BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF PUBLIC SERVICE COMPANY OF NEW MEXICO'S CONSOLIDATED APPLICATION FOR APPROVALS FOR THE ABANDONMENT, FINANCING, AND RESOURCE REPLACEMENT FOR SAN JUAN GENERATING STATION PURSUANT TO THE ENERGY TRANSITION ACT	)	19-_____-UT

DIRECT TESTIMONY

OF

NICHOLAS L. PHILLIPS

July 1, 2019

NMPRC CASE NO. 19-_____-UT
INDEX TO THE DIRECT TESTIMONY OF
NICHOLAS PHILLIPS

WITNESS FOR
PUBLIC SERVICE COMPANY OF NEW MEXICO

DIRECT TESTIMONY
OF NICHOLAS L. PHILLIPS
NMPRC CASE NO. 19-_____-UT

I. INTRODUCTION AND PURPOSE

Q. PLEASE STATE YOUR NAME, POSITION AND BUSINESS ADDRESS.

A. My name is Nicholas L. Phillips. I am the Director of Integrated Resource Planning for Public Service Company of New Mexico ("PNM"). My address is 414 Silver Avenue, SW, Albuquerque, New Mexico 87102.

Q. PLEASE SUMMARIZE YOUR EDUCATIONAL BACKGROUND AND PROFESSIONAL QUALIFICATIONS.

A. My educational background and relevant employment experience are summarized in PNM Exhibit NLP-1 attached to my testimony.

Q. PLEASE DESCRIBE YOUR RESPONSIBILITIES AS DIRECTOR OF INTEGRATED RESOURCE PLANNING.

A. I direct PNM's Integrated Resource Planning team. The Integrated Resource Planning team is responsible for developing PNM's resource plans and the regulatory filings to support those resource plans, including the annual renewable energy portfolio procurement plan and the triennial Integrated Resource Plan ("IRP"). The Integrated Resource Planning team is also responsible for performing resource planning analysis to support abandonment and retirement decisions as well as resource additions and acquisitions, all of which require New Mexico Public Regulation Commission ("NMPRC" or "Commission") approval such as those being requested in this docket.

Q. HAVE YOU PREVIOUSLY PROVIDED TESTIMONY IN NMPRC PROCEEDINGS?

A. Yes. Cases in which I have testified before the Commission are identified in PNM Exhibit NLP-1.

Q. WHAT DOES YOUR TESTIMONY COVER?

A. I explain PNM's resource planning process in general and the resource planning analysis that supports PNM's proposed abandonment of the San Juan coal plant and proposed replacement resources ("Scenario 1"). I also address the resource planning analysis of the other potential replacement resource portfolios PNM presents in its Consolidated Application, which are referred to as Scenarios 2, 3, and 4. PNM's resource planning analysis shows that replacing the San Juan coal plant's capacity with the proposed replacement resources in Scenario 1 results in cost savings for PNM's customers and a net public benefit by providing a diverse portfolio of resources capable of meeting the demand and energy requirements of PNM's customers at lowest reasonable cost as well as New Mexico's Renewable Portfolio Standard ("RPS").

Q. WHAT DOES YOUR TESTIMONY DEMONSTRATE?

A. The analysis performed to support PNM's Consolidated Application demonstrates that it is in the best interest of PNM's customers for PNM to abandon its interests in the San Juan coal plant by June 30, 2022. By abandoning its share of the San

Juan coal plant and supplanting this capacity with PNM's recommended replacement portfolio for Scenario 1, PNM's customers can expect economic and environmental benefits over the next 20 years. This is consistent with PNM's recommendation to pursue retirement of the remainder of PNM's interest in Units 1 and 4 at the San Juan coal plant contained in its 2017 IRP, which was accepted by the Commission in Case No. 17-00174-UT.

Q. HOW IS YOUR TESTIMONY ORGANIZED?

A. First, I provide background surrounding PNM's historical evaluations of the San Juan coal plant, including the 2017 IRP, leading up to the Application filed in this docket. Next, I describe how the abandonment analysis supported by PNM in this filing was conducted, including the updates related to the Energy Transition Act. Then I discuss PNM's role in determining its recommended replacement resource portfolio and how PNM engaged with outside consultants, who performed independent analyses to arrive at their replacement resource portfolio recommendations. Included within this discussion, I also explain how these independent analyses support and refine PNM's recommendations. Finally, I present an economic impact study commissioned by PNM to examine the direct and indirect economic effects on PNM's service territory and the state of New Mexico related to the matters at issue in this docket.

II. BACKGROUND SUPPORTING SAN JUAN COAL PLANT ABANDONMENT

Q. PLEASE DESCRIBE THE BACKGROUND FOR CONSIDERATION OF AN EARLY RETIREMENT OF THE SAN JUAN COAL PLANT.

A. PNM has considered the early retirement of San Juan several times over the ten years preceding the 2017 IRP and, until the 2017 IRP, found each time that continuing to operate at least some of the generating capacity at the plant was less expensive than the costs of abandoning and replacing the plant.[1] In Case No. 13-00390-UT, the Commission approved PNM's request to retire Units 2 and 3 at the San Juan coal plant. In that case, PNM analyzed retiring the capacity as an alternative to a federal environmental plan to address regional haze, which would have required installation of costly pollution control technology on all four operating units at the San Juan coal plant by September 21, 2016.[2] Ultimately, Units 2 and 3 retired at the end of 2017, resulting in a reduction of PNM's use of coal capacity.

In PNM's 2017 IRP, PNM recommended abandoning its remaining interest in Units 1 and 4 at the San Juan coal plant. Since completing the 2017 IRP, PNM has continued to study abandonment while considering bids from an all-source replacement and a second battery storage request for proposals. In addition to

[1] In its 2008 IRP, PNM considered retiring 240 MW of San Juan and found the cost of replacement options to be too high to be economic for PNM's customers. In the 2011 IRP, PNM examined retiring its share of SJGS Units 1 and 2 in 2022 and once again found the cost of replacement options to be too high to be economic for PNM's customers.

[2] A similar analysis was performed in the 2014 IRP concurrently to Case No 13-00390-UT.

performing the tasks identified in the 2017 IRP Four-year Action Plan, as necessary before a recommendation to abandon the San Juan coal plant should be finalized, PNM has also twice updated its analysis to reflect more recent coal pricing received from the San Juan Coal Company as well as to reflect a reduction in cost of service due to the passage of the Tax Cuts and Jobs Act at the end of 2017. The conclusions reached in these interim analyses continued to show net public benefits and savings to consumers from retirement of the plant and confirmed the recommendation to retire Units 1 and 4.

Q. WHY IS PNM PROPOSING TO RETIRE THE SAN JUAN COAL PLANT IN 2022?

A. The same conclusions reached in the 2017 IRP concerning the retirement of the plant in 2022 still support retirement. Of course, 2022 is an opportune time because the San Juan coal agreement and ownership agreements terminate in 2022.

The new analyses performed in preparation for filing the Consolidated Application demonstrate, consistent with the conclusions reached in the 2017 IRP and updated analyses, that the early retirement of Units 1 and 4 will result in long-term cost savings for PNM's retail customers and net public benefits. Retiring the San Juan coal plant will also provide the opportunity for PNM to replace the plant with resources that better match varying loads and are better suited to

accommodate the anticipated deployment of more renewable energy in New Mexico and the regional market.

In addition, as I discuss later in my testimony, the recent enactment of the Energy Transition Act adopts an energy policy favoring the closure of coal generation facilities and the development of more renewable and carbon-free energy. This is another factor to consider in the abandonment of the San Juan coal plant.

PNM Witness Fallgren explains that the decision by the plant owners, except the City of Farmington, not to continue operations after 2022 is also a driver for a plant closure in 2022.

Q. HOW DOES PNM DETERMINE LONG-TERM COST SAVINGS IN THE RESOURCE PLANNING CONTEXT?

A. PNM measures long-term cost savings by comparing the Net Present Value ("NPV") of costs required to meet retail customer loads over a 20-year planning period under two primary scenarios: (i) assuming the continued operations of Units 1 and 4; and (ii) assuming Units 1 and 4 cease operations at the end of the current coal supply agreement on June 30, 2022. This is consistent with the requirement in the Commission's IRP Rule (17.7.3 NMAC) to consider resource portfolio costs over a 20-year planning period. PNM's calculation of long-term cost savings includes the following:

- Cost to operate and maintain existing resources over 20 years,
- Cost to build, operate, and maintain any resources added in the 20-year study period, and
- Costs associated with retiring any resources during the 20-year study period

When modeling the 20-year scenarios for comparison, the capacity expansion analysis selects portfolios of generation, storage and demand-side resources. The portfolios are constructed subject to a number of applicable conditions. First, the portfolio must be capable of meeting the power and energy loads of PNM's customers. Second, the candidate portfolios must meet regulatory requirements such as renewable portfolio standards. Also, the system must be able to meet reliability requirements. Other factors may include lead-time needed for approval and construction of a resource, location, land-use limitations and similar factors affecting the availability of resources. All the costs of construction or acquisition of resources, fuel/variable production costs, O&M costs, and others are translated into revenue requirements. Costs are calculated for the 20-year period and converted to NPV to reflect differences in timing.

Q. HOW DOES THE 2017 IRP FIT IN TO PNM'S ONGOING ANALYSIS OF THE SAN JUAN COAL PLANT?

A. PNM continually conducts resource planning and analyzes its future resource needs based on currently available information and data. The 2017 IRP was a

step in this process that evaluated the implications of retiring the San Juan coal plant in 2022. The 2017 IRP recommended that PNM pursue abandonment and established some tasks that were necessary before PNM could request abandonment in this case.

Q. PLEASE SUMMARIZE THE TASKS RELATED TO ABANDONMENT CONTAINED IN THE 2017 IRP FOUR YEAR ACTION PLAN.

A. The Action Plan required PNM to perform the following tasks in order to pursue the abandonment of the San Juan coal plant in 2022.[3]

1. Consult signatories to the Case No. 13-00390-UT Modified Stipulation on the scope or form of an all-resource request for proposals ("RFP");
2. Invite stakeholders to a public advisory discussion on energy storage options;
3. Issue an all-resource RFP that included invitations to bid offering all resource technologies and technology combinations;
4. Evaluate bids to build a portfolio of specific replacement resources for the San Juan coal plant replacement including an analysis of transmission to define siting requirements; and
5. Make a filing with the NMPRC on the extent to which the San Juan coal plant should continue serving PNM's retail customers after June 30, 2022.

[3] 2017 IRP at Action Plan (Pages 147-149)

Q. HAS PNM PERFORMED EACH OF THESE TASKS CONSISTENT WITH THE 2017 IRP FOUR-YEAR ACTION PLAN?

A. Yes. In October 2017, PNM met with Best Available Retrofit Technology ("BART") Signatories to discuss the RFP. Also, in July 2017, PNM hosted an energy storage conference in PNM's offices. PNM issued an all-source RFP for replacement resources and followed up with a supplemental storage RFP in April 2019. PNM has completed its evaluation of those bids which has culminated in the scenarios and analysis that support this filing. For more details on the RFP see the testimonies of PNM Witnesses Nagel and Fallgren. On December 31, 2018, PNM made its compliance filing in Case No. 13-00390-UT and indicated PNM would make a future filing seeking approval for the abandonment of the San Juan coal plant and replacement resources.

Q. WHAT WAS THE NEXT STEP IN COMPLETING THE FOUR-YEAR ACTION PLAN ASSOCIATED WITH SAN JUAN COAL PLANT ABANDONMENT?

A. The next step was to update the capacity expansion, economic dispatch, and reliability analyses to identify the best combination of resources and locations from the alternatives presented utilizing the received RFP bids.

Q. HOW DO THE PRICES CONTAINED IN THE RFP RESPONSES COMPARE TO THE PRICES FOR REPLACEMENT RESOURCES ASSUMED IN THE 2017 IRP?

A. The pricing bids for all resources (natural gas, solar, wind and energy storage) are lower than was assumed in the 2017 IRP.

Q. WHAT IMPACT DO LOWER PRICES HAVE ON THE ABANDONMENT DECISION?

A. All else held equal, lower pricing for replacement resources favors abandonment of San Juan coal plant more than was identified in the 2017 IRP.

III. ANALYSES SUPPORTING ABANDONMENT OF THE SAN JUAN COAL PLANT

Q. HAS PNM PERFORMED ADDITIONAL ABANDONMENT ANALYSES REGARDING A SAN JUAN COAL PLANT SHUTDOWN?

A. Yes, an update of the 2017 IRP analysis was performed in June 2018 after receipt of updated coal pricing, prior to PNM notifying the other San Juan coal plant participants that it intended to seek abandonment of the facility from the NMPRC. A second updated analysis was performed in December 2018 to analyze additional coal pricing information. Both of these analyses remained consistent with the 2017 IRP, finding that abandonment of San Juan coal plant was in the best interest of PNM's customers.

Q. WHAT MODELING TOOL WAS USED TO COMPLETE THE ANALYSES?

A. The 2017 IRP, and both of the subsequent analyses, were completed utilizing the Strategist modeling tool.

Q. IS PNM STILL USING STRATEGIST TO DETERMINE FUTURE RESOURCE PORTFOLIOS?

A. No. PNM has moved from using Strategist for expansion planning to a more modern tool called EnCompass. PNM evaluated Strategist along with other expansion planning software and determined that EnCompass provides additional features and capabilities while maintaining the strengths of the Strategist model.

Q. WHAT IS ENCOMPASS?

A. The EnCompass is a power supply optimization software by Anchor Power Solutions that uses Mixed Integer Programming ("MIP") to simultaneously optimize multiple objectives and constraints (financial, physical, operational, reliability, etc.).[4] The EnCompass modeling effort was aided by the expertise of Horizon Energy to evaluate the continued operations of San Juan coal plant as well a retirement scenario for San Juan coal plant with multiple Replacement

[4] Previously PNM used Strategist to perform resource planning analysis. The EnCompass model performs similar analysis to Strategist but utilizes a more modern optimization algorithm and contains additional logic to support more resources (both number of resources and resource types) and constraints than Strategist. Strategist has reached then end of its life cycle and is no longer supported. The EnCompass software brochure and be viewed at https://anchor-power.com/wp-content/uploads/2018/06/EnCompass-Software-Brochure.pdf

Portfolios. Previously, PNM used the Strategist model to perform NPV analyses. To inform EnCompass, a database of candidate replacement and expansion resources provided by the RFP Evaluation team was used.[5]

Q. PLEASE DESCRIBE PNM'S RECENT ANALYSES OF CONTINUED OPERATIONS AT THE SAN JUAN COAL PLANT.

A. The general methods used to evaluate the continued operations of the San Juan coal plant followed the same protocols used in the 2017 IRP and subsequent analysis. Initially, two primary paths were examined that isolated the long-term cost differentials associated with the continued operations of the plant compared to PNM's abandonment of its remaining interest in the plant.

Q. PLEASE DESCRIBE THE ASSUMPTIONS USED FOR THE SAN JUAN COAL PLANT RETIREMENT ANALYSIS YOU PERFORMED IN JUNE 2019.

A. The following input assumptions were used to perform the retirement analysis:

- New coal pricing offered by San Juan Coal Company in May 2018 for the San Juan coal plant continues scenario;
- Updated plant operating and maintenance costs and capital forecast for the retirement scenario;

[5] For modeling purposes and to isolate San Juan coal plant retirement replacement decision only; generic placeholder resources were used for any capacity additions to support load growth assumption in the outer years of the analysis after 2022.

- Updated system operating and maintenance costs to reflect the tax code changes caused by the "2017 Tax Cut and Jobs Act" for both the retirement and the continuation scenarios;
- New natural gas and CO^2 price assumptions obtained from Pace Global in April 2018 for both the retirement and the continuation scenarios adjusted for futures prices as of April 26, 2019;
- Candidate Resources based on pricing received in response to an all-resource RFP and the supplemental RFP;
- Inclusion in all modeling runs of the 140 MW of new wind generation under consideration in Case No. 19-00159-UT and 50 MW of new solar for the PNM Solar Direct program under consideration in Case No. 19-00158-UT;
- PNM assumed that it would limit its participation in the Four Corners Power Plant ("Four Corners") to no longer than 2031 in both scenarios; and,
- PNM assumed that it would extend its lease arrangements in Units 1 and 2 of the Palo Verde Nuclear Generating Station ("Palo Verde") in both scenarios.

The last two modeling assumptions above were applied to maintain consistency in existing resources and to isolate the effects of the analysis solely to the decision whether to retire the San Juan coal plant in 2022.

Q. ARE THERE ANY OTHER FACTORS THAT AFFECT THE ABANDONMENT ANALYSIS?

A. Yes. Earlier this year, the State of New Mexico enacted the Energy Transition Act, which accelerates the state's transition away from high-carbon emitting generating resources such as coal-fired generation through increasing the RPS and providing a preference for zero-carbon resources.

The Energy Transition Act further reduces the cost of abandonment by providing a mechanism for issuance of low interest rate bonds that allows PNM to recover undepreciated investments in the San Juan coal plant at a reduced cost to customers, compared to traditional utility financing and recovery of net plant costs. Combining the low-cost replacement resources' bids received in response to PNM's RFPs and the reduced abandonment costs resulting from the Energy Transition Act result in not only long-term cost savings but a first-year reduction in PNM's revenue requirements after the San Juan coal plant is removed from service.

The Energy Transition Act also requires the promulgation of new stricter emission restrictions that apply should the plant continue to operate past January 1, 2023, likely increasing the cost of continued operations of the coal plant significantly, even prohibitively.

Q. PLEASE FURTHER DESCRIBE HOW THE SECURITIZATION PROVISIONS OF THE ENERGY TRANSITION ACT AFFECT ABANDOMENT COSTS.

A. The Energy Transition Act provides for a transition from coal-generating resources to carbon-free resources by allowing investor-owned utilities to issue securitized bonds, or "energy transition bonds," to qualified investors related to the retirement of coal-fired generating facilities. The securitized financing bonds are highly rated because they are securitized by a non-bypassable charge paid by all customers of the utility. As discussed by PNM Witnesses Eden and Atkins, securitization significantly lowers the cost of financing to be paid by the customers. All else held equal, when modeled with these lower cost financing assumptions, the cost of a retirement scenario is further reduced when compared to previous estimates, making retirement scenarios even more favorable than continuation scenarios. As a result, the revenue requirement associated with the San Juan coal plant retirement is lower than in the 2017 IRP analysis.

Q. DID PNM INCLUDE ANY ADDITIONAL COSTS IN THE "PLANT CONTINUES" SCENARIO TO ACCOUNT FOR THE EXIT OF OTHER OWNERS FROM THE SAN JUAN COAL PLANT OR FOR ADDITIONAL ENVIROMENTAL COMPLIANCE COSTS?

A. No. The analysis performed by PNM was conservative in the sense of providing the best chance for continued operations of the plant. PNM modeled the "San

Juan coal plant continues" case as an extension of the status quo – that is, PNM's proportionate share of the total plant costs would not increase and that plant dispatch would not be altered from historic practice. The reality is that all of the other joint owners of San Juan coal plant aside from the City of Farmington have announced their intention to exit participation in the plant, as discussed by PNM Witness Fallgren. As a consequence, even if PNM were to continue its participation, its share of the fixed costs (O&M, CapEx, must take minimum coal requirements, etc.) likely would increase, in turn worsening the economics of the plant continued operations.

As previously discussed, if the coal plant were to continue to operate it would also be subject to additional environmental compliance costs. These cost risks that have not been quantified in PNM's modeling further reinforce the customer and public benefits of retiring the plant in June 2022.

Q. DID THE ENERGY TRANSITION ACT LEAD TO ANY CHANGES IN THE WAY PNM ANALYZED THE ABANDONMENT OF THE SAN JUAN COAL PLANT?

A. Yes. As I mentioned earlier, PNM initially considered two primary scenarios that isolated the long-term cost differentials associated with the continued operations of the plant compared to PNM's abandonment of its remaining interest in the plant. In the abandonment scenario, the replacement portfolio was primarily

based on economic and reliability conditions. Following the passage of the Energy Transition Act, which identified additional considerations for replacement resources, additional abandonment scenarios were evaluated.

Q. WHAT SCENARIOS HAS PNM EVALUATED FOR THIS ANALYSIS?

A. PNM evaluated different scenarios that met various factors described in the Energy Transition Act, as well as the additional case assuming the San Juan coal plant continues to operate. Using the bids received in the RFP and input from stakeholders, PNM constructed portfolios that were optimized to minimize 20-year cost NPVs under the following scenarios:

- Scenario 1. This is the scenario that includes a mix of resources selected based on the various policy factors under the Energy Transition Act. This scenario has the lowest reasonable overall cost that meets reliability requirements, including PNM's risk tolerance as discussed by PNM Witness Fallgren. Modeling this scenario required all candidate battery resources to be no greater than 40 MW and the combined battery additions in 2022 to be no more than 130 MW.
- Scenario 2. In addition to the Scenario 1 requirements, Scenario 2 required at least 450 MW of the replacement resources to be located in the school district.
- Scenario 3. In addition to the Scenario 1 requirements, Scenario 3 also restricted new resource additions to non-fossil fueled resources, *i.e.* no new gas-fired resources.

- Scenario 4. In addition to the Scenario 3 requirements, Scenario 4 also restricted new resource additions to exclude storage options, *i.e.* only new renewable resources.
- San Juan Continued Operations, San Juan coal plant continues to operate until the end of its useful life.

Q. HAS PNM COMPARED THE CONTINUATION OF THE COAL PLANT TO RESOURCE PORTFOLIOS FOR THESE SCENARIOS?

A. Yes. PNM has identified replacement portfolios for different scenarios that include Energy Transition Act factors, using the "best in class" bids received in the RFP, as supplemented.[6] PNM Table NLP-1A and NLP-1B below show the 20-year NPV estimates for the continued operations scenario and the replacement scenarios including PNM's recommended replacement plan, Scenario 1. These comparisons re-confirm the 2017 IRP conclusion to retire the San Juan coal plant based on customer cost savings in all of the three scenarios.

[6] See the Direct Testimonies of PNM Witnesses Fallgren and Nagel for a discussion on the determination of "best in class" bids.

PNM Table NLP-1B

Year	Scenario 2	MW	Scenario 3	MW
2022	Heavy Frame #1	196	Clenera Arroyo Solar PV	300
	Pinon Gas 7xLM6000s	268.8	Clenera Arroyo Battery Storage	40
			Primary Jicarilla Solar PV	50
			Primary Jicarilla Battery Storage	20
			Solar PV Project #1	150
			Battery #1	40
			Battery #2	40
			Battery #3	40
			Battery #4	40
			Battery #5	40
			Battery #6	40
			Battery #7	40
			Affordable Sandia Battery Storage	40
			Affordable Zamora Battery Storage	30
2023-2025	40 MW Battery Storage	40	50 MW Battery Storage	50
	170 MW Solar	170	0 MW Solar	0
	130 MW Wind	130	0 MW Wind	0
2026-2030	200 MW Battery Storage	200	250 MW Battery Storage	250
	200 MW Solar	200	30 MW Solar	30
	110 MW Wind	110	60 MW Wind	60
2031-2035	280 MW Battery Storage	280	240 MW Battery Storage	240
	260 MW Solar	260	300 MW Solar	300
	160 MW Wind	160	200 MW Wind	200
2036-2038	20 MW Battery Storage	20	40 MW Battery Storage	40
	180 MW Solar	180	110 MW Solar	110
	150 MW Wind	150	130 MW Wind	130
NPV ($2019)	$5,943,995,328		$6,014,615,895	
Delta NPV	$21,347,592		$91,968,160	

Q. WHAT DO YOU CONCLUDE FROM THIS ANALYSIS?

A. The EnCompass modeling confirmed what the previous analyses using the Strategist model indicated that the best course of action is to abandon PNM's remaining interest in the San Juan coal plant on or around June 30, 2022, and replace that capacity with a mixture of renewable energy resources, battery

PNM Table NLP-1A

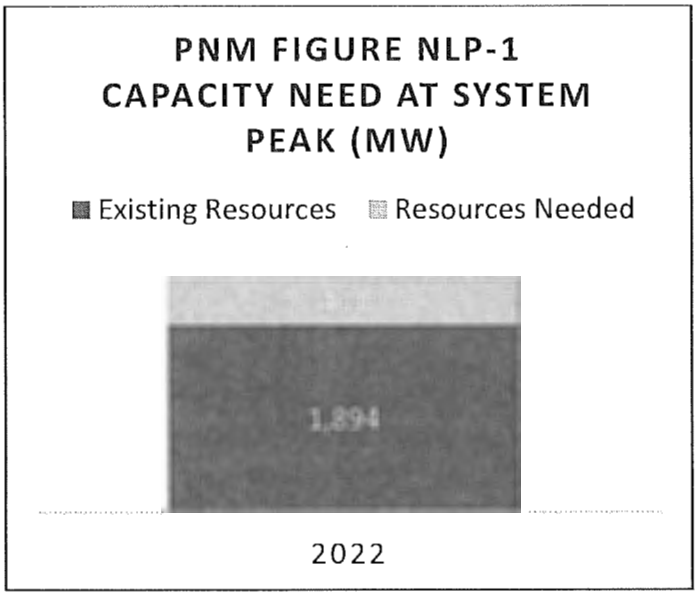
Year	Scenario 1	MW	San Juan Continues	MW
2022	Pinon Gas 7xLM6000s	269	Clenera Arroyo Solar PV	300
	Clenera Arroyo Solar PV	300		
	Clenera Arroyo Battery Storage	40		
	Primary Jicarilla Solar PV	50		
	Primary Jicarilla Battery Storage	20		
	Affordable Sandia Battery Storage	40		
	Affordable Zamora Battery Storage	30		
2023-2025	80 MW Battery Storage	80	10 MW Battery Storage	10
	0 MW Solar	0	0 MW Solar	0
	20 MW Wind	20	0 MW Wind	0
2026-2030	230 MW Battery Storage	230	200 MW Battery Storage	200
	130 MW Solar	130	370 MW Solar	370
	140 MW Wind	140	50 MW Wind	50
2031-2035	260 MW Battery Storage	260	280 MW Battery Storage	280
	240 MW Solar	240	90 MW Solar	90
	170 MW Wind	170	90 MW Wind	90
2036-2038	30 MW Battery Storage	30	50 MW Battery Storage	50
	210 MW Solar	210	0 MW Solar	0
	160 MW Wind	160	20 MW Wind	20
NPV ($2019)	$5,922,647,735		$6,301,694,730	
Delta NPV	$0		$379,046,994	

storage and flexible gas generating capacity. Given the increase in the amount of renewable resources and the flexibility provided by new battery storage systems, Scenario 1 would provide the most benefit to PNM's customers while ensuring that PNM can maintain reliable service. It would also locate resources in the San Juan County, as envisioned by the Act.

IV. ANALYSIS OF SAN JUAN REPLACEMENT RESOURCES

Q. WHY ARE REPLACEMENT RESOURCES NEEDED IF THE SAN JUAN COAL PLANT IS ABANDONED?

A. PNM's share of Units 1 and 4 at the San Juan coal plant totals 497 MW of firm, dispatchable generating capacity that can be called on to meet peak load. Absent this capacity and without replacement resources, PNM would not be able to reliably serve its customers and meet its reserve margins. PNM Figure NLP-1 below shows the capacity deficit in 2022 assuming the abandonment of the San Juan coal plant absent any replacement resources.



Q. WHAT ROLES DID THE RESOURCE PLANNING TEAM PLAY IN EVALUATING POSSIBLE REPLACEMENT RESOURCES FOR THE 2022 RETIREMENT OF THE SAN JUAN COAL PLANT?

A. PNM's resource planning analysis served two primary functions: first, it received the best in class bids from the owner's engineer (PNM Witness Nagel) and developed candidate portfolios in EnCompass to develop least cost portfolios for the above scenarios recognizing the battery reliability requirements discussed by PNM Witnesses Fallgren and Kemp. Second, it coordinated the work of two independent consultants, Astrape Consulting, LLC ("Astrape") and Ascend Analytics, LLC ("Ascend") to help determine the final resource mix.

Q. PLEASE EXPLAIN HOW THE IRP TEAM WORKED IN CONJUNCTION WITH PNM'S OUTSIDE CONSULTANTS.

A. This could best be described as working independently, yet with coordinated efforts. Each of the consultants' analyses utilized their own modeling tools and to some degree their own assumptions. The specific inputs to the models such as PNM load, cost and performance information were maintained consistent. The process of identifying the resource portfolios was iterative between the modeling groups because multiple models were needed to select portfolios for each scenario, calculate production costs and assess reliability metrics. Generally speaking, PNM and its outside consultants acted as a system of checks and balances on the modeling analyses, ensuring that portfolios minimized cost while meeting reliability requirements. This required a team effort as the results of the capacity expansion model would sometimes need to be refined based on the results from the intra-hourly economic and reliability analysis. If this occurred, PNM would compare the recommendations made by its consultants to ensure they were generally consistent with PNM's planning practices and analysis.

Q. WHAT MODELING WORK WAS PERFORMED?

A. PNM's capacity expansion modeling work focused on the initial development of candidate portfolios and associated economics between the San Juan coal plant abandonment scenario and the continued operations scenario. This analysis was performed using EnCompass to evaluate the continued operations of the coal plant as well as all candidate scenarios. The EnCompass modeling used a minimum planning reserve margin as an input; this means in each year over the

20- year planning horizon, EnCompass will require enough incremental resource additions after consideration of all existing resources and retirements, as well as load growth, to meet the planning reserve margin requirement. However, as I discuss in more detail, planning reserve margin alone is no longer sufficient to ensure system reliability on a system with large renewable penetrations. Furthermore, the value that flexible generating resources provide on a system with large renewable penetrations is not fully captured by traditional, hourly planning and production cost models, or by the use of planning reserve margin metrics. Sub-hourly economic and reliability modeling was performed by Astrape using its proprietary Strategic Energy Risk Valuation Model ("SERVM") model as well as by Ascend Analytics using its proprietary PowerSimm model.

A. Sub-hourly Analysis and Risk Assessment

Q. PREVIOUSLY THE COMMISSION HAS REQUIRED A MINIMUM PLANNING RESERVE MARGIN TO ENSURE RELIABILITY. WHY IS PLANNING RESERVE MARGIN ALONE NO LONGER ADEQUATE TO ENSURE SYSTEM RELIABILITY?

A. Planning reserves are forecasted generation capacity over and above the amount required to serve the projected peak-hour demand of the year. In a system dominated by conventional resources that could be called upon and dispatched to meet changing system requirements, planning reserve margins were sufficient for peak load capacity planning. However, with the increase in non-dispatchable

renewable resources, merely adding more resources doesn't capture the whole picture. The right type of resources both in terms of firm capacity provided, as well as the flexibility attributes of the resources must be sufficient to ensure reliability. Consequently, planning reserves alone are not sufficient to achieve the high RPS and zero-carbon goals contained within the Energy Transition Act. In order to meet these goals, the system must be designed to facilitate increasing uncertainty of renewable resources.

Q. HOW WERE THE PLANNING RESERVE REQUIREMENTS ESTABLISHED?

A. PNM's planning reserve requirement has been defined by the Commission and not by a specific North American Electric Reliability Corporation or Federal Energy Regulatory Commission regulation. Planning reserves are not required to be spinning or non-spinning, and, therefore, can be any type of available capacity. In past IRP analyses, PNM targeted a 14% planning reserve margin as a result of the stipulation approved in NMPRC Case No. 08-00305-UT. Section 9 of that stipulation states:

> Beginning with its 2011 Integrated Resource Plan ("IRP"), PNM will use a planning reserve margin of 13% of peak demand, but not less than 250 MW of planning reserve capacity, for resource planning purposes, instead of the 15% used in the current IRP and as agreed to in Paragraph 18 of the Merchant Plant Stipulation. The Signatories acknowledge that PNM's actual reserve margin may temporarily deviate from the planning reserve margin due to unexpected changes in load or imbalances caused by the magnitude of new resource additions to meet load growth, system requirements and renewable portfolio standards.

As the stipulation makes clear, the prescribed 13% reserve margin is a target, not a hard and fast rule, and the actual reserve margin may temporarily differ from the target for a variety of reasons, including the need to add resources in increments that do not precisely match immediate on-peak requirements and the need to add resources to meet other system requirements. The planning reserve margin of 13% was contemplated as an adequate measure of meeting load requirements at a time when levels of renewable penetration across the grid were low. Today, this measure is inadequate to meet the volatile nature of high levels of intermittent resources on the grid.

Q. IS A RESOURCE PORTFOLIO THAT MEETS THE PLANNING RESERVE MARGIN REQUIREMENTS GUARANTEED TO BE RELIABLE?

A. No. Due to the intermittency and uncertainty of renewable resources, the calculation of planning reserves alone is no longer the primary criteria for assessing a portfolio's ability to provide reliable service. As more renewables are integrated, reliability assessments and metrics need to change to consider the system's ability to meet peak load (both gross and net of renewable resources) as well as the ability of the system to respond to sudden changes in renewable output. In the past, regulators and resource planners could reasonably use a single metric such as reserve margin as an indicator of expected reliability, at least for long-term system construction planning. Supply resources tended to be

conventional generators that provided roughly the same delivery capacity around the clock and through the different seasons of the year. Today, renewable sources are intermittent depending on sunshine and weather; they are dependent on the hour of the day, and they vary considerably with the season. Also, renewable energy is not dispatchable. As a result, the key moment of stress on the system is no longer the summer afternoon hour when load is highest; now it tends to be those occasions when net load (load less current renewable production) is highest.[7] To assure reliability, we now must look at year-round capacity reserves and also load following flexibility.

Q. WHY WAS IT NECESSARY TO PERFORM SUB-HOURLY ANALYSES TO ASSESS THE ECONOMICS AND RELIABILITY OF THE REPLACEMENT PORTFOLIOS?

A. The energy landscape, especially in the western United States, is rapidly evolving. Wind speeds and direction, solar radiation and cloud cover change minute by minute. As penetrations of renewable energy resources increase, more frequent and larger volatilities in generation output manifest. This yields a premium on flexible generation and storage technologies to reliably and economically manage the system. In order to most accurately assess the system under these conditions, sub-hourly models that are capable of assessing the uncertain nature of weather

[7] Other events contribute to system stress such as weather, load uncertainty, unplanned generator outages, etc. In order to best endure reliability PNM's fleet must be flexible and contain sufficient load carrying capacity to meet its peak load plus reserves.

and its effects on load and renewable energy output are required. PNM Witnesses Wintermantel and Dorris both describe these topics in detail and how their individual analyses reflect these factors.

Q. SHOULD THE NMPRC RELY EXCLUSIVELY ON PLANNING RESERVES AS ITS STANDARD FOR RELIABLE SERVICE?

A. No. In the past the electric industry typically used a system reliability expectation that the utility will experience a loss in firm load event no more than once in every ten years. This is a common standard and has been widely used in the electric industry for 50 years. Traditionally, the simplest planning metric for modeling this reliability objective has been the reserve margin. As I have already explained, planning reserves no longer solely define a reliable portfolio. For PNM's system, the need to respond rapidly to supply and demand imbalances has the most significant impact on the type of future resource needs. Therefore, PNM needs to consider reliability metrics also as a standard.

Q. HOW ARE THE EVALUATED PORTFOLIOS ASSESSED FOR SYSTEM RELIABILITY IF PLANNING RESERVE MARGIN ALONE IS NO LONGER ADEQUATE AS A MEASURE OF RELIABILITY?

A. System reliability for the replacement portfolios has been assessed by Astrape and Ascend based on loss of load probability metrics, not planning reserve margin analysis. As discussed by PNM Witnesses Wintermantel and Dorris, loss of load

probability modeling requires comprehension of variability of demand as well as the capabilities of resources such as batteries and flexible gas turbines to load follow, provide sufficient operating and contingency reserves, and to provide resilience to the system on a sub-hourly level.

Q. WILL PNM'S GENERATION PORTFOLIO BE RELIABLE WHEN THE SAN JUAN COAL PLANT IS REPLACED WITH THE PROPOSED COMBINATION OF STORAGE, NATURAL GAS PEAKING AND RENEWABLE ENERGY SUPPLIES?

A. Yes. PNM's system will remain reliable, and it should even see a reliability improvement by reducing the system's dependence on two large spinning shafts at the San Juan coal plant (the largest single source of supply for PNM's system) and replacing them with a diverse set of smaller generators. PNM also incorporated battery technology risks as recommended by PNM Witnesses Kemp and Dorris.

Q. WHAT OTHER RISKS DID PNM CONSIDER IN ADDITION TO RELIABILITY?

A. PNM evaluated natural gas price risk. This process began with PNM's evaluation of replacement resources across a wide range of potential future scenarios in the 2017 IRP. The 2017 IRP showed that only the unlikely combination of a return to natural gas prices above $6 per MMBtu with a paradigm shift to a higher level of

load growth without an associated preference for renewable energy supply favor continuing to rely on the San Juan coal plant.

Q. HOW DID PNM EVALUATE NATURAL GAS PRICE RISKS?

A. PNM evaluated the replacement portfolios based on the best information available: PNM's current load forecast with a projection of natural gas prices from natural gas futures prices. In the terminology of the 2017 IRP this is the equivalent of an update to the mid-load, mid-gas scenarios. From that base, cost risk is evaluated within the economic dispatch algorithms of Astrape's SERVM model and Ascend's price simulation routines. Both of these approaches use a probabilistic risk analysis of the impact of changes in supply, demand and price. The portfolio of replacements proposed by PNM is recommended based on the results of the SERVM analysis, and this recommendation was confirmed by Ascend's analysis.

B. Results and the Preferred Portfolio

Q. PLEASE BRIEFLY DESCRIBE THE ANALYSIS PERFORMED BY ASTRAPE.

A. The analysis performed by Astrape began with the conclusion and recommendation from the PNM Resource Planning team's analysis to abandon PNM's remaining share of the San Juan coal plant, and the retirement of the San Juan coal plant was constant in Astrape's modeling. Astrape performed an

independent evaluation to determine the lowest reasonable cost portfolio that will meet both peak and flexible capacity reliability metrics, *i.e.* an independent evaluation of Scenario 1 using the same data and candidate resources as PNM used in its abandonment analysis. The reason for this evaluation was twofold: (i) it served as an independent check on PNM's analysis, and (ii) it would highlight whether the sub-hourly modeling could identify additional economic value or reliability concerns that hourly model could not capture. Astrape also explicitly evaluated the reliability and economics of the Scenarios 2 and 3 portfolios resulting from PNM's abandonment analysis discussed in Section III of this testimony. The results of Astrape's sub-hourly analysis for Scenario 1 were similar to PNM's baseline EnCompass result, in that Astrape also identified that a mixture of renewable energy resources, battery storage and flexible gas turbines were the best portfolio of replacement resources. However, Astrape's portfolio demonstrated that there was additional value in batteries identifying the best combination of replacement resources to contain 70 additional MWs of battery storage in lieu of 120 MW of gas turbines that was selected by EnCompass. As a result of Astrape's modeling, PNM adopted the Astrape portfolio for Scenario 1.

PNM's Scenario 2 portfolio was shown to meet reliability metrics but was confirmed to be more costly than Scenario 1. Astrape's analysis also demonstrated that while the portfolio selected by EnCompass under Scenario 3 assumptions (*i.e.* No New Gas), while sufficient to meet planning reserve

requirements, did not meet loss of load expectation metrics. Finally, Astrape also evaluated Scenario 4, a scenario not evaluated by PNM that considered only new renewable resources for placement resources (*i.e.,* no new gas and no storage). This scenario was never able to meet reliability requirements. A more complete discussion of Astrape's analysis is contained in the Direct Testimony and Exhibits of PNM Witness Wintermantel.

Q. PLEASE BRIEFLY DESCRIBE THE ANALYSIS PERFORMED BY ASCEND.

A. The analysis performed by Ascend also assumed the retirement of PNM's remaining share of the San Juan coal plant in 2022. Ascend conducted two evaluations. First, it took each of the four scenarios evaluated by Astrape and evaluated them with Ascend's proprietary sub-hourly model, PowerSimm, using an independent set of fuel, power price and market assumptions to evaluate the economics of the portfolios and assess reliability. Generally speaking, the results confirmed and reinforced Astrape's analysis. The Scenario 1 portfolio was the lowest reasonable cost portfolio that met reliability metrics. While reliable, Scenario 2 was more costly, and Scenarios 3 and 4 did not meet reliability metrics. Ascend also attempted to create its own "No New Gas" portfolio but was unable to meet reliability requirements and reduce cost below the Scenario 1 portfolio. A more complete discussion of Ascend's analysis is contained in PNM Witness Dorris's testimony and exhibits.

Q. PLEASE SUMMARIZE THE RESULTS OF THE ANALYSES PERFORMED BY PNM, ASTRAPE, AND ASCEND.

A. The results of the modeling performed by both Astrape and Ascend reach the same conclusion: the portfolio that achieves reliability at lowest reasonable costs is the Scenario 1 portfolio consisting of 350 MW of new solar photovoltaic resources, 130 MW of battery storage and 280 MW of flexible gas turbines. PNM Table NLP-2 below summarizes the economic results from the analyses.

PNM Table NLP-2

Delta NPVs Millions	Scenario 1	Scenario 2	Scenario 3	Scenario 4	San Juan Continues
PNM NPV ($M 2019)	$0	$21	$92	n/a	$379
Astrape NPV ($M 2023)	$0	$54	$156	$774	n/a
Ascend NPV ($M 2019)	$0	$99	$43	$560	n/a

Q. DOES THE MODELING PEFORMED BY PNM, ASTRAPE, AND ASCEND PROVIDE A REASONABLE BASIS FOR THE COMMISSION TO DETERMINE THAT THE ECONOMICS OF REPLACING THE SAN JUAN COAL PLANT WITH NEW RESOURCES ARE MORE FAVORABLE FOR CUSTOMERS AND THE PUBLIC?

A. Yes. The resource planning modeling performed by PNM, Astrape and Ascend shows that the economics from the public and customer perspective favor closing and replacing the San Juan coal plant with a new, more diverse and flexible portfolio of replacement resources, and that this can be done under the

requirements of the Energy Transition Act and providing reliable service. These analyses were performed using three different models by three different organizations working collaboratively, but independently, arriving at a consensus decision on the selected portfolio.

Q. IS THE RECOMMENDED REPLACEMENT PORTFOLIO FOR SCENARIO 1 CONSISTENT WITH THE CONCLUSIONS REACHED IN THE IRP?

A. Yes. The recommended replacement portfolio is consistent with the 2017 IRP because the IRP contemplated additional consideration of renewable resources, battery storage systems and flexible gas generation in selecting new replacement resources for the San Juan coal plant.

V. INDEPENDENT ECONOMIC IMPACT STUDIES

Q. HAS PNM STUDIED OTHER ECONOMIC IMPACTS ON ITS SERVICE TERRITORY THAT MAY RESULT FROM SHUTTING DOWN SAN JUAN COAL PLANT?

A. Yes. In early 2019 PNM commissioned a study by Regional Economic Models, Inc. ("REMI") that was intended to take a broader look at closing the coal plant rather than simply examining potential rate impacts. The REMI study was intended to independently examine the impact of the plant and San Juan mine closures on the economies within PNM's service territory. The REMI study

examines how the plant and mine closures and replacement resources might affect economic activity through construction and subsequent electric rate impacts. The construction and operation of a replacement portfolio will mitigate some of the adverse area economy effects in the San Juan County region and provide statewide benefits. The REMI study is attached to my testimony as PNM Exhibit NLP-2.

The REMI study indicates how events in San Juan County could impact the service territory economy resulting from five direct impact categories. These are: (1) the San Juan coal plant and coal mine retirements, (2) the investment in and operation of the replacement generating assets, (3) PNM's electricity price change, (4) Energy Transition Act assistance funds for San Juan County, and (5) changes in mine reclamation and plant decommissioning spending at the San Juan site.

Q. PLEASE SUMMARIZE THE FINDINGS OF THE REMI ECONOMIC IMPACT STUDY.

A. The REMI study projects there will be benefits through an increase in the gross regional product for the service territory economy, which result primarily from construction of replacement resources (some of which are assumed to be located in the service territory counties) and beneficial effects for PNM customers from a

projected reduction in electricity costs associated with shutting down the San Juan coal plant versus its continued operation.

Q. DOES THE REMI STUDY SUGGEST THE SAN JUAN COAL PLANT SHOULD CONTINUE OPERATING AFTER JUNE 2022?

A. No, despite the adverse effects on the San Juan County community the REMI study does not suggest that the San Juan coal plant should remain operating beyond June 2022. Consequently, continuing non-economic operation of the San Juan coal plant is an inefficient means of aiding those impacted by the closure. However, in light of adverse impacts noted in the study, the provisions of the Energy Transition Act which focus on providing economic support to the San Juan region can be viewed as a well-considered policy for the State to have implemented as part of the overall energy transition away from coal-fired generation.

VI. CONCLUSION

Q. PLEASE SUMMARIZE YOUR CONCLUSIONS.

A. The analysis performed to support PNM's Consolidated Application demonstrates that it is in the best interest of PNM's customers for PNM to abandon its interests in the San Juan coal plant by June 30, 2022. By abandoning its share of the San Juan coal plant and supplanting this capacity with PNM's proposed replacement portfolio for Scenario 1, PNM's customers can expect economic and

environmental benefits over the next 20 years. This is consistent with PNM's recommendation to pursue retirement of the remainder of PNM's interest in Units 1 and 4 at the San Juan coal plant contained in its 2017 IRP.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes it does.

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