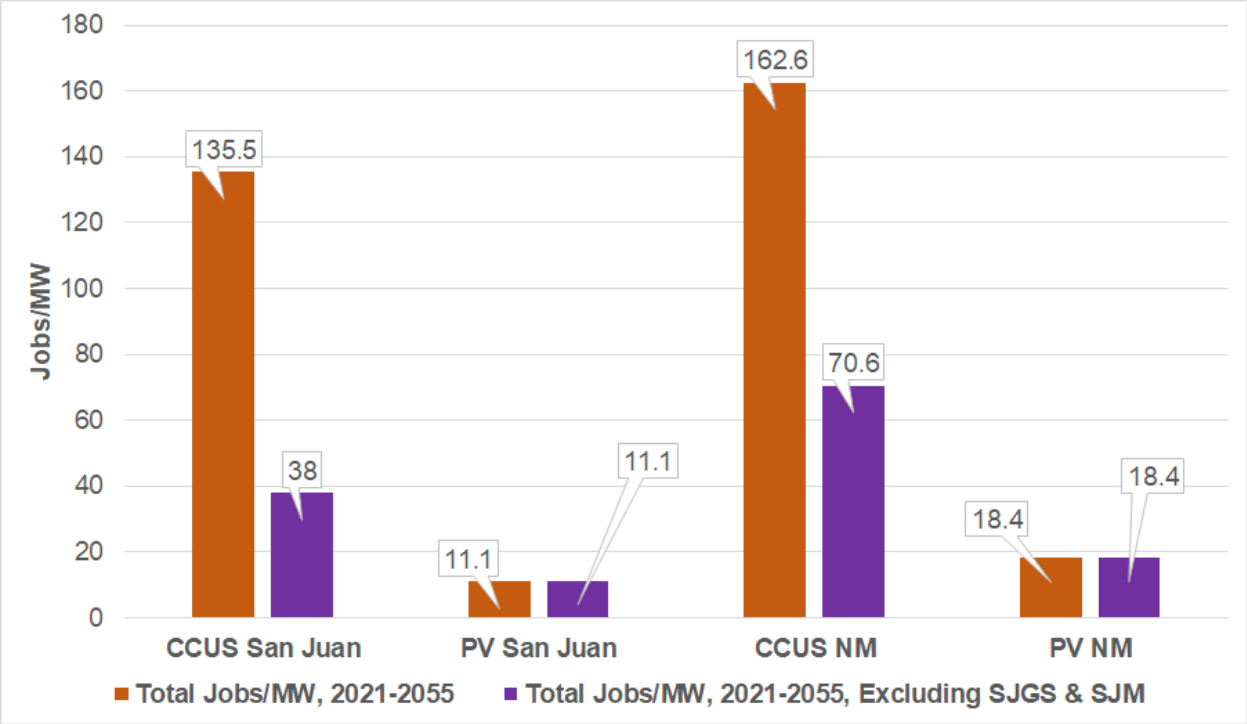
Figure V-12 shows the differences in jobs created per MW over the period 2021-2055 under the CCUS scenario and photovoltaics portion of the PNM scenario. It illustrates major differences. In terms of total jobs per MW over this period:

- In San Juan, the CCUS scenario generates over 135 jobs/MW whereas the photovoltaics portion of the PNM scenario generates 11.1 jobs/MW – a more than 12X difference.
- In New Mexico, the CCUS scenario generates over 162 jobs/MW whereas the photovoltaics portion of the PNM scenario generates 18.4 jobs/MW – a nearly 9X difference.

In terms of total jobs per MW over this period, excluding jobs from the SJGS and the SJM:

- In San Juan, the CCUS scenario generates 38 jobs/MW whereas the photovoltaics portion of the PNM scenario generates 11 jobs/MW – a 3.5X difference.
- In New Mexico, the CCUS scenario generates 70.6 jobs/MW whereas the photovoltaics portion of the PNM scenario generates 18.4 jobs/MW – a nearly 4X difference.

Figure V-12
Comparison of Total Jobs Per MW Under the CCUS Scenario and the Photovoltaics Portion of the PNM Scenario, 2021-2055



Source: Management Information Services, Inc.

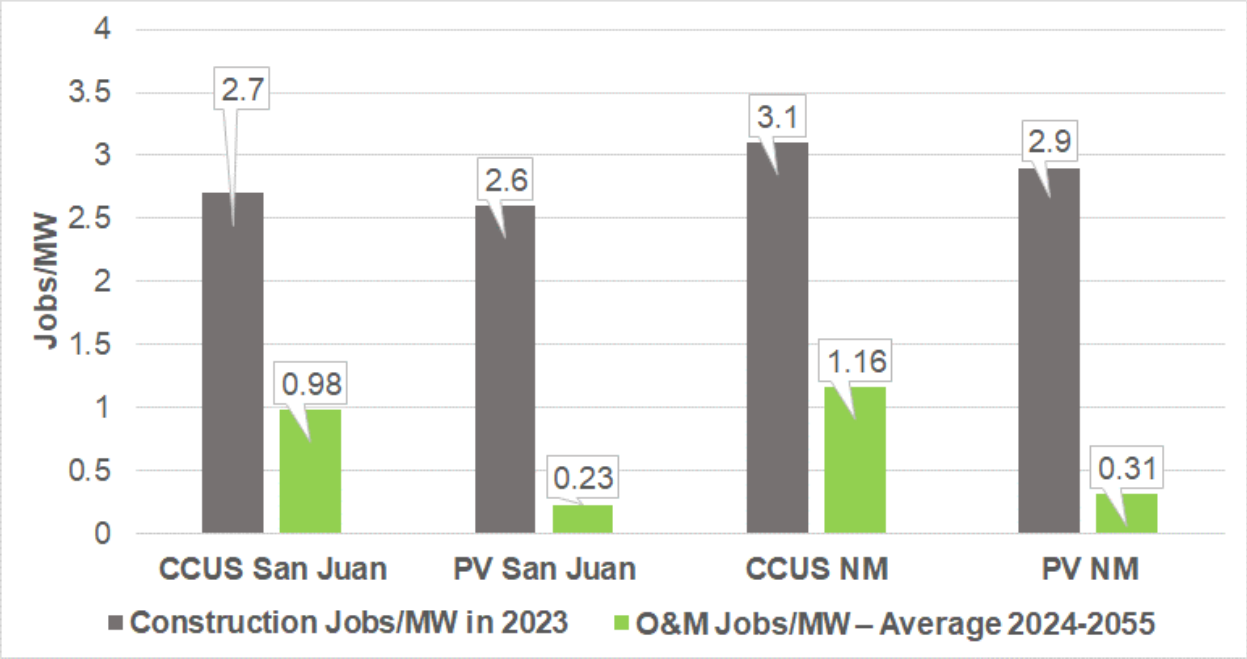
Figure V-13 shows the differences in jobs created per MW under the under the CCUS scenario and photovoltaics portion of the PNM scenario by construction in 2023 – the year of maximum construction, and average O&M jobs over the period 2024-2055. It also illustrates substantial differences. In terms of construction jobs per MW in 2023:

- In San Juan, the CCUS scenario generates about 2.7 jobs/MW under the CCUS scenario whereas the photovoltaics portion of the PNM scenario generates about 2.6 jobs/MW – a 4% difference.
- In New Mexico, the CCUS scenario generates 3.1 jobs/MW whereas the photovoltaics portion of the PNM scenario generates 2.9 jobs/MW – a 7% difference.

In terms of average O&M jobs per MW over the period 2024-2055:

- In San Juan, the CCUS scenario generates 0.98 jobs/MW whereas the photovoltaics portion of the PNM scenario generates 0.23 jobs/MW – a 4.3X difference.
- In New Mexico, the CCUS scenario generates 1.16 jobs/MW whereas the photovoltaics portion of the PNM scenario generates 0.31 jobs/MW – a 3.7X difference.

Figure V-13
Comparison of Construction and O&M Jobs Per MW Under the CCUS Scenario and the Photovoltaics Portion of the PNM Scenario



Source: Management Information Services, Inc.

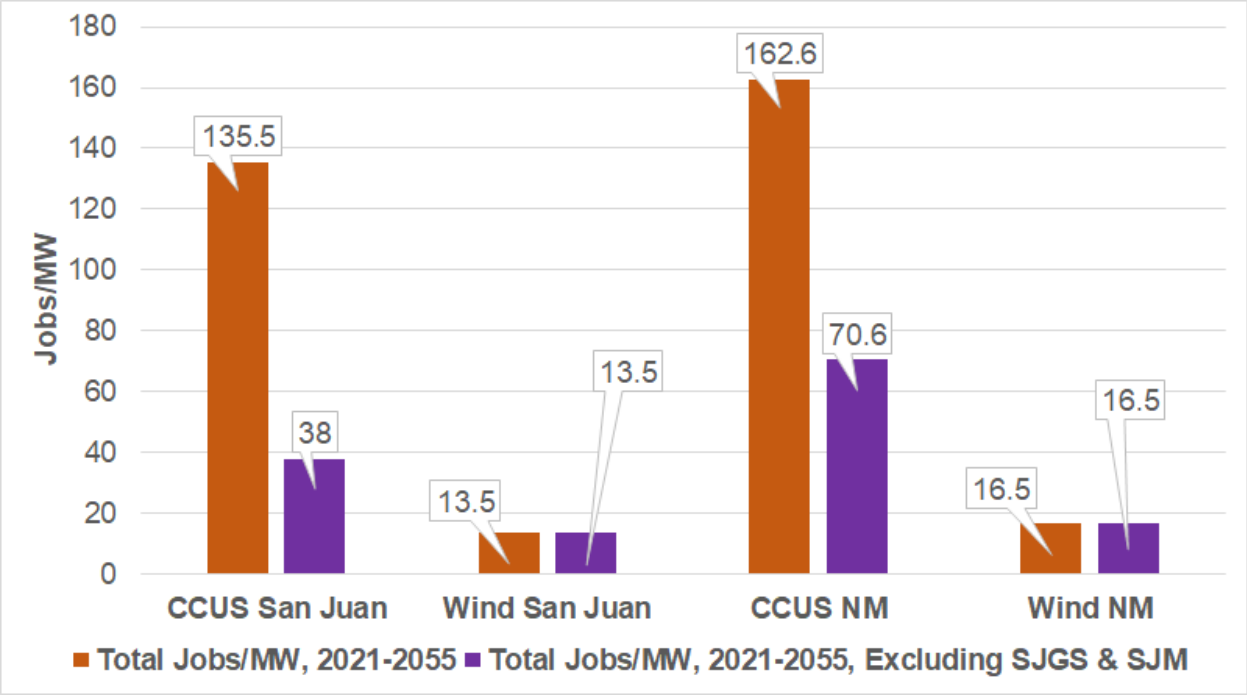
Figure V-14 shows the differences in jobs created per MW over the period 2021-2055 under the CCUS scenario and the wind portion of the PNM scenario. It illustrates substantial differences. In terms of total jobs per MW over this period:

- In San Juan, the CCUS scenario generates over 135 jobs/MW whereas the wind portion of the PNM scenario generates 13.5 jobs/MW – a 10X difference.
- In New Mexico, the CCUS scenario generates over 162 jobs/MW whereas the wind portion of the PNM scenario generates 16.5 jobs/MW – a 9.8X difference.

In terms of total jobs per MW over this period, excluding jobs from the SJGS and the SJM:

- In San Juan, the CCUS scenario generates 38 jobs/MW whereas the wind portion of the PNM scenario generates 13.5 jobs/MW – a 2.8X difference.
- In New Mexico, the CCUS scenario generates 70.6 jobs/MW whereas the wind portion of the PNM scenario generates 16.5 jobs/MW – more than a 4X difference.

Figure V-14
Comparison of Total Jobs Per MW Under the CCUS Scenario and the Wind Portion of the PNM Scenario, 2021-2055



Source: Management Information Services, Inc.

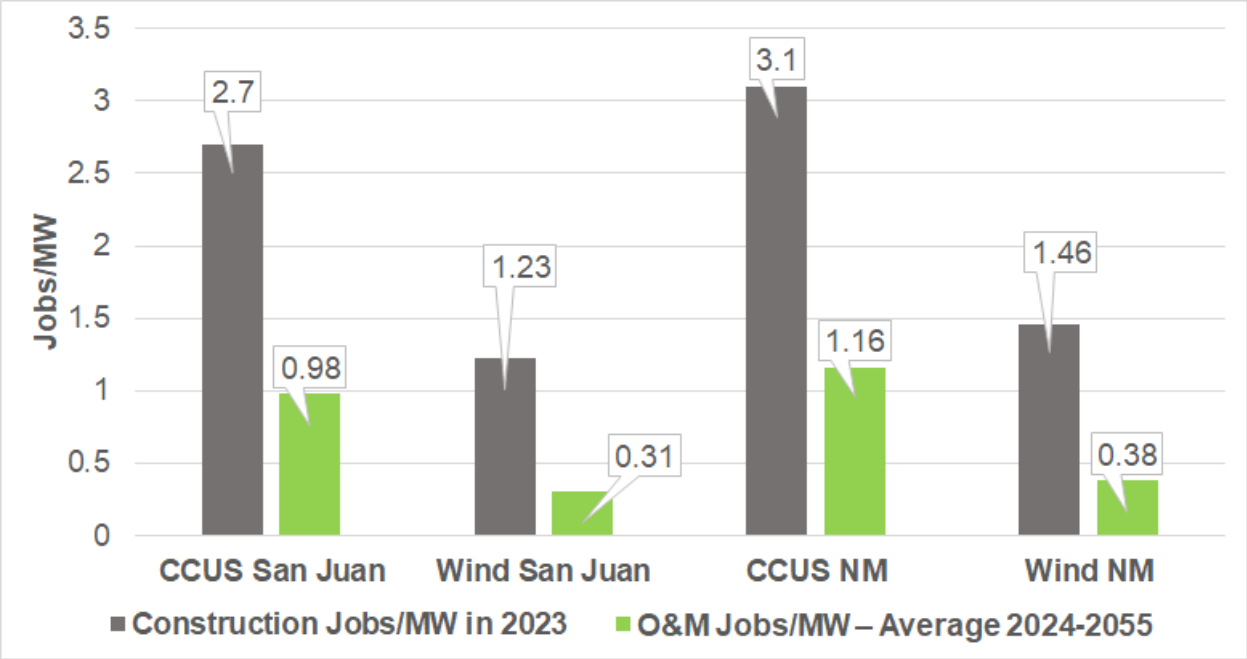
Figure V-15 shows the differences in jobs created per MW under the under the CCUS scenario and the wind portion of the PNM scenario by construction in 2023 – the year of maximum construction, and average O&M jobs over the period 2024-2055. It also illustrates striking differences. In terms of construction in 2023 jobs per MW in 2023:

- In San Juan, the CCUS scenario generates about 2.7 jobs/MW under the CCUS scenario whereas the wind portion of the PNM scenario generates about 1.2 jobs/MW – a 2.3X difference.
- In New Mexico, the CCUS scenario generates 3.1 jobs/MW whereas the wind portion of the PNM scenario generates 1.46 jobs/MW – a more than 2X difference.

In terms of average O&M jobs per MW over the period 2024-2055:

- In San Juan, the CCUS scenario generates 0.98 jobs/MW whereas the wind portion of the PNM scenario generates 0.31 jobs/MW – a 3.2X difference.
- In New Mexico, the CCUS scenario generates 1.16 jobs/MW whereas the wind portion of the PNM scenario generates 0.38 jobs/MW – a 3X difference.

Figure V-15
Comparison of Construction and O&M Jobs Per MW Under the the CCUS Scenario and the Wind Portion of the PNM Scenario



Source: Management Information Services, Inc.

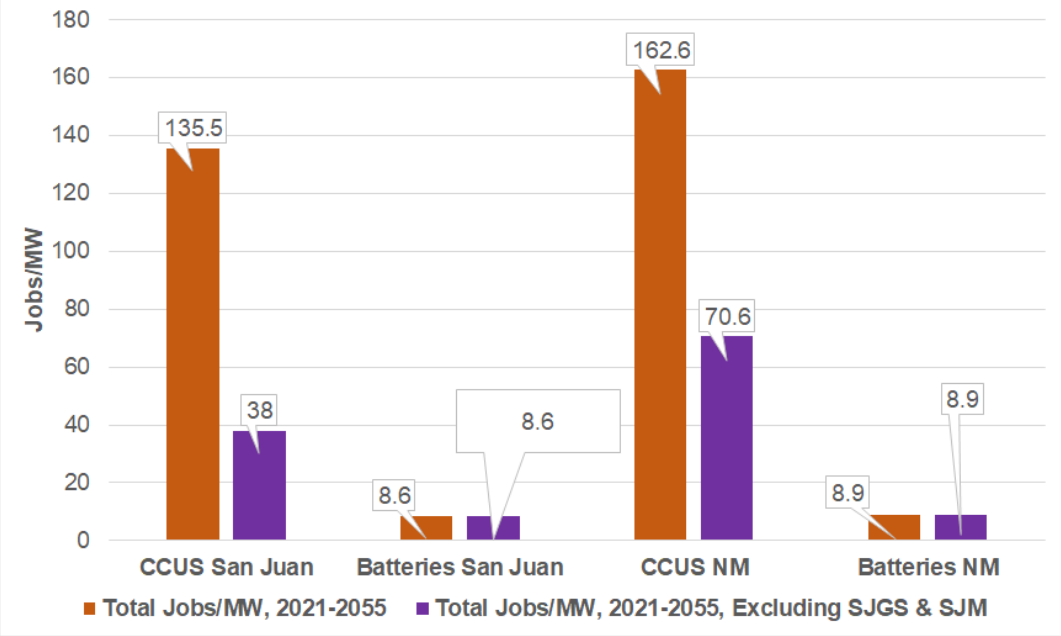
Figure V-16 shows the differences in jobs created per MW over the period 2021-2055 under the CCUS scenario and the batteries portion of the PNM scenario. It illustrates striking differences. In terms of total jobs per MW over this period:

- In San Juan, the CCUS scenario generates over 135 jobs/MW whereas the batteries portion of the PNM scenario generates 8.6 jobs/MW – a 16X difference.
- In New Mexico, the CCUS scenario generates over 162 jobs/MW whereas the batteries portion of the PNM scenario generates 8.9 jobs/MW – an18X difference.

In terms of total jobs per MW over this period, excluding jobs from the SJGS and the SJM:

- In San Juan, the CCUS scenario generates 38 jobs/MW whereas the batteries portion of the PNM scenario generates 8.6 jobs/MW – a 4.4X difference.
- In New Mexico, the CCUS scenario generates 70.6 jobs/MW whereas the batteries portion of the PNM scenario generates 8.9 jobs/MW – an 8X difference.

Figure V-16
Comparison of Total Jobs Per MW Under the CCUS Scenario and the Batteries Portion of the PNM Scenario, 2021-2055



Source: Management Information Services, Inc.

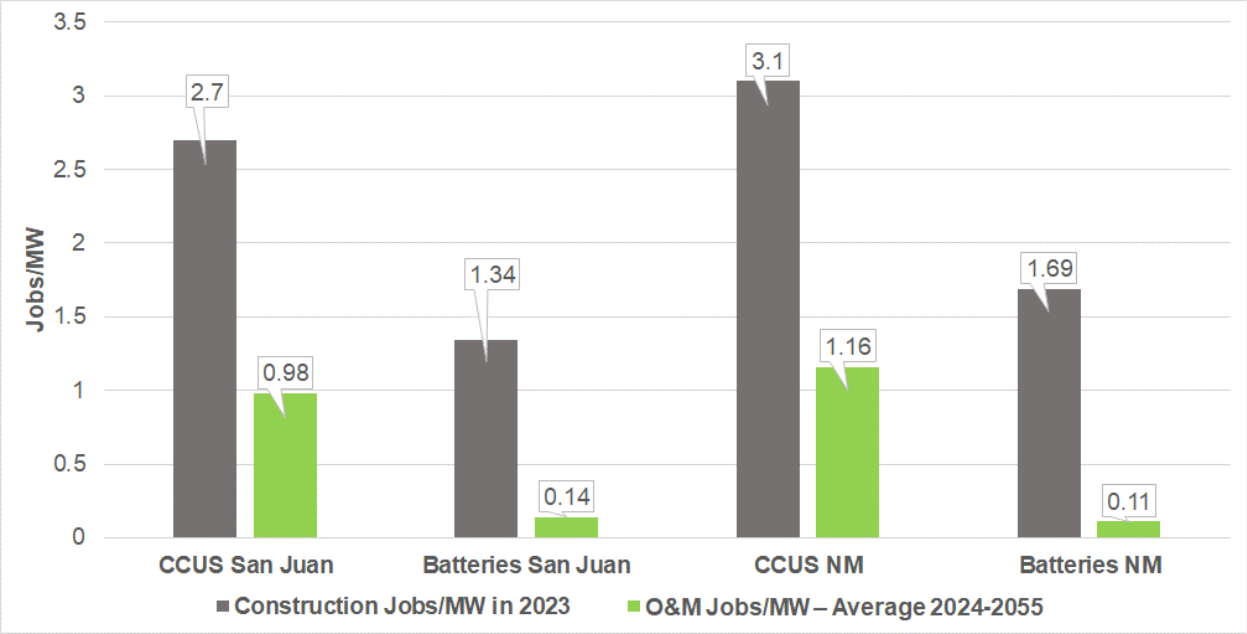
Figure V-17 shows the differences in jobs created per MW under the under the CCUS scenario and the batteries portion of the PNM scenario by construction in 2023 – the year of maximum construction, and average O&M jobs over the period 2024-2055. It also illustrates striking differences. In terms of construction in 2023 jobs per MW in 2023:

- In San Juan, the CCUS scenario generates about 2.7 jobs/MW under the CCUS scenario whereas the batteries portion of the PNM scenario generates 1.34 jobs/MW – a 2X difference.
- In New Mexico, the CCUS scenario generates 3.1 jobs/MW whereas the batteries portion of the PNM scenario generates 1.69 jobs/MW – a nearly 2X difference.

In terms of average O&M jobs per MW over the period 2024-2055:

- In San Juan, the CCUS scenario generates 0.98 jobs/MW whereas the batteries portion of the PNM scenario generates 0.14 jobs/MW – a 7X difference.
- In New Mexico, the CCUS scenario generates 1.16 jobs/MW whereas the batteries portion of the PNM scenario generates 0.11 jobs/MW – a more than 10X difference.

Figure V-17
Comparison of Construction and O&M Jobs Per MW Under the the CCUS Scenario and the Batteries Portion of the PNM Scenario



Source: Management Information Services, Inc.

Figure V-18 presents a summary comparison of jobs per MW in New Mexico under the CCUS scenario and the wind, photovoltaic, and batteries portions of the PNM scenario – an appropriate comparison since all of the PNM renewables are in New Mexico. This figure shows that in terms of total jobs per MW in New Mexico, 2021-2055, the CCUS scenario generates:

- Nearly 9X as many jobs/MW as the photovoltaics portion of the PNM scenario
- Nearly 10X as many jobs/MW as the wind portion of the PNM scenario
- More than 19X as many jobs/MW as the batteries portion of the PNM scenario

Figure V-18 shows that in terms of total jobs per MW, 2021-2055, excluding jobs from the SJGS and the SJM the CCUS scenario generates:

- Nearly 4X as many jobs/MW as the photovoltaics portion of the PNM scenario
- More than 4X as many jobs/MW as the wind portion of the PNM scenario
- More than 8X as many jobs/MW as the batteries portion of the PNM scenario

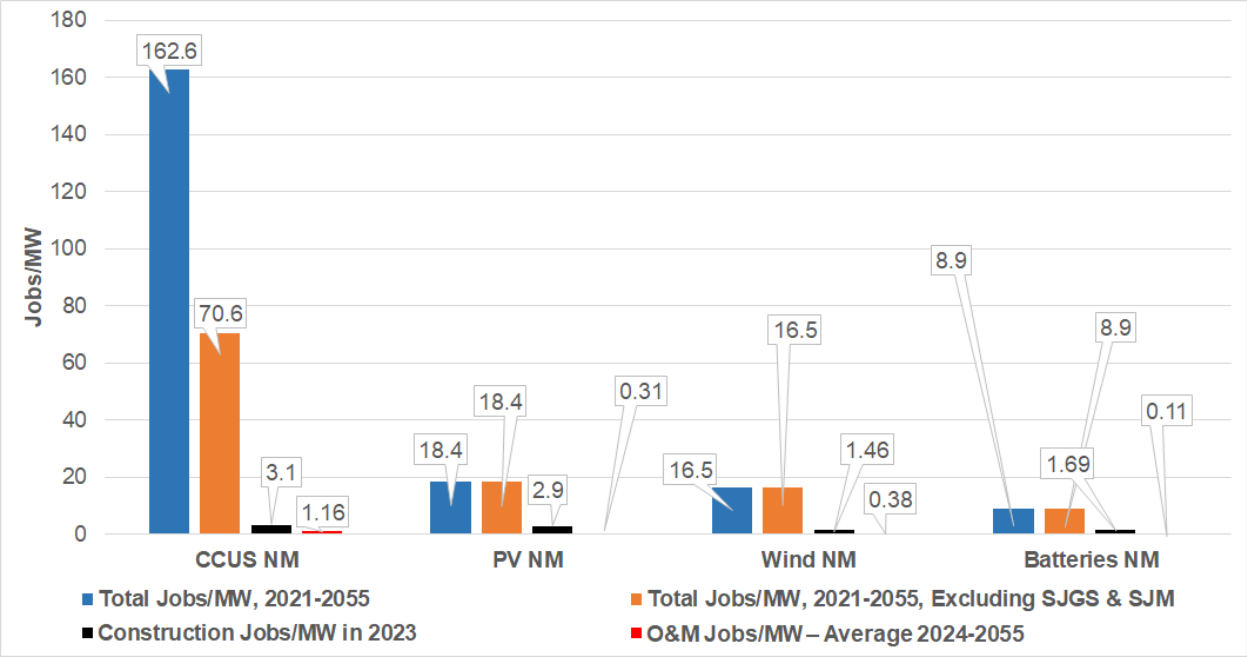
Figure V-18 shows that in terms of total jobs per MW generated by construction in 2023 – the year of maximum construction, the CCUS scenario generates:

- Seven percent more jobs/MW as the photovoltaics portion of the PNM scenario
- More than 2X as many jobs/MW as the wind portion of the PNM scenario
- Nearly 2X as many jobs/MW as the batteries portion of the PNM scenario

Figure V-18 shows that in terms of average O&M jobs per MW over the period 2024-2055, the CCUS scenario generates:

- Nearly 4X as many jobs/MW as the photovoltaics portion of the PNM scenario
- More than 3X as many jobs/MW as the wind portion of the PNM scenario
- More than 10X as many jobs as/MW the batteries portion of the PNM scenario

Figure V-18
Comparison of Jobs Per MW in New Mexico Under the CCUS Scenario and the Wind, Photovoltaic, and Batteries Portions of the PNM Scenario



Source: Management Information Services, Inc.

Thus, irrespective of the comparison, it is clear that the CCUS scenario generates substantially more jobs/MW than does the PNM option or any of the RE components of the PNM option – both in the local San Juan area and in the state of New Mexico. There is no appropriate comparison in which the PNM scenario, or any of its RE components, generates more jobs/MW than does the CCUS scenario – in either the San Juan local area or in the state of New Mexico. This holds true whether we are measuring the jobs/MW created by each scenario, by each scenario excluding the jobs impacts of SJGS and SJM, the construction portions of the scenarios, or the O&M portions of the scenarios. Specifically, here we made 68 individual comparisons. In two of these cases, the jobs/MW advantage of the CCUS option over the alternative was between 4% and 7%. In all of the other 66 comparison cases, the jobs/MW advantage of the CCUS option over the alternative was very large – many in the range of orders of magnitude. Thus, the CCUS scenario will generate substantially more jobs/MW – in many cases orders of magnitude more jobs/MW -- than the PNM scenario or the RE components of the PNM scenario – both in the local San Juan area and in the state of New Mexico.

V.C. Metric Comparison Issues

Development of appropriate comparison jobs metrics for coal and coal/CCUS compared to renewables is difficult, complex, and controversial for many reasons.

V.C.1. Issues of Megawatt Equivalency

The first issue that must be addressed is what is meant by renewables "equivalent" to a base load 847 MW coal power plant – or any other size coal plant. Installation of 847 MW of wind and solar is neither equivalent to nor a substitute for an 847 MW coal plant, since wind and solar have capacity factors in the range of 30%, or less. Installation of 3X 847 MW of wind and solar is also neither equivalent to nor a substitute for an 847 MW coal plant, since wind and solar are inherently intermittent and non-dispatchable. Thus, substantial storage and/or backup power will be required.

This is actually recognized explicitly in the PNM IRP. As discussed in Section II.C, PNM proposed four alternative scenarios to the CCUS scenario. It is notable that two of these scenarios, including the PNM recommended hybrid scenario, involved substantial natural gas generation to supplement and backup the RE and battery installations. It is also notable that these two scenarios are the only ones that PNM estimated would provide "reliability within standards – (few to no blackouts)." The other two PNM scenarios contained no natural gas generation. Scenario 3 which included no gas generation and only photovoltaics, wind, and batteries, is the one utilized here for comparison with the CCUS scenario, and is very close to the one approved by the NM PRC in July 2020. Scenario 4 contained only photovoltaics and wind, and no batteries.

Thus, PNM explicitly recognizes that its RE/battery only scenario is not "equivalent" to the 847 MW SJGS – even though this scenario comprises 1,050 MW compared to 847 MW. In other words, even an RE/battery replacement that is 25% larger than the SJGS is not "equivalent" to the SJGS. Rather, this scenario would result in "technology challenges and possible blackouts."[77]

PNM scenario 4 illustrates the problem even more starkly. This scenario is comprised of 975 MW of photovoltaics, 1,199 MW of wind, and no batteries. However, PNM warns that this scenario is even worse than scenario 3 and would result in "reliability not within standards and blackouts probable."[78] In other words, even an RE replacement that is 2.6X larger than the SJGS is not only not "equivalent" to the SJGS, but would also likely result in blackouts.

In comparing RE to coal generation, even after we specify a given capacity of renewables, we have to determine what type of renewables mix we are talking about. Would it be, for example, X MW of wind? If so, what size turbines, and where? Would it be X MW of solar? If so, would it be central station photovoltaic (PV) power plants? Distributed rooftop solar PV? Would it solar central station thermal plants using heliostats

[77]Public Service of New Mexico, *Integrated Resource Plan*, 2017-2036, op. cit.
[78]Ibid.

– the power tower concept? Distributed solar thermal collectors on buildings? Or, would it be some combination of wind, solar, batteries, DSM, and energy efficiency initiatives? If the latter, what combination are we talking about? Here MISI adhered as closely as possible to the resource portfolio and schedules contained in the PNM IRP and the ETA.

Coal plants constitute "base-load" power that is critical for maintaining grid stability and reliability. Unlike intermittent wind and solar, coal plants are always dispatchable.[79] And unlike natural gas plants, they keep months of fuel on site, providing essential security and resiliency for a grid increasingly dependent on just-in-time fuel delivery. However, often no mechanism exists to ensure the economic viability of base-load generation that must compete with cheap natural gas and subsidized renewables.

Base-load power is especially important during weather extremes when the demand for electricity typically spikes. For example, the summer of 2019 was the second hottest on record in the state of Texas. On August 13 and again on August 15, the Electric Reliability Council of Texas (ERCOT) declared power emergencies as demand reached nearly 75 GW – 96% percent of installed capacity. Households and businesses were implored to voluntarily reduce consumption between the hours of 3 and 8 p.m. as wind generation, accounting for 16 percent of installed grid capacity, went stagnant. Absent the 20 percent of power provided by the state's base-load coal plants running full out, brownouts or blackouts likely would have occurred – as occurred in August 2020 in California, which relies heavily on nondispatchable wind and solar.[80]

Similarly, extremely cold weather, such as the 2014 "polar vortex" and the 2018 "bomb cyclone," has strained power grids in the Northeast and Midwest. In response, PJM, the nation's largest regional transmission operator providing electricity to 65 million people in 13 mideastern and Midwestern states, has adopted a price floor in its wholesale power market that recognizes the importance of coal and nuclear plants in assuring grid resiliency and reliability.[81]

In 2018, the North American Electric Reliability Corporation (NERC) warned that "an accelerated retirement of coal-fired and nuclear power plants over the next several years could lead to power outages, temporary shortfalls in surplus generation, and transmission problems in several regions."[82] Steven Winberg, DOE Assistant Secretary For Fossil Energy, recently observed: "We're seeing potential early retirements on coal-fired power plants. Once they shut down, they just may not restart."[83]

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[79]Bernard L. Weinstein, "We Still Need Coal to Ensure Power Grid Reliability," *The Hill*, June 18, 2020.
[80]Katherine Blunt, "California Blackouts a Warning For States Ramping up Green Power," Katherine Blunt *Wall Street Journal*, August 17, 2020.
[81]Though a capacity charge or price floor has been debated in Texas, the state remains an "energy only" market and its power grid continues to be at risk during summer heatwaves.
[82]Michael Brooks, "NERC Releases 'Stress Test' Analysis of Gen Retirements," *RTO Insider*, December 20, 2018.
[83]Taylor Kuykendall, "US to be 'Long on Electricity,' Coal Closures May Accelerate – DOE Official," *S&P Global*, May 7, 2020.

Thus, “We have taken for granted the balance, fuel security and reliability offered by a power mix built upon a foundation of base-load generation. What is needed to ensure that essential capacity stays in the marketplace is a pricing system that puts a premium on fuel security and grid reliability.”[84] As stated by Neil Chatterjee, FERC Chairman, “Coal and nuclear need to be properly compensated to recognize the value they provide to the system and should be recognized as an essential part of the fuel mix.”[85]

The SJGS has a power production capability of 847 MW. Based on current operating performance, it would require approximately 3.7 MW of wind capacity to produce the same amount of energy as 1.0 MW of dependable, dispatchable capacity.[86] Thus, to replace SJGS could require more than 3,130 MW of wind capacity. Even this may be an optimistic estimate, since there would still be periods of little to no wind.

Renewable energy is scheduled to be a growing percentage of total generation in the electric power sector of New Mexico. However, RE’s inherent nature-related variations and other shortcomings must be accommodated by adjustments in on-line generators. As RE is planned to grow significantly in New Mexico, the backup power burden can no longer come from minor adjustments to dispatchable power plants. On this basis, the cost of large-scale RE generation must include not only the cost of the wind generators themselves but also the cost of dedicated dispatchable backup generation of a size which accommodates significant intermittent units operating on the system. The location of backup generators for RE must be relatively close to the RE generators, otherwise large blocks of backup electric power would have to be shuttled over long distances over routes that at times are constrained and thus cannot accommodate such shuttling.

As renewable energy generation increases as a percentage of New Mexico’s generation capacity mix over the coming decade, the more necessary a source of non-intermittent generation from a facility like SJGS will become. Replacement of base load non-intermittent generation with intermittent renewable capacity will require generation from SJGS to be available and to be on-line more frequently. This will make SJGS all that more valuable. Further, as discussed below, since the performance and capacity factors of wind turbines deteriorate over time – starting the year of installation, the need for and the value of SJGS will increase every year.

V.C.2. Backup Problems

PNM, and numerous other organizations, have tried to minimize the intermittency, unreliability, and non-dispatchability of renewable options by either ignoring the problem, assuming sufficient system backup from existing fossil fuel plants, or including storage

[84]Weinstein, op. cit.
[85]Gavin Bade, “Chatterjee: Coal plants should be 'properly compensated' for grid value,” *Utility Dive*, August 15, 2017.
[86]https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf.

options as part of the RE package. For example, in PNM's IRP, the storage options considered in New Mexico include flywheels, compressed air, pumped hydro, hydrogen, thermal, ice, and various types of batteries. All of these have problems.

For example, battery storage, despite the hyperbole, is not technically feasible and is prohibitively expensive. As Michael Kelly, Emeritus Prince Philip Professor of Technology at the University of Cambridge and former chief scientific adviser to the UK Department for Communities and Local Government, recently noted "The £45m battery installed by Elon Musk outside Adelaide, South Australia, can power that city for 30 minutes. If you wanted to be able to cover a week's power outage after a major storm, it would cost around 1,300 times as much using batteries as it would with diesel generators. The idea is ludicrous."[87]

In the U.S., battery storage costs $2,500 - $4,000+ per kilowatt for discharge duration of two hours or more, and is not a feasible solution to the renewables intermittency problem.[88] For example, New York State plans for the installation of 9,000 MW of offshore wind capacity by 2035 and 3,000 MW of battery storage by 2030.[89] The wind system will likely cost in excess of $9 billion, and the battery system will likely cost about $7.5 billion. However, this planned battery deployment is wholly inadequate to remedy the wind intermittency. If the wind system has an average output of 33% of its rated output, then the planned 3,000 MW of battery storage would only be able to deliver the average wind output for about two hours. To replace output for a full day when the wind is not blowing, 36,000 MW of storage would be needed at a cost of $90 billion, or about ten times as much as the wind system itself.[90] Since several days without wind in most locations is common, even a day of battery backup is inadequate. In addition, a battery system under daily discharge-recharge cycling will have a lifespan of only 7-10 years. Coal power plants last for 35 years or more. In general, it has been estimated that wind or solar with battery backup costs about *nine times* more than the fossil fuel electricity it displaces.[91]

Nevertheless, renewable advocates propose electricity storage to solve the intermittency problem and to help renewable energy replace traditional coal, natural gas, and nuclear generators. The theory is that when wind and solar output is high, excess electricity would be stored in batteries and then delivered when renewable output is low, to try to replace traditional power plants that generate reliable dispatchable electricity 24x7. Headlines acclaim the growth of battery installations for grid storage, growing 80% in 2019 and increasing 400% from 2014.

[87]Michael Kelly, "Electrifying the UK and the Want of Engineering," Global Warming Policy Foundation, June 2020.
[88]U.S. Energy Information Administration, "U.S. Battery Storage Market Trends," May 2018.
[89]https://www.governor.ny.gov/sites/governor.ny.gov/files/atoms/files/2019StateoftheStateBook.pdf
[90]Steve Goreham, "Battery Storage -- an Infinitesimal Part of Electrical Power," *Energy Central*, June 28, 2019.
[91]https://www.ruthfullyyours.com/2020/05/22/green-electricity-delusions-by-norman-rogers/.

However, in reality, the amount of U.S. electricity stored by batteries today is less than miniscule. Pumped storage, not batteries, currently provides about 97% of U.S. grid power storage. Nevertheless, less than one in every 100,000 watts of U.S. electricity is provided by pumped storage. In 2019, U.S. power plants generated about 4.1 million GW-hours of electrical power.[92] Battery storage provided only about 1 GW-hr. of capacity, and thus less than one-millionth of U.S. electricity can be stored in grid-scale batteries. The annual output of Tesla's Gigafactory, the world's largest battery factory, could store three minutes' worth of annual U.S. electricity demand. It would require 1,000 years of production to produce sufficient batteries for two days' worth of U.S. electricity demand. Meanwhile, 50–100 pounds of materials are mined, moved, and processed for every pound of battery produced.[93]

In addition, battery storage has reliability and safety problems of its own, which are only gradually being appreciated. For example, in 2019 an explosion at an Arizona energy storage facility was started by a defective battery cell that overheated and caused a buildup of flammable gas. Firefighters unintentionally ignited the gas on April 19 when they opened a door to the facility located near Phoenix, Arizona. The battery fire suppression system failed to stop the faulty cell from melting other nearby cells, leading to a cascading thermal runaway.[94] Thermal runaway is a potential problem with large scale battery storage systems.

Finally, as noted, constant charging and recharging of large battery backup systems limits their useful life to about 7-10 years. Aside from the serious disposal problems this creates, the short battery system life implies that, for example, over the 30 years+ life of the SJGS CCUS system, a battery backup system would have to be replaced at least four times – increasing costs by at least four-fold.

Another storage concept currently be considered in New Mexico is hydrogen storage in caverns. Aside from being an untested technology, there is the question of how the hydrogen would be produced – 96% of hydrogen is currently being produced using fossil fuels, mainly natural gas.[95] Similarly, other storage options listed in the PNM IRP have shortcomings: Flywheels have high power density but relatively low energy capacity and provide only short powerful discharge, compressed air requires geology with good containment, pumped hydro has limited available sites, etc.

The backup systems usually recommended for renewables are natural gas power plants. However, to backup the PNM RE scenario the natural gas power plants would have to be nearly 847 MW in capacity. This is because U.S. transmission grid operators must meet a reliability standard known as loss of load expectation (LOLE), an event in which electricity demand exceeds available generation capacity. That reliability standard

[92]https://www.eia.gov/energyexplained/electricity/electricity-in-the-us-generation-capacity-and-sales.php.
[93]Mark P. Mills, "The 'New Energy Economy:' An Exercise in Magical Thinking," Manhattan Institute, March 2019.
[94]"Report Ties Ariz. Energy Storage Fire to Defective Battery," *Energywire*, Wednesday, July 29, 2020.
[95]Roger H. Bezdek, "The Hydrogen Economy and Jobs of the Future," *Renewable Energy and Environmental Sustainability*, Vol. 4, No. 1 (2019).

for grid operators in the U.S. allows for a LOLE of one day every 10 years, or 0.1 days per year. The result of a loss of load is likely to be brownouts or blackouts.[96] The only way to ensure this is to have a stand-by natural gas power plant – or other backup power system -- available and dispatchable 24x7x365. This would be hugely wasteful of capital. More important, with natural gas at anywhere near current or forecast prices, it would be cheaper to run the gas plants and not even install any renewables. However, natural gas may be a non-starter. New Mexico has legislated the most aggressive renewable energy and zero carbon requirements in the U.S. The ETA sets a statewide renewable energy standard of 50% by 2030 for New Mexico investor-owned utilities and rural electric cooperatives and a goal of 80% by 2040, in addition to setting zero-carbon resources standards for investor-owned utilities by 2045 and rural electric cooperatives by 2050.[97] As noted, in July 2020 the New Mexico PRC disallowed PNM Scenario 1, which contained substantial natural gas resources, and mandated an all-renewables scenario very similar to PNM Scenario 3.[98]

V.C.3. Cost Issues

The renewable energy costs often quoted are severely underestimated because they ignore the ancillary costs inevitably associated with wind power and solar renewables resulting from:[99]

- Unreliability in terms of both power intermittency and power variability.
- The non-dispatchability of renewables: The wind will not blow and clouds will not clear away to order when needed.
- Poor timing of power generation, often unlikely to be coordinated with demand. For example, solar energy is virtually absent in winter, 1/9th of the output in the summer period of lower demand.
- Long transmission lines to remote generators, incurring both costly power losses in transmission and increased maintenance.
- Additional infrastructure necessary for access.
- The costs of essential backup generation only used on occasions but wastefully running in spinning reserve nonetheless.
- Any consideration of electrical storage using batteries, which would impose very significant additional costs, were long-term, (a few days), battery storage even economically feasible.
- Unsynchronized generation with lack of inherent inertia to maintain grid frequency.

[96]See the discussion in New York Independent System Operator, *2018 Reliability Needs Assessment*, 2019.

[97]https://www.governor.state.nm.us/2019/03/22/governor-signs-landmark-energy-legislation-establishing-new-mexico-as-a-national-leader-in-renewable-transition-efforts/.

[98]"A 100% renewables portfolio was the only replacement option that fully satisfied the state's Energy Transition Act (ETA), passed last year, which requires the state to make an economically just transition to 100% carbon-free energy by 2045." Catherine Morehouse, op. cit.

[99]Charles Rotter, "The Excess Costs of Weather Dependent Renewable Power Generation in the EU," *edmdotme*, July 8, 2020.

- Weather dependent renewables cannot be relied upon to provide a "black start" recovery from a major grid outage.

The Levelized Cost of Electricity is not a sound methodology to compare highly variable and interruptible electricity technologies with electricity supplied by reliable dispatchable electricity generating technologies. Researchers have found that "LCOE neglects certain key terms such as inflation, integration costs, and system costs."[100] Similarly Paul Joskow concluded that "Many international reports prove that such electricity supply is costly due to its variability, interruptibility, inefficiency and its requirement of 100% backup".[101]

More generally, grid operators, except in extreme circumstances, are usually required to accept all the renewable electricity generated. In order to do this, fossil-fuel plants have to vary their output to compensate for the erratic wind and solar. Wind and solar plants cannot replace fossil-fuel plants for the simple reason that at times the wind and solar plants are not generating electricity. Rather, there must be adequate fossil fuel power to carry the full load. The consequence is that the electric system has to continue to maintain and pay for its traditional plants regardless of how much wind and solar is added to the grid. The only real economic contribution of wind or solar is to reduce fuel consumption in the fossil-fuel plants during times when wind or solar electricity is being generated.

Thus, the proper cost comparison is to compare the cost of renewable electricity versus the marginal cost (fuel) of operating the fossil fuel plants – renewables are really nothing buy fuel savers. Wind or solar with battery backup costs about $130 per megawatt hour. For grid stability reasons, new wind and solar plants are being equipped with battery storage, greatly increasing the cost. The electricity supplied by wind or solar at $130 per megawatt hour (not counting subsidies) could be generated in existing fossil fuel plants for a fraction of the cost.[102]

Renewable energy costs are often quoted inclusive of the myriad massive RE subsidies available from the federal government, state and local governments, and utilities. These subsidies are pervasive, inefficient, regressive, and cost distorting. For example, retail net metering as it currently exists in many states is deeply flawed. Paying rooftop solar-owners the full bundled retail rate for a product whose actual value is but a fraction of it has incentivized a large volume of rooftop solar installations. But the policy is, on its face, detached from economic reality. It causes massive cost shifts from solar rooftop owners to other customers. Due to poor retail rate design, its impact is overwhelmingly regressive, as generally high-income solar adopters transfer their costs onto low-income consumers. Long-term, the policy is unsustainable. If rate design does not evolve to recognize this immutable truth, inequities between customers will

[100]M.D. Sklar-Chik, "Critical Review of the Levelised Cost of Energy (LCOE) Metric," *South African Journal of Industrial Engineering*, December 2016.
[101]Paul Joskow, "Comparing The Costs of Intermittent and Dispatchable Electricity Generating Technologies," *American Economic Review*, Vol. 101, No. 3 (May 2011), pp. 234-241.
[102]Goreham, op. cit.

grow. Thus, according to a former PUC commissioner, “Rooftop solar deployed in the service of extracting rents for solar developers is a political and economic house of cards that imperils any state official unlucky enough to be in office when it comes crashing down. It is a regulatory time bomb. Once the deficiencies of full retail net metering become obvious for all to see, it is too late.”[103]

RE advocates constantly emphasize past and future cost reductions in RE technologies. RE technologies have improved greatly and will continue to become cheaper and more efficient. However, the era of large cost reductions is over. The physics boundary for silicon photovoltaic cells, the Shockley-Queisser Limit, is a maximum conversion of 34% of photons into electrons, and the best commercial PV technology currently exceeds 26%. Wind power technology has also improved greatly, but here, too, no large efficiency gains are left. The physics boundary for a wind turbine, the Betz Limit, is a maximum capture of 60% of kinetic energy in moving air, and commercial turbines currently exceed 40%.[104] Thus, “Scientists have yet to discover, and entrepreneurs have yet to invent, anything as remarkable as hydrocarbons in terms of the combination of low-cost, high-energy density, stability, safety, and portability.”[105]

V.C.4. Intractable Wind Problems

Electric power from wind generators varies according to the cube of the wind speed impacting the turbine blades, but wind speeds vary dramatically over the course of a day, week, month, and year. Variations in wind power thus range from zero (no or very little wind blowing) to full nameplate capacity of the wind generators (during excessively high wind speeds, generators are shut down to avoid damage). Such on- again, off-again cycling of wind generators, as well as solar generator outputs, is termed intermittent. Thus, the dispatching of wind turbines must accommodate intermittency, which is a significant system operational concern because consumers require reliable, always available power-on-demand.[106]

Intermittency is critical because wind power requires 100% 24x7x365 backup by power plants that are reliable and dispatchable.[107] The reserve required to operate immediately to assure the changes to the supply/demand requirements are in balance is called “spinning reserve.”[108]

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[103]Tony Clark, “Hard Truths About Net Metering and the Perils of Regulatory Nihilism,” *Utility Dive*, June 24, 2020.

[104]Mark P. Mills, op. cit.

[105]In practical terms, this means that spending $1 million on utility-scale wind turbines, or solar panels will each, over 30 years of operation, produce about 50 million kWh -- while an equivalent $1 million spent on a shale rig produces enough natural gas over 30 years to generate over 300 million kWh – only 1/6 as much. Ibid.

[106]James Schlesinger and Robert Hirsch, “Getting Real on Wind and Solar,” *Washington Post*, April 24, 2009.

[107]Ibid.

[108]Roger Bezdek and Robert Wendling, “Not-So-Green Superhighway: Unforeseen Consequences of Dedicated Renewable Energy Transmission,” *Public Utilities Fortnightly*, February 2012, pp. 34 - 42.

To reiterate, wind turbines do not generate electricity when the wind does not blow. However, few understand the degree to which these resources fail to operate when electric power is most urgently required. Production data on the U.S. power industry clearly illustrate that wind's intermittency requires significant generation resources to be operating on the electric system to assure reliable continuous supply, which can only be accommodated by generation of sufficient size and operating capability to furnish such backup.

Wind Power Not Available When Needed Most

Wind resources fail when electric power is most urgently required. EIA estimates average capacity factors for wind of about 33 percent, for solar thermal of about 22 percent, and for photovoltaics of about 25 percent.[109] Other estimates of wind capacity factors are in the range of 20 to 30 percent, and could be even lower.[110] Given the time frame of the daily load cycle during which peak loads occur, capacity factors for wind turbines are often much lower. For example, as shown in Figure V-19, during the California heat wave in July 2006, which resulted in significant increases in electric demand, actual wind generation was at only about five percent of available name plate capacity. Thus, in this case, the capacity factor for wind was closer to five percent than 33 percent or even 20 percent. Balancing off such wind turbine availability is the availability of solar arrays during peak summer periods, but as is the case in many parts of the U.S. during periods of summer peak, solar arrays are also adversely impacted by thunder storm cloud cover.

Similar availability issues have been encountered in Texas, which also has an aggressive wind power program. In 2008, the state installed nearly 2,700 MW of new wind capacity, and if Texas were an independent country, it would have then ranked sixth in the world in terms of total wind power production capacity. However, the Electric Reliability Council of Texas (ERCOT) analyzed the capacity factor of wind and estimated it to be less than nine percent. In a 2007 report, ERCOT determined that only "8.7 percent of the installed wind capability can be counted on as dependable capacity during the peak demand period for the next year. Conventional generation must be available to provide

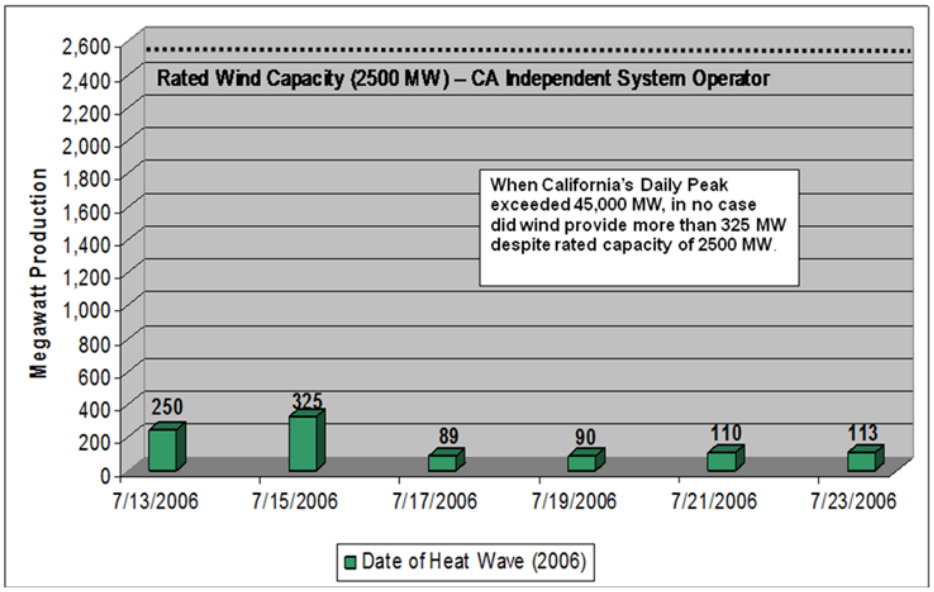
[109]U.S. Energy Information Administration, "Capacity Factors for Utility Scale Generators Not Primarily Using Fossil Fuels, January 2013-September 2017," *Electric Power Monthly*, December 1, 2017.

[110]Centre for Sustainable Energy, "Common Concerns About Wind Power," June 2017. In addition, Hughes found that the normalised load factor for UK onshore wind farms declines from a peak of about 24% at age 1 to 15% at age 10 and 11% at age 15. He found that the decline in the normalised load factor for Danish onshore wind farms is slower but still significant, with a decline from a peak of 22% to 18% at age 15. Gordon Hughes, "Analysis of Wind Farm Performance in UK and Denmark, prepared for the Renewable Energy Foundation," December 2012. Similarly, Boccard noted "For two decades, the capacity factor of wind power measuring the mean energy delivered by wind turbines has been assumed at 35 percent of the nameplate capacity. Yet, the mean realized value for Europe over the last five years is closer to 21 percent thus making levelized cost 66 percent higher than previously thought." Nicolas Boccard, "Capacity Factor of Wind Power: Realized Values vs. Estimates," October 2008. The actual capacity factors for wind in Germany ranged between 14 and 21 percent over the period 2000 through 2007; see *Wind Energy Report Germany 2008*, ISET, Univ. Kassel, Germany, 2008.

the remaining capacity needed to meet forecast load and reserve requirements." [111] In 2009, ERCOT re-affirmed its decision to use the 8.7 percent capacity factor.[112]

For non-coastal wind, ERCOT has measured a historical capacity factor of only 12% in summer months.[113] Analysis of Seasonal Assessment of Resource Adequacy (SARA) reports and historical data from the summers of 2012 through 2015 indicates that wind capacity utilization could be as low as 4.1%. This implies that total wind output across ERCOT could total only 679 MW on a peak summer day – when the power is most needed.

Figure V-19
Wind Generation's Performance During the 2006 California Heat Wave



Source: U.S. Department of Energy.

ERCOT planners continued to estimate that that wind projects would provide less than 9% of their nameplate capacity towards meeting peak demand.[114] That estimate for Effective Load-Carrying Capability (ELCC) was based on the fact that wind production is not dependable and may be inversely correlated with demand, especially during hot summer days with little or no breeze.

[111]Robert Bryce, "Texas Wind Power: The Numbers Versus the Hype," *Energy Tribune*, August 5, 2009.
[112]Ibid.
[113]Keith Poli, "ERCOT Seasonal Assessment Report for Summer 2016," Constellation Energy Resources, LLC, March 2016.
[114]ERCOT was eventually pressured by groups like the Sierra Club pressured use selected past history to make wind appear more reliable -- even if that meant an optimistic assumption that could result in capacity shortfalls under certain circumstances.

A report by the Texas Comptroller of Public Accounts found that little wind power is available in the summer months when Texans use the most power.[115] The report highlighted the monumental failure of wind power to be available when it is required, stating "For summer 2014, even though Texas had more than 11,000 MW of total wind capacity, ERCOT counted on just 963 MW of wind generation being available. The lack of wind generation during summer peak demand means that energy planners, such as ERCOT, have to ensure that a lot of flexible natural gas generation is available to meet the reserve margin."[116] Thus, as shown in Table V-1, wind generation is lowest during the summer months when energy demand is the highest.

Table V-1
Comparison of Generation Ability

GENERATION SOURCE	AVAILABILITY OF INSTALLED CAPACITY, 2013	2013 GENERATION (% OF TOTAL)	ELECTRICITY DELIVERED AT 2013 PEAK DEMAND
GAS (ALL TYPES)	81%-89%	41%	59%
COAL (ALL TYPES)	84%-86%	37%	29%
NUCLEAR	85%	12%	7.5%
WIND	8.7%*	10%	3.5%

Note: *Because wind generation varies so much each day, wind percentage is reported as the effective load-carrying capacity used by ERCOT for forecasting purposes. Total available wind capacity was 11,066 MW as of May 1, 2014. Other resources were excluded from this comparison due to their limited capacity.

Source: Electric Reliability Council of Texas and Texas Reliability Entity.

Despite massive investments and continuing subsidies, wind power has been providing only a small percent of Texas's total reliable generation of energy, and ERCOT's projections show that wind will continue to remain an insignificant player in terms of reliable capacity. Accordingly, Texas will continue to rely almost entirely on natural gas, coal, and nuclear power to generate electricity.

The experience of the Pacific Northwest, another region with an aggressive wind program, is similar. Often when it is very hot or very cold and electric power demand is greatest, wind generation is simply not available. For example, during the cold days of January 5 to 28, 2009 wind generation in the region was virtually non-existent.[117] Another example of wind generation variability took place on October 16, 2012 when wind generation on the Bonneville Power Administration system was producing 4,300 MW, accounting for 85 percent of total generation in the pre-dawn hours. The next day, wind generation was practically non-existent, falling to almost zero.[118]

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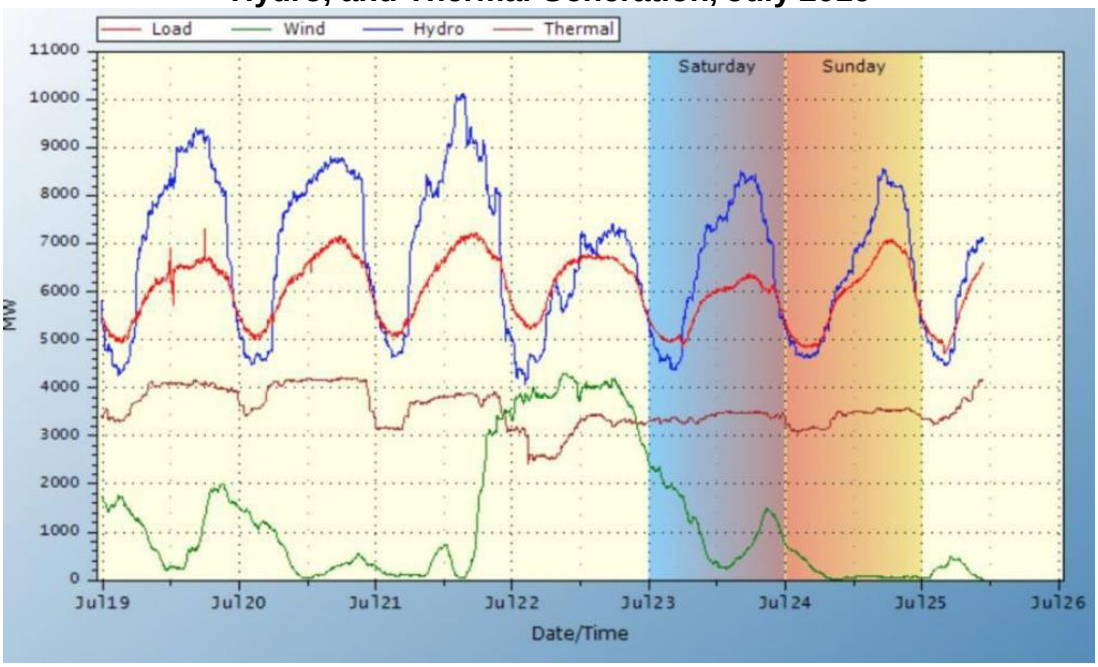
[115]Susan Combs, "Texas Power Challenge: Getting the Most For Your Dollars," Texas Comptroller of Public Accounts, September 2014.
[116]Ibid.
[117]http://www.transmission.bpa.gov/business/operations/wind/WindGen_VeryLow_Jan08Jan09x.xls.
[118]*See* "In a First, Wind Exceeds Hydro in BPA Region," Platt's *Megawatt Daily*, October 19, 2012, p. 9.

Similarly, an extreme 2016 heat in Washington State illustrated the reliability problems with wind power.[119] Figure V-20 illustrates that during the heat wave, nuclear power (the largest proportion of the thermal curve shown) provided power continuously at a capacity factor of 98% and hydro was used to load-follow. Wind blew occasionally, and mostly when it was not needed. Most of the electricity needed to combat this heat wave was concentrated during peak hours of the afternoon when the wind turbines were not turning.

Figure V-20
BPA Balancing Authority Load and Total Wind, Hydro, and Thermal Generation, July 2016



Source: Bonneville Power Administration.

Analysis of four years of generation data in ERCOT with over 10,000 MW of wind capacity, the Midwest ISO (MISO) with almost 12,000 MW of wind capacity, and the PJM Interconnection (PJM) with over 5,000 MW of wind capacity, found that:[120]

- In all three regions, over 84 percent of the installed wind generation failed to produce electricity when electric demand was greatest.
- In MISO, only between 1.8 percent and 7.6 percent of wind capacity was available and generating power during the peak hours on the highest demand days.
- In ERCOT, only between 6.0 percent and 15.9 percent of wind facilities generated power during peak summer periods.
- In PJM, the range was between 8.2 percent and 14.6 percent during peaks.

[119] James Conca, "America's Heat Wave no Sweat For Nuclear Power," *Forbes*, July 28, 2016.
[120] Jonathan A. Lesser, "Wind Intermittency and the Production Tax Credit: A High Cost Subsidy For Low Value Power," Continental Economics, October 2012.

- These availability values are significantly lower than median availability for the entire period.

The July 2012 heat wave in Illinois, where temperatures reached 103 degrees in Chicago, provides another example of wind generation's limitations to perform when needed most. During this heat wave, Illinois wind units generated less than five percent of name plate capacity, producing only an average of 120 MW of electricity from over 2,700 MW installed. On July 6, 2012, when the demand for electricity in northern Illinois and Chicago averaged 22,000 MW, the average amount of wind power available during the day was virtually nonexistent at 4 MW.[121]

More generally, the greatest amounts of wind generation occur in the spring and fall, when the demand for electricity is lowest, and the smallest amounts of wind generation occur in summer, when the demand for electricity is the greatest. Wind generation data in PJM, the nation's largest independent system operator, show that the "load-wind gap" (the difference between summer electric demand and summer wind availability, relative to respective annual averages) was almost 70 percent in the summers of 2010 and 2011. In summer 2012, the load–wind gap was 59 percent.[122]

The New York wind experience is similar to that in other regions. For example, an analysis of 16 wind projects in New York State between 2008 and 2011 found that, despite vendor promises prior to installation of capacity factors of 30 percent to 35 percent, average annual capacity factors ranged between 14.1 percent and 22.7 percent.[123]

Researchers also analyzed four New York State wind projects since their inception in a comprehensive study centered on the Noble Chateaugay project, which has 71 GE 1.5 SLE turbines and is capacity-rated at 106.5 megawatts.[124] Their research determined that the actual annual output of the Chateaugay project was only 23 MW, giving it a capacity factor of 21.6 percent. The other northern New York projects had similar capacity factors. The researchers noted that this is substantially less than the 30 to 35 percent commonly predicted by wind developers. They also found that all northern New York wind projects had more than 1,200 hours annually that produced no electricity at all -- the equivalent of 50 24-hour days, or 14 percent of the time, with zero generation. Thus "It appears wind developers notoriously inflate expected capacity factors to entice investors and increase chances of permitting approvals." Further, "Both Vesta and GE turbines have a manufacturer's life expectancy rating of 20 years, yet no northern New York wind project is on track to sell enough electricity in 20 years to pay for itself."[125]

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[121]J. Lesser, "Wind Power in the Windy City: Not There When Needed" *Energy Tribune,* July 25, 2012, and J. Lesser, "Wind Generation Patterns and the Economics of Wind Subsidies," *The Electricity Journal*, Volume 26, No. 1 (January-February 2013), pp. 8-16.
[122]Ibid.
[123]http://dailyenergyreport.com/wp-content/uploads/2011/06/NY_CF2008-2010_final.jpg. The data for the estimates were obtained from the *2011 New York ISO Gold Book*.
[124]Nina Pierpont, "Wind Turbine Syndrome: A Report on a National Experiment," May 2013.
[125]Ibid.

All New York generating units, both renewable and non-renewable, have an "unforced capacity value" (UCAP) for purposes of the capacity markets, which is used for reliability planning and which load serving entities such as the state's electric utilities purchase to assure that installed generating reserve is available to serve customer load during peak periods.[126] This UCAP value is a percentage of a resource's nameplate MW value; for wind and solar this number is based on an initial NYISO designated rating for Year 1 of operation and on actual historical energy output for every year thereafter. The values are facility specific, but the UCAP for onshore wind in NY is 10-14 percent for the summer peak -- when electricity is needed the most and electricity prices are the highest.[127]

This unforced capacity value is not unique to New York State, or even to the U.S. Similar unforced capacity values are the case in the Netherlands, Denmark, England, Germany, Spain, Portugal, and Ireland, or anywhere that large scale wind generation is part of the installed generation mix.[128] An Australian study found that even wind farms spread over large, widely dispersed areas and interconnected into a single electric system cannot produce electricity with capacity factors close to name plate capacity.[129]

Thus, "While renewable energy sources have made many advances in recent years, they are not widespread enough to be able to support an electrical grid as a base load. Renewable energy is intermittent, unreliable, requires back-up, is non-dispatchable, and not is available during emergencies."[130]

Wind Performance Declines With Age

The performance and capacity factors of wind turbines deteriorate over time. A UK study found that[131]:

- Load factors declined with age, at a rate similar to that of other rotating machinery.
- Onshore wind farm output declines 16% a decade.

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[126]UCAP is a measure of the amount of capacity that capacity resources may offer in the capacity market, and on a seasonal basis, represents the capability of the resource adjusted by the potential unavailability of the unit based on historical performance data. See Paul Hibbard, Todd Schatzki, and Sarah Bolthrunis, "Capacity Resource Performance in NYISO Markets an Assessment of Wholesale Market Options," Analysis Group Inc., October 2017.

[127]New York State Reliability Council, LLC, Installed Capacity Subcommittee, *New York Control Area Installed Capacity Requirement For the Period May 2016 To April 2017: Appendices*, December 2015; *NYISO 2011 Installed Capacity Manual*.

[128]For example, due to Britain's increasing reliance on wind turbines to generate electricity, Steve Holliday, Chief Executive of the British National Grid, stated that, by 2020, the British people will have to change their behavior to use electricity "when it is available" rather than when it is needed; "Era of Constant Electricity at Home is Ending, Says Power Chief," the *Daily Telegraph*, March 2, 2011.

[129]Paul Miskelly, "Wind Farms in Eastern Australia -- Recent Lessons," *Energy & Environment*, Vol. 23, No, 8 (December 2012) pp. 1233-1260.

[130]Roger H. Bezdek, "Sur-Rebuttal Testimony Before the Office of Administrative Hearings For The Minnesota Public Utilities Commission, State Of Minnesota in the Matter of the Further Investigation in to Environmental and Socioeconomic Costs Under Minnesota Statute 216B.2422, Subdivision 3," OAH Docket No. 80-2500-31888, MPUC Docket No. E-999-CI-14-643, September 10, 2015.

[131]Iain Staffell and Richard Green "How Does Wind Farm Performance Decline With Age?" *Renewable Energy*, Volume 66 (June 2014), Pages 775-786.

- Performance declines with age occurred in all farms and all generations of turbines.
- Decreasing output over a turbine's life increased the LCOE.
- The degradation rate was consistent for different vintages of turbines and for individual projects, ranging from those built in the early 1990s to early 2010s.

Similarly, Gordon Hughes in a seminal study found that the load factor for UK onshore wind projects declines from a peak of 24% at age 1, to 15% at age 10, and 11% at age 15. He also found that the load factor for Danish onshore wind projects declined from a peak of 22% to 18% at age 15.[132] Hughes analysed 3,000 onshore wind turbines -- the most comprehensive study of its kind – and warned that they will continue to generate electricity effectively for just 12 to 15 years – not the wind energy industry estimate of lifespans of 20 to 25 years. Hughes found:[133]

- Routine wear and tear will more than double the cost of electricity being produced by wind farms in the next decade.
- Older turbines need to be replaced more quickly than the industry estimates.
- A wind turbine will typically generate less than half as much electricity in its 15th year of operation than in its first year.
- The load factor is reduced from 24% in the first 12 months of operation to just 11% after 15 years.
- Larger wind farms have systematically worse performance than smaller wind farms.
- The decline in the output of offshore wind farms is even more dramatic: The load factor offshore is reduced from 39% to 15% after 10 years.

Wind Power Lacks Black Start Capability

A valuable capability supporting local reliability is a plant's black start capability.[134] Black start is the ability of a single plant in isolation to restore operations after becoming de-energized without depending on outside sources of electric supply or on an external electric transmission network for the restoration.[135] Studies have determined that the societal and economic consequences of not having a black start capability are so significant that substantial capital investments are justified to ensure such a capability.[136]

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[132]Gordon Hughes, "Analysis of Wind Farm Performance in UK and Denmark, prepared for the Renewable Energy Foundation," December 2012. The load factor is determined by measuring the actual amount of electricity output over a time period against the total output expected had the turbine operated for 100 percent of the time period. The ratio is expressed as a percentage.

[133]Ibid. Professor Hughes is in the process of expanding and updating his research, and his new report will be available in April 2019. MISI is in contact with Dr. Hughes on this.

[134]Paul Hibbard, Susan Tierney, and Katherine Franklin, "Electricity Markets, Reliability and the Evolving U.S. Power System," Analysis Group, June 2017.

[135]U.G. Knight, "The 'Black Start' Situation," Section 7.5 in *Power Systems in Emergencies -- From Contingency Planning to Crisis Management*, New York: John Wiley & Sons. 2001.

[136]Brendan Kirby and Eric Hirst, "Maintaining System Black Start In Competitive Bulk-Power Markets," American Power Conference, Chicago, Illinois, April 1999.

The electric power used within a power plant termed auxiliary load is normally provided from the station's own generators. If all of the plant's main generators are de-energized, electric station service may be provided by drawing power from the transmission system to which the plant is interconnected. However, during a wide-area system outage, off-site power supply from the transmission system will not be available, and in the absence of such electric supply, a black start needs to be performed to re-energize the power station. To provide a black start, power stations have diesel generators which may be started in isolation and be used to provide the electric supply required to restart the auxiliary equipment needed for generator restart and operation. Generating plants using steam turbines may require station service power of up to 10 percent of generator capacity for boiler feedwater pumps, boiler forced-draft combustion air blowers, and for fuel preparation. Not all power stations have black start capability, and such stations rely on the transmission network and other power plants to provide the electric supply needed for black restart.

For a larger integrated transmission network, re-energizing the network that has gone black will often involve re-energizing multiple "islands" of generation within the network (each supplying local load areas) and then synchronizing and reconnecting these islands to form a complete integrated transmission system. The power stations involved have to be capable of ramping up output to accept load that is brought back on line or re-energized as the transmission system is restored to service and loads are reconnected to the transmission system. The larger the generating station, the greater the capability to restore customer service in a timely fashion.

Not all generating plants have black-start capability. In particular, wind turbines are not suitable for black start because wind may not be available when required, and wind turbines are often connected to induction generators which are, unless provided with costly equipment, incapable of providing power to re-energize the network.[137] Such lack of black start capability is a cause for concern, since wind power currently comprises a significant and increasing portion of the new generation planned for New Mexico.

Decommissioning Wind Turbines: The 800-Pound Gorilla

Decommissioning wind turbines is enormously difficult and expensive and is an issue that the wind industry and its advocates do not want to address. Coal and natural gas plants have a lifetime of 30 - 50 years. With license renewal, nuclear plants can operate for 60 years, and some reactors can operate for 80 years. By contrast, wind turbines have a lifetime of 15 - 20 years – or even less.

Germany has 28,000 wind turbines, and by 2023 more than a third --10,300 -- must be decommissioned. This is a huge environmental problem and is extremely costly. Their concrete bases go as deep as 100 feet in-ground and are hard to fully

[137]Brendan Fox, et al, *Wind Power Integration -- Connection and System Operational Aspects*, Institution of Engineering and Technology, 2007, p. 245.

remove, while the rotor blades contain glass and carbon fibers that emit dust and toxic gases -- so burning them is prohibited.[138]

Deconstruction of one of Europe's earliest offshore wind projects, off Denmark, demonstrated the problem. The blades, nacelle, and tower needed to be dismantled and individually removed by a mobile crane on a jack-up vessel. The concrete gravity-base foundations had to be dismantled on-site by hydraulic demolition shears, and collected afterwards.[139]

Europe is only belatedly beginning to address decommissioning. The oldest offshore wind farms are mostly demonstration projects, close to shore, with few turbines. Decommissioning becomes more difficult as the focus moves from demonstration projects to larger, industrial-scale developments further offshore, and the costs are more than originally estimated. Costs depend on various factors, including the size and type of the project, its distance from shore, whether monopiles and inter-array and export cables have to be fully removed, whether the seabed is returned to its original state, etc. Because decommissioning is expensive, there is always the risk of insolvency.[140]

Since, thus far, there has been little decommissioning of offshore turbines, costs have been underestimated. Current estimates are that it will cost €500,000/MW to decommission offshore turbines, equal to 60-70% of installation costs. With larger installations in more challenging conditions, the costs are higher.[141]

Most U.S wind turbines have been installed within the past decade, and in Texas most have become operational since 2005. Estimates put the tear-down cost of a single onshore wind turbine at $200,000. With more than 50,000 U.S. wind turbines, decommissioning could cost more than $10 billion.[142] Decommissioning the 12,000 turbines in Texas could cost as much as $2.3 billion. In Texas, with little regulatory oversight, there is no requirement for wind companies to escrow funds for decommissioning. Many smaller wind farm companies operating in Texas may just abandon aging projects. This could begin even before turbines outlive their useful life, as manufacturing warranties expire. Thus, Texas could be liable for billions dollars to remove and decommission abandoned wind turbines. Give the requirements of the ETA, New Mexico will face similar problems.

[138]"Wind Energy's Big Disposal Problem," Deutsche Welle, 2018, https://www.dw.com/en/wind-energys-big-disposal-problem/a-44665439.
[139]David Weston, "Dong Begins Vindeby Decommissioning" March 15, 2017.
[140]Jan Dodd, "Decommissioning -- Should They Stay or Should They Go?" May 29, 2015.
[141]Ibid.
[142]Rick Kelley, "Retiring Worn-Out Wind Turbines Could Cost Billions That Nobody Has," *Valley Morning Star*, February 18, 2017.

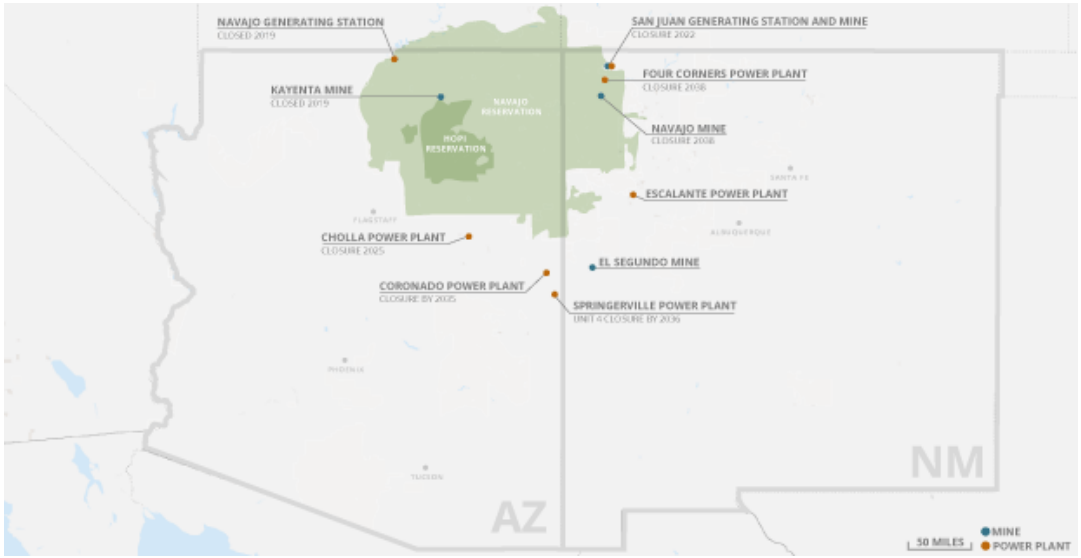
VI. IMPACTS ON NATIVE AMERICANS

"It is truly an injustice that this is happening in the United States of America." Joe Seidenberg, Executive Director, Red Feather Development Group, commenting on the devastating economic impacts on Native Americans of coal facility closures in Arizona and New Mexico.[143]

VI.A. Coal, the Navajos, and the Hopis

The Navajo reservation, the largest in the country, is a 27,000-square-mile area of high plains and desert in New Mexico, southern Utah, and Arizona. It comprises an area as large as the state of West of Virginia and is home to about 250,000 residents. Coal has been part of the social fabric of the Navajos and the Hopis since the 1960s, when electric utilities turned to the Navajo's rich coal deposits to power a booming population in the Southwest. They built seven coal plants in and around the Navajo Nation and the Hopi Reservation – Figure VI-1.

Figure VI-1
Coal Power Plants and Coal Mines in Arizona and New Mexico Constructed to Avoid Dams on the Colorado River



Source: *E&E News*.

Ironically, these coal power plants and coal mines in New Mexico and Arizona were originally sited there due to the demands of environmentalists – who now demand that all of the facilities be closed. Stewart Udall served as Secretary of the Interior for both President John Kennedy and Lyndon Johnson. Udall was a committed westerner and environmentalist and originally proposed dams to provide electricity for the Central

[143]Melissa Sevigny, "Hopi Tribal Members Face Lack of Reliable, Affordable Fuel," NPR, January 27, 2020.

Arizona Project (CAP) and subsidize the project's cost. They would have been located on the Colorado River at the upper and lower ends of the Grand Canyon.[144]

Environmentalists, led by David Brower -- founder of Friends of the Earth, the Sierra Club, and others launched a successful campaign to stop the dams. Udall brokered a compromise where the coal power plants would be built to provide the required electricity and the dams would not be built. In addition, the power plants and mines would provide much needed economic development and jobs for the Navajos and the Hopis. In 1968 President Johnson signed the Colorado River Basin Project Bill, effectively launching CAP.[145] Originally the Hopi and Navajo tribes had unfavorable royalty deals, but renegotiation made the facilities worth millions of dollars annually to the tribes. In addition, up to 90% of the employees at the facilities were Native American.

The Hopi and the Navajo Nations are both dependent on their abundant coal resources as the backbone of their local economies. Coal built the Navajo and Hopi middle class, and coal revenues represented 80% or more of the Tribes' annual income and annual operating budgets.[146] Jobs at the SJGS and the SJM are among the highest paying and most sought after in the region. Their employees – largely Native Americans -- have employer sponsored healthcare and other benefits and earn an average of $86,000.[147] The average coal power plant worker could expect to earn a salary and benefits worth $117,000 annually -- a huge amount compared with the median household income of about $26,000 on the reservation.[148] These earnings are more than twice the local average and are even twice the average San Juan County *family* income. The impacts of a SJGS closure will be especially onerous due to the closure in 2019 of the Navajo Generating Station (NGS), which is already devastating the Navajos and Hopis.

The NGS was a 2,250 MW coal plant located on the Navajo Nation, near Page, Arizona – Figure VI-2. The plant provided electric power to customers in Arizona, Nevada, and California and, as noted, provided the power for pumping Colorado River water for the Central Arizona Project, supplying water to central and southern Arizona. Ninety percent of NGS's approximately 500 full-time employees were Navajo or Hopi, and most of the 350 full-time workers at the Kayenta Mine were Navajo or Hopi.[149] In 2017, the utility operators of the power station voted to close the facility in 2019. In March 2019, the Navajo Nation ended efforts to buy the plant and continue running it after the lease

[144]George Mumford, "The Navajo Generating Station and Environmental Debates," *Intermountain Histories*, https://www.intermountainhistories.org/items/show/61; Robert Dean, ""Dam Building Still Had Some Magic Then: Stewart Udall, the Central Arizona Project, and the Evolution of the Pacific Southwest Water Plan, 1963-1968," *Pacific Historical Review*, February, 1997.

[145]Ibid. Also see Bill Corcoran, "The Sierra Club's Shadowy History with the Navajo Generating Station, *Sierra*, October 12, 2017.

[146]Felicia Fonseca, "Coal Industry on Navajo Nation Could End With Plant Closure," the Associated Press, January 24, 2020

[147]Sally Burbridge, op. cit.

[148]Benjamin Storrow, "The Navajo, Circled by Coal, See Jobs Vanish as CO_2 Falls," *E&E News*, January 2, 2020.

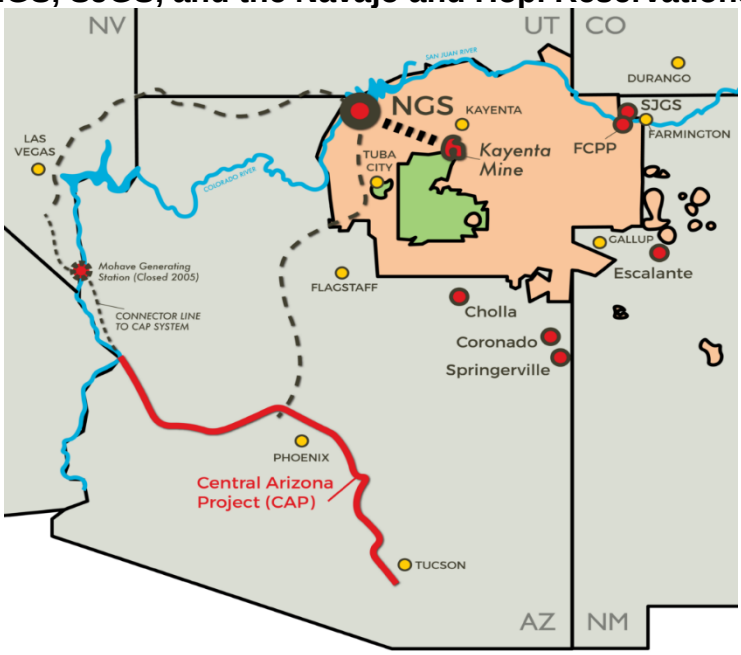
[149]Bonner R. Cohen, "Coal-Fired Power Plant Closure Imperils Grid Security, Jobs," Heartland Institute, January 30, 2018.

expires, and in November 2019 the plant ceased commercial generation.[150] Closure of the NGS and the associated Kayenta coal mine was a devastating blow to the Navajos and the Hopis and resulted in the loss of:[151]

- Over 3,000 jobs.
- Over $500 million in Gross Navajo Nation Product.
- $240 million in labor income.
- A large portion of the local tax revenues.

Thus, "The fiscal impacts of the NGS and Kayenta Mine closures stand to devastate regional public services that have long been funded by a coal industry."[152]

Figure VI-2
NGS, SJGS, and the Navajo and Hopi Reservations*



*The Hopi Reservation, in Green, is surrounded by the Navajo Reservation, Peach colored.

More than a third of the Navajo and Hopi live without electricity, paved roads, cell phone service, landlines, safe housing, or other essentials of modern life. About 75 percent of the roads are dirt and washboard, most of them studded with rocks and wheel-

[150]Katherine Locke, "Navajo Generating Station Shuts Down Permanently," *Navajo-Hopi Observer*, November 18, 2019.
[151]Cindy Yurth, "2018: Year of Schism," *Navajo Times*, December 27, 2018; Ryan Randazzo and Noel Lyn Smith, "Navajo Nation Votes to End Efforts to Purchase Coal-Fired Power Plant, Sealing Its Fate," *Arizona Republic*, March 22, 2019.
[152]Karl Cates and Pam Eaton, "As Coal Economy Collapses, Imminent Public Budget Crisis Confronts Hopi-Navajo Tribes," Institute for Energy Economics and Financial Analysis, May 2019.

swallowing potholes. The dirt turns to gumbo in rain and snow and the roads become impassable.[153]

Many Navajo and Hopi live on 10 gallons of water a day, the equivalent of two or three flushes of a toilet. (Most Americans, by comparison, use about 100 gallons a day.) The lack of clean water has many of the same health consequences as in parts of Africa, including high rates of hospitalizations for severe diarrhea, which can be life-threatening for children under five. The Navajo Nation, in addition, has more substandard housing than any tribal lands in America. Families with small children and elderly grandparents live in ramshackle mobile homes that lack heat, windows, or proper roofs. To stay warm in winter, people burn coal or wood inside the house.[154]

When there is no electricity, Native American children cannot turn on a lamp to do homework after dark. Parents cannot serve fresh, healthy foods, because they lack electricity for a refrigerator. They wish for better roads so they could get police or an ambulance to their door in an emergency. They lack phone service -- landlines rarely exist and cell phone signals are spotty.[155]

San Juan County, New Mexico – which would be seriously affected by closure of the SJGS and the SJM -- suffers from a poverty rate above 20%, is experiencing declining population and economic prospects, and its population is 60% minority.[156] The Navajo Nation and Hopi Tribe (Figures VI-1 and VI-2) are especially at risk, since they have many of the characteristics of a third world nation. For example:[157]

- Over the last 20 years, unemployment in the Navajo Nation has been nearly 50% – compared to, as of January 2020, 4.7% in New Mexico and less than 4% in the U.S.
- Navajo Nation median household income is $20,000 – compared to $47,000 for New Mexico and $60,000 for the U.S.
- 43% of those living in the Navajo Nation earn below the federal poverty level.
- 39% of Navajo 65 and older live in poverty – five times the share in New Mexico.
- 45% of children in the Navajo Nation live in poverty.
- More than a third of the Navajo live without electricity, paved roads, cell phone service, landlines, safe housing, or other essentials of modern life.
- The Navajo Nation has more substandard housing than any tribal lands in America.
- 40% of Navajo households lack running water, a problem so acute that the Navajo often compare the region to sub-Saharan Africa. They haul water home in plastic containers, driving as much as 20 miles each way to obtain it from unimproved

[153]Amy Linn, "A Forgotten Health Crisis in Navajo Lands," Center for Health Journalism, July 24, 2018.
[154]Ibid.
[155]Ibid.
[156]"San Juan County Profile," https://datausa.io/profile/geo/san-juan-county-nm/.
[157]U.S. Census Bureau, "San Juan County Quick Facts," https://www.census.gov/quickfacts/sanjuancounty newmexico; Alysa Landry, "Loss of Jobs Inevitable With Closing of San Juan Generating Station," *Navajo Times*, March 23, 2017.

wells or livestock tanks, where water is potentially contaminated with fecal waste, E coli, viruses, parasites, arsenic, or uranium.[158]

- In the Navajo nation, 38% percent of residences lack electrical service and running water, and 86% are without natural gas service.[159]

The Hopi Tribe is among the most underdeveloped and most vulnerable populations in the U.S. and has already suffered grievously from stringent and inflexible environmental regulations and from environmental campaigns to shut down the coal industry and coal power plants.[160] The shutdown of the Mohave Generating Station (MGS) over a decade ago had already imposed a highly disproportionate economic burden on the Tribe. The Hopi suffered loss of nearly $7 million annually from the MGS closure. The shutdown of NGS, the sole remaining buyer of Hopi coal after MGS, is further devastating the Hopi Tribe. The loss of SJGS and the SJM would complete the economic destruction of the Hopi.

The Hopi Tribe is also extremely impoverished – in some respects even worse than the Navajos. For example:[161]

- Households on the Hopi Tribe are four times as likely to receive Food Stamps/ SNAP as are residents of Arizona -- over one-fourth (28%) of all households on the Hopi Reservation receive assistance from the Supplemental Nutrition Assistance Program (SNAP).
- Hopi employment is a low 149 per 1,000 residents, which is the lowest of all Arizona unincorporated areas.
- The unemployment was 86% for the Hopi Reservation in 2017.
- Hopi per capita income is less than half that of the Arizona average.
- Poverty rates on the Hopi Reservation are almost twice as high as the state average.
- Almost half (48%) of all children under 18 years of age are considered to be living in poverty
- Over one-third (35%) of those living on the Hopi Tribe are classified as “severely poor.”
- Twice as many Hopi 65 or older live in poverty as the state average
- 40 percent of Hopi households lack running water.

[158]Amy Lin, op. cit.

[159]https://navajobusiness.com/fastFacts/demographics.htm.

[160]Hopi Tribe Office of Community Planning and Economic Development and Land Information Systems, “Hopi Comprehensive Economic Development Strategy,” prepared for the U.S. Economic Development Administration, 2018.

[161]Thomas Combrink, “Demographic Analysis of the Hopi Tribe Using 2011-2015 American Community Survey, Arizona Rural Policy Institute, Alliance Bank Economic Policy Institute, W.A. Franke College of Business, Northern Arizona University, June 2018; Bureau of Women's and Children's Health, Arizona Department of Health Services, “Hopi Tribe Primary Care Area (PCA) 2019 Statistical Profile,” February 2020; Shiloh Deitz and Katie Meehan, “Plumbing Poverty: Mapping Hot Spots of Racial and Geographic Inequality in U.S. Household Water Insecurity,” *Annals of the American Association of Geographers*, Volume 109, No. 4 (2019), pp. 1092-1109.

- On the Hopi Reservation, there are no hospitals, no skilled nursing facilities, no licensed home health agencies, no ambulatory care sites, no licensed pharmacies, and no certified ambulance services.

To make matters worse, coal-related revenues provided over 80% of the Navajo and Hopi Tribe budgets.[162] After NGS closed, the Navajo government announced that it will reduce tribal spending by nearly 25% in the first full fiscal year following NGS's closure. The Hopi government has not announced what it will do: It depends on coal operations for 85% of its public-services budget, which, like that of the Navajo, fund crucial childcare programs, healthcare, education, and a host of other public services.[163] Thus, "With the closing of Navajo Generating Station (NGS), the biggest funding source for the Hopi tribe, the tribe will be facing a huge loss of royalties that were given by the Peabody coal company."[164]

VI.B. Navajo and Hopi Energy and Public Health Crisis

The closure of the Kayenta Mine – due to the closure of the NGS, and the potential closure of the San Juan Mine are having another devastating but little noticed impact on the Navajo and Hopi. For decades, coal has been at the center of Native Americans' life, literally. In the middle of each home is a coal-burning stove that keeps families warm through the winter. According to Leigh Wayne Lomayestewa, an official with the Hopi cultural preservation office, "A lot of people relied on the coal to heat their homes and ceremonial chambers, the kivas, and now we're only relying on the cedar wood." [165] However, he notes that cedar does not burn as long as coal: "Usually at nighttime, you can put in about two or three times a night."[166]

Navajo and Hopi families have long relied on coal to heat their homes, but now must seek other sources after the Kayenta Mine closed in 2019 after decades of supplying the Navajo Generating Station. The Navajo and Hopi tribes shared in the coal royalties. In addition, Tribal members also had access to the coal, regularly loading the long-burning fossil fuel into pickups or buying it from roadside vendors. Peabody Energy, which owned the Kayenta Mine, had provided cards for free coal to Navajo and Hopi government centers to distribute to tribal members. Others could purchase it. The loading facility was open three days a week, from late October to mid-March, serving thousands of visitors a year.

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[162]Laurel Morales, "Hopi Look To Tourism, Ranching For Income After Coal Power Plant Closure," *All Things Considered*, January 14, 2020.
[163]Karl Cates, "As Coal Economy Collapses, Imminent Public Budget Crisis Confronts Hopi-Navajo Tribes," Institute for Energy Economics and Financial Analysis, May 2019
[164]"Hopi Tribe Facing Budget Cuts," *Hopi Tutuveni*, November 20, 2018.
[165]Laurel Morales, "Hopi Look to Tourism, Ranching For Income After Coal Power Plant Closure," *All Things Considered*, NPR, January 14, 2020.
[166]Ibid.

In the first winter without the Kayenta Mine, 2019-20, Tribal members had to travel much farther for coal – to the SJM, switch to firewood, or even had to burn household items to stay warm. According to Monica Nuvamsa, "Coal economically works better because it burns longer, you don't need as much in order to heat your home." [167] She would drive two hours from her home in Shungopavi on the Hopi reservation to collect coal for her grandmother from the Kayenta Mine.

Since they do not have access to electricity or natural gas, many tribal members have no option but to heat their homes with coal-burning stoves. To do so, they relied on coal from the Kayenta Mine and, after it closed, have been relying on coal from the San Juan Mine. Two or three truckloads of coal can warm a house all winter. Further, burning wood leads to a build-up of creosote, a hazardous flammable residue.

Losing coal has led to a public health crisis for many Navajo and Hopi, since there are few other options for heating homes. Propane and space heaters are expensive, and many houses do not have electricity. Trees are scarce; the nearest places to buy or cut wood are hours away by car, and wood is an inferior heating fuel compared to coal: "It takes Sekakuku and her three children a full day to gather a truckload of wood, which only lasts one week. It's just a lot of physical work, and not everyone is able to afford wood, but it's a necessity now." [168] Sekakuku burns wood in her coal stove now. "I'm having to get up twice a night to check the fire, make sure it's still going. I'm having to chop wood beforehand, in the morning, in the evening."[169] Wood sells for $240 a cord, and many tribal members cannot afford it: They are forced to burn weeds or their clothes to keep warm.

When NGS and the Kayenta Mine closed, Navajo and Hopi had to switch to traveling for their coal to the SJM, which is 200 miles east of the now closed Kayenta Mine. After NGS closed, one of the companies that provides SJM coal has experienced an increase in visits from Navajo and Hopi tribal members needing coal to heat their homes from 2,000 to 6,000. Navajo government officials are working with the SJM to deliver coal to dozens of Navajo communities and to expand the program to the Hopi reservation.[170]

However, if PNM has its way, the SJM will close in 2022 and tribal members will lose another source of their desperately needed coal. "There are people that are living with extreme housing disparities, with major holes in their roofs, with cardboard

[167]Melissa L. Sevigny, "Navajos, Hopis Turn to Other Heat Sources After Coal Mine Closure," the Associated Press, March 6, 2020.
[168]Ibid.
[169]Ibid.
[170]In addition, the Navajo Transitional Energy Company (NTEC) has instituted an emergency program to supply Native Americans with coal from the Navajo Mine. However, the NTEC program is a stopgap measure that is able to supply only a fraction of the very large quantity of coal needed – MISI staff discussions with Native American representatives, September 8, 2020. Further, while the Navajo Mine and Four Corners plant are currently scheduled to stay open until 2031, various interest groups are trying to get them closed much earlier than that. The bottom line is that many Native Americans will have increasing difficulty heating their homes.

windows, that are at a real risk for freezing to death."[171] More than a dozen Navajo and Hopi freeze to death each winter, and this toll is likely to increase if the SJM closes and with it the last source of coal for the tribes.

VI.C. Impacts of SJGS and SJM Closures on Native Americans

Approximately half of the workers and the SJGS and SJM are Native American – virtually all of them Navajo, since the Hopi Reservation is 150 miles distant. Thus, closure of the SJGS and the SJM will be a serious blow to the Navajo, since these are jobs that will not be easily replaced. They include direct jobs at the San Juan Generating Station, the San Juan Mine, and related contractors and supporting businesses. It is also worth noting that members of the Navajo Nation will be especially hard hit. Many of the employees who will lose their job are Navajo and the income from their jobs often support large families and extended families.

As discussed in Section III-C, the job impacts under the CCUS scenario derive from:

- CCUS Construction
- CCUS plant O&M
- Pipeline construction
- Pipeline O&M
- Continued operation of the SJGS
- Continued operation of the SJM

The job impacts from the PNM scenario derive from:

- PV plant construction
- PV plant O&M
- Wind turbine plant construction
- Wind turbine plant O&M
- Battery storage construction
- Battery storage O&M
- Continued operation of the SJGS through 2022
- Continued operation of the SJM through 2022
- Decommissioning of the SJGS 2023-2025

The net job impacts on the Navajo result from the difference between the job impacts of the CCUS scenario compared to the PNM scenario. Since approximately half of the workers and the SJGS and SJM are Navajo we assume here that approximately half of the net job losses (direct and indirect) under the PNM scenario compared to the CCUS scenario will be experienced by the Navajo.

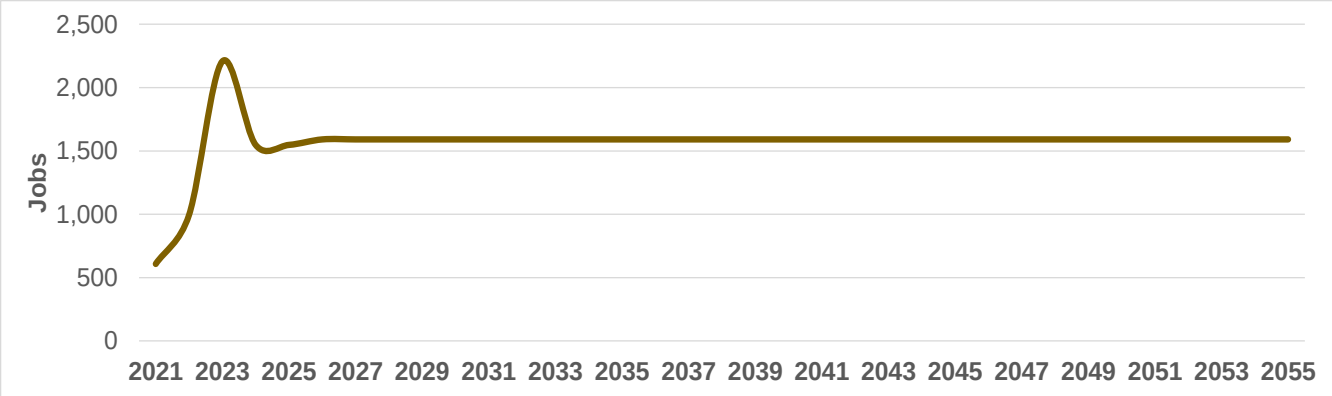
Figure VI-3 shows the net differences in jobs created for San Juan area Navajos between the CCUS scenario and the PNM scenario – it shows the net increase in jobs

[171]Melissa L. Sevigny, op. cit.

for Navajos created each year, 2021-2055, by the CCUS scenario compared to the PNM scenario. It illustrates that:

- During the construction phases of the CCUS and the RE facilities, 2021-2023, the net Navajo job gain of the CCUS scenario over the PNM scenario increases from about 600 jobs in 2021 to over 2,200 in 2023
- In 2024 and 2025, when under the PNM scenario the SJGS and SJM are closed and are being decommissioned, the net Navajo job gain of the CCUS scenario over the PNM scenario is about 1,550 jobs each year.
- During 2026 - 2055, when under the PNM scenario the SJGS and SJM are closed and decommissioning has been completed, the net Navajo job gain of the CCUS scenario over the PNM scenario is just under 1,600 jobs each year.
- Over the period 2021-2055, the CCUS scenario creates a total of 54,635 more jobs for Navajos than the PNM scenario.

Figure VI-3
Net Navajo Job Differences For San Juan Area Navajos
Between the CCUS Scenario and the PNM Scenario



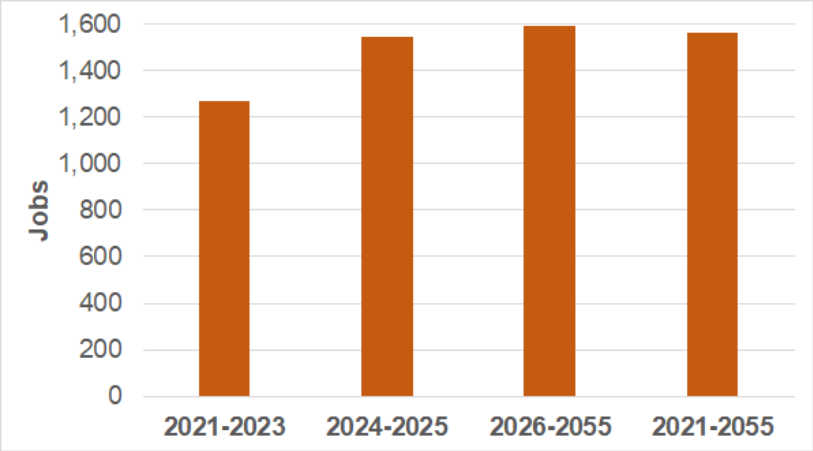
Source: Management Information Services, Inc.

Figure VI-4 shows the average annual net differences in jobs created for San Juan area Navajos between the CCUS scenario and the PNM scenario – it shows the net average annual increase in jobs for Navajos created each year, 2021-2055, by the CCUS scenario compared to the PNM scenario. It illustrates that:

- During the construction phases of the CCUS and the RE facilities, 2021-2023, the average annual net Navajo job gain under the CCUS scenario compared to the PNM scenario is about 1,270 jobs.
- In 2024 and 2025, when under the PNM scenario the SJGS and SJM are closed and are being decommissioned, the net average annual Navajo job gain under the CCUS scenario compared to the PNM scenario is about 1,550 jobs.
- During 2026 - 2055, when under the PNM scenario the SJGS and SJM are closed and decommissioning has been completed, the net average annual Navajo job gain under the CCUS scenario compared to the PNM scenario is just under 1,600 jobs each year.

- Over the period 2021-2055, the CCUS scenario creates a net annual average of about 1,560 more Navajo jobs each year than the PNM scenario

Figure VI-4
Average Annual Net Job Differences For San Juan Area Navajos Between the CCUS Scenario and the PNM Scenario

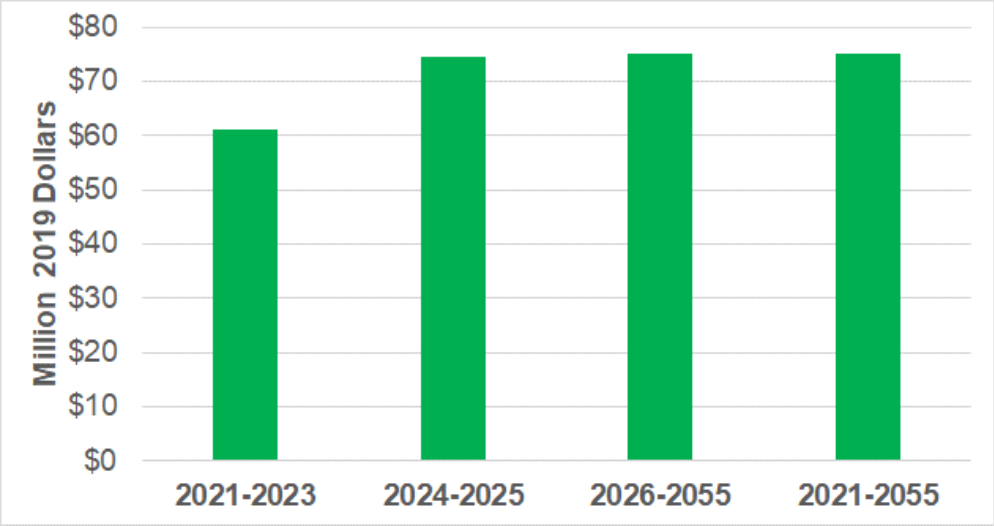


Source: Management Information Services, Inc.

Figure VI-5 shows the average annual net differences in wages and benefits created for San Juan area Navajos between the CCUS scenario and the PNM scenario – it shows the net average annual increase in wages and benefits for Navajos created each year, 2021-2055, by the CCUS scenario compared to the PNM scenario. It illustrates that:

- During the construction phases of the CCUS and the RE facilities, 2021-2023, the average annual net Navajo wages and benefits gain under the CCUS scenario compared to the PNM scenario is about $61.1 million each year.
- In 2024 and 2025, when under the PNM scenario the SJGS and SJM are closed and are being decommissioned, the net average annual Navajo wages and benefits gain under the CCUS scenario compared to the PNM scenario is about $74.5 million each year.
- During 2026 - 2055, when under the PNM scenario the SJGS and SJM are closed and decommissioning has been completed, the net average annual Navajo wages and benefits gain under the CCUS scenario compared to the PNM scenario is $75.2 million each year.
- Over the period 2021-2055, the CCUS scenario creates a net total of about $2.6 billion more Navajo wages and benefits than the PNM scenario.

Figure VI-5
Average Annual Net Differences in Wages and Benefits Created For San Juan Area Navajos Between the CCUS Scenario And the PNM Scenario



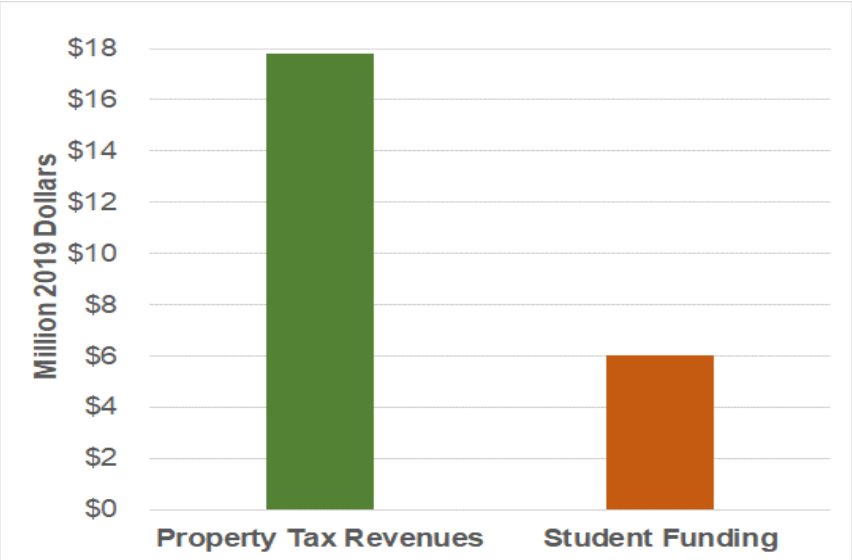
Source: Management Information Services, Inc.

The San Juan Central Consolidated School District (CCSD) has 6,000 students and 1,200 staff in 15 schools. It has a student body that is 91% Native American students and has 72% of its students classified as financially disadvantaged. Under the PNM scenario, CCSD will see dramatic reductions in tax revenues and student funding and will have to reduce staff and close schools.[172] However, as shown in Figure VI-6, under the CCUS scenario compared to the PNM scenario these negative consequences would not occur and, instead, the CCSD would receive:

- $17.8 million more each year in property tax revenues
- $6 million more each year in student funding

[172]CCCD study; Alicia Corbell, "Impacts: San Juan Generating Station & San Juan Mine," School of Energy at San Juan College, 2019. About one-third of the students at the San Juan Community College are Native American.

Figure VI-6
San Juan Central Consolidated School District Budget Annual Increases Under the CCUS Scenario Compared to the PNM Scenario



Source: Management Information Services, Inc.

VI.D. Potential Native American Alternatives to SJGS and SJM

The November 2019 closure of the NGS and the Kayenta Mine was devastating for Native Americans and resulted in:[173]

- The loss of a total of 1,400 – 1,900 Hopi jobs
- The loss of a total of 1,200 – 2,000 Navajo jobs
- The loss of a total of 2,600 - 3,900 Native American jobs
- The loss of $14 million annually to the Hopi from royalties, bonuses, scholarships, and water payments
- The loss of $20-30 million annually to the Hopi from payrolls and benefits
- The loss of $140 million annually to the Navajo Nation from payrolls, benefits, royalties, bonuses, scholarships, and water payments.
- Total annual losses to the Hopi and Navajo of $75 million from CAP payments.

As discussed, the closure of the SJGS and the SJM will further devastate Native Americans in terms of both job losses and tribal revenues, especially following the closure of NGS and the Kayenta Mine. Accordingly, the Navajo and Hopis are desperately searching for industries, projects, and initiatives to replace the jobs and revenues lost by the closure and impending closure of coal power plants and coal mines. The options available are not promising.

[173]Northwest New Mexico Council of Governments, *Regional Economic Assessment & Strategy for the Coal-Impacted Four Corners Region*, February 8, 2017.

While numerous fanciful options relating to RE development, tourism, recreation, native arts and crafts, etc. have been proposed, it is noteworthy that one of the few viable job development initiatives moving forward is for the SJGS retrofit project. In June 2020, the San Juan College School of Energy, the City of Farmington, the Farmington Electric Utility System, and Enchant Energy signed a memorandum of understanding (MOU) to develop programs that will result in the skilled workforce required for the ongoing safe and efficient operation of SJGS with the planned CCUS.[174] Under the MOU, the School of Energy will support professional development training for current and new employees at the plant. The school will also train a new workforce with the skills needed for the ongoing control, operation, and maintenance of the plant and future carbon capture facilities. In addition, the School of Energy plans to develop a one-year certification and a two-year Associate of Applied Science degree that will include the technical skills and training needed to work in coal-fired power plants equipped with carbon capture technology. The carbon capture contractor, Kiewit Power Constructors, estimates that the carbon capture island alone will require 2,000,000 worker-hours in direct construction, union labor to build.

Other options proposed for the Navajos and Hopis are questionable, at best.

For example, the remote location of the Hopi reservation creates challenges for responding to job opportunities, due to the one-way driving route of 90+ miles, for example from Flagstaff driving to and from a job either living on the reservation or driving to the main Hopi headquarters. If housing for workers is not available on the reservation, commuting by the Hopi Senom Transit System is an option from any Hopi Village to, for example, the City of Flagstaff totaling a 180 mile round trip. This sort of commute is often mandatory if a Hopi wants to either find a job off reservation or work at a job on the reservation. This is a loss as far as travel time, and it is a double loss when the only large economic centers for groceries, clothing, and other amenities are located in these various non-Indian communities. Because of this lack of a vibrant economy of businesses on the reservation, the Hopi Tribe and its members contribute a steady stream of tribal dollars to the economies of these surrounding non-Native American communities -- all at the expense of much need on-reservation development. This economic loss is a significant loss to the Hopi Tribe since a high percentage of a person‘s paycheck is spent off reservation for daily living necessities, such as food, clothing, and other household needs.

Tourism is a challenge because of the Hopi tribe's location: They are isolated, completely surrounded by the Navajo Nation. "We're in a remote area so money-wise it's hard for us to go out and even advertise our tourism program. So it's really hard."[175] The Hopi are working with the Navajo to build a road that would loop them into popular

[174]San Juan College School of Energy, the City of Farmington, Farmington Electric Utility System and Enchant Energy, “Memorandum of Understanding to Guide Collaboration For Development of Skilled Workforce at San Juan Generating Station, June 29, 2020.

[175]Laurel Morales, “Hopi Look to Tourism, Ranching For Income After Coal Power Plant Closure,” *All Things Considered*, NPR, January 14, 2020.

destinations like Monument Valley and Canyon de Chelly for tour companies coming from Las Vegas.[176] However, future benefits are uncertain and are likely to be relatively small.

The Hopi tribe is even exploring unusual ideas like the one pitched by engineer T.J. Agardy who came to a recent tribal council meeting. He is proposing technology used in Germany and Japan to harvest coalbed methane and turn it into natural gas. [177] However, the New Mexico ETA will likely prevent such a venture.

Given the geography of the Hopi Tribe, Hopi Villages are in need of energy improvements for future energy security for present and future growth. The Hopi Tribe's future energy is jeopardized due to the decrease in energy from coal-fired power plants, leaving the Hopi Tribe paralyzed when it comes to future energy. Current questions need to be answered, such as, how much energy does the current Hopi electricity system generate and use? Capacity building through infrastructure both by fossil energy and renewable energy will need to be analyzed to obtain a better understanding of the existing system of the Hopi Tribe. Other questions deal with production, transmission, and distribution both for basic village use, along with future housing growth along with small economic development.[178]

Coal revenues form NGS and the Kayenta Mine represented 88% of the Hopi Tribe's annual income and annual operating budget.[179] Potential Hopi economic development projects aimed at developing new coal markets have included a rail delivery system to transport the coal off the reservation to other markets via the BNSF rail. However, such plans are likely not feasible in light of federal policies and environmental opposition to any coal development. The Hopi Tribe continues to explore, and supports the funding of economic projects for coal gasification, solar/wind generation and other energy alternative strategies – thus far with little success.

The Hopi resources are diverse and include coal, coal-bed methane, natural gas, oil, solar, and wind. Potential liquefaction and gasification of coal could provide options to continue to identify other revenue based coal development projects. The Hopi Tribe has potential to identify funding to seek more information about other coal energy development projects. This type of venture could potentially be built on Hopi creating another employment center for Hopi tribal members. Plants similar to the Peabody Energy mining complex from construction to ongoing daily operations would generate a stable economy. However, the economic analysis referencing a viable market would be

[176]Ibid.
[177]Ibid.
[178]Hopi Tribe Office of Community Planning and Economic Development and Land Information Systems, "Hopi Comprehensive Economic Development Strategy," prepared for the U.S. Economic Development Administration, 2018.
[179]*Analysis of Economic Impacts on the Hopi Tribe and Navajo Nation of a Stringent NOx BART Decision for the Navajo Generating Station, March 1, 2010*, Pg. 39. Prepared for the Hopi Tribe. ICF Resources, LLC, Fairfax, VA 22031 *Letter Dated March 1, 2010 from Leroy Shingoitewa, Chairman, Hopi Tribal Council, to Jared Blumenfeld, EPA; Document number 0211 in the docent for the ANPRM: EPA-OAR-2009-0598.*

key from the southwest to the Midwest power markets.[180] More important, environmental regulations, the New Mexico ETA, and opposition of environmentalists make development of coal-related projects unlikely.

While wind resource development should be explored, it is likely to be a limited economic resource for the Hopi. The Hopi reservation is a Class 2/Marginal and Class 3/Fair location for wind energy development; making Hopi land marginally economically feasible to construct a wind plant.[181] Serious questions arise in the economic analysis and the basic question of dispatchability of the wind energy resource. Reliable energy is critical to the health, safety, and prosperity of the Hopi Tribe. Energy is vital in creating and maintaining a homeland through everyday life; from safe drinking water to the traditional values of the Hopi way of life. The Hopi Tribe currently experiences frequent brownouts, which are of great concern due to compliance with the Safe Drinking Water Act (SDWA), and wind is interment and unreliable.

In addition, the return on investment from wind powered generation pales in comparison to the coal revenues the Hopi received from the NGS. The estimates that have been made show Hopi receiving revenues of $233,000 per year from a 50 MW wind plant verses the annual revenues for NGS of $13.5 million.[182] Thus, the wind generation would replaces less than 2% of the NGS revenues, and wind resource development is likely to be an extremely limited economic resource for the Hopi. The Hopi Tribe would need approximately 57 wind plants of 50 megawatts each – a total of 2,850 MW, just to replace the NGS coal revenues. This is simply not feasible given current conditions and Hopi cultural constraints on land use.[183]

Businesses that generate revenues and jobs include hotels, restaurants, shopping, and southwestern artifacts. Continued research into tourism combined with knowledge of traditional and private culture and social and cultural education could possibly be incorporated into the creation of economic tourism. The tourism concept can generate more awareness and opportunities for growth and expansion on and off the Navajo and Hopi reservations utilizing all existing properties. The Navajo and Hopi could capitalize on the work of Native American artisans that live on and off the reservation through silver and gold jewelry, turquoise jewelry, kachina carvings, sculptures, weaving and traditional designs, southwest clothing, pottery, plaques and baskets, paintings, moccasins, and other valued artwork. Although the world wide web through online sales for local artisans is also a viable possibility, sales from direct artisans is still in demand through local art galleries and shops (most of which are out of the homes of the artisan) that are located

[180]Hopi Tribe Office of Community Planning and Economic Development and Land Information Systems, "Hopi Comprehensive Economic Development Strategy," prepared for the U.S. Economic Development Administration, 2018.
[181]These classifications are according to EIA. See NREL, Renewable Energy Development on Tribal Lands, https://www.nrel.gov/docs/fy04osti/35509.pdf
[182]Hopi Tribe Office of Community Planning and Economic Development and Land Information Systems, "Hopi Comprehensive Economic Development Strategy," prepared for the U.S. Economic Development Administration, 2018.
[183]Ibid.

in villages throughout the area. However, even the most optimistic forecasts acknowledge that such activates could provide only a small fraction of lost coal revenues.

Renewable energy has been much hyped and advocated as a wary for the Navajo to replace the jobs and revenues that would be lost with the closure of the SJGS and SJM. However, the key point is that RE power energy generation is less labor intensive than coal-produced energy. This means transition to this industry will not generate as many overall jobs for the region as the SJGS has, even with investment in retraining. Further, much of the job creation associated with renewables will be short lived, tied largely to the construction needed over the first two years.[184] There is also widespread concern that, despite language in the ETA emphasizing prioritization for disadvantaged communities in workforce retraining, Native American communities could be excluded from future opportunities in the renewable energy workforce.[185] Further, while some displaced coal workers can transition into other jobs, the work that they usually find pays only $12 to $15/hour, compared to the average of more than $85,000/year salary plus benefits they earn as coal miners.[186]

The U.S. EPA provides several supposedly helpful case studies of Native American communities that have successfully transitioned from coal plant operations to solar power generation.[187] Among those often cited is the Apache Powder Superfund Site near Benson and St. David, Arizona.[188] However, this is a 1.4 kW capacity combined solar and wind project, which is trivial compared to the 847 MW SJGS.

Brett Isaac, a member of the Navajo Nation, helped found the Navajo Power Company to produce RE on Navajo land. "The idea was let's start with solar projects in the shadows of these coal facilities because you already have the asset infrastructure we would need."[189] However, even solar enthusiasts like Isaac concede renewables will have difficulty replacing jobs lost by coal. While there are construction jobs generated during project development, there are far fewer jobs once panels start producing electricity.[190]

Land-use is also significant barrier to renewable energy development, since many Navajo and Hopi rely on livestock for their livelihood, so large-scale RE development threatens to reduce the land size that is needed to graze livestock.[191] Since the U.S. Federal Government holds reservation land in trust, homesite leases are a way to distribute land among enrolled tribal members -- which are usually a one square-acre

[184]University of New Mexico Native American Budget and Policy Institute, "The Projected Impact of the Energy Transition Act on Native American Communities in New Mexico," June 2019.
[185]Ibid.
[186]Roger H. Bezdek, "The 2020 Presidential Election and Prospects For Coal, *American Coal*, August 2020.
[187]https://www.epa.gov/re-powering/re-powering-success-stories-powering-remediation#file-121335.
[188]https://www.epa.gov/sites/production/files/2015-04/documents/success_apachepowder_az.pdf
[189]Benjamin Storrow, "Coal's Days in Navajo Country Are Numbered," *E&E News*, April 8, 2019.
[190]Ibid.
[191]Sherralyn Sneezer, "Solar Energy Development on the Navajo Nation," Environmental Studies Department, Dartmouth College, June 2019.

area of land that a Native American can apply to lease for a certain amount of time, usually one lifespan, to build a house and live there.

However, it has become a difficult process to obtain a homesite lease since permission must be obtained from people who live in the area or have grazing permits in the area. Each person must approve an application, or it will be denied if one person does not support it. In some cases, the process of obtaining land on the Navajo Nation or Hopi reservation can be nearly impossible since people do not want to share or relinquish parts of their land, even if there are not any true property rights. In order to have water or electricity at a home, the owner must have a homesite lease to give to the Navajo Tribal Utility Authority (NTUA), so that it is authorized to install transmission lines or water pipes on the land. One respondent had attempted to get a homesite lease in Tuba City, and he explained, "People don't want to give up grazing sites even though you don't see a sheep or cow for miles. They say that's theirs, and they don't want nothing."[192]

In the case of homesite leases, there is a perceived double barrier where Native Americans cannot obtain homesite leases, which means that they cannot utilize the NTUA residential solar program. Further, developing utility-scale solar farms would be difficult since Native Americans have a strong connection to their land. Cost is also a serious barrier to RE energy development, since RE requires a large up-front cost which is difficult for Native American families to pay off when attempting to purchase a solar system.[193]

Native American workers worry that even with the retraining and severance assistance, they will not find jobs that pay as well, since many positions in RE pay half or less than jobs at the SJGS and SJM. Local officials already reeling from the decline of region's natural gas industry and the recent departure of two major employers, ConocoPhillips and WPX Energy, fear another wave of population attrition and lost tax revenues as SJGS plant and SJM mine workers leave to find work elsewhere.[194]

For local officials, the debate is not about one type of power over another, it is about keeping the economy afloat. San Juan County Manager Mike Stark noted that none of the proposed RE replacement power projects will generate nearly enough jobs or tax revenues to replace what will be lost if SJGS and SJM close. Stark stated "The pain that we'll feel from the loss of jobs is real, and it's quite great. This plant and the mine represent 10 percent of our total tax base. The area already lost 10 percent of its tax base in 2019, after the shuttering of another coal-fired power plant in the region, the Navajo Generating Station."[195]

Many workers doubt that the retraining and transition funding will help much. Derek Rawson, an engineer at the SJM who has lived in Farmington for 24 years, stated that he and his wife and four children will likely look for opportunities elsewhere if the mine

[192]Ibid.
[193]Ibid.
[194]April Reese, "As New Mexico Swaps Coal For Renewables, San Juan County Struggles to Chart a New Future," *Searchlight NM*, February 25, 2020.
[195]Ibid.

closes.[196] Given that getting a technical degree costs about $24,000, the $8,000 in retraining funding per mine employee offered by PNM will not go very far. It is not going to be enough, agrees Lorenzo Reyes, San Juan College's Dean of Workforce and Economic Development: "Workers won't survive financially if they don't have assistance after their unemployment insurance ends."[197]

Another option being explored is promoting Navajo and Hopi tour companies at the Grand Canyon and Las Vegas. However, there has been little assistance offered by the federal, state and tribal governments and little progress has been made. More important, the feasibility of expecting large numbers of tourists from Las Vegas is questionable.

The Navajo-Hopi area is not without various options: The film industry, reclaiming a Superfund site near Shiprock, establishing a rail line to export produce, expanding the community college, and others. Native Americans are willing to work at whatever will pay a salary comparable to the six-figures they have made with the SJGS and SJM so that they can provide for their families and save for their children and grandchildren.[198] Nevertheless, whether PNM replaces coal with a natural gas plant or goes all-in on renewables, there will be major job losses as they move from construction to maintenance. The hope is that budding economic diversification measures will have succeeded by the time construction jobs run their course. So far, in meetings run by Four Corners Economic Development and the San Juan Citizens Alliance, legislators have heard that outdoor recreation tops the list. However, local residents and officials are skeptical: "We're not a ski resort, we're not Canyon de Chelly. How they're going to come up with that, I don't know."[199]

[196]Ibid.
[197]Ibid
[198]Elizabeth Miller, "Life After Coal: San Juan Miners, Economists Wonder What's Next," *New Mexico in Depth*, February 22, 2019.
[199]Ibid.

VII. CONCLUSIONS

This research had three major objectives:

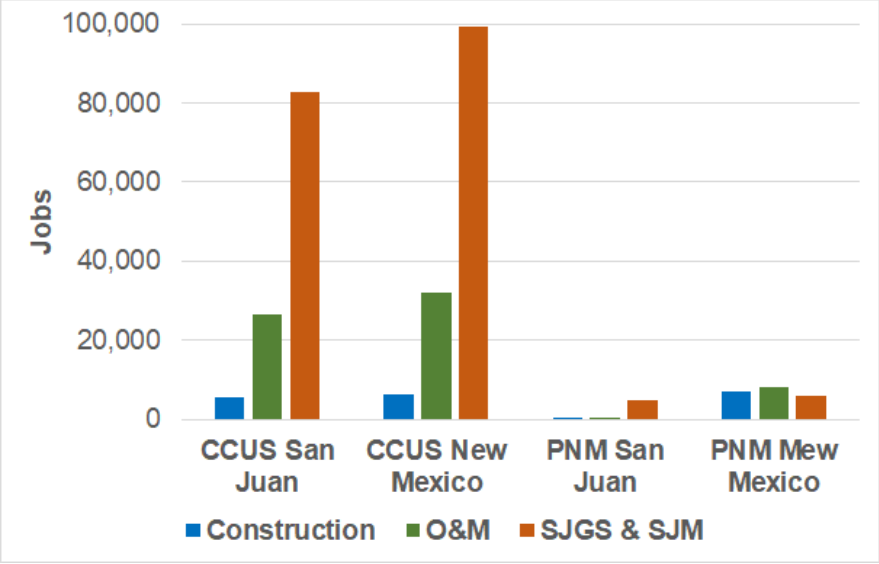
1. Estimate the relative economic impacts of CCUS retrofit of the SJGS compared to its replacement by the PNM RE scenario.
2. Develop metrics that can be used to compare the jobs impacts of coal power plants to those of renewable energy.
3. Estimate the impact on Native Americans of the two scenarios.

VII.A. Relative Economic Impacts of the Two Scenarios

We found that the CCUS scenario can achieve CO_2 emissions reductions significantly greater than those achieved under the PNM scenario, avoids economic harm and job losses to the San Juan area and to New Mexico, and creates large numbers of jobs in the process. Figure VII-1 shows that the CCUS scenario creates significantly more jobs both in San Juan County and in New Mexico than does the PNM scenario. In San Juan County, compared to the PNM scenario:

- The CCUS Scenario creates 26 times as many construction jobs.
- The CCUS Scenario creates 92 times as many O&M jobs.
- The CCUS Scenario creates 17 times as SJGS and SJM jobs.[200]

Figure VII-1
Total Jobs Created by the CCUS Scenario and the PNM Scenario, 2021-2055



Source: Management Information Services, Inc.

In New Mexico, compared to the PNM scenario:

[200]SJGS decommissioning jobs included in the PNM total.

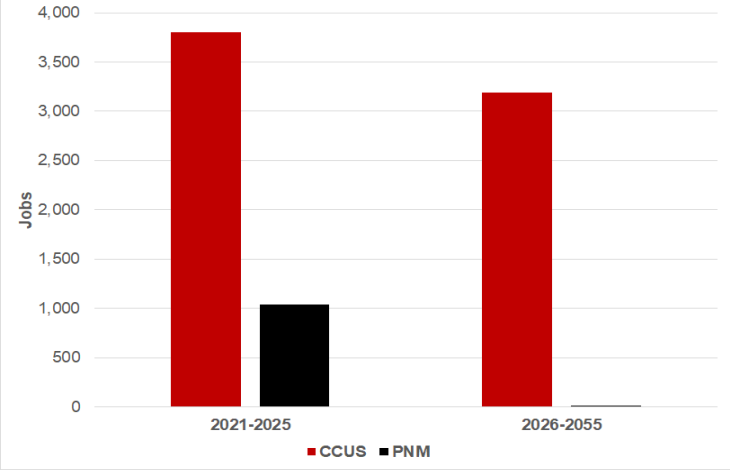
- The CCUS Scenario creates about the same number of construction jobs.
- The CCUS Scenario creates four times as many O&M jobs.
- The CCUS Scenario creates more than 16 times as SJGS & SJM jobs.[201]

We found that the CCUS scenario creates orders of magnitude more jobs than the PNM scenario. Figure VII-2 shows the time periods over which the jobs are created in San Juan County by the CCUS and the PNM scenarios. It demonstrates that the CCUS scenario creates more than 20 times as many jobs in San Juan County than the PNM scenario but, due to the construction and decommissioning schedules, most of the PNM jobs are created in the years 2021-2025. Specifically, in San Juan County:

- In years 2021-2025, the CCUS scenario creates annually, on average, 3.7 times as many jobs as the PNM scenario.
- In years 2026-2055, the CCUS scenario creates annually, on average, 355 times as many jobs as the PNM scenario.

We conclude that, over the long term, the CCUS scenario would ensure near full employment in San Juan County whereas the PNM scenario would result in over 12% unemployment in the County.

Figure VII-2
Average Number of Jobs Created in San Juan County



Source: Management Information Services, Inc.

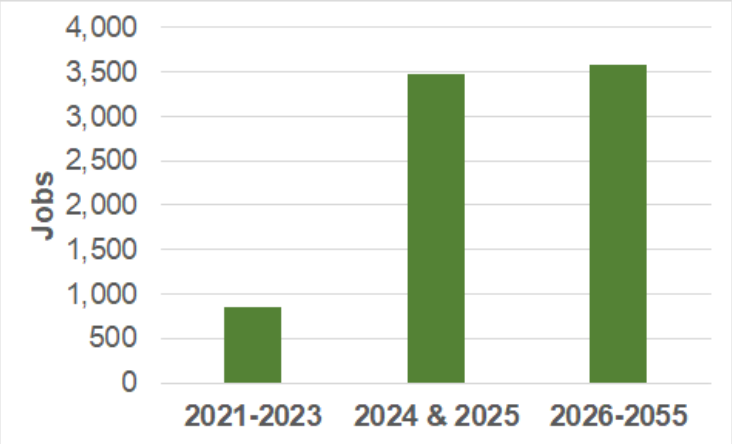
We conclude that similar results hold true for the impacts on the state of New Mexico – Figure VII-3:

- In years 2021-2023, the CCUS scenario creates annually in New Mexico, on average, 814 more jobs than the PNM scenario – more than 20% more jobs each year.
- In years 2024 and 2025, the CCUS scenario creates annually in New Mexico, on average, about 3,500 more jobs as the PNM scenario – about 10 times as many jobs each year.

[201]SJGS decommissioning jobs included in the PNM total.

- In years 2026 - 2055, the CCUS scenario creates annually in New Mexico, on average, about 3,600 more jobs as the PNM scenario – about 14 times as many jobs each year.

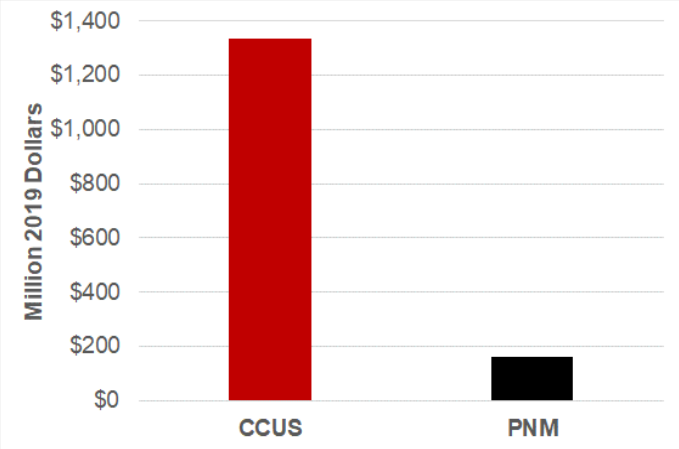
Figure VII-3
Net Difference in Jobs Created Annually in New Mexico by the CCUS Scenario Compared to the PNM Scenario



Source: Management Information Services, Inc.

We determined that the two scenarios will have very different impacts on local San Juan area tax revenues, as illustrated in Figure VII-4.

Figure VII-4
Total Local San Juan Tax Revenues, 2021-2025, Generated by Each Scenario



Source: Management Information Services, Inc.

This figure shows that:

- Over the period 2021-2055, the CCUS scenario generates about $1.33 billion in total local tax revenues.

- Over the period 2021-2055, the PNM scenario generates about $160 million in total local tax revenues.
- Over the period 2021-2055, the CCUS scenario generates about $1.17 billion more in local tax revenues than the PNM scenario.
- Over the period 2021-2055, the CCUS scenario generates more than eight times as much local tax revenues than the PNM scenario.

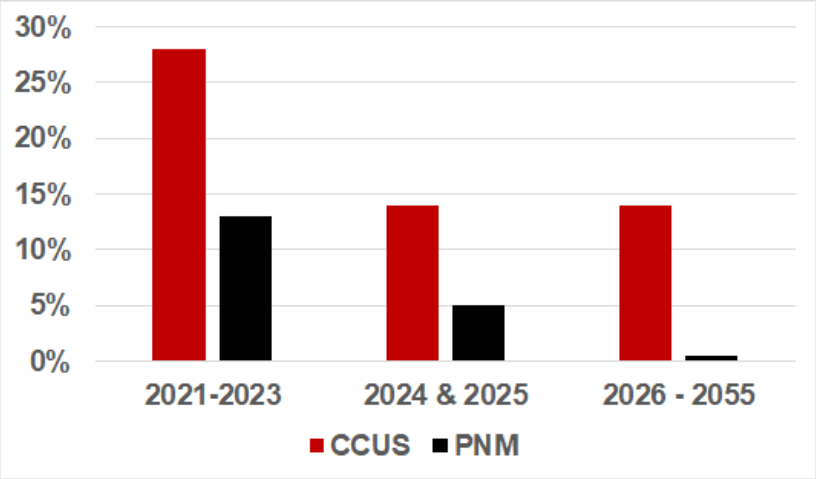
We thus conclude that the CCUS scenario will greatly improve the local San Juan fiscal situation. Since the SJGS and the SJM will not be prematurely retired, they will continue to generate real estate tax revenues and the jobs at the facilities will also continue to generate local tax revenues. Under the PNM scenario this would not be the case. Further, the CCUS scenario will also increase San Juan tax revenues starting in 2023 when construction is complete. First, jobs at the SJGS and the SJM will be maintained and additional CCUS O&M jobs will be created. Second, not only will the SJGS continue in operation and maintain the plant's assessed valuation, but the assessed valuation – and thus real estate taxes -- will increase substantially.

We found that the CCUS scenario would greatly benefit local educational institutions. Figure VII-5 places the San Juan local area tax revenue impacts of the two scenarios into perspective. The differing impacts of the CCUS scenario and the PNM scenario on the total tax revenues from all sources for San Juan County, the Central Consolidated School District (CCSD), and the San Juan Community College (SJCC) are shown in Figure VII-5.[202] This figure illustrates that:

- During the years 2021-2023 of facilities' construction, the CCUS scenario contributes 28% of all tax revenues to the three jurisdictions and the PNM scenario contributes 13%.
- In 2024 and 2025, when under the PNM scenario decommissioning is still occurring and severance, job training, and community assistance payments are being made, the PNM scenario contributes 5% of all tax revenues to the three jurisdictions and the CCUS scenario contributes 14%.
- During the years 2026-2055, the CCUS scenario contributes 14% of all tax revenues to the three jurisdictions and the PNM scenario contributes less than 0.5%.
- Over the long term, the CCUS scenario would annually generate a substantial portion of the tax revenues of San Juan County, the CCSD, and the SJCC, whereas the PNM scenario would generate annually a trivial share of the tax revenues of the jurisdictions.
- Over the long term, under the PNM scenario San Juan County, the CCSD, and the SJCC would have to raise, each year, an additional $35 million to $40 million in tax revenues from other sources.
- Over the long term, under the PNM scenario San Juan County, the CCSD, and the SJCC would have to raise a total of an additional $1.1 billion to $1.2 billion in tax revenues from other sources.

[202]Based on the total estimated 2018 tax revenues for the three jurisdictions.

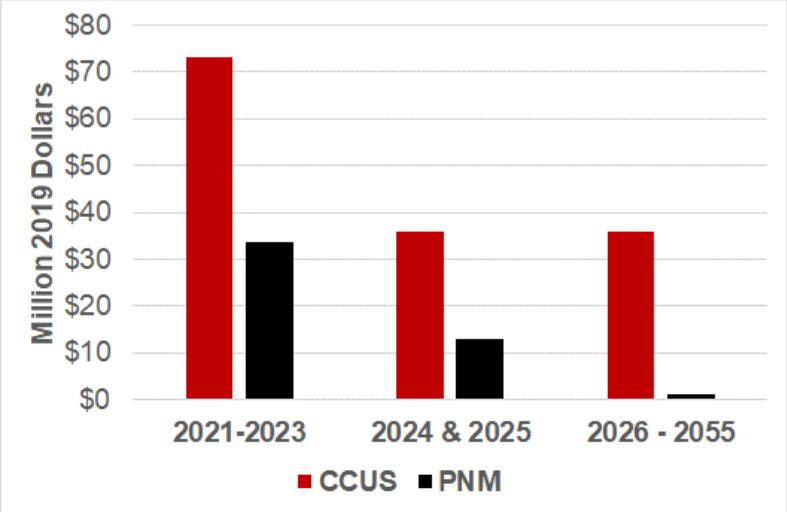
Figure VII-5
Impacts of the CCUS Scenario and the PNM Scenario on the Total Tax Revenues From All Sources of San Juan County, the CCSD, and the SJCC



Source: Management Information Services, Inc.

The estimated local San Juan average annual tax revenue impacts under each scenario are shown in Figure IV-9.

Figure VII-6
Average Annual San Juan Area Tax Revenue Impacts



Source: Management Information Services, Inc.

We conclude that the increased economic activity and jobs in the San Juan local community under the CCUS scenario will create increase earnings and tax revenues:

- During the construction phase for the CCUS and the RE facilities, 2021-2023, the CCUS scenario generates over $73 million per year in local tax revenues and the PNM scenario generates less than $34 million per year in local tax revenues.

- Thus, in years 2021-2023, the CCUS scenario generates each year more than twice the local tax revenues as does the PNM scenario.
- In the years 2024 and 2025, the CCUS scenario generates about $36 million per year in local tax revenues and the PNM scenario generates about $13 million per year in local tax revenues.
- Thus, in years 2024-2025, the CCUS scenario generates each year nearly three times the local tax revenues as does the PNM scenario.
- In the years 2026- 2055, the CCUS scenario generates about $36 million per year in local tax revenues and the PNM scenario generates about $1.1 million per year in local tax revenues.
- Thus, in years 2026-2055, the CCUS scenario generates each year 33-fold more in local tax revenues as does the PNM scenario.

VII.B. Jobs Metrics

We determined that the CCUS scenario would result in substantially more jobs/MW than the PNM scenario. Figure VII-7 summarizes the differences in jobs created per MW over the period 2021-2055 under the CCUS scenario and the PNM scenario in the San Juan area and in New Mexico. It illustrates stark differences. In terms of total jobs per MW over this period:

- In San Juan, the CCUS scenario generates over 135 jobs/MW whereas the PNM scenario generates 5.2 jobs/MW – a 26X difference.
- In New Mexico, the CCUS scenario generates over 162 jobs/MW whereas the PNM scenario generates 20 jobs/MW – a greater than 8X difference.

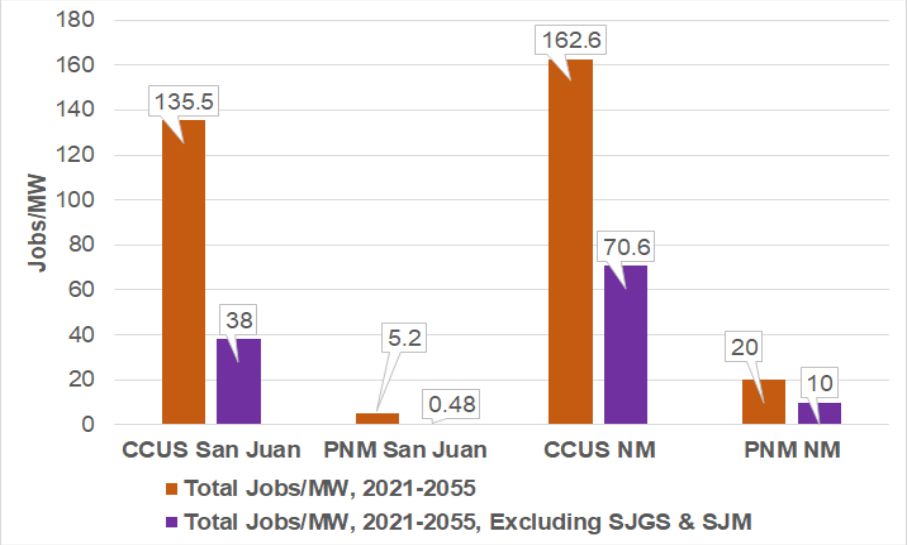
In terms of total jobs per MW over this period, excluding jobs from the SJGS and the SJM:

- In San Juan, the CCUS scenario generates 38 jobs/MW whereas the PNM scenario generates 0.48 jobs/MW – a 79X difference.
- In New Mexico, the CCUS scenario generates 70.6 jobs/MW whereas the PNM scenario generates 10 jobs/MW – a greater than 7X difference.

Figure VII-8 shows the differences in jobs created per MW over the period 2021-2055 under the CCUS scenario and photovoltaics portion of the PNM scenario. It illustrates stark differences. In terms of total jobs per MW over this period:

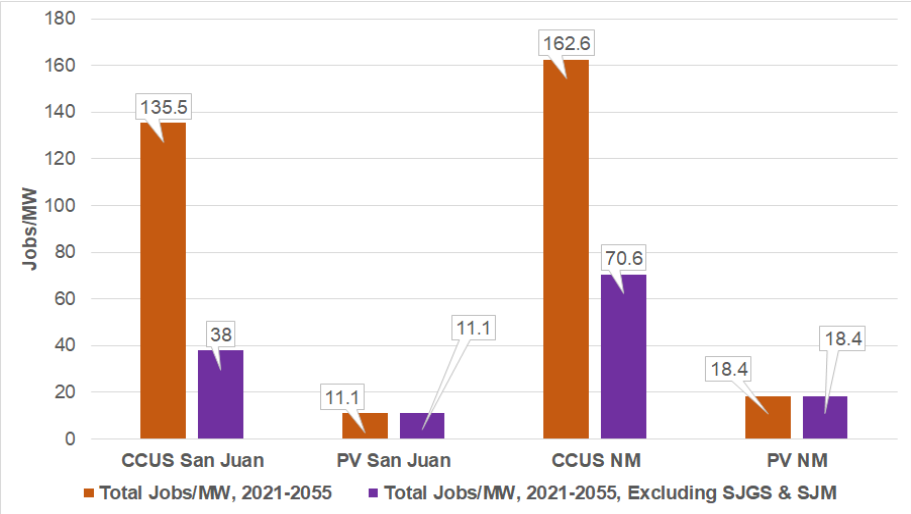
- In San Juan, the CCUS scenario generates over 135 jobs/MW whereas the photovoltaics portion of the PNM scenario generates 11.1 jobs/MW – a more than 12X difference.
- In New Mexico, the CCUS scenario generates over 162 jobs/MW whereas the photovoltaics portion of the PNM scenario generates 18.4 jobs/MW – a nearly 9X difference.

Figure VII-7
Comparison of Total Jobs Per MW Under CCUS and PNM Scenarios, 2021-2055



Source: Management Information Services, Inc.

Figure VII-8
Comparison of Total Jobs Per MW Under the CCUS Scenario and the Photovoltaics Portion of the PNM Scenario, 2021-2055



Source: Management Information Services, Inc.

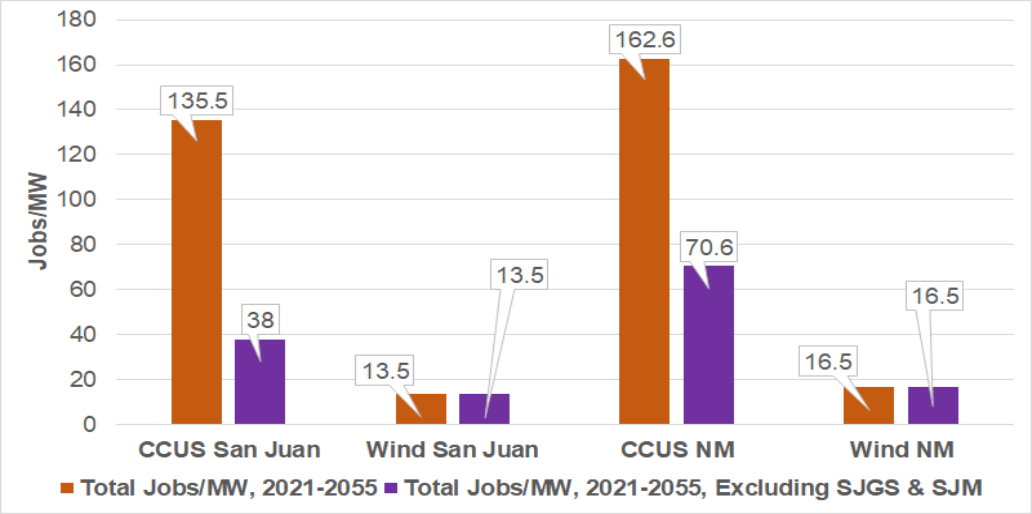
In terms of total jobs per MW over this period, excluding jobs from the SJGS and the SJM:

- In San Juan, the CCUS scenario generates 38 jobs/MW whereas the photovoltaics portion of the PNM scenario generates 11 jobs/MW – a 3.5X difference.
- In New Mexico, the CCUS scenario generates 70.6 jobs/MW whereas the photovoltaics portion of the PNM scenario generates 18.4 jobs/MW – a nearly 4X difference.

Figure VII-9 shows the differences in jobs created per MW over the period 2021-2055 under the CCUS scenario and the wind portion of the PNM scenario. It illustrates striking differences. In terms of total jobs per MW over this period:

- In San Juan, the CCUS scenario generates over 135 jobs/MW whereas the wind portion of the PNM scenario generates 13.5 jobs/MW – a 10X difference.
- In New Mexico, the CCUS scenario generates over 162 jobs/MW whereas the wind portion of the PNM scenario generates 16.5 jobs/MW – a 9.8X difference.

Figure VII-9
Comparison of Total Jobs Per MW Under the CCUS Scenario and the Wind Portion of the PNM Scenario, 2021-2055



Source: Management Information Services, Inc.

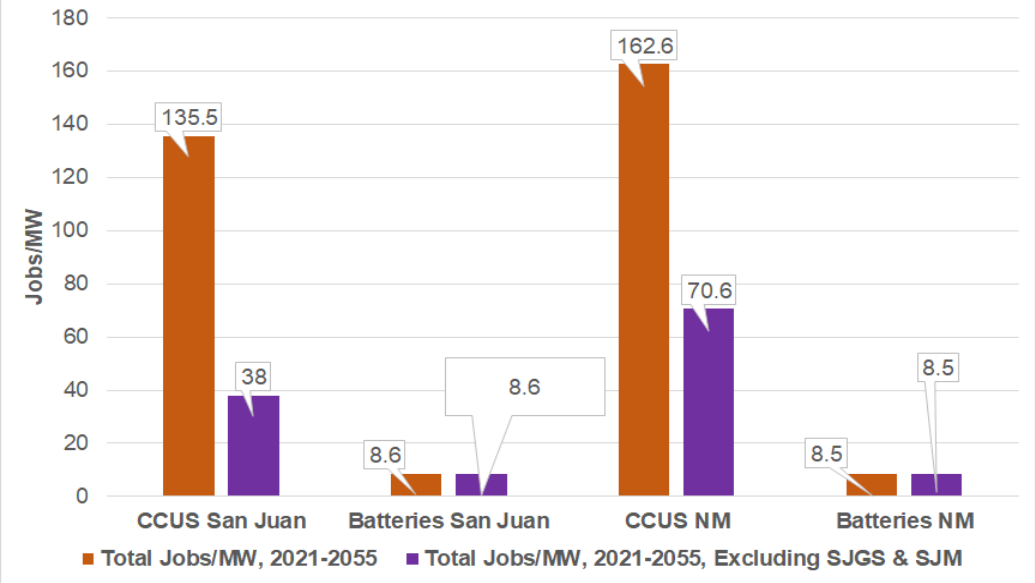
In terms of total jobs per MW over this period, excluding jobs from the SJGS and the SJM:

- In San Juan, the CCUS scenario generates 38 jobs/MW whereas the wind portion of the PNM scenario generates 13.5 jobs/MW – a 2.8X difference.
- In New Mexico, the CCUS scenario generates 70.6 jobs/MW whereas the wind portion of the PNM scenario generates 16.5 jobs/MW – more than a 4X difference.

Figure VII-10 shows the differences in jobs created per MW over the period 2021-2055 under the CCUS scenario and the batteries portion of the PNM scenario. It illustrates major differences. In terms of total jobs per MW over this period:

- In San Juan, the CCUS scenario generates over 135 jobs/MW whereas the batteries portion of the PNM scenario generates 8.6 jobs/MW – a 16X difference.
- In New Mexico, the CCUS scenario generates over 162 jobs/MW whereas the batteries portion of the PNM scenario generates 8.5 jobs/MW – a 19X difference.

Figure VII-10
Comparison of Total Jobs Per MW Under the CCUS Scenario and the Batteries Portion of the PNM Scenario, 2021-2055



Source: Management Information Services, Inc.

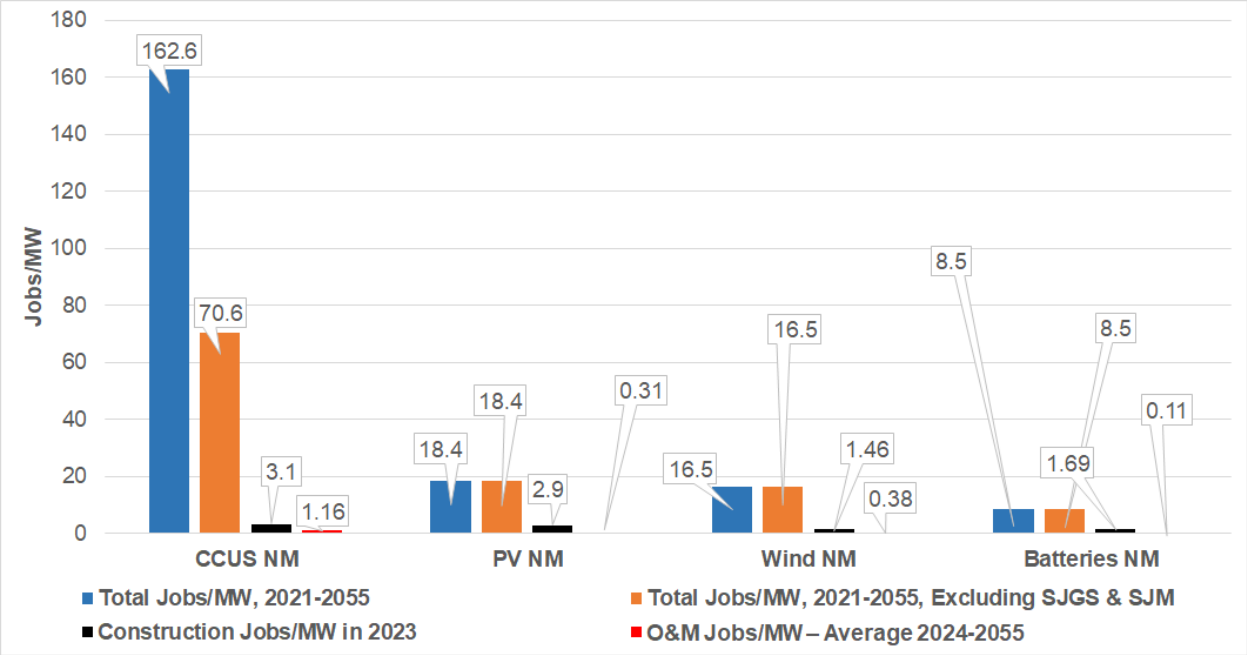
In terms of total jobs per MW over this period, excluding jobs from the SJGS and the SJM:

- In San Juan, the CCUS scenario generates 38 jobs/MW whereas the batteries portion of the PNM scenario generates 8.6 jobs/MW – a 4.4X difference.
- In New Mexico, the CCUS scenario generates 70.6 jobs/MW whereas the batteries portion of the PNM scenario generates 8.5 jobs/MW – more than an 8X difference.

Figure VII-11 presents a summary comparison of jobs per MW in New Mexico under the CCUS scenario and the wind, photovoltaic, and batteries portions of the PNM scenario. This figure shows that in terms of total jobs per MW in New Mexico, 2021-2055, the CCUS scenario generates:

- Nearly 9X as many jobs/MW as the photovoltaics portion of the PNM scenario.
- Nearly 10X as many jobs/MW as the wind portion of the PNM scenario.
- More than 19X as many jobs/MW as the batteries portion of the PNM scenario.

Figure VII-11
Comparison of Jobs Per MW in New Mexico Under the CCUS Scenario and the Wind, Photovoltaic, and Batteries Portions of the PNM Scenario



Source: Management Information Services, Inc.

Figure VII-11 shows that in terms of total jobs per MW, 2021-2055, excluding jobs from the SJGS and the SJM, the CCUS scenario generates:

- Nearly 4X as many jobs/MW as the photovoltaics portion of the PNM scenario.
- More than 4X as many jobs/MW as the wind portion of the PNM scenario.
- More than 8X as many jobs/MW as the batteries portion of the PNM scenario.

Figure VII-11 shows that in terms of total jobs per MW generated by construction in 2023 – the year of maximum construction, the CCUS scenario generates:

- Seven percent more jobs/MW as the photovoltaics portion of the PNM scenario.
- More than 2X as many jobs/MW as the wind portion of the PNM scenario.
- Nearly 2X as many jobs/MW as the batteries portion of the PNM scenario.

Figure VII-11 shows that in terms of average O&M jobs per MW over the period 2024-2055, the CCUS scenario generates:

- Nearly 4X as many jobs/MW as the photovoltaics portion of the PNM scenario.
- More than 3X as many jobs/MW as the wind portion of the PNM scenario.
- More than 10X as many jobs as/MW the batteries portion of the PNM scenario.

We thus conclude that, irrespective of the comparison, the CCUS scenario generates substantially more jobs/MW than does the PNM option or any of the RE components of the PNM option – both in the local San Juan area and in the state of New Mexico. There is no valid comparison in which the PNM scenario or any of its RE

components generates more jobs/MW than does the CCUS scenario – in either the San Juan local area or in the state of New Mexico. This holds true whether we are measuring the jobs/MW created by each scenario, by each scenario excluding the jobs impacts of SJGS and SJM, the construction portions of the scenarios, or the O&M portions of the scenarios. Specifically, here we made 68 individual comparisons. In two of these cases, the jobs/MW advantage of the CCUS option over the alternative was between 4% and 7%. In all of the other 66 comparison cases, the jobs/MW advantage of the CCUS option over the alternative was very large – many in the range of orders of magnitude. Thus, the CCUS scenario will generate substantially more jobs/MW – in many cases orders of magnitude more jobs/MW -- than the PNM scenario or the RE components of the PNM scenario – both in the local San Juan area and in the state of New Mexico.

We found that metric comparisons between the CCUS and PNM scenarios are complicated due to basic RE problems:

- Since RE is intermittent and unreliable, metric comparisons with dispatchable coal power plants are not valid.
- Required backup to RE, such as batteries, are inefficient, cost prohibitive, and unreliable.
- The costs of RE technologies are vastly underestimated due to their inherent non-dispatchability and imbedded subsidies and mandates.
- There are intractable problems with RE technologies such as wind that render them infeasible as large scale energy alternatives.

VII.B. Impacts on Native Americans

We found that:

- The Hopi and the Navajo Nations suffer from extreme economic deprivation and poverty.
- Both tribes depend on their abundant coal resources as the backbone of their local economies.
- Both have been devastated by the closure of the NGS and the Kayenta Mine and will be further devastated if SJGS and SJM close.

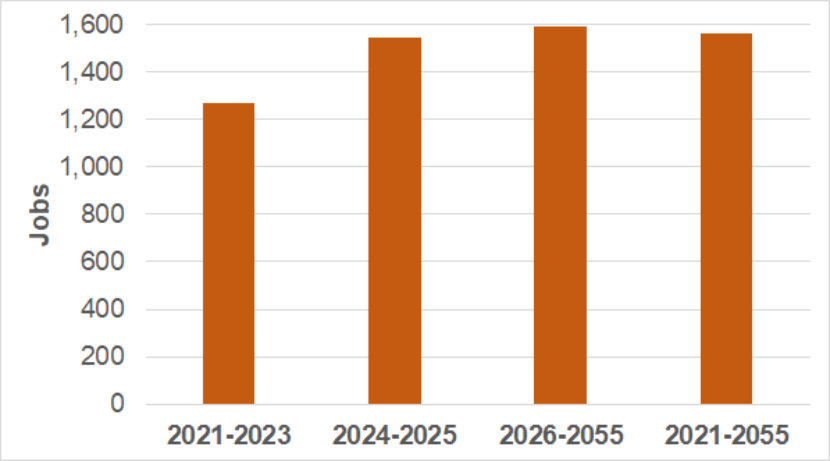
We determined that closure of the SJM would result in a significant, but little appreciated, public health crisis for the Navajo and Hopis. Navajo and Hopi families have long relied on subsidized coal to heat their homes, but now must rely on the SJM after the Kayenta Mine closed in 2019. If the SJM closes, they will have no source of coal to heat their homes. This will result in significant hardship and health problems for the Navajo and Hopi.

We found that the CCUS scenario will provide many more jobs for Native Americans than the PNM scenario. Figure VII-12 shows the average annual net differences in jobs created for San Juan area Navajos between the CCUS scenario and the PNM scenario – it shows the net average annual increase in jobs for Navajos created

each year, 2021-2055, by the CCUS scenario compared to the PNM scenario.[203] It illustrates that:

- During the construction phases of the CCUS and the RE facilities, 2021-2023, the average annual net Navajo job gain under the CCUS scenario compared to the PNM scenario is about 1,270 jobs.
- In 2024 and 2025, when under the PNM scenario the SJGS and SJM are closed and are being decommissioned, the net average annual Navajo job gain under the CCUS scenario compared to the PNM scenario is about 1,550 jobs.
- During 2026 - 2055, when under the PNM scenario the SJGS and SJM are closed and decommissioning has been completed, the net average annual Navajo job gain under the CCUS scenario compared to the PNM scenario is just under 1,600 jobs each year.
- Over the period 2021-2055, the CCUS scenario creates a net annual average of about 1,560 more Navajo jobs each year than the PNM scenario.

Figure VII-12
Average Annual Net Job Differences For San Juan Area Navajos Between the CCUS Scenario and the PNM Scenario



Source: Management Information Services, Inc.

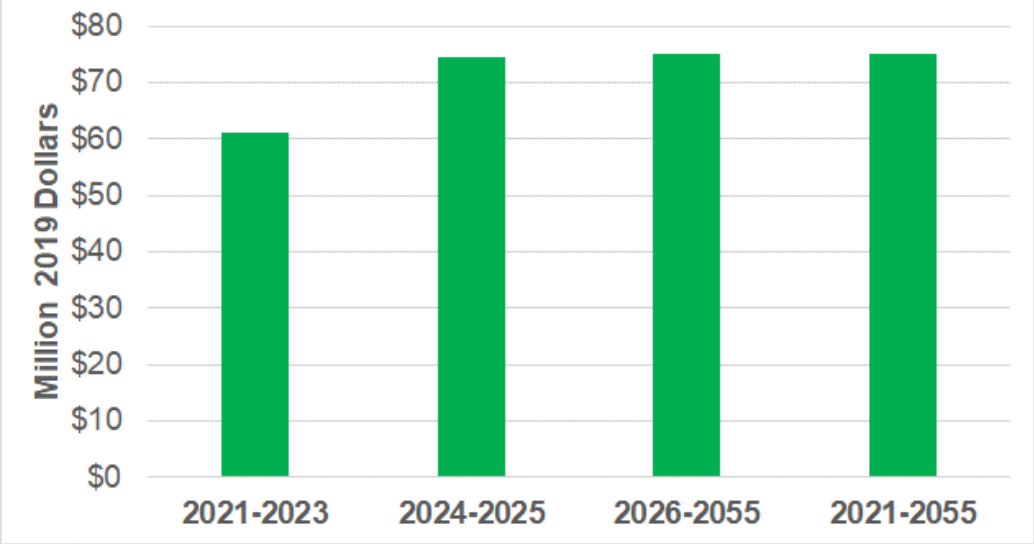
We conclude that the CCUS scenario would result in enormous increases in wages and benefits for Navajos. Figure VII-13 shows the average annual net differences in wages and benefits created for San Juan area Navajos between the CCUS scenario and the PNM scenario – it shows the net average annual increase in wages and benefits for Navajos created each year, 2021-2055, by the CCUS scenario compared to the PNM scenario. It illustrates that:

- During the construction phases of the CCUS and the RE facilities, 2021-2023, the average annual net Navajo wages and benefits gain under the CCUS scenario compared to the PNM scenario is about $61.1 million each year.

[203]Relatively few jobs at the SJGS and SJM are held by Hopi because the Hopi reservation is 150 mile distant.

- In 2024 and 2025, when under the PNM scenario the SJGS and SJM are closed and are being decommissioned, the net average annual Navajo wages and benefits gain under the CCUS scenario compared to the PNM scenario is about $74.5 million each year.
- During 2026 - 2055, when under the PNM scenario the SJGS and SJM are closed and decommissioning has been completed, the net average annual Navajo wages and benefits gain under the CCUS scenario compared to the PNM scenario is $75.2 million each year.
- Over the period 2021-2055, the CCUS scenario creates a net total of about $2.6 billion more Navajo wages and benefits than the PNM scenario.

Figure VII-13
Average Annual Net Differences in Wages and Benefits Created For San Juan Area Navajos Between the CCUS Scenario And the PNM Scenario



Source: Management Information Services, Inc.

We found that the economic development prospects for the San Juan area if the SJGS closes are not promising. One of the few viable job development initiatives moving forward is for the SJGS retrofit project, which is developing programs to train the skilled workforce required for the ongoing operation of SJGS with the planned CCUS and future carbon capture facilities.

VII.D. Basic Conclusions Concerning CCUS v Renewables

The basic conclusion derived here is that the CCUS retrofit scenario for the SJGS is greatly preferable to the PNM renewable scenario on numerous bases:

- It provides much greater economic and jobs benefits for the local San Juan area and for New Mexico.
- It produces greater CO_2 emissions reductions than the PNM scenario.

- It preserves and expands the San Juan local area tax revenues and the tax revenues of the SJ CCSD and SJCC.
- It represents the difference in San Juan between continued full employment and double-digit unemployment under the PNM scenario.
- It preserves and expands well-paying jobs for Native Americans – in an area in which there are few other such jobs available.
- It preservers and expands revenues for Native American tribes – who have few other sources of revenues.
- It prevents a potential public health crisis for the Navajo and Hopi by retaining their sole supply of critically required coal for home heating.
- On the basis of every job metric, including total jobs/MW, construction jobs/MW, and O&M jobs/MW, the CCUS scenario generates substantially more jobs per MW than does the PNM scenario -- in both San Juan and in New Mexico.

If the SJGS closes, the implications for the San Juan area and for Native Americans state are ominous: Their historically stable source of well-paying jobs and revenues will no longer exist. Thus, CCUS may be the key to San Juan's and New Mexico's future. CCUS can be a win-win: This report has documented the immense long term economic and job benefits that CCUS retrofits of the SJGS will have for the state, for local communities within the state, and for Native Americans. Also important, CCUS is a technology whose time has come:

- It is a proven GHG reduction technology.
- The UN has concluded that ambitious GHG reduction goals are simply not feasible without massive CCUS initiatives.[204]
- Even advocates of the Green New Deal have acknowledged the necessity for CCUS as a large part of the program.[205]
- CCUS enjoys strong bipartisan in the U.S.[206]
- It is a program that will likely continue to enjoy broad support for many years to come.
- When combined with EOR, CCUS is economically viable.

[204]"If the world is to succeed in constraining CO_2 emissions to levels consistent with a less than 2°C rise in global temperatures, then Carbon Capture and Storage (CCS) will need to contribute about one-sixth of needed CO_2 emission reductions in 2050, and 14 percent of the cumulative emissions reductions between 2015 and 2050." United Nations Commission for Europe, "Carbon Capture and Storage: A Technological Challenge Already Solved," 2020.

[205]"When Representative Alexandria Ocasio-Cortez (D-NY) and Senator Ed Markey (D-MA) introduced a resolution for a Green New Deal in February this year, both lawmakers left nuclear energy and carbon capture on the table." https://www.theverge.com/2019/8/22/20828794/bernie-sanders-green-new-deal-2020-elections-climate-change

[206]For example, in the U.S. Congress, at the FY20 DOE Budget Hearing, Representative Greg Walden stated "I am encouraged by the work DOE is doing to support transformative breakthroughs in 'carbon free' fossil energy and carbon capture technologies." Opening Statement of Republican Leader Greg Walden, Subcommittee on Energy "The Fiscal Year 2020 DOE Budget," May 9, 2019. Further, Democrat Presidential nominee, Joe Biden, is on record as supporting CCUS. Also see Adam Aton, "Climate Heresy in Wis. as Democrats Call For 'Clean Coal,'" *E&E News*, September 10, 2020.

Finally, aggressive CCUS initiatives will establish San Juan and New Mexico as a world leader in the technology. This will pay large and increasing dividends to the San Juan area, to Native Americans, and to the state as CCUS becomes established as one of the dominant economic and energy technologies of the 21st century.

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