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	)))))))	**Case No. 19-00195-UT**

REBUTTAL TESTIMONY

OF

GARY W. DORRIS

January 13, 2020

NMPRC CASE NO. 19-00195-UT
INDEX TO THE REBUTTAL TESTIMONY OF
GARY W. DORRIS

WITNESS FOR
PUBLIC SERVICE COMPANY OF NEW MEXICO

REBUTTAL TESTIMONY
OF GARY W. DORRIS
NMPRC CASE NO. 19-00195-UT

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME AND POSITION.

A. My name is Gary W. Dorris. I am President and CEO of Ascend Analytics ("Ascend"). My business address is 1877 Broadway, Boulder, CO.

Q. HAVE YOU PREVIOUSLY FILED TESTIMONY IN THIS CASE?

A. Yes, I filed Direct Testimony on July 1, 2019 in support of PNM's Consolidated Application. I also filed Supplemental and Direct Errata Testimony on October 1, 2019.

Q. WHAT IS THE PURPOSE OF YOUR REBUTTAL TESTIMONY?

A. I rebut the intervenor direct testimonies that address PowerSimm modeling and the assumed resource attributes associated with PNM joining the Western Energy Imbalance Market ("EIM") in 2021.

Q. WHOSE TESTIMONY ARE YOU REBUTTING?

A. I rebut the testimony of the following witnesses, with the following references:

i. Southwest Generation Operating Company, LLC ("SWG") witness William Babcock, who incorrectly asserts the following:

- PNM ignored the benefits of EIM membership in its modeling (page 28 line 6 through page 30 line 7);

- PowerSimm is limited because it does not consider "other power system reliability issues such as reactive power, voltage, or system frequency" (page 22 lines 18 to 20); and
- Ascend's PowerSimm analysis supports PNM lifting any limitations on battery storage as a replacement resource (page 56 lines 1 to 19); and

ii. Sierra Club witness Michael Goggin, who incorrectly asserts the following:

- PowerSimm modeling should not have assumed that a lack of flexibility or capacity will result in a loss of load event (page 39 line 17 to page 41 line 11);
- Scenario 1 may have failed reliability metrics with "more accurate treatment of correlated gas plant outages" (page 48 line 14 to page 49 line 4);
- PowerSimm would show more favorable results for portfolios with less gas had PNM "risk-adjusted" its analysis for carbon cost and increasing fuel costs (page 65 line 19 to page 66 line 18);
- the relatively low capacity factors of the Pinon gas facility in 2035 and 2040 indicate it may become a stranded asset (page 71 line 8 to line 15);
- gas aeroderivatives are problematic as the renewable portfolio standard increases (page 71 line 8 to line 15); and
- zero carbon fuels are infeasible (page 72 line 1-11).

I rebut each intervenor's witness's criticism of Ascend's resource planning software, PowerSimm, and the application of this software as used to develop my findings for my Direct Testimony. However, if I do not address a particular witness's argument in my Rebuttal Testimony it does not indicate I agree with the argument.

Q. WHAT ARE YOUR QUALIFICATIONS TO REBUT THIS TESTIMONY?

A. My qualifications are described in my Direct Testimony, which was filed on July 1, 2019.

Q. WHAT BENEFITS DOES YOUR POWERSIMM SOFTWARE PROVIDE IN THE RESOURCE PLANNING PROCESS?

A. PNM Witness Nicholas Phillips provides a description of PNM's overall planning approach, including the capabilities of each model used in its replacement resource analysis. PowerSimm uses uncertainty and variability in weather as a fundamental driver that affects load, prices, and renewable generation. In addition, PowerSimm captures variation in plant availability, impacting reliability through simulating unplanned outages in thermal generators. PowerSimm performs multiple simulations over a range of future states to determine cost and reliability over a range of probabilistically determined outcomes rather than determining a single cost for a single assumed future state. Ascend also performed sub-hourly modeling for PNM to determine the potential benefits of different resources through EIM participation and performed analysis to determine the

amount of flexible capacity needed for PNM have sufficient ramping resources as a function of renewable generation.

Q. HAS YOUR REVIEW OF THE INTERVENORS' DIRECT TESTIMONIES CHANGED YOUR POSITION ON PNM SCENARIO 1?

A. No. I still recommend that the New Mexico Public Regulation Commission ("Commission") approve PNM Scenario 1 as the most cost-effective supply portfolio to transition to a carbon free energy supply and meet reliability requirements. PNM Scenario 1 offers the lowest system cost, maintains reliability standards, provides needed firm capacity that will be important both now and in a low/zero carbon future, and allows time for further cost declines and technology improvement in battery storage before locking in investments. My assessment includes the benefits of participating in the EIM and the flexibility value of batteries, and PNM Scenario 1 remains the best option of the portfolios considered.

Q. IS THE PINON GAS PLANT AN ESSENTIAL ELEMENT OF PNM SCENARIO 1?

A. Yes. Even at low capacity factors, the Pinon Gas Plant provides critical backup capacity for those times when renewable resources are unavailable to meet load. PowerSimm simulates the uncertainty and variability in load, renewable generation, battery state of charge, and traditional generation in order to assess capacity shortages. Even though renewables may generally, or on average, be

available to meet load, resource planning must ensure the ability to maintain reliability every hour of the day and every day of the year, even during infrequent weather events and other events which cause instability on the system. Ascend's stochastic PowerSimm simulations of PNM Scenario 1 accounts for these infrequent events. The additional Ascend simulations of portfolios without the Pinon Gas Plant simply do not exhibit sufficient reliability, as shown in PNM Table GWD-4 (Corrected) in the errata to my Direct Testimony.

Q. IS PNM SCENARIO 1 CONSISTENT WITH THE ETA'S REQUIREMENT OF A CARBON-FREE PORTFOLIO BY 2045 AND PNM'S STATED GOAL OF A CARBON-FREE PORTFOLIO BY 2040?

A. Yes. The aeroderivative units are a cost-effective and critical component of PNM's transition to a zero-carbon portfolio. Flexible thermal resources such as the Pinon Gas Plant complement renewable resources and energy storage by providing critical backup capacity during extreme or infrequent reliability events. Thermal backup power is the critical resource that enables power system reliability with high renewable penetrations. Moreover, the aeroderivatives can continue to provide value in a zero-carbon future by being configured to burn any of a variety of carbon-neutral fuels that may be available, including hydrogen, renewable natural gas, biofuels, or others.[1] This possible use case for thermal

[1] https://www.bloomberg.com/news/articles/2019-08-21/cost-of-hydrogen-from-renewables-to-plummet-next-decade-bnef

generation is already being anticipated and planned for by utilities,[2] government agencies,[3] manufacturers,[4] and industry observers.[5-6]

II. RESPONSE TO SWG

Q. DID PNM FAIL TO CONSIDER THE BENEFITS OF EIM MEMBERSHIP IN ITS REPLACEMENT RESOURCE ANAYSIS?

A. No. To the contrary, Ascend's PowerSimm modeling specifically considered the sub-hourly revenue potential for batteries and LM6000s through EIM membership, showing the greater EIM revenue potential for batteries. Even including these greater sub-hourly revenues for batteries, the results of Ascend's analysis are still consistent with Astrape's and PNM's own analysis, which all showed that PNM Scenario 1 is the best portfolio of replacement resources. With capital costs of less than half of the energy storage projects of equivalent capacity, the LM6000s carry a significant cost advantage over battery storage that simply cannot be overcome by the potential added market revenue opportunities attributed to battery storage.

---

[2] https://www.utilitydive.com/news/natural-gas-plant-replacing-los-angeles-coal-power-to-be-100-hydrogen-by-2/568918/.
[3] See California Energy Commission Grant Funding Opportunity GFO-19-305 "Developing non-Lithium Ion Energy Storage Technologies to Support California's Clean Energy Goals", which includes a dedicated funding track for renewable hydrogen.
[4] Goldmeer, J. "Fuel flexible gas turbines as enablers for a low or reduced carbon energy ecosystem," GE White Paper 33861.
[5] "Green hydrogen production: Landscape, projects and costs," Wood Mackenzie Report, 2019. https://www.woodmac.com/news/editorial/the-future-for-green-hydrogen/.
[6] https://www.powermag.com/high-volume-hydrogen-gas-turbines-take-shape/

Q. HOW DID ASCEND CONSIDER THE BENEFITS OF PARTICIPATING IN THE EIM WITH ADDITIONAL GAS AND BATTERY RESOURCES?

A. As described in my Direct Testimony and Supplemental Direct Errata Testimony, Ascend generated a sub-hourly price forecast based on observed market dynamics at a nearby EIM node: DGAP-PNM-APND. The sub-hourly price forecast provides simulated prices consistent with observed market conditions and the evolution of the fundamental drivers of sub-hourly price dynamics.[7] To mitigate the potential of perfect foresight to overstate market opportunities, Ascend ascribed fixed hourly rules for resources to either perform ancillary services or bid into the EIM based on historical and projected patterns of prices that would maximize value. The annual revenues from EIM participation were then determined for each asset and added to the total system NPV as the 'EIM Benefit' shown in PNM Figure GWD-4 (Corrected).[8]

I should emphasize that the EIM Benefit shown in PNM Table GWD-6 for each asset type only indicates the incremental net revenues (revenues – variable costs) that the asset can achieve and does not include the capital costs of the system. It would be inappropriate to only consider the differences in EIM benefit between assets and then assert these differences extend to total system costs, as SWG did.

[7] Sub-hourly price spikes positive and negative are principally driven by renewable penetration rates and mitigated by the entry of flexible generation.
[8] The EIM revenues were determined as additive to hourly market revenue opportunities. The EIM component represents the difference between hourly and sub-hourly resource values.

Q. WOULD PNM ACHIEVE GREATER BENEFITS FROM PARTICIPATING IN THE EIM IF IT WERE TO REPLACE SOME OF THE PINON CAPACITY IN PNM SCENARIO 1 WITH ADDITIONAL BATTERIES, AS SWG CLAIMS?

A. SWG's claim appears to be speculative. Exchanging some Pinon capacity for battery capacity would cause the EIM benefit shown in PNM Figure GWD-4 (Corrected) to be larger. However, this benefit would be offset by higher capital costs and a sacrifice in reliability. SWG's assumed trade off does not take into consideration all impacts on cost, revenue, and reliability. Furthermore, the ability of storage resources to maintain their current economic value may diminish as more storage resources respond and diminish the magnitude and frequency of real-time price spikes, both positive and negative. Finally, I compared PNM's Scenario 1 with PNM Scenario 3 which tests similar assumptions, and the conclusion is that the additional EIM benefits do not overcome the incremental capital costs as shown in my Direct Testimony, PNM Table GWD-3(Corrected).

Q. CAN PNM RELY ON EIM TO MEET ITS RELIABILLITY REQUIREMENTS?

A. No. The primary advantage of a utility joining the EIM is the opportunity to buy real-time energy and INC[9] that may be cheaper than the utility's own available supply. However, each Balancing Authority must plan to have sufficient capacity

[9] INC refers to incremental energy needed to balance generation and load over intervals of 5 minutes or more.

available to meet its own load and cannot use EIM capacity in its system planning. In order to participate in the EIM, PNM will have to demonstrate resource adequacy and sufficient flexible ramp capacity prior to each and every hour to serve its forecasted load.

Q. WHY CAN THE EIM NOT BE USED AS A SOURCE OF RELIABILITY IN THE RESOURCE PLANNING PROCESS?

A. An electricity grid in which each participant had a planned reliance on another utility to meet its own capacity obligations could quickly result in shortages and a loss of reliability. Even if capacity from neighboring systems may be available in real-time, this capacity cannot be counted upon in the planning process because the neighboring system is also relying on that same capacity in its own planning process. To assume that backup capacity would be available in the EIM would effectively double-count the capacity in each balancing area, which would be inappropriate.

Accordingly, the PowerSimm modeling did not allow market purchases to meet capacity shortfalls for mean LOLE calculations. For more extreme and less frequent events, for example LOLE at the 95th percentile (instead of the mean), then I would consider limited market purchases to be appropriate for maintaining reliability. While the SERVM modeling described by PNM Witness Nick Wintermantel in his Direct Testimony and Rebuttal Testimony allowed limited

market purchases to prevent some loss of load events, this limit should certainly not be increased as SWG argues.

Q. IS PNM'S INCLUSION OF NEW GAS CAPACITY IN PNM SCENARIO 1 CONSISTENT WITH THE APPROACHES OF OTHER UTILITIES PURSUING ZERO CARBON PORTFOLIOS?

A. Yes. Los Angeles Department of Water and Power ("LADWP") is replacing its coal-fired Intermountain Power Plant with natural gas capacity, with the intention to run it on carbon-free hydrogen by 2045.[10] Ascend's resource plan analysis work for Glendale Water and Power[11] and Hawaiian Electric Company[12] similarly showed the necessity for firm thermal capacity in high renewables penetration scenarios. In addition to our own work, the importance of flexible thermal resources has also been shown by other industry experts even in the hydro-abundant Pacific Northwest.[13] Furthermore, for Europe, studies have shown renewable fuels will be a necessary cornerstone for the continent to realize 100 percent carbon free energy.[14] High renewables scenarios rely on renewable generation to provide a majority of energy (reducing the capacity factor of the

[10] https://www.utilitydive.com/news/natural-gas-plant-replacing-los-angeles-coal-power-to-be-100-hydrogen-by-2/568918/.
[11] https://www.glendaleca.gov/home/showdocument?id=51814.
[12] https://www.hawaiianelectric.com/documents/clean_energy_hawaii/grid_modernization/dkt_2014_0183_20161223_companies_PSIP_update_report_4_of_4.pdf.
[13] Resource Adequacy in the Pacific Northwest, E3 Report, 2019. https://www.ethree.com/wp-content/uploads/2019/03/E3_Resource_Adequacy_in_the_Pacific-Northwest_March_2019.pdf.
[14] Child, M., Kemfert, C., Bogdanov, D., & Breyer, C. (2019). Flexible electricity generation, grid exchange and storage for the transition to a 100% renewable energy system in Europe. *Renewable energy*, *139*, 80-101.

thermal plants) but the firm capacity of the thermal plants is necessary for maintaining reliability, particularly during infrequent reliability events.

Q. WHY ARE OTHER UTILITIES THAT HAVE CARBON-FREE GOALS FINDING FLEXIBLE THERMAL GENERATION NECESSARY TO MAINTAIN RELIABILITY?

A. The economic merits of including new thermal generation on the pathway toward 100% carbon-free generation are the same from Hawaii to California to New Mexico because of the following:

i. The cost of storage is projected to decline;

ii. The declining effective load carrying capacity ("ELCC") of future storage additions creates a need for future thermal generation; and

iii. Seasonal surpluses of renewable generation provide economic conditions for production of renewable fuels.

Thermal generation, which has the potential of consuming renewable fuels, has proven to be necessary to maintain system reliability during extreme meteorological events, where renewables combined with battery storage are not adequate to serve load. The need for thermal generation as "back-up" capacity provides an economic source of dependable capacity during these extreme events. Furthermore, the production of renewable fuels serves as a natural mechanism to utilize seasonal surpluses of renewable energy in the spring and fall to serve peak energy needs.

To be on an economically efficient pathway toward meeting a 100% carbon free energy supply, PNM must make investment decisions today that economically move towards this clean energy goal. Each resource investment choice should consider the ELCC over time as more and more storage supports the PNM system versus the declining marginal cost of storage. Because the ELCC of a four-hour storage system declines as a greater portion of peak load is served with storage[15], thermal generation becomes a necessary component to the least cost pathway to 100% renewables. The investment decision analysis needs to consider the optionality today by jointly valuing future reliability needs and future projected costs. The pathway toward a 100% renewable supply made by the aforementioned utilities included investments in thermal generation based on relative value.

Investment in the Pinon Gas Plant has less risk than additional investment in storage for PNM because of the future need and sustained value of its capacity and the limited downside risk of becoming an uneconomic investment a few years later. Investing in LM6000's today may seem counter-intuitive for utilities with strong ambitions to aggressively realize a 100 percent carbon free energy supply. However, the least-cost economics of this investment over the next 20 years relative to other options, combined with the inherent ability to utilize renewable

[15] https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/irp/2018/2019%20IRP%20Preliminary%20Results%20Workshop%20Slides.pdf (slide 41).

fuels in the future, makes the investment in LM6000's a critical component on the pathway toward a carbon free energy supply.

Q. HOW DO YOU RESPOND TO CRITICISM THAT ASCEND DID NOT MODEL REACTIVE POWER, VOLTAGE, OR SYSTEM FREQUENCY?

A. PowerSimm follows the common industry practice in supply planning of focusing on capacity, flexibility, and ancillary products. It is uncommon in supply planning to consider reactive power, voltage, or system frequency beyond accounting for necessary ancillary service capacities.

PNM Witness Thomas Duane explains PNM's analysis of reactive power, voltage, and system frequency in his rebuttal testimony.

Q. DO YOU SUPPORT LIFTING PNM'S SIZE LIMITATIONS ON BATTERY STORAGE?

A. No. As I discussed in my Direct Testimony, batteries are expected to continue to undergo steep price declines through the 2020s.[16,17] Given that there will be further capacity needs by PNM in the future, it is far more economically prudent to procure necessary thermal capacity now, which has relatively stable capacity costs, while delaying the procurement of energy storage to take advantage of the future cost reductions and technology improvements that I described in my Direct

[16] Values taken from the NREL Annual Technology Baseline: https://atb.nrel.gov/electricity/data.html.
[17] https://about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices/.

Testimony. Put another way, if both additional thermal capacity and batteries are needed in the future, the lowest cost approach is to procure thermal capacity now and batteries later. Flexible thermal capacity will be a necessary cornerstone of a renewable future, utilizing seasonal surpluses of renewable generation in the spring and fall to create renewable fuel to be utilized in summer months.[18]

III. RESPONSE TO SIERRA CLUB

Q. HOW DO YOU RESPOND TO SIERRA CLUB'S ASSERTION THAT A SHORTFALL IN FLEXIBLE CAPACITY INCORRECTLY RESULTS IN A LOSS OF LOAD EVENT IN POWERSIMM?

A. Sierra Club's assertion is factually incorrect with regard to PowerSimm's modeling structure and misleading with regard to PNM's obligation as a Balancing Authority in the Western Electricity Coordinating Council ("WECC"). With respect to the modeling, as in actual operations, PowerSimm foregoes meeting ancillary service constraints of contingent reserves and operating reserves before an actual outage occurs. Operating and contingent reserve constraints are binding up to the point of a loss of load event.[19] Furthermore, by modeling the PNM system at the sub-hourly level in the EIM, nearly all flexibility requirements

[18] Ram M., Bogdanov D., Aghahosseini A., Gulagi A., Oyewo A.S., Child M., Caldera U., Sadovskaia K., Farfan J., Barbosa LSNS., Fasihi M., Khalili S., Dalheimer B., Gruber G., Traber T., De Caluwe F., Fell H.-J., Breyer C. Global Energy System based on 100% Renewable Energy – Power, Heat, Transport and Desalination Sectors. Study by Lappeenranta University of Technology and Energy Watch Group, Lappeenranta, Berlin, March 2019.

[19] PowerSimm does add an economic penalty reflective of potential emergency purchases for any deficiency in operating or contingency reserves.

can be met through the real-time market, less the CAISO market participation requirement to demonstrate adequate capacity and flexible reserves.

Q. WHAT MISLEADING ASSERTION DOES SIERRA CLUB MAKE WITH REGARD TO PNM'S OBLIGATION AS A BALANCING AUTHORITY?

A. Sierra Club makes a misleading comparison to Xcel Energy's operation of its wind farms in Colorado as an economically appropriate means to meet flexible reserves that should or could be adopted by PNM. Xcel Energy is neither a member of an integrated power market like the EIM nor has significant battery storage, so the economic solution for Xcel to manage sub-hourly demand and supply imbalances is to curtail wind generation. While wind curtailments remain a viable operational option in PowerSimm, the subhourly market price dynamics of the EIM govern the potential curtailment of renewables. Sierra Club is incorrect in stating PNM has 75 minutes to correct its area control error within its limits when called upon by WECC under the current Reliability Based Control, which provides a limit of 30 minutes.[20]

Q. DOES POWERSIMM MODELING CONSIDER POTENTIAL CORRELATED GAS PLANT OUTAGES?

A. PowerSimm considers the possibility of coincident outages through the multiple stochastic simulations (termed 'Sim-Reps') it performs. However, PowerSimm

[20] https://www.nerc.com/pa/Stand/Project%202010141%20%20Phase%201%20of%20Balancing%20Authority%20Re/BAL-001-2_comments_recd_042513_2.pdf.

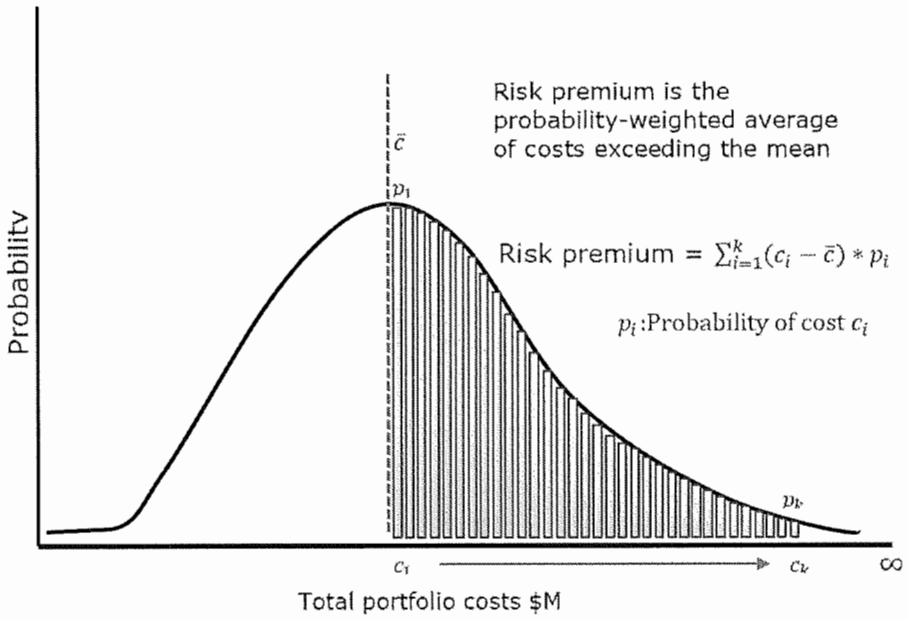
did not specifically consider correlated outages of the type Sierra Club describes, that result from a single event. For such an event to materially impact reliability, as Sierra Club claims, there would need to be some evidence that gas constraints or disruptions could materially impact thermal generation during peak demand events in the desert southwest. Ascend is not aware of such evidence. Furthermore, PNM has firm gas transport from both the Permian basin and San Juan basin, which provides a diverse gas source portfolio and limits the possibility of such a correlated outage event.

Q. DID POWERSIMM CONSIDER EXPOSURE TO INCREASING FUEL COSTS?

A. Yes. PowerSimm uses repeated stochastic simulations to model volatility and uncertainty in weather, prices, load, and generation. The reported NPV for the PowerSimm results was the average across all Sim-Reps, and therefore included the impact of the modeled uncertainty and variability in fuel costs. Moreover, as shown in PNM's response to the October 7, 2019 Bench Request Order, PNM Scenario 1 was lower cost than Scenario 3 in every single Sim-Rep, regardless of whether the fuel cost was high or low in the Sim-Rep. The usage of multiple Sim-Reps also allows calculating a 'risk premium,' which is the integral of the probability distribution above the mean, as shown in PNM Figure GWD-1 (Rebuttal). This metric gives a measure of the exposure of a portfolio to high cost possibilities. In our fifty Sim-Rep analysis for the same bench request, the risk premium of Scenario 1 was $64 million while the risk premium of Scenario 3 was

$57 million. This difference in risk premium of $7 million is too small to make up for the $32 million difference in NPV between the two scenarios calculated with PowerSimm.

PNM Figure GWD-1 (Rebuttal). Definition and calculation of risk premium



Q. DO THE RELATIVELY LOW CAPACITY FACTORS OF THE PINON GAS PLANT IN 2035 AND 2040 INDICATE IT MAY BECOME A STRANDED ASSET?

A. No. As I explained in my Direct Testimony, under the current paradigm of resource planning, the expected capacity factors for the Pinon Gas Plant in 2035 and 2040 indicate it will perform exactly the job PNM's customers need: providing firm capacity for those situations when renewables and batteries are unable to do so. Reliability must be maintained not only in average years when

solar, wind, and batteries are providing an average ELCC, but also during infrequent storms, heat waves, low wind, generator outages, and other similar events. Average conditions are not representative of all conditions. Even if the need for the Pinon Gas Plant capacity is infrequent, it is still necessary, and infrequent needs are best met by resources with relatively low capital costs, such as the aeroderivatives in the Pinon facility. Moreover, the aeroderivatives can continue to provide value even in a zero-carbon future by being configured to burn any of a variety of potential zero-carbon fuels that may be available in the future.

Q. ARE FUTURE ZERO-CARBON FUELS FEASIBLE?

A. Yes, for example as I described in my Direct Testimony, the aeroderivatives could operate on a variety of carbon-neutral fuels that are likely to be available in the future and are a focus of ongoing research and development.[21] The seasonal variation in solar production in particular creates a strong opportunity for utilizing otherwise-curtailed or negatively priced energy to generate renewable fuels (i.e. hydrogen by electrolysis) that may be used in a combustion turbine.[22] Sierra Club's discussion of technical challenges with hydrogen in Mr. Goggin's testimony does not consider alternate end products and only considers blending hydrogen into existing natural gas infrastructure. However, other potential use

[21] https://www.bloomberg.com/news/articles/2019-08-21/cost-of-hydrogen-from-renewables-to-plummet-next-decade-bnef.
[22] Götz, Manuel, et al. "Renewable Power-to-Gas: A technological and economic review." Renewable energy 85 (2016): 1371-1390.

cases include co-locating hydrogen production and usage and building new production and distribution infrastructure dedicated to hydrogen.

While it is possible that other forms of seasonal energy storage may be available in the future, combustible fuels, whether hydrogen, hydrogen-derived fuels, or biofuels, remain the most mature technology at present.

Q. ARE OTHER UTILITIES OR STAKEHOLDERS CONSIDERING HYDROGEN OR OTHER ZERO-CARBON FUELS AS A FUTURE RESOURCE?

A. Yes. The potential for natural gas plants to burn low/zero-carbon fuels is a key part of other utility plans, including a recent announcement from LADWP.[23] The potential for similar facilities to burn future zero-carbon fuels was also a key consideration in the resource plans we developed for Glendale Water and Power and Hawaiian Electric Company. These use cases are also already being planned for by the manufacturers of natural gas turbines.[24] A recent report by Wood Mackenzie explored future hydrogen use and production, estimating that electrically-derived hydrogen becomes cost competitive with hydrogen generated by steam methane reformation when electricity prices drop below $30/MWh,[25]

[23] https://www.utilitydive.com/news/natural-gas-plant-replacing-los-angeles-coal-power-to-be-100-hydrogen-by-2/568918/.
[24] Goldmeer, J. "Fuel flexible gas turbines as enablers for a low or reduced carbon energy ecosystem," GE White Paper 33861.
[25] "Green hydrogen production: Landscape, projects and costs," Wood Mackenzie Report, 2019. https://www.woodmac.com/news/editorial/the-future-for-green-hydrogen/.

which is already higher than many current wind[26] and solar[27] PPA prices in the west. The future availability of hydrogen remains an active area of consideration among a variety of stakeholders. While technological innovation for alternative fuels for electricity production is still an emerging field, it clearly offers potential to expand the long-term benefits to PNM customers, in addition to the economic and operational benefits that are known today from including flexible LM6000s in PNM's Scenario 1 portfolio.

Q. WILL THE ADDITION OF THE PINON GAS PLANT MAKE IT MORE DIFFICULT FOR PNM TO MEET THE INCREASING RPS REQUIREMENTS IN 2030 AND 2040?

A. No. As I explained above, the addition of the Pinon Gas Plant is actually a necessary step for PNM to meet the increasing renewables requirements in the Energy Transition Act, with the firm and flexible capacity of the Pinon plant serving as the critical resource that enables reliable high renewable penetrations. A common mistake that non-resource planners make is to rely on average renewable generation or storage behavior to justify meeting load. However, reliability must still be maintained during non-average events, so resource planning cannot rely simply on average renewable generation behavior. While batteries are effective for smoothing the short-duration variability of renewable

[26] LBNL 2018 Wind Technologies Market Report, https://emp.lbl.gov/sites/default/files/wtmr_final_for_posting_8-9-19.pdf.
[27] Utility-Scale Solar Empirical trends in project technology, cost, performance, and PPA pricing in the United States – 2019 Edition, https://emp.lbl.gov/sites/default/files/lbnl_utility_scale_solar_2019_edition_final.pdf.

generation, they can be depleted quickly during longer-duration reliability events. Having the flexible and firm capacity of the Pinon plant available to provide capacity during those infrequent events is what allows the system to rely on renewables and batteries for most of the energy production most of the time.

IV. CONCLUSION

Q. PLEASE SUMMARIZE THE CONCLUSIONS YOU HAVE REACHED IN RESPONSE TO INTERVENOR TESTIMONIES PROPOSING ALTERNATIVE OUTCOMES IN PLACE OF PNM SCENARIO 1.

A. The testimonies of intervenors that recommend against approval of PNM Scenario 1 have not adequately considered real-world operating contingencies and the need to maintain system reliability under non-average or extreme system events. Market benefits that may be gained from the addition of batteries do not offset increased capital costs that would result from having equivalent reliability attributes of the proposed Pinon Gas Plant. Nor are batteries currently able to provide sustainable capacity to maintain system reliability during a long-lasting system event. Additionally, it is not feasible or permissible to rely on the market to provide reliability as assumed by some of the witnesses. Based on my review of the alternative proposals of intervenors, PNM Scenario 1 remains the most reasonable portfolio.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes it does.

GCG#526580

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	)	**Case No. 19-00195-UT**

AFFIDAVIT

STATE OF COLORADO)
) ss
COUNTY OF BOULDER)

GARY W. DORRIS, Chief Executive Officer, Ascend Analytics, LLC, upon being duly sworn according to law, under oath, deposes and states: I have read the foregoing **Rebuttal Testimony of Gary W. Dorris** and it is true and accurate based on my own personal knowledge and belief.

SIGNED this 20 day of December, 2019.

GARY W. DORRIS

SUBSCRIBED AND SWORN to before me this 20 day of December, 2019.

NOTARY PUBLIC IN AND FOR
THE STATE OF COLORADO

My Commission Expires:
3-20-23

ELIZABETH JUNE CRISLER
NOTARY PUBLIC
STATE OF COLORADO
NOTARY ID 20194011066
MY COMMISSION EXPIRES MARCH 20, 2023