PUBLIC SERVICE COMPANY OF NEW MEXICO

LOAD-FOLLOWING AND RENEWABLE INTEGRATION COST REPORT

Prepared per the Amended Stipulation

In Case No. 10-00086-UT

August 8, 2012

EXECUTIVE SUMMARY:

As part of the Amended Stipulation to Conform to Commission Order (Stipulation) filed in NMPRC Case No. 10-00086-UT pursuant to the Final Order Partially Approving Certification of Stipulation that was issued on August 8, 2011, PNM agreed to the following:

Within twelve (12) months of the date of the Commission's Final Order approving this Stipulation, PNM shall file with the Commission and serve on the Signatories an internally-prepared report regarding PNM's generating plants that are used for load-following, including the San Juan and Afton plants, and regarding system integration costs for renewables. The report shall include:

- *a.) Historical information on the use of PNM's plants for load-following;*
- *b.) An analysis to the extent practical of the effects of load-following on the costs or avoidance of costs of fuel and purchased power, operation and maintenance and other relevant factors such as the effects of load-following on off-system sales opportunities;*
- *c.) Recommendations on actions that can be taken to mitigate the costs to retail ratepayers of load-following; and*
- *d.) Identification of integration costs for renewable resources and how these costs currently are being collected from ratepayers.*

This report was prepared by PNM in compliance with this agreement. In summary, the findings of this report are as follows:

- a.) PNM primarily uses Four Corners, San Juan, and Luna for load-following. Afton is used when maintenance is being performed on Luna or when it is economic to operate. Peaking plants are used during the summer months to meet peak demand, but are often providing contingency spinning reserves with unloaded capacity instead of being used for regulation. Lordsburg is used for low cost quick-starts when other generating units trip offline or significant wind generation is lost unexpectedly. PNM utilizes wholesale market purchases and sales to balance resources with demands as much as economically and operationally practical and reduces curtailments at San Juan and Four Corners by selling excess baseload power into the wholesale markets at a profit.

- b.) Utilizing simplifying assumptions, PNM has estimated a net $7.1 million of lost opportunity costs in 2010 that can be attributed to load-following. Quantifying incremental O&M expenses associated with ramping units is difficult, but PNM will continue to monitor regional study assumptions and consider additional analysis. Generally, PNM considers maintenance expenses for non-baseload plants as being incurred on a $/start basis and operations expenses as fixed, resulting in minimal incremental costs being directly attributable to providing regulation.

c.) Even though load-following costs cannot be fully quantified at this point, there are certain actions that PNM can take to better understand and mitigate the costs of load-following and integrating increasing amounts of renewable resources. PNM will continue to participate in regional study efforts and support cooperative renewable integration management strategies. PNM will also consider implementing procedures to gather more detailed load-following data to see if current forecasting and operational strategies can be improved. Resource planning and renewable siting decisions are also important to minimize renewable integration costs.

d.) Approximately three years before the Stipulation was signed, PNM consulted with EnerNex Corporation to investigate the costs of integrating current and potential future wind generation within PNM's Balancing Area. PNM attempted to better define and quantify the costs associated with load-following and variable renewable generation for this report, but has been impeded by several practical difficulties including a lack of sub-hourly modeling capability, problems surrounding quantifying incremental maintenance expenses due to load-following, and an absence of historical short-term forecasts made by PNM's system operators. Even though historical data is not sufficient to determine why plants were operated the way they were, the EnerNex study used a statistical approach along with hourly dispatch modeling in an attempt to quantify the incremental dispatch costs of wind integration. However, the approach that EnerNex utilized did not fully capture current and potential future wind integration costs. Additionally, the EnerNex study assumptions are now out-of-date and do not reflect compliance metrics based on the Reliability Based Control (RBC) field trial. PNM believes solar integration costs are negligible at current penetration levels because of PNM's approach to siting reasonably small solar facilities at diverse locations within its distribution system, but should be studied further as solar generation increases. PNM's renewable integration costs are embedded in the Fuel and Purchased Power Adjustment Clause (FPPCAC) and in plant maintenance costs, so they are collected from ratepayers through the fuel adjustment factor and through base rates. Most of the costs of renewable integration that PNM has identified are "opportunity/inefficiency" costs that impact customer's fuel rates. PNM believes that incremental maintenance expenses will be minimal until the point at which increasing levels of variable renewable generation starts to force dispatch of additional gas resources specifically due to regulation needs.

As renewable resources become a greater share of energy production in the United States, cooperative efforts by utilities, regulators, and developers will be required in order to integrate variable generation without significant incremental cost impacts to customers. Regional efforts are underway in order to investigate system impacts and examine ways to mitigate integration costs. Regulatory, operational and market changes may be necessary going forward in order to avoid undue burdens on Control Areas with disproportionate shares of variable generation. The costs to integrate renewable resources in the future will depend on multiple factors beyond PNM's control including market prices, regional resources and loads, operating standards, regulatory measures, changing weather patterns, and variable generation forecasting capabilities.

SCOPE AND METHODOLOGY NOTES:

This report is not meant to include a detailed engineering analysis of cycling impacts on PNM's power plant hardware but rather to provide data and analyses that present an overview of the different cost impacts associated with load-following and integration of renewable resources. PNM has reviewed the cost and operational details of its generating assets in conjunction with reviewing external data and studies in order to compile this report. The integration cost data presented in this report is not meant to be exact and load-following costs are expected to fluctuate over time due to factors outside of PNM's control. This report includes recommendations for the future as renewables become more prevalent, including further study at local and regional levels.

Historical Operations Data Availability: PNM's historical hourly and intra-hourly system data is available back to 2003. Since the New Mexico Wind Energy Center (NMWEC) came on-line in 2003, PNM does not have detailed data to review prior to first integrating renewable resources. During the data-gathering process for this report, it was determined that PNM has not been tracking the short-term forecasts for wind generation and load used by its system operators. Such forecasts would be needed to accurately estimate a historical regulation reserve breakout between load-following for variability in system demand versus regulating for the renewables that PNM currently has on its system.

Changing Operations Over Time: Because PNM's generating assets and operating strategies have shifted significantly over the years due to changing market conditions, operational rules, loads, and resource mixes, it was decided that focusing on the last two years for a detailed historical load-following analysis was the most appropriate with higher level data being examined for resource usage back through 2003. The last few years have been similar from an operational standpoint, with the exception of additional San Juan Generating Station (SJGS) curtailments to conserve coal during the latter part of 2011 and first part of 2012 due to a fire at the San Juan underground mine. Due to this, primarily 2010 data is provided and analyzed for this report. Because visible material impacts of cycling often take many years to become apparent, the attempt was made to gather cost and operational information prior to 2003, especially for the SJGS. Due to different accounting and operations data archiving, it proved impossible to gather comprehensive data for the life of PNM's older generating assets. However, historical high-level operations were reviewed along with conclusions from a San Juan Life Assessment study prepared by EPRI in 2004/2005 which did not find major component damage due to cycling-specific causes. Also, it is assumed for this report that the impact on system costs of current and additional renewable resources is the primary interest, not costs due to system operations from the '80s and '90s.

RENEWABLE INTEGRATION STUDIES AND ONGOING WORK:

Regional Studies: Over half of the states in the US have renewable portfolio standards making the need to site, transmit, and regulate increasing amounts of renewable generation an issue of great concern for the electric industry. Numerous local and regional studies have been conducted over the past few years in order to assess the impacts on costs, operations, and system reliability of adding significant amounts of renewable energy. The most applicable regional study is being managed by the National Renewable Energy Laboratory (NREL) and is called the "Western Wind and Solar Integration Study" (WWSIS). Phase 1 of the study was completed in 2010, and Phase 2 is ongoing. PNM is participating in this study and most of the data and results are publically available. Because regional studies have higher levels of funding and better access to experts on various aspects of renewable integration than PNM does, the operations and cost analysis at a regional level should be evaluated in conjunction with the analysis provided in this report.

Energy Imbalance Market: Numerous efforts have been initiated to look at means to expand beyond the limitations of a single balancing area by taking advantage of efficiencies that can be achieve through cooperation across multiple balancing areas. The most recent efforts have focused on the establishment of an energy imbalance market (EIM) in the west. Provided adequate protocols are defined, an EIM would allow buyers or sellers to balance variable resource schedules with resources offered on a short-term basis across multiple balancing areas. This should increase overall system efficiency and lower renewable integration costs. Implementing an EIM would require establishing the communication and IT infrastructure to manage the market offers and requests and assess congestion related reliability impacts of the short-term schedules. Feasibility studies currently underway indicate potentially favorable integration costs in the west compared to individual BA efforts to integrate variable resources.

PNM Studies: PNM has done prior company-specific work regarding the impact of wind generation on load-following needs and costs because of its resource mix and purchase of all output from the NMWEC including a wind-specific study was performed by EnerNex Corporation on behalf of PNM's Transmission Department. However, the modeling and analysis from this study did not fully capture the costs of wind integration. An additional research study that contains information related to the impacts and costs related to using SJGS for historical load-following is the "San Juan Life Assessment Study" prepared by EPRI. PNM was directed to conduct this study by the other owners of SJGS in order to provide information to assist in the evaluation of possible plant retirement timeframes.

OVERVIEW OF GENERATION DISPATCH OPERATIONS AND ASSETS:

Understanding the difficulties with integrating renewable resources into the system requires a basic knowledge of the generation dispatch operations and the assets available to meet the instantaneous changes to the system. The electric industry is unique in that power generated must instantaneously match power demands at an interconnected grid level and cannot be directly stored in any significant amount. Electric generation sources utilize multiple technologies and fuel sources which can give them vastly different ability to respond to changes. Fuel supplies and the associated electric generation assets are often located in remote locations from load centers and transmission capabilities are limited. This results in incremental energy costs that can vary dramatically from one hour to the next and from one transmission hub to the next. It also results in the need for electric utilities to build generating resources that are expected to operate less than 10% of the time (peaking plants) to meet the highest expected demand each year along with a planning reserve margin to allow for contingencies.

Regional Operations: In order to comply with renewable generation mandates, electric utilities have recently been building significant amounts of non-dispatchable "variable generation" (i.e. wind and solar) and will continue to build variable generation for years to come. This has added to the challenge of balancing loads and resources due to the unpredictable nature of wind and solar energy. Additionally, existing transmission capabilities may not be adequate to transport renewable generation to the load centers where it is used. Due to the significant impacts of variable generation on bulk power operations and planning, numerous local and regional studies are ongoing to investigate strategies for dealing with variable generation. The integration capabilities of any single balancing area are limited and integration costs vary significantly depending on resources within the balancing area. These issues are clear and are key considerations in regional studies. Key conclusions of the WWSIS include the need for regional balancing authorities to cooperate extensively in order to integrate large amounts of variable generation.

PNM Operations: PNM has a variety of dispatchable generation assets that are dispatched to meet its retail and FERC load obligations and regulate for must-take resources such as renewable generation in a cost-effective manner. Excess energy can be sold in the wholesale power markets and shortfalls can be covered by market purchases when there are economic benefits of doing so, with the allocated benefits being credited back to retail customers. Although PNM's Wholesale Power Marketing group (WPM) usually controls resource dispatch, Power Operations has the responsibility for the safe and reliable operations of PNM's transmission system and can schedule "load-side" generation in the Albuquerque area when needed, generally to avoid overloading transmission lines and provide voltage support.

Wholesale Power Marketing: WPM looks at the most cost-effective ways of matching supply and demand during three different time-frames which can be roughly described as "month(s)-ahead," "day(s)-ahead," and "hour(s)-ahead." The forwards traders look at the most cost effective ways to optimize dispatch usually a month or more ahead of time and enter into monthly hedges to lock in a portion of the expected positions. The day-ahead traders generally commit most natural-gas fired resources and make on and off peak purchases or sales. The real-time operators make the minute-to-minute operational decisions to match instantaneous and short-term resources with loads and comply with applicable operational requirements. The real-time operators (which include a scheduler, a generation dispatcher, and a trader) bear virtually all the responsibilities to manage renewable volatility and changes in load utilizing hourly trading and sub-hourly resource dispatch changes. Although PNM has tools and guidelines for evaluating economic dispatch decisions, most real-time operational decisions are left to the operators along with short-term forecasting responsibilities. The majority of PNM's real-time trading is hour-ahead, making the forecasts for load and wind in the next hour the most relevant to determining load-following needs and costs. Historical forecasts utilized in forwards and day-ahead trading decisions are tracked, but the real-time forecasts are not tracked.

PNM Resource Overview: PNM's generation assets vary widely in capabilities, costs, and ages. PNM is a partial owner of Palo Verde, Four Corners, San Juan, and Luna and can be impacted by the operational decisions of other participants. This is a key consideration in Luna operations: based on historical usage patterns, PNM is assuming that the other participants are scheduling over 50% of their share in the numbers above. Currently, Luna is not dispatched overnight by any of the participants and any single participant deciding to use it while the other participants aren't using it carries significant cost and operational penalties to the user due to minimum loading requirements for a 1x1 configuration versus running both CTs (2x1 configuration).

The table below provides an overview of resources with relevant load-following details.

Resource Name	PNM share Net Operating Capacity Range (MW)	Resource Type - Duty Cycle	Year of first commercial operations	Cold start in under 15 minutes?	PNM Ramp Rate (MW/min)	Estimated Cold Start ($)
NMWEC (PPA)	0 - 200	Wind Turbines - Variable	2003	NA	NA	NA
Reeves PV	0 - 2	Solar Photovoltaic - Variable	2011	NA	NA	NA
Deming PV	0 - 5	Solar Photovoltaic - Variable	2011	NA	NA	NA
Los Morros PV	0 - 5	Solar Photovoltaic - Variable	2011	NA	NA	NA
Alamo PV	0 - 5	Solar Photovoltaic - Variable	2011	NA	NA	NA
Las Vegas PV	0 - 5	Solar Photovoltaic - Variable	2011	NA	NA	NA
Prosperity PV	0 - 0.5 (+0.25 batt.)	PV + battery - part variable	2011	NA	NA	NA
→ Customer PV	0 - 25	Solar Photovoltaic - Variable	NA	NA	NA	NA
Palo Verde #1	134 - 134	Nuclear PWR - Baseload	1986	No	NA	>$35,000
Palo Verde #2	134 - 134	Nuclear PWR - Baseload	1986	No	NA	>$35,000
Palo Verde #3	134 - 134	Nuclear PWR - Baseload	1988	No	NA	>$35,000
Four Corners #4	60 - 100	Supercritical Coal - Reg. Baseload	1969	No	5	>$35,000
Four Corners #5	60 - 100	Supercritical Coal - Reg. Baseload	1970	No	5	>$35,000
San Juan #1	60 - 170	Subcritical Coal - Reg. Baseload	1976	No	1.8	>$35,000
San Juan #2	60 - 170	Subcritical Coal - Reg. Baseload	1973	No	1.7	>$35,000
San Juan #3	71 - 211	Subcritical Coal - Reg. Baseload	1979	No	3.4	>$35,000
San Juan #4	88 - 241	Subcritical Coal - Reg. Baseload	1982	No	3	>$35,000
Luna (plant)	0 - 190*	2x1 CC - Intermediate	2006	No	6.2	varies
Afton (plant)	160 - 233	1x1 CC - Intermediate	2007 as CC	No	3.8	$25,000
Reeves #1	10 - 44	ST - Loadside/Peaking	1960	No	2.3	$5,000
Reeves #2	10 - 44	ST - Loadside/Peaking	1958	No	1.8	$5,000
Reeves #3	28 - 62	ST - Loadside/Peaking	1962	No	3.6	$5,000
Delta (PPA)	70 - 132	Lrg. Frame CT - Loadside/Peaking	2000	Yes	12.7	$20,000
Valencia (PPA)	80 - 143	Lrg. Frame CT - Loadside/Peaking	2008	Yes	7.2	$8,000
Lordsburg A	10 - 40	Aero. CT - Recovery/Peaking	2002	Yes	6.2	$200
Lordsburg B	10 - 40	Aero. CT - Recovery/Peaking	2002	Yes	12.5	$200
DSM programs	depends on time	Load Management - Peaking	2007	NA	NA	NA
Wholesale Pwr Mkt	NA	market - optimization	NA	NA	NA	NA

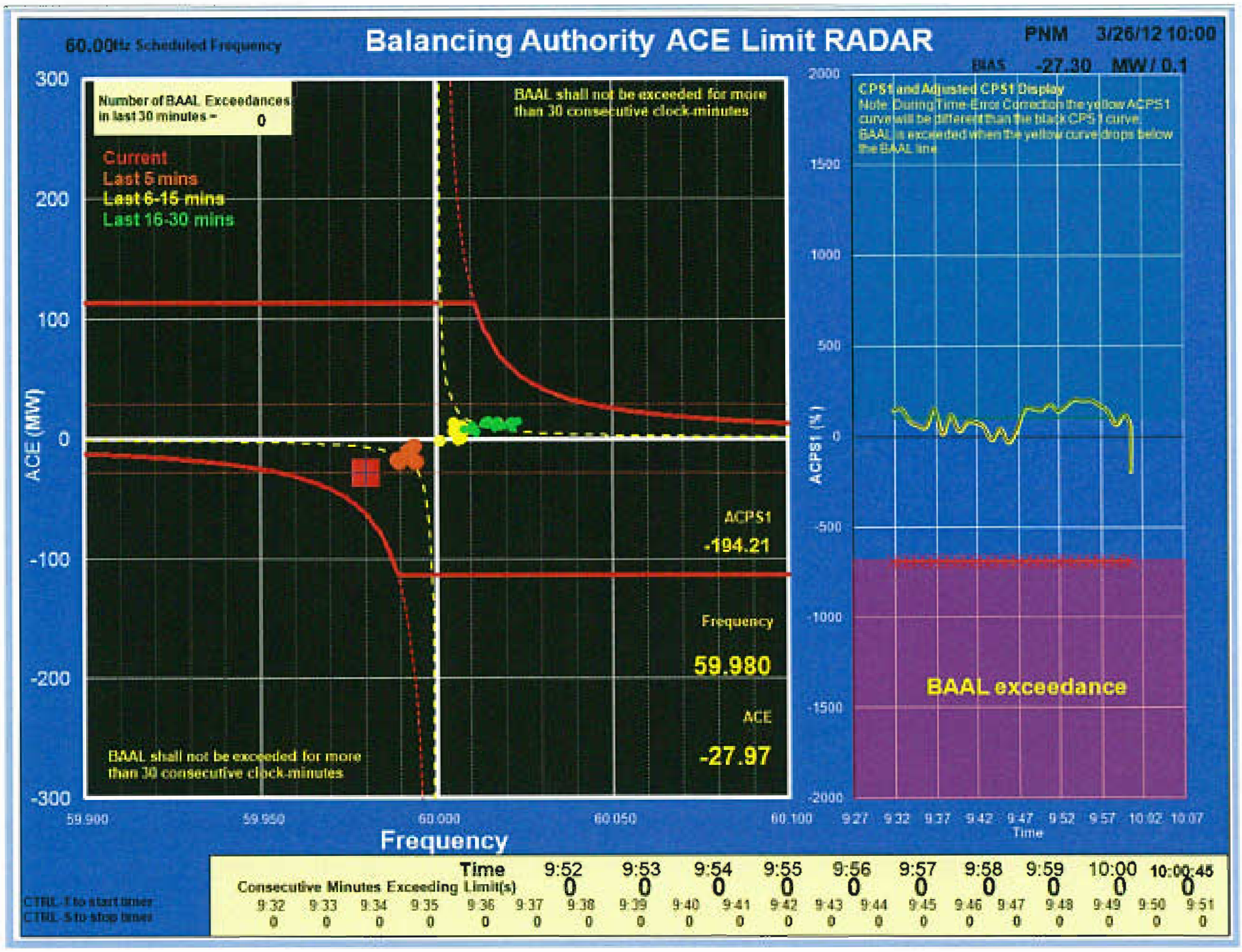
(*) Luna's operating capacity range for PNM assumes the other participants are utilizing most of their share

OVERVIEW OF OPERATING STANDARDS AND RESERVE DEFINITIONS:

Electric utilities must comply with numerous rules and regulations that are in place to ensure reliable electric service and fair market operations. The regulations that are considered relevant for consideration in this report are the North American Electric Reliability Corporation (NERC) Control Performance Standards and PNM's methods of compliance which are Southwest Reserve Sharing Group (SRSG) participation to assist with Disturbance Control Standard (DCS) compliance and participation in the Western Electricity Coordinating Council (WECC) Reliability Based Control (RBC) field trial for frequency (CPS1) and area control error management (CPS2) compliance. PNM started participating in the RBC trial in March 2011, and it should be noted that CPS2 compliance has been waived for participants in the RBC field trial.

Operating Reserves: PNM participates in the SRSG in order to reduce the amounts of contingency reserves that it needs by pooling reserves with other participants. The SRSG provides PNM with an hourly contingency reserve quota, with at least half the reserves required to be spinning reserves and the rest non-spinning reserves. Spinning reserves are defined in the SRSG agreement as "Unloaded generation which is synchronized and ready to serve additional demand," while non-spinning reserves are defined as "That portion of Operating Reserve not connected to the system, but capable of serving demand within ten (10) minutes, or interruptible load that can be removed from the system within ten (10) minutes." Operating Reserves are defined as "That capability above firm system demand required to provide for regulation, Load forecasting error, forced and scheduled outages, and local area protection. Operating Reserve consists of Spinning Reserve and Non-Spinning Reserve." For the purposes of this report, PNM refers to "regulating reserves" as operating reserves that are used to manage for load and variable generation and "contingency reserves" as operating reserves required by the SRSG. In the absence of quick-start units, spinning regulating reserves must be in addition to the SRSG spinning reserves in order for PNM to avoid violating its spinning reserve quotas if variable generation drops or demand increases. However, with the availability of the Lordsburg units, non-spinning reserves associated with Lordsburg are effectively the same as spinning reserves from a regulating reserve standpoint.

Reliability Standards: In the past, PNM has been in compliance with NERC CPS1 and CPS2 standards. Starting in March of 2011, compliance with the CPS2 standard has been superseded by participation in the RBC trial that should theoretically result in better system stability throughout the western interconnection by making the allowable area control error (ACE) for each balancing authority dependent on the deviation from scheduled system frequency and whether the BA is having a positive or negative impact on the system frequency. However, this makes PNM's allowable ACE bandwidths dependent on a metric that PNM has very little impact on, whereas under CPS2 regulations, the bandwidths were fixed. The compliance measurement that PNM is required to meet is also different under RBC versus CPS2 in that under CPS2, PNM's 10-minute average ACE had to be within the L10 bandwidths during at least 90% of the 10-minute intervals each month, but under the RBC trial, PNM has 30 minutes to bring ACE within acceptable limits after an excursion. A sample of PNM's RBC field trial radar is shown below and further details can be found at http://www.wecc.biz/committees/StandingCommittees/OC/OPS/PWG/081309/default.aspx.



Compliance with these reliability standards are a key driver of the amount of regulating reserves that PNM requires for load and variable generation.

SECTION A – HISTORICAL USAGE OF PNM'S PLANTS FOR LOAD-FOLLOWING:

Detailed historical operational data is archived for PNM's system back through about 2003, usually with time increments measured in seconds. Even though this data shows "how" PNM has operated its generation assets for the last 9 years, it does not contain the "why." Dispatch decisions made by the system operators are not documented in detail and are often based on numerous variables (many of which are not under PNM's control) making it very difficult to definitively assign causes to the way units are being operated at any given instant. Because PNM attempts to optimize the dispatch of its resources (including must-take renewable energy) utilizing the wholesale power markets, it is often unclear whether certain resources are dispatched for market sales or to serve load or both. Day-ahead and hourly power purchases are often utilized instead of turning on PNM's own gas units, which effectively offloads some load-following duty to other participants in the wholesale market but does not decrease PNM's intra-hourly regulation needs. These factors make it necessary to make simplifying assumptions in order to provide estimates of the utilization of PNM's resources for load-following. The assumptions are as follows:

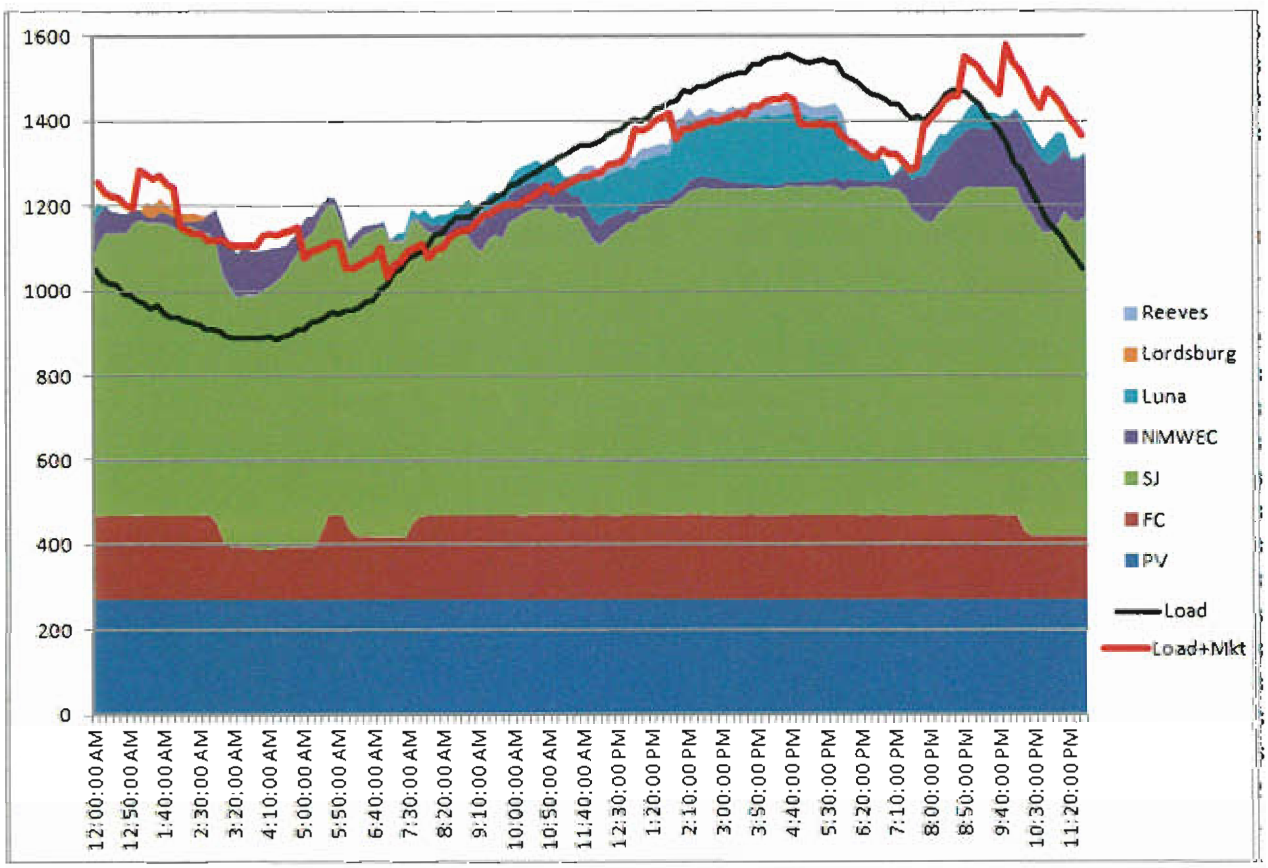
1. "Load-following" is defined in its broadest sense as matching total system resources with total system demands, including all short and long term market sales and purchases. However, this report assumes that the primary cost-analysis focus should be on the regulation reserves that are needed in order to follow load and that incremental regulation needs due to renewable resources is a primary interest. PNM has looked into ways of differentiating between ramping activities due to wind ("wind-following") versus "normal" load-following, but is unable to provide estimates of the amounts due to a lack of historical short-term forecast data. Therefore, "load-following" as used in this report encompasses regulating for renewable resources.

2. If a baseload resource is being curtailed by WPM, it is assumed that it is being used for regulation reserves. A portion of these curtailments may be due to excess generation that could not be sold due to a lack of real-time market liquidity or poor pricing conditions in which excess baseload power could not be sold at a profit, but these conditions were rare in 2010 and do not have a significant impact on the analysis. Because baseload curtailments usually represent the majority of lost opportunity costs, they are analyzed further in Section B of this report.

3. Based on the broad definition, all non-baseload resources are being used for load-following whenever they are running. However, from a regulation reserve standpoint, peaking gas resources are often left on at a certain loading below their max output and aren't ramped because they are used to provide SRSG spinning reserves with their unloaded capacity. Contingency reserves cannot be used as regulation reserves. The table below shows the amount of time each gas resource was providing power to the grid based on an analysis of 10-minute sampled data from 2010 along with PNM's average loading share and an estimate of how often the units are being ramped by PNM.

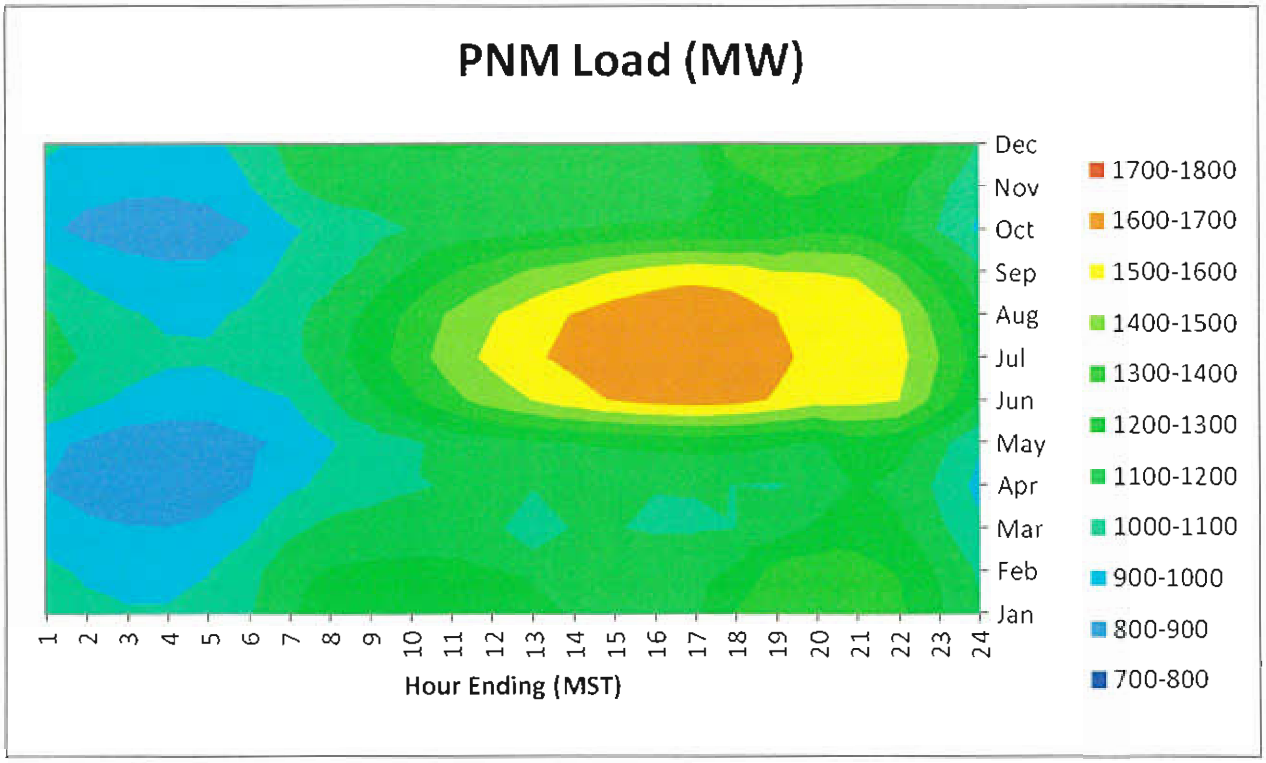
Resource	Percentage of time online	Average loading when online (MW)	Ramping as % of time online
SJ1	85.4%	157.5	11.6%
SJ2	72.3%	154.6	11.3%
SJ3	67.4%	190.9	15.2%
SJ4	81.4%	218.0	19.9%
Luna	73.9%	80.1	55.5%
Afton	21.9%	150.7	21.2%
Lordsburg A	8.5%	23.9	40.8%
Lordsburg B	8.8%	24.7	38.3%
Reeves 1	9.5%	22.3	9.0%
Reeves 2	9.1%	22.9	7.9%
Reeves 3	18.1%	27.5	9.1%
Valencia	9.5%	94.1	15.9%
Delta	0.8%	77.6	14.2%

In order to provide a high-level sample of how PNM uses its generation in conjunction with market purchases and sales, the following graph and narrative is provided:

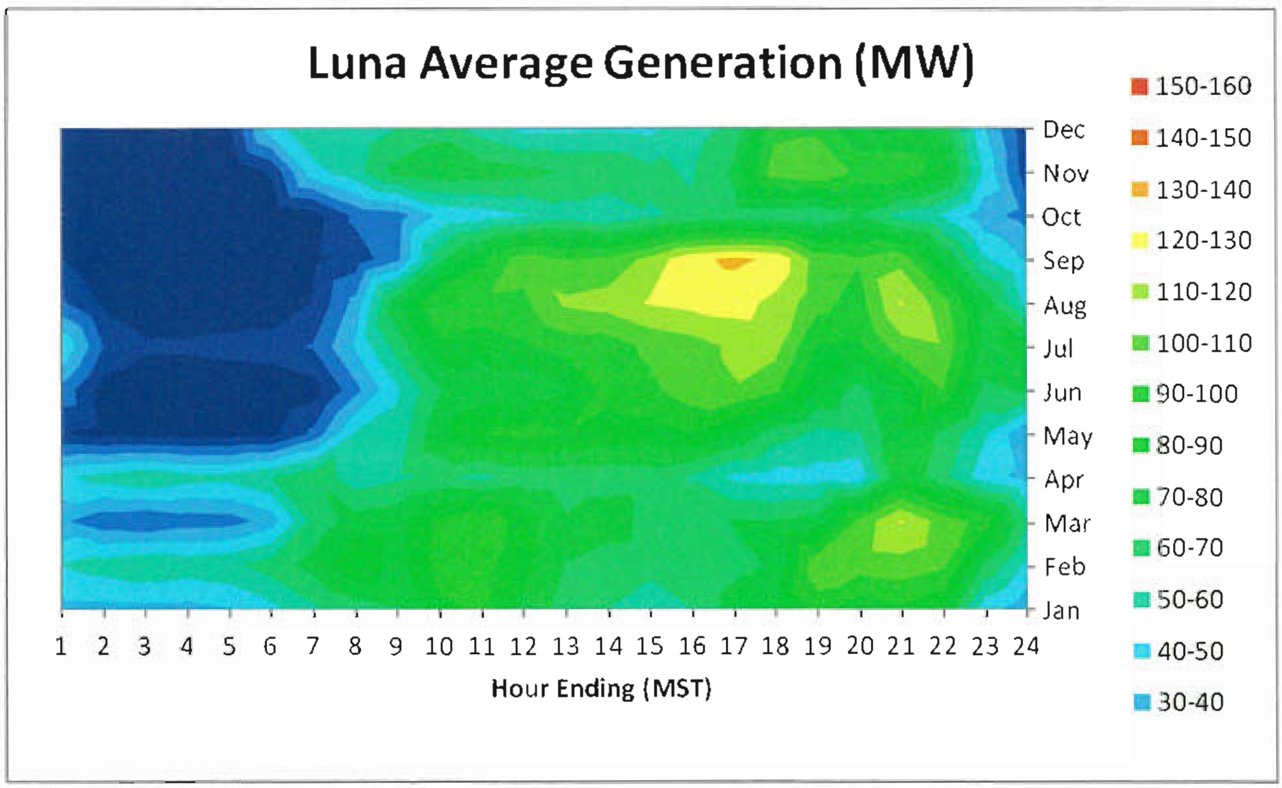


June 2, 2010 was randomly selected as a sample. The graph demonstrates a typical "late spring/early summer" day for PNM in which all baseload units are running and Luna is running for approximately 16 hours. The real-time operations log provides some notes regarding what happened during the day, but it is not a comprehensive description. According to the log, there is a 45 MW PNM-share derate at FC at 3:10 AM MST that lasted less than an hour and a roughly 50 MW PNM-share derate at SJ at 3:23 AM MST that lasted about 8 hours due to operational issues, but the rest of the ramps down during the day are due to load-following needs including wind regulation. It is clear in this example that PNM utilized market sales to avoid baseload curtailments as much as possible during the night and utilized market purchases to save money versus turning on its own assets during the afternoon. Baseload curtailments occur when energy supplies from baseload resources are cut for non-operational reasons (operational cuts are called "derates") and are generally due to load-following/regulation reserve needs. Reeves unit 3 was on during the afternoon for load-side purposes and was not an economic dispatch decision. Additionally, Lordsburg running for about an hour starting at 1 AM was also uneconomic dispatch, but the reason was not documented. During much of the afternoon, Luna takes over load-following responsibilities from San Juan and is the resource that PNM uses the most for load-following.

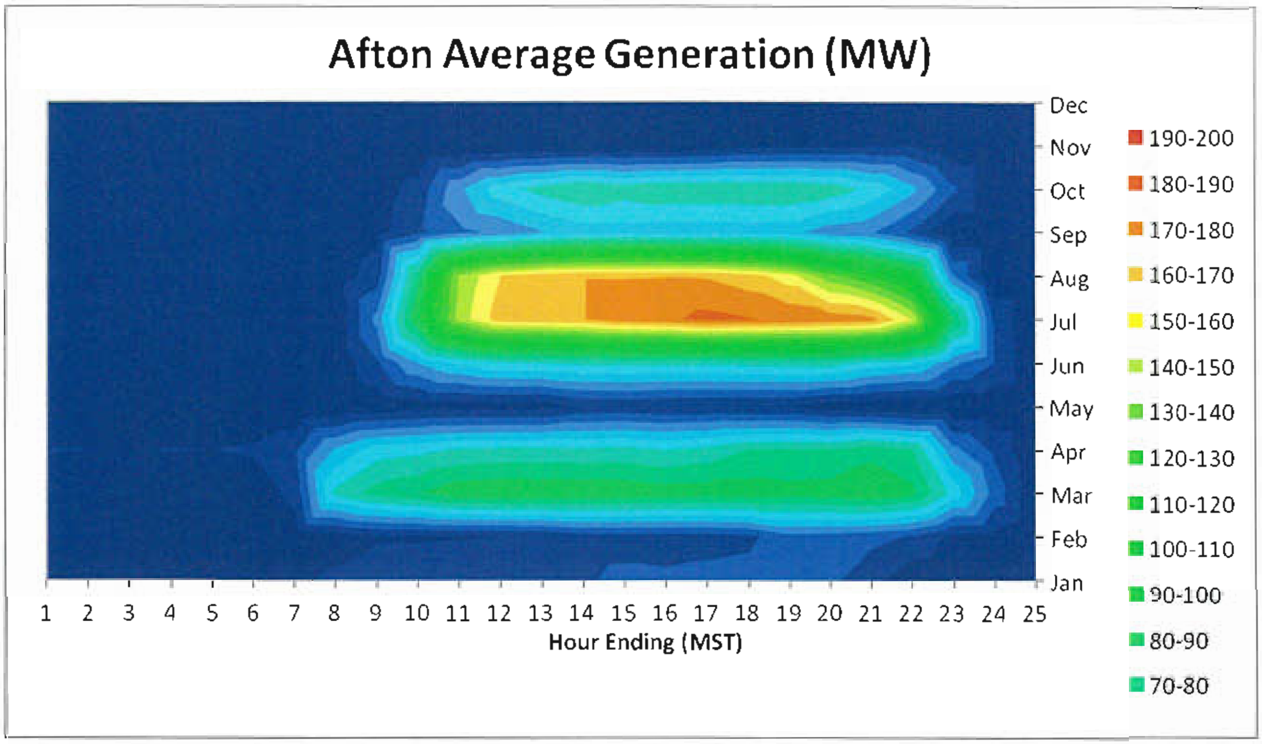
PNM's intermediate and peaking resource usage is generally correlated with loads as demonstrated by the 2010 heat maps shown below. For clarity, a monthly average for each hour of the day is utilized. It is important to remember that PNM's natural gas resource usage is dependent on market conditions and units normally aren't utilized if it is cheaper to procure energy from the wholesale market.



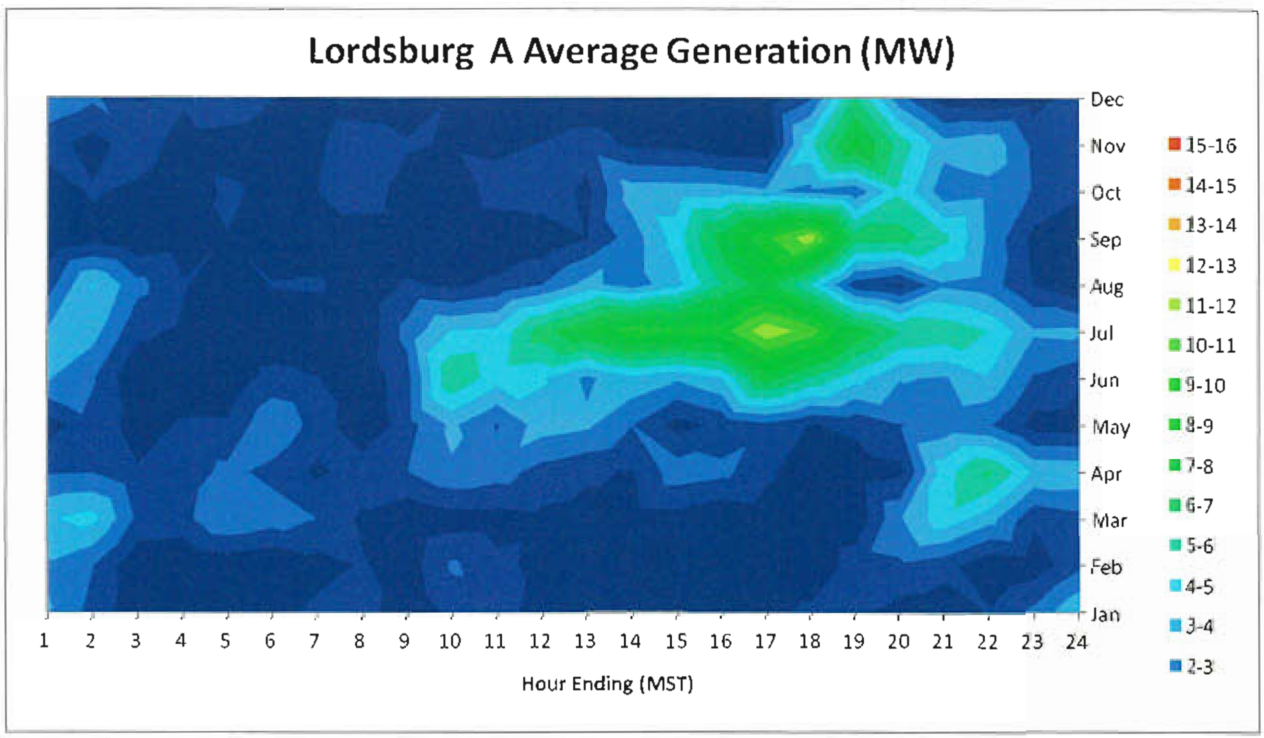
Cooling load in the summer drives peak demands.



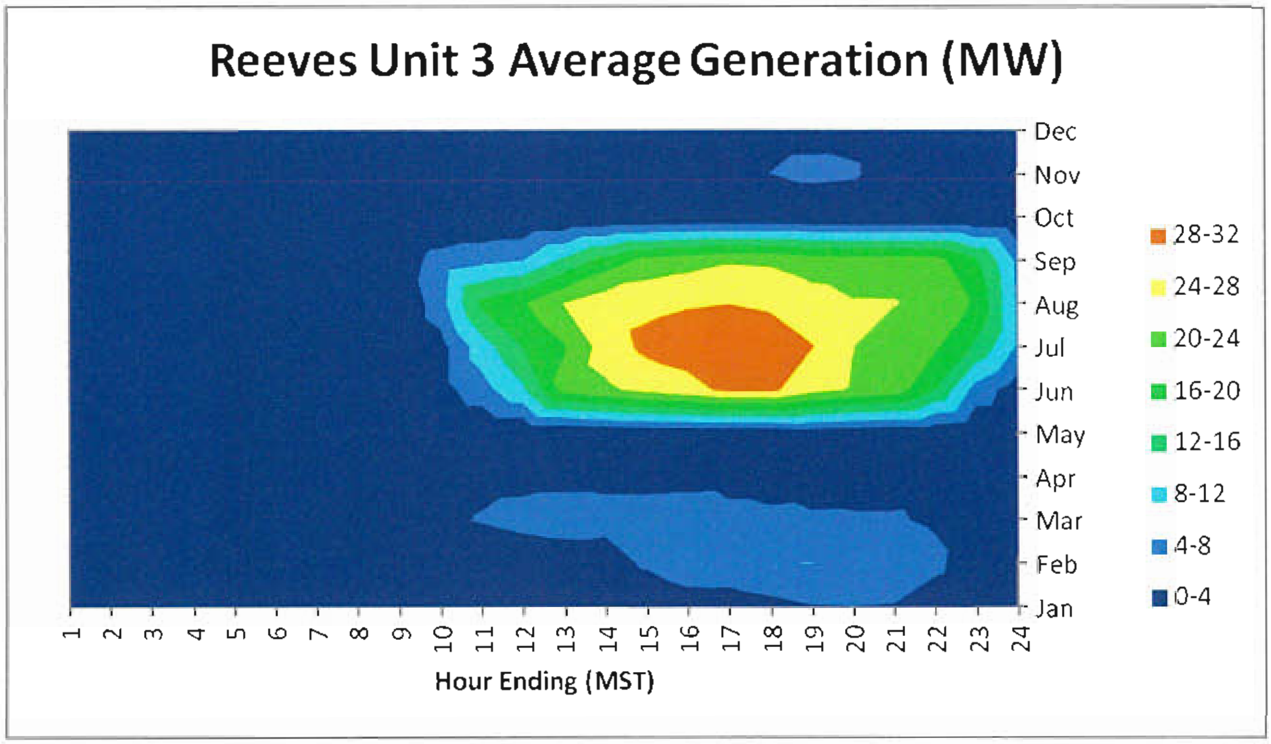
Luna is normally on about sixteen hours each day and is heavily utilized for regulation and reliability reserves. Scheduled maintenance outages occur in the spring and/or fall.



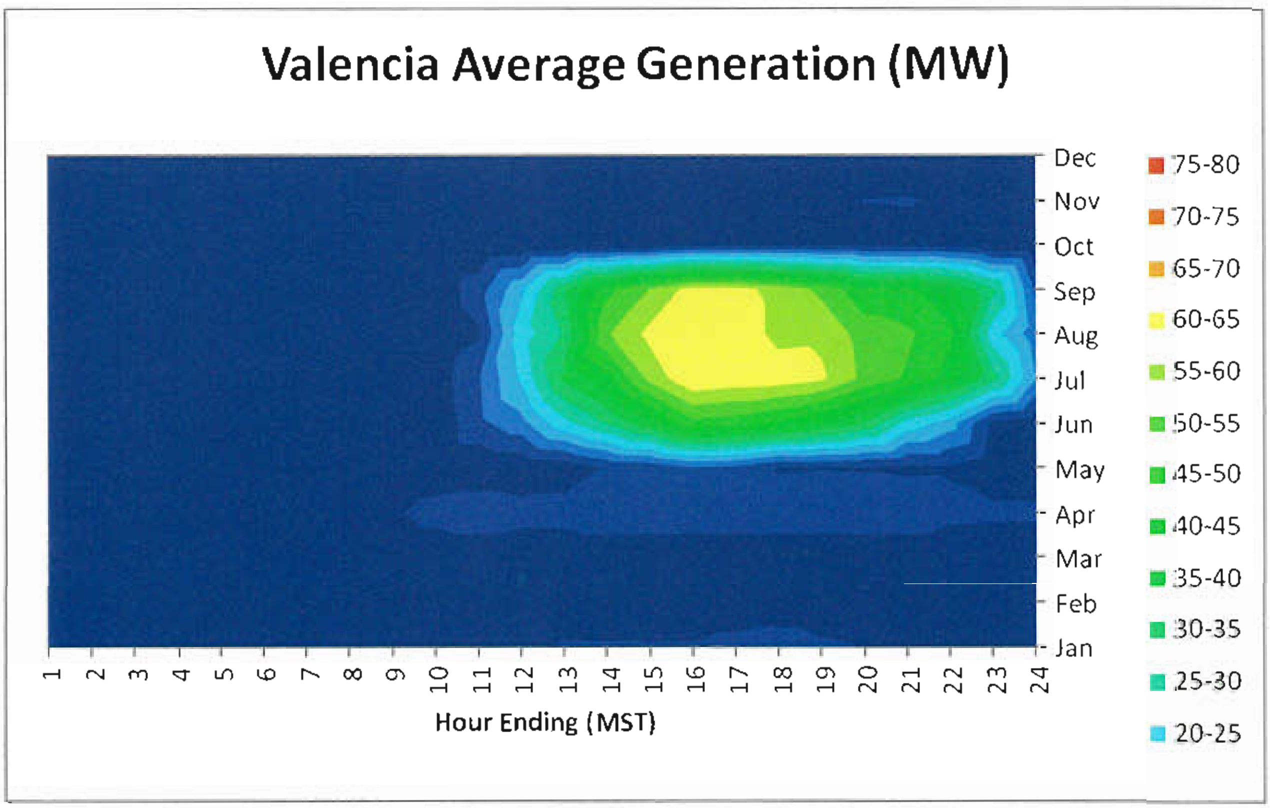
Afton is utilized in the summer and for reserves when Luna is offline for maintenance.



Lordsburg is utilized for peaking and for short-term balancing issues.

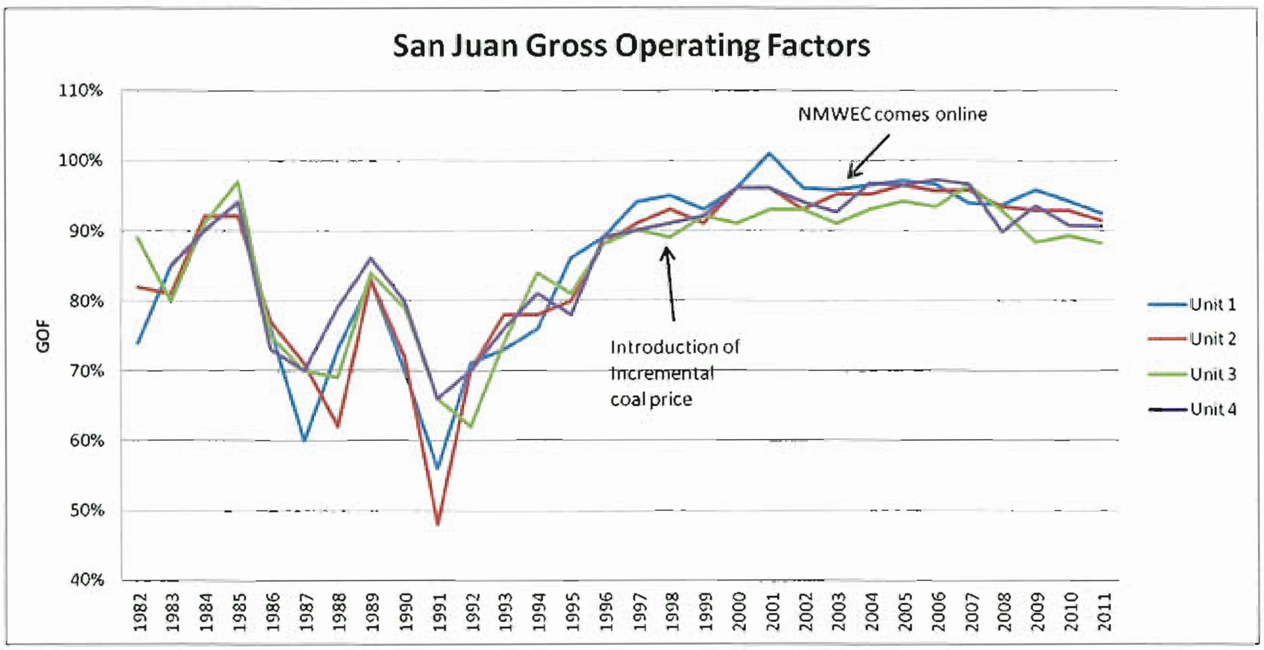


Reeves is used for peaking and loadside needs.



Valencia is used for peaking and loadside needs.

San Juan Generating Station Usage: Because SJGS has been used for load-following to varying extents for the life of the plant, including some periods of being PNM's primary load-following resource, additional operational analysis for SJGS is warranted. EPRI's "San Juan Life Assessment Study" included an analysis of SJGS historical operations and costs along with an assessment of the condition of the major plant components as of 2004. The personnel conducting the study specifically looked for potential cycling damage and determined that there was no evidence of significant damage at that point. However, because it is well understood that thermal cycling increases certain damage mechanisms such as creep damage, the study recommended increased inspections near the end of the designed life of turbine components. It is clear that PNM and other participants have reduced load-following at SJGS in recent years. Much of this reduction was enabled by the introduction of a "base" and a much lower "incremental" coal price in 1998 which enabled SJGS incremental power to clear the wholesale power markets more often.



SJGS was curtailed extensively prior to the introduction of an incremental coal price. The addition of the NMWEC has had a relatively insignificant impact.

Test results indicated that certain components at SJGS were nearing the end of their useful lives and PNM and the other SJGS participants decided to conduct major overhauls of the SJGS units during outages from 2008 through 2010 to replace and upgrade various components. This decision was primarily due to obsolescence, general age, and/or evidence of damage that was not related to cycling. Due to these overhauls, certain components that may have had some "invisible" damage due to cycling were replaced before the cycling could impact costs.

It is clear from recent operations data that PNM utilizes San Juan, Four Corners, and Luna for the majority of its load-following needs. This is primarily due to the fact that gas resources are generally not used overnight and Luna is often the only gas resource on during peak hours for much of the year. In the recent past, it has often proven to be more economical to purchase market power to meet demands above the ability of the baseload plants and Luna instead of turning on additional gas resources. By doing this, PNM is utilizing available regional excess capacity to lower maintenance expenses at its own plants. However, PNM must maintain intra-hourly regulation on the units that are running, so these units can still be categorized as being used for load-following.

SECTION B – COSTS OF LOAD-FOLLOWING:

There are five primary cost types worth noting when analyzing power plant costs. These are capital, variable operations and maintenance ("O&M"), fixed O&M, fuel, and opportunity. These costs vary significantly between types of power plants, but in general, plants designed for baseload operations have relatively high capital and fixed O&M expenses but low fuel and variable O&M expenses while peaking plants have relatively low capital and fixed O&M expenses but much higher fuel and variable O&M expenses per MWh of generation. Opportunity costs are caused by being forced to make sub-optimal dispatch decisions and/or not being able to fully realize the value of excess power in the wholesale market because of the need to regulate for load or renewable generation. Opportunity costs are often hard to quantify because they have to be looked at from a "net" impact standpoint instead of the normal "gross" impact analysis. They often look like benefits because they often show up as avoided costs (i.e. a reduction in fuel and variable O&M) if the unit costs are examined independently. However, if the lost off-system sales and/or the impact on other units are taken into account, then they can be seen as having a true net negative impact to total system costs. For the purposes of this report, variable O&M, fuel, and opportunity costs are considered to be the key interests but capital and fixed O&M plays a significant role in decisions to invest in future load-following resources.

Wear and Tear: Another important concept to review at a high level are the causes of damage to the components of thermal power plants. This is often called "wear-and-tear" and EPRI provides a definition for each.

- "Wear" refers to the mechanisms by which power plant components normally reach the end of their useful life including creep, thermal fatigue, erosion, corrosion, etc.
- "Tear" refers to the mechanisms that reduce the useful life of components during periods of non-normal operating conditions such as during periods of poor fuel quality, poor combustion control, poor water chemistry, etc.

Using power plants for load-following can increase both wear and tear, with the most damage usually being done during periods of startup and shutdown due to extreme temperature changes. This is why start charges are often different based on "hot" versus "cold" and occasionally "warm" conditions, which are defined based on the time elapsed since the unit completed normal shutdown procedures or tripped offline. Additionally, because unit trips are usually much more damaging to power plant components than a controlled shutdown, they are included in certain maintenance calculations by being added as a "factored" start. This is usually a formula that assigns a level of damage relative to a normal start that depends on the operating conditions of the unit right before it tripped. The amount of damage caused by cycling varies from plant to plant, and is particularly difficult to accurately estimate for "custom" plant designs (most baseload plants). Peaking plants are usually more standardized, and often have maintenance schedules that are defined by the turbine manufacturer that are set based on starts, operational hours, time, or combinations thereof.

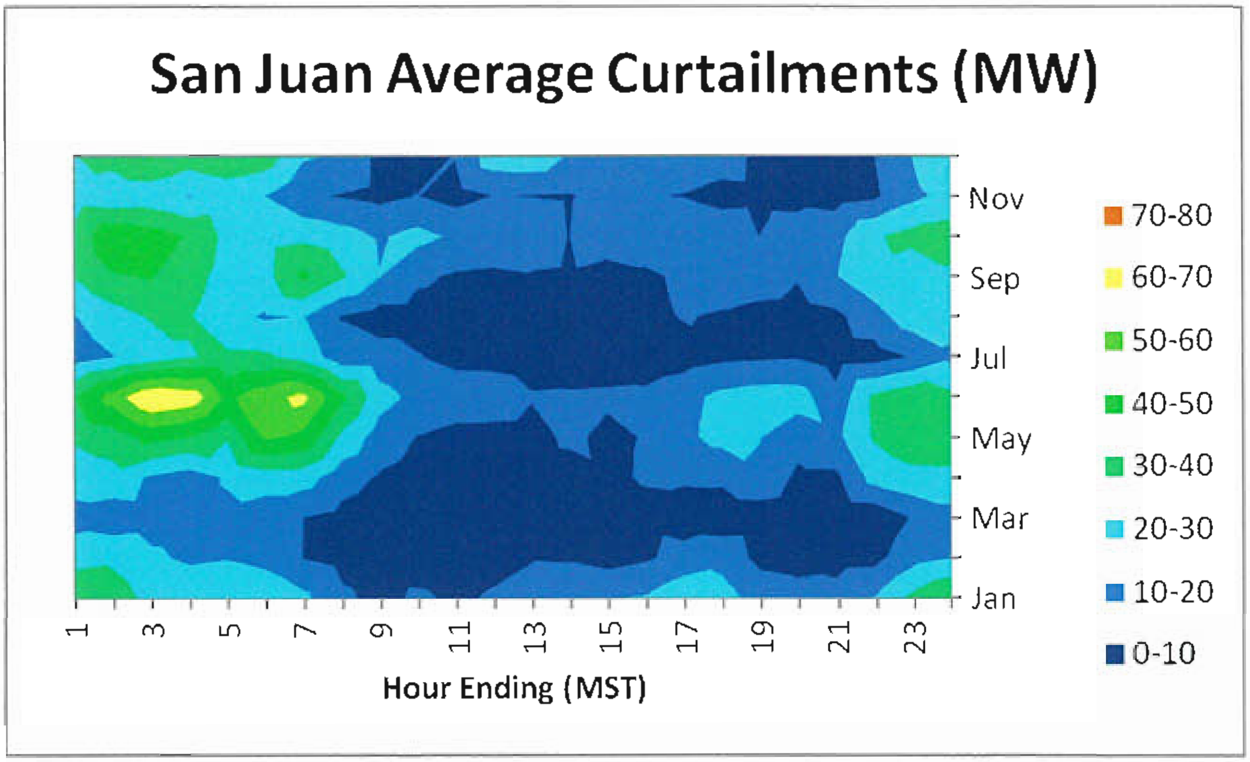
Operations and Maintenance Costs: From an O&M analysis standpoint, it is important to consider "operations" expenses apart from "maintenance" expenses because of the fixed and variable nature of each along with the timing that the expenses are seen (i.e. operations expenses are ongoing, while maintenance expenses occur sporadically). PNM has determined that the majority of "operations" costs can be considered fixed and are not impacted by load-following activities with the exception of minimal chemical/water treatment, fuel-handling, and overtime expenses. Most maintenance expenses for PNM's natural gas fired plants are dependent on how much the plants are actually operated and can be attributed to load-following duties. However, no additional or avoided O&M costs are attributed to providing regulation reserves at this point, except for PNM's power purchase agreements for Delta and Valencia which have avoided variable O&M due to the structure of the contracts.

Incremental Baseload Load-Following Costs: Baseload plants probably incur additional "wear and tear" type expenses while being used for load-following and regulation versus consistent operation at max capacity, but PNM believes that the amount is unquantifiable without detailed engineering studies. One of the goals of phase 2 of the WWSIS is to examine the O&M impacts of additional cycling of thermal resources due to renewable integration, but ramping expenses are currently too difficult to properly assess for PNM's units. EPRI's assessment of the current condition of SJGS in their life assessment study was "Cycling damage at SJGS is minimal due to the low number of annual starts, relatively small load swings, and moderate ramp rates used on loading." PNM continues to try to minimize curtailments of generation from its coal-fired units, but a key component needed to do this is the ability to economically sell excess off-peak coal power into the wholesale markets. For the purposes of this report, PNM does not attribute any baseload O&M expenses to load-following.

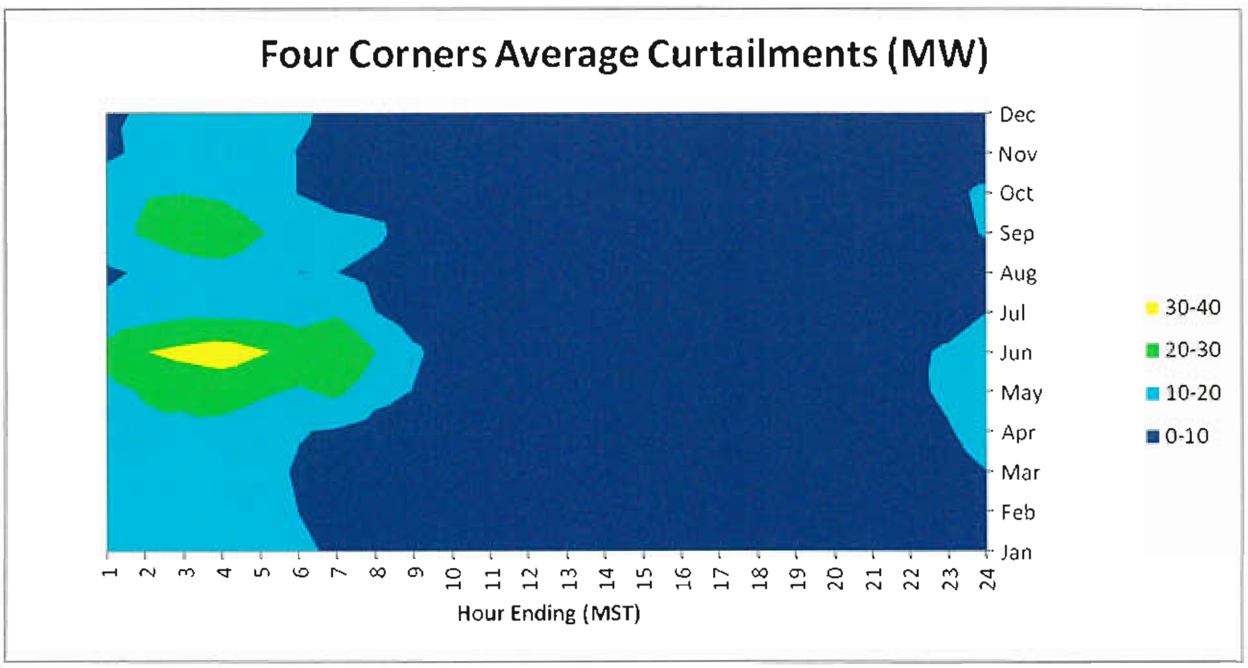
Opportunity Costs: Load-following affects off-system sales primarily because the significant regulation reserves needed for load-following and renewable integration can be viewed as lost profitable power sales opportunities. Due to the unpredictable nature of wind generation, PNM generally does not sell much of the expected wind generation in the day-ahead market, and most decisions related to wind management are left to the real-time operators. Additionally, a load forecast is utilized for day-ahead dispatch decisions, but real-time traders usually develop their own short-term forecast in an attempt to improve forecast accuracy. The real-time market is less liquid than the day-ahead market and leaves the risk of an inability to find a buyer for excess energy or a seller if short-term power is needed. During off-peak hours, wind generation and deviations from load forecasts generally affect PNM's coal resources. PNM attempts to avoid coal curtailments as much as economically possible by selling excess power whenever market prices are above the incremental dispatch price of coal.

Fuel Costs: Fuel expenses represent the majority of the incremental costs of load-following. Baseload energy costs generally do not fluctuate from day to day and the fuel is the generally the lowest on a $/mmBtu basis. However, the plants primarily utilized in the Southwest for load-following are natural gas fired. Natural gas expenses are dependent on market conditions making the cost to operate natural gas fired plants vary widely over time since the natural gas market is very volatile. Natural gas fired resources usually set on-peak wholesale market power prices at Four Corners and Palo Verde and can affect off-peak pricing as well. The net fuel expenses to PNM's customers are usually dominated by baseload fuel expenses and decreases in market power prices are usually detrimental due to the fact that PNM usually has excess off-peak baseload power that it can often sell to other utilities.

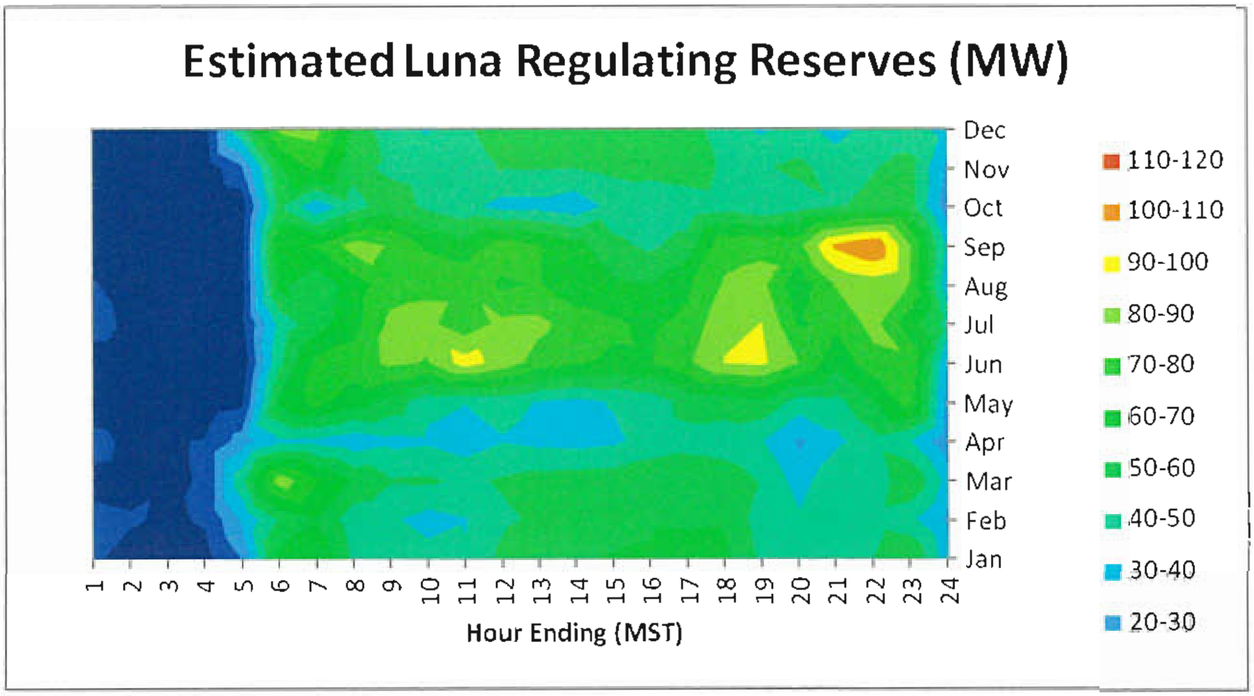
Analysis of Regulation Reserve Opportunity Costs: When a unit is providing regulation reserves, there are avoided fuel costs but the net impact to the customer is usually negative because of the fact that the reserve power could have been sold into the wholesale market at a profit. To analyze the lost opportunity cost of regulation reserves, PNM examined 2010 market and operations data and determined that a reasonable approximation of the opportunity costs of regulation reserves could be made by multiplying the hourly regulating reserves at San Juan, Four Corners, and Luna by the difference between the hourly PV market price and the incremental dispatch cost of each resource. Because PNM purchased off-peak spinning reserves during all of 2010 and gas units were on during on-peak hours, the coal curtailments are all assumed to be regulating reserves. However, because Luna is often providing contingency reserves as well as regulating reserves, a different method was used to develop an estimate for Luna involving looking at the spinning reserves in excess of contingency requirements. Additionally, it is clear that there were numerous hours where Luna was curtailed due to economic reasons, but the negative margins are removed from the opportunity cost calculations. The following charts provide visual representations of the data.



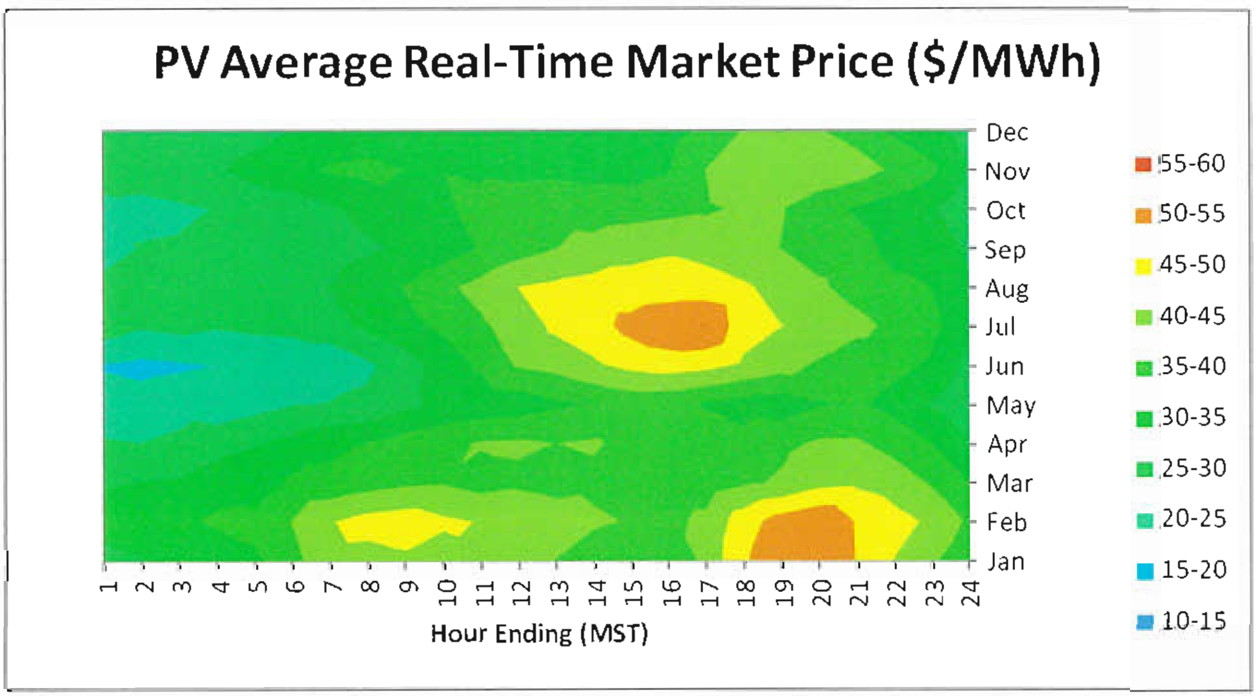
SJGS is utilized for off-peak regulation reserves.



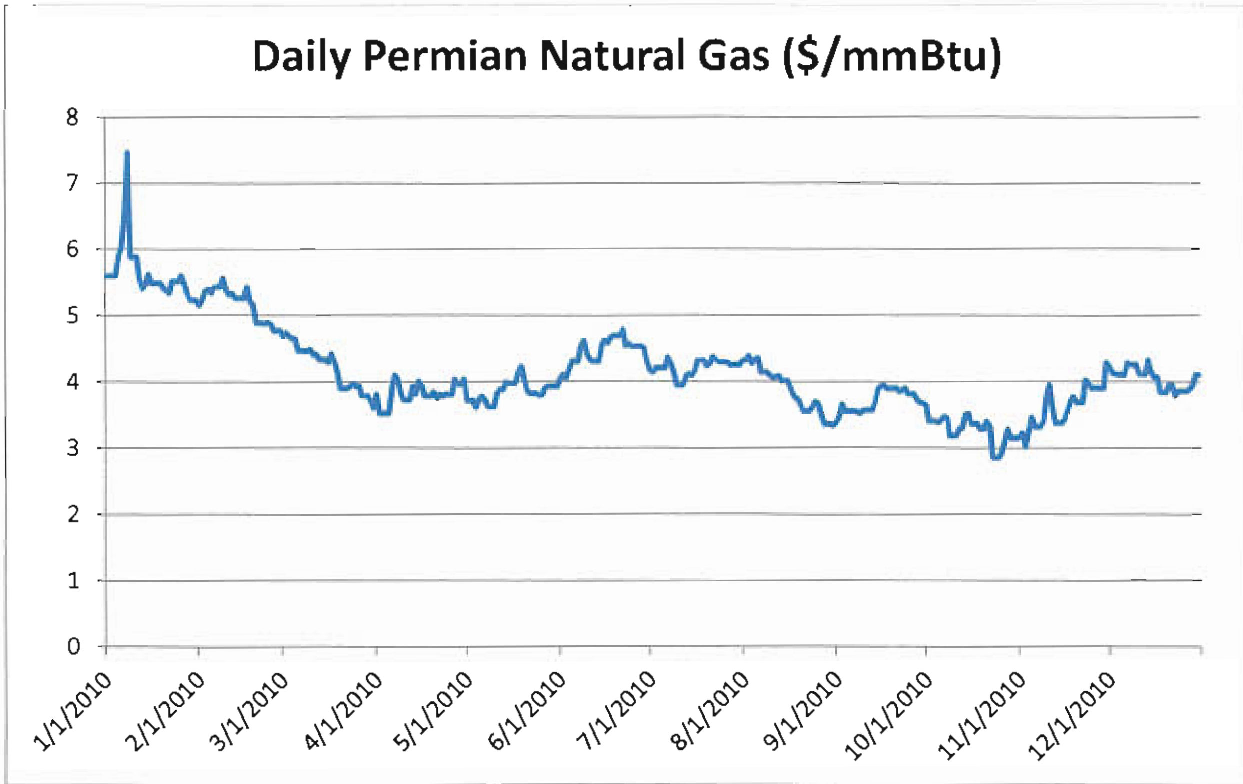
Four Corners is utilized for off-peak regulation reserves



Luna provides most of the regulating reserves during the day.



Power prices are directly correlated with regional loads and gas prices



Natural gas prices are very volatile

Results of Regulation Cost Analysis: The results of the analysis show a $7.1 million lost opportunity cost in 2010. There are a relatively small amount of avoided non-fuel costs, but they are offset by heat rate and potential maintenance penalties that were not included. Additionally, there are lost opportunity costs that can be attributed to regulation reserves on other units, but they are minimal compared to San Juan, Four Corners, and Luna.

Estimated 2010 Load-Following Opportunity Costs

Resource	Lost Market Revenues	Avoided Fuel Costs	Net Lost Opportunity Cost
San Juan	**$4,870,826**	**$1,442,199**	$3,428,627
Four Corners	$3,153,477	$1,863,984	$1,289,493
Luna	$10,586,813	$8,209,540	$2,377,273
Total	**$18,611,116**	**$11,515,723**	**$7,095,393**

SECTION C – RECOMMENDATIONS TO MITIGATE LOAD-FOLLOWING COSTS:

Numerous strategies can be explored to mitigate load-following costs. Further investigation of the options will be considered going forward as load-following becomes more important due to variable renewable generation additions in order to comply with New Mexico's renewable portfolio standard. Many recommendations are precursors to determining if additional costmitigation strategies can be developed such as better forecast tracking and continuing to follow regional studies.

1. **Track evolving generation technologies and model load-following benefits appropriately for resource planning** - As renewables become a greater share of the electricity generated in the US and other countries, the low cost operational flexibility of new units will become more and more important. Turbine manufacturers are aware that electric utilities desire better performance with lower operational costs in their new resources and many are responding accordingly in their newest designs. As part of PNM's IRP process, PNM will continue to track developments in operational capabilities and model them appropriately for future resource evaluation purposes.

2. **Participate in regional load-following studies and support cooperative regulation efforts** - Regional studies are being performed to evaluate the cost and operational impacts to the electric grid of an increasing amount of renewable resources. PNM continues to participate in the WWSIS and other regional efforts to better understand and mitigate renewable integration costs. Cooperation between utilities is anticipated to be needed to minimize the costs by enabling the most efficient regional operations and to be able to locate renewables where there is the most wind and sun.

3. **Gather additional forecast data for further analysis** - Costs associated with load-following may be caused by problems in forecasting and dispatching techniques. Even though PNM believes it is minimizing the costs to customers using its current operational strategies, tracked data is insufficient to conduct a detailed analysis. It is recommended that PNM start tracking real-time operational wind generation and load forecasts in order to see if there are potential benefits of developing or purchasing short-term forecasting tools and/or standardizing forecast methodologies. Additionally, this will allow PNM to more accurately determine the costs of variable renewable generation.

4. **Review current operating and dispatch practices to reduce cycling stresses** - Because many cycling related damage mechanisms are well understood and can reduce the life of certain power plant components, PNM should continue to attempt to minimize cycling needs and reduce the impacts of cycling at both a unit operations and at a system dispatch level. This could involve reviewing unit ramping and startup practices to look for ways to reduce thermal and other stresses. Although many components are currently anticipated to need replacement before cycling related damage becomes a concern, components that might fail due to cycling damage should be identified and monitored.

5. **Consider detailed San Juan study** - Cycling damage at SJGS was not apparent during the life-assessment work done by EPRI. However, PNM has received a proposal from

Intertek APTECH to conduct more in-depth analysis of SJGS components and operations and recommend strategies to mitigate cycling impacts and decrease future maintenance expenditures. Intertek APTECH employs experts in the field of cycling damage analysis and has conducted studies on many power plants in the United States. Depending on the operations of SJGS going forward and/or if cycling problems start to become apparent, PNM should consider additional SJGS analysis with the help of experts.

6. **Build wind and solar resources in diverse locations** - Locational diversity is a key strategy to reduce the net impacts to the system of variable renewable resources. PNM should continue to build solar and wind resources that are in varying locations to mitigate the increases in load-following needs.

7. **Continue to minimize load-following costs by utilizing the wholesale power market and investigate strategies for lowering maintenance charges** - PNM often utilizes market purchases as an alternative to turning on peaking plants and/or Afton. This is generally due to the fact that peaking plants and Afton have high start charges that make it difficult for them to clear the market. Although this strategy keeps maintenance costs down, it sacrifices intra-hour operational flexibility and is dependent on market liquidity going forward. PNM should continue to utilize wholesale power markets to keep dispatch costs low and look for ways to lower start charges and variable maintenance expenses at its plants so that they might be economically utilized ahead of the wholesale power market.

8. **Avoid incentivizing inappropriate performance metrics** – In the past, capacity factor metrics have been considered to set a performance standard at SJGS. Because off-peak regulation reserves are carried on San Juan, additional wind generation will negatively impact SJGS capacity factors. However, measures of plant availability will not be impacted and are a more appropriate performance metric to use.

9. **Continue to watch FERC rule-making activities related to renewable integration** – Because of New Mexico's abundant wind and sun, renewable developers are interested in utilizing PNM's transmission system for wind and solar projects to deliver energy to non-PNM loads. So far, PNM has been able to net-meter wind projects within its control area (i.e. having the balancing authority that is taking delivery of the wind energy also provide regulation) but FERC rules require PNM to provide regulation services utilizing its own generation for new interconnections if alternative arrangements aren't agreed upon. PNM should continue to monitor FERC activities and attempt to ensure that it will be able to recover the appropriate integration costs if non-PNM renewable resources continue to be built within PNM's balancing area.

SECTION D – INTEGRATION COSTS AND BENEFITS OF RENEWABLE RESOURCES:

As described in preceding sections, PNM has found that it is difficult to determine precise historical impacts that the NMWEC has had on operations and system costs due to a lack of archived short-term forecast data. The most apparent renewable integration costs are primarily "lost market opportunity" and sub-optimal dispatch costs that arise due to the need to regulate for generation that is not dispatchable. The EnerNex study primarily focuses on this aspect of wind integration costs, but there may be additional costs that are not immediately seen. These costs include additional maintenance costs due to increased wear and tear on thermal units in order to regulate for variable generation and "capacity" costs associated with the fixed expenses of units providing additional regulation reserves.

Opportunity/Inefficiency Costs – These costs are due to forced uneconomic dispatch decisions due to the variable and must-take nature of wind and solar resources. Thermal units must dispatch at lower efficiencies or additional units must be utilized to provide additional regulation capabilities and economic market purchases and sales opportunities are impacted. Much of these costs arise due to variances in forecasted short-term generation versus actual generation and if large intra-hourly generation changes occur. Costs associated with inefficiency and lost opportunities generally impact PNM's fuel and purchased power adjustment clause.

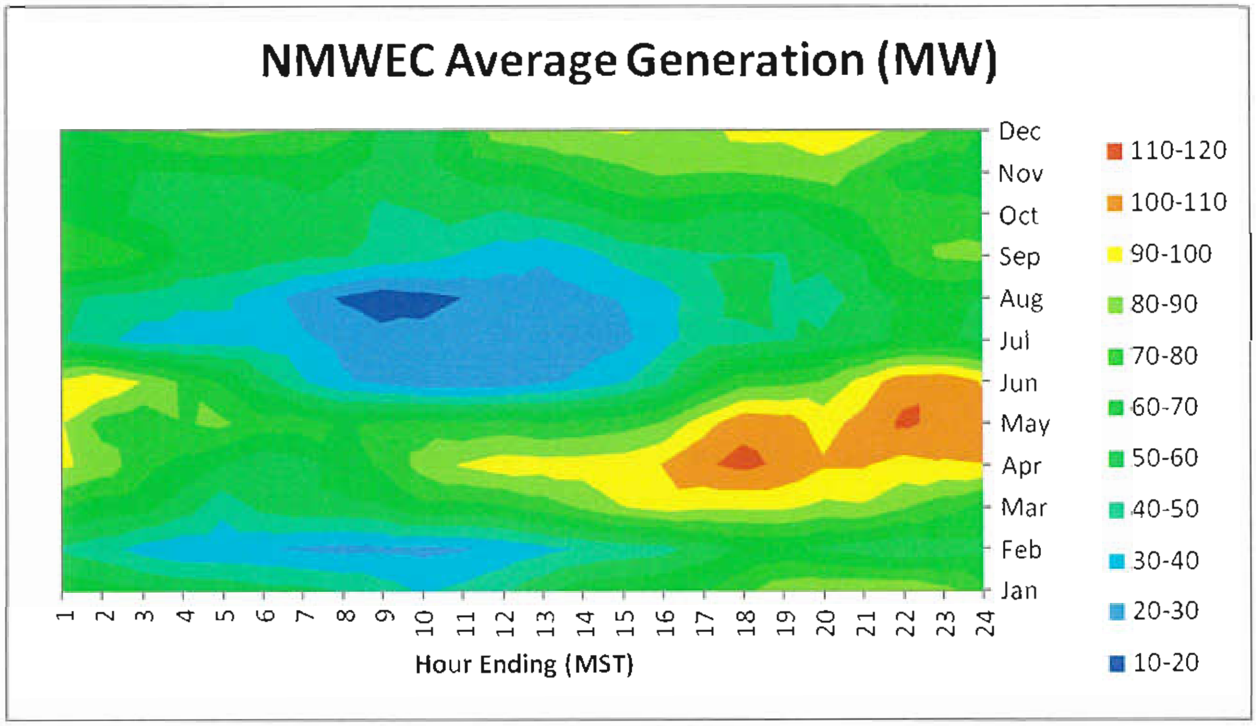
Regulation Reserves: The hourly average regulation reserve needs estimated in the EnerNex study were compared to historical system operations and determined to be reasonable on a total regulating reserve need basis. However, PNM has not been able to validate the load-following reserve needs versus "wind-following" reserve needs that were estimated by EnerNex. EnerNex utilized a statistical approach based on compliance with NERC CPS2, but it was determined that the hourly regulating reserve needs during the RBC field trial can vary significantly from CPS2 compliance because ACE bandwidths depend on system frequency.

Thermal Unit Maintenance Costs – The vast majority of maintenance needs are incurred as a thermal unit is actually used. However, the maintenance expenses usually don't show up until the maintenance takes place, often months or years in the future. This makes it difficult to determine maintenance impacts due to renewable variability on plants such as Reeves, San Juan, and Four Corners. However, because newer GE units such as the 7FA.03 and LM6000 have well-defined maintenance schedules and/or maintenance contracts, it is easier to approximate the maintenance impacts of each time the unit is utilized. In PNM's case, the maintenance costs for large-frame combustion turbines are mostly captured via a $/start charge while the maintenance costs for the aeroderivatives are captured via a $/hour of operation charge.

Incremental Maintenance Due to Renewable Integration: PNM has determined that most maintenance expenses for its owned natural gas fired plants (other than Lordsburg which has a maintenance cycle based on hours of operation) can be viewed as being incurred during startup and shutdown due to thermal and other stresses. However, there are indications that ramping units for load-following purposes increase wear-and-tear on the units and can potentially increase maintenance expenses. Intertek APTECH has provided estimates to NREL based on analysis of numerous thermal units to utilize in the WWSIS phase 2 study, but the data is preliminary and may not be fully incorporated into modeling assumptions. Ramping cost estimates should continue to be monitored, but are not included in this report. At this point in time, PNM can usually regulate for the renewables on its system without turning on additional gas resources. However, wind generation will occasionally drop off unexpectedly and Lordsburg is utilized to manage these situations due to its low startup costs and quick start capability. PNM believes that aeroderivatives are a good option for managing the potential of rapid drops in variable generation due to the fact that they are designed for rapid low-cost startups and shutdowns. If variable generation penetration ever reaches a point at which larger gas resources have to be turned on specifically for regulation purposes, it is anticipated to start having a significant impact on maintenance costs.

Capacity Reservation Costs - Due to the need to reserve additional system capacity in order to provide regulating reserves for renewable resources, a "capacity reservation" cost can be assigned to variable generation sources depending on the anticipated regulation needs that cover an appropriate share of fixed expenses. Existing resources are anticipated to be adequate in the near term to manage increasing amounts of renewable generation, but as thermal resources are retired and new resources are built, it is important to consider operational capabilities and production costs for new plants. New resources may have higher capital costs but lower operational costs and higher operational flexibility. The capital differences in new resource additions for extra operational flexibility should be considered when assigning costs to renewable integration. Additionally, even if existing resources are adequate to manage for renewable integration, the costs of holding the capacity for regulation should also be considered.

Avoided Costs of Renewables – As a must-take resource tied to an interconnected power grid, wind and solar resources clearly have impacts on other resources locally and regionally. When managing for increasing NMWEC generation, PNM has two basic choices (although a combination of the two is often utilized). It can sell the power into the wholesale market for the next hour and hope that the wind doesn't suddenly drop off, or ramp online generation down. Generally, PNM doesn't operate its gas plants unless they are cheaper than procuring wholesale power and normally does not have gas resources on overnight. Therefore, the usual "best choice" for wind generation management is to attempt to sell as much as possible in order to maximize off-system sales profits assuming real-time market prices are higher than the incremental cost of online thermal generation. Allocated off-system sales margins are fully credited back to PNM's retail customer, so the customer sees a net benefit of this strategy equal to the difference between wholesale market prices and the incremental cost of PNM's highest cost thermal resource when compared to simply ramping down the incremental resource. Therefore, PNM has found that the most appropriate "avoided cost" metric for renewable resources is the real-time Four Corners or Palo Verde market prices instead of an avoided PNM fuel cost. This "avoided cost" arguably includes some O&M expenses due to market price discovery mechanisms. It should be noted that this avoided cost methodology does not incorporate the integration costs discussed above, so the "net" avoided cost of renewables would need to discount the additional load-following costs incurred due to the variable nature of the resources. The average generation profile of the NMWEC in 2010 is provided for reference in the following chart:



Wind generation is high in the spring and low in the summer.

Wind Integration Costs: The EnerNex study and many other studies show that as wind generation increases, the per-unit cost of regulating for the wind generation also increases. Even though the EnerNex study does not fully capture all the costs associated with wind integration, it demonstrates that increasing amounts of wind generation will have an increasing impact on dispatchable resources and costs of PNM's system. PNM recommends continuing regional and internal study to better quantify and manage wind integration costs.

Solar Integration Costs: Solar resources of any significant amount have only recently started to come online on PNM's system. Because of the diverse locations utilized for the solar facilities combined with a generally predictable generation profile, PNM believes that additional regulation needs to manage solar variability are minimal at this point. However, further study is needed to better understand intra-hour generation volatility caused by cloud cover and correlations between load reductions and solar generation reductions caused by cloud cover. It is anticipated that integration costs will start to become quantifiable as additional solar resources are added and additional operational data is gathered.

Renewable Integration Cost Recovery: Most of the costs associated with managing the variable nature of solar and wind resources will be recovered from the customer via the fuel and purchased power adjustment clause ("FPPCAC") and lost opportunity costs make the net FPPCAC amounts that the customer must pay higher because off-system profits aren't realized. The avoided costs of renewable generation are also mostly credits that are included in the FPPCAC. Incremental maintenance expenses are recovered via base rates if the last rate case included them (because of the "as-needed" nature of maintenance at gas plants, the annual maintenance expenses fluctuate significantly). Portions of major maintenance activities are often capitalized and affect rate base along with capital expenditures on new resources.

Additional Information: Variable generation integration and load-following are complex topics that cannot be fully addressed within this report. PNM recommends reviewing regional studies and analysis for further information. The Western Wind and Solar Study can be found at http://www.nrel.gov/wind/systemsintegration/wwsis.html. Phase 2 of the WWSIS is ongoing and a reference cannot be provided at this point. Numerous other studies and resources are publically available and many can be found utilizing internet search engines.

ACRONYM REFERENCE:

ACE: Area Control Error
BA: Balancing Authority
CC: Combined Cycle
CPS1: NERC Control Performance Standard 1 (frequency)
CPS2: NERC Control Performance Standard 2 (ACE)
CT: Combustion Turbine
DCS: NERC Disturbance Control Standard
DSM: Demand Side Management
EIM: Energy Imbalance Market
EPRI: Electric Power Research Institute
FC: Four Corners power plant
FERC: Federal Energy Regulatory Commission
FPPCAC: Fuel and Purchased Power Cost Adjustment Clause
IRP: Integrated Resource Plan
mmBtu: Million British Thermal Units
MST: Mountain Standard Time
MW: Megawatt
MWh: Megawatt-hour
NERC: North American Electric Reliability Corporation
NMPRC: New Mexico Public Regulation Commission
NMWEC: New Mexico Wind Energy Center
NREL: National Renewable Energy Laboratory
O&M: Operations and Maintenance
PNM: Public Service Company of New Mexico
PV: Palo Verde Nuclear Generating Station
PWR: Pressurized Water Reactor
RBC: Reliability Based Control
SJGS: San Juan Generating Station
SRSG: Southwest Reserve Sharing Group
ST: Steam Turbine
WECC: Western Electricity Coordinating Council
WPM: Wholesale Power Marketing
WWSIS: Western Wind and Solar Integration Study

BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF THE APPLICATION OF PUBLIC SERVICE COMPANY OF NEW MEXICO FOR REVISION OF ITS RETAIL ELECTRIC RATES PURSUANT TO ADVICE NOTICE NOS. 397 AND 32 (FORMER TNMP SERVICES),	)	**Case No. 10-00086-UT**
PUBLIC SERVICE COMPANY OF NEW MEXICO,	)	
Applicant.	)	

CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of **Public Service Company of New Mexico's Load-Following and Renewable Integration Cost Report** was mailed by first class mail, postage prepaid, or hand-delivered to the addresses below on August 8, 2012:

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