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2017 Integrated Resource Plan Report

Prepared for:

Los Alamos County

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EXHIBITS

EXECUTIVE SUMMARY

In its 2017 Integrated Resource Plan (2017 IRP), the Incorporated County of Los Alamos (LAC), as part of the Los Alamos Power Pool (LAPP) with Los Alamos National Laboratory (LANL), identifies its preferred strategy for satisfying its electric power requirements over the 2017-2036 timeframe (the planning horizon). The 2017 IRP evaluates a comprehensive range of supply-side and demand-side resources during the planning horizon to formulate strategies to guide near-term and long-term decisions for the County to implement the policies adopted by the Board of Public Utilites (BPU). In 2013, the BPU established the strategic goal for LAC to become a carbon neutral electric provider by 2040. Subsequently, BPU formed a Future Energy Resources Committee (FER) to recommend future generation resources.

LAC and LANL have pooled their generation resources under an Electric Energy and Power Coordination Agreement (ECA) since 1985. Under the ECA, the generation resources of LAC and LANL are part of the LAPP, and the power outputs are distributed to LAC and LANL according to their respective load requirements. Traditionally, LANL has consumed about 80 percent of the total energy produced or purchased by the ECA pool. The current ECA term is through June 30, 2025. This IRP provides analysis and insights as to how LAC and LANL can best move forward post 2025.

In terms of generation, as a load serving entity, LAC has a mix of generation assets, including coal, hydro, and small solar assets; LANL owns a gas-fired combustion turbine, a steam turbine and a diesel-fired reciprocating engine, which are currently used for emergency purposes. LAC is concerned with finding a least-cost, risk-averse, and environmentally responsible plan to meet its load requirements and its carbon neutral goal over the planning horizon. To achieve this goal, LAC would like to evaluate its positions in coal assets including a minority ownership in the San Juan Generation Station Unit 4 (SJGS 4) and its long term Power Purchase Agreement (PPA) in Laramie River Station (LRS). LAC has considered a variety of technology options including natural gas fired Combined cycle (CC), combustion turbines, reciprocating engines, solar, wind, geothermal, Small Modular Nuclear Reactors (SMNR), storage, and combination of these options.

MOTIVATING QUESTIONS

Pace Global's Risk-Integrated Resource Planning (RIRP) analysis is designed to identify solutions to key challenges that LAC will face over the planning horizon. The RIRP is intended to provide insight into the following key questions.

- What are the prudent, cost competitive and environmentally responsible approaches in LAC's long term resource planning to address the trends in the energy industry and the utility space such as decreasing prices for renewables and energy storage, and the increasing penetration of distributed energy resources?
- Should and if so, how can LAC and LANL best share resources for the benefit of both parties with a post 2025 ECA renewal?
- What are the possible options for DPU to meet the policies established by the adopted FER committee recommendations?
- What is the best portfolio of resources to meet DPU's goal of being carbon neutral by 2040?

- With the current participation agreement in the coal-fired SJGS expiring in June 2022, when should LAC terminate its current ownership in SJGS Unit 4?
- If possible, when is the most economical time to exit the Laramie River Station PPA?
- Should DPU continue its participation in the UAMPS Carbon Free Power Project (CFPP) using a series of Small Modular Nuclear Reactors (SMNR)? How can DPU secure transmission for the CFPP with all of the movement and discussions around a combined Independent System Operator (ISO)?
- What are the possible options for DPU to meet the policies established by the adopted Future Energy Resources Committee (FER) recommendations? What additional opportunities exist for cost-effective demand-side programs, including energy efficiency, demand response, and distributed energy storage?
- How should DPU cost-effectively meet the requirements for reliable and economic operations inside the Balancing Area of the Public Service Company of New Mexico (PNM)?
- How will the potential New Mexico Clean Power Plan (CPP) compliance strategy impact LAC's choice of a Preferred Resource Plan?

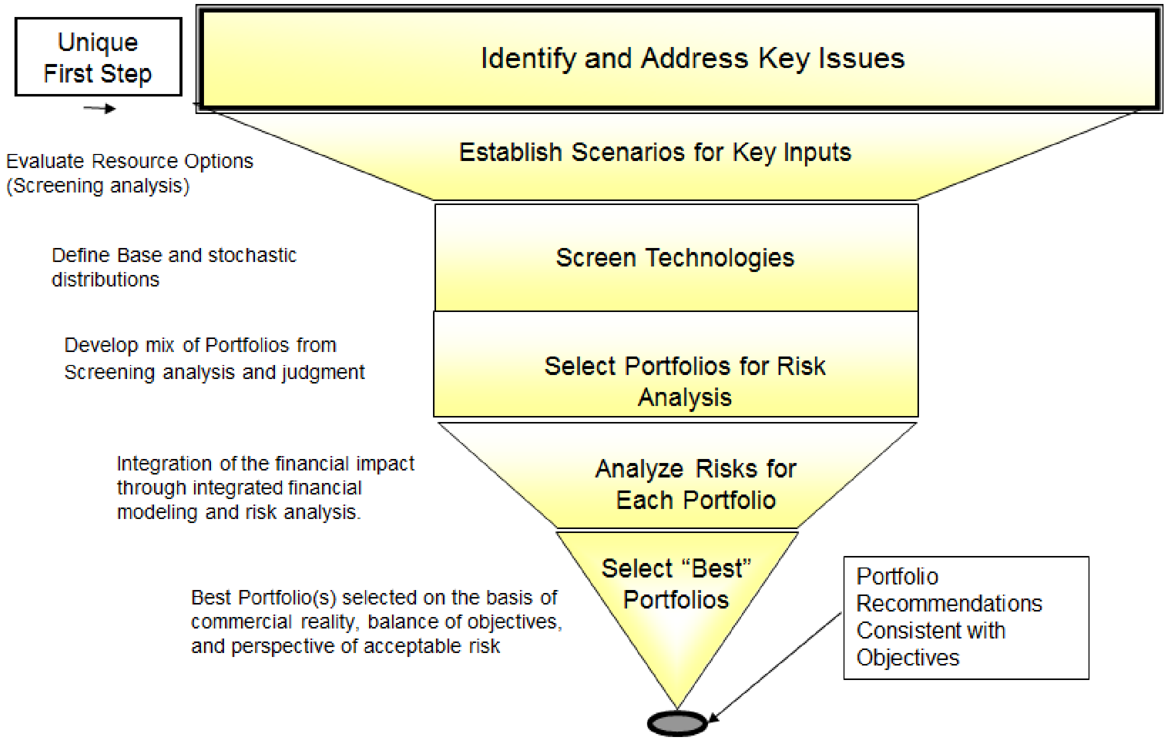
EVALUATION PROCESS

Like many other utilities, LAC has to make resource decisions under a great deal of uncertainty. A resource decision that meets all objectives when judged only under current or best guess forecasted conditions may prove to be a future financial burden over time. The tradeoffs between costs, risks, reliability, environmental stewardship, diversification and other utility objectives need to be evaluated. The Pace Global RIRP methodology addresses all above important questions through a highly structured process that consisted of the following steps:

- Identify overall objectives and metrics
- Recommend two CPP compliance cases
- Provide load forecasts (LAC and LANL)
- Technology screening analysis under three State of the World Scenarios
- Deterministic analysis of initial portfolios
- Stochastic risk analysis of candidate stochastic portfolios to identify the Preferred Resource Plan
  - Provide stochastic distributions for key variables
  - Perform risk analysis for the candidate stochastic portfolios
- Develop strategy and recommendations

The major steps listed above are presented in subsequent sections in this report.

Exhibit 1: IRP Approach and Process



Source: Pace Global.

PREFERRED RESOURCE PLAN

Pace Global recommends a Preferred Resource Plan that includes a staged new build approach to best satisfy its cost, risk, environmental and operational objectives. The most balanced portfolio that meets renewable goals and carbon reduction targets is a portfolio that relies heavily on solar and storage (based on current indicative bids). The addition of the solar and storage should be tailored with the load growth and existing resources retirement schedules. Exhibit 2 shows the key elements of the Preferred Resource Plan.

The staged new build of solar capacities helps to achieve 90 percent carbon neutral by 2036 for LAC and 30 percent onsite renewable generation during 2025-2036 for LANL. The firming mechanism could be either battery storage or onsite Reciprocating Internal Combustion Engine (RICE) units. Onsite RICE units are more expensive but allow more flexibility during prolonged weather events when solar photovoltaic (PV) does not generate.

A portfolio with Small Modular Nuclear Reactors (SMNR) could be competitive and adds to the portfolio diversity, if risk mitigation measures to protect ratepayers from cost overruns and schedule delays are in place. Hence, the optimal approach is to preserve optionality by continuing to pursue SMNR risk mitigation measures and preserve the ability to take advantage of declining solar and storage costs. If the SMNR costs can be capped and development risks can be mitigated, it could be an important option especially in the event that local land becomes unavailable for the amount of solar PV needed to achieve renewable goals.

Beyond building new renewable/ clean energy capacities to meet the carbon neutral goal and renewable objectives, additional gas-fired generation capacity (Combined Cycle or RICE) involves upfront capital investments in a soft market, and is not advised unless control of resources is a priority to LAPP. However, RICE could be considered for firming or balancing purposes.

In conclusion, the County needs not to be in any rush to commit to new resources until several uncertainties regarding SMNRs, solar and storage are resolved. A staged approach to add smaller and incremental capacity resources on a need basis provides overall cost benefits for LAPP and maintains the flexibility in the face of future uncertainties.

Exhibit 2: Key Elements of the Preferred Resource Plan

Portfolio	San Juan 4 Exit Date	LRS Exit	LAPP New Builds	Reserve Margin (2017-2036)
S8: **Solar Firmed with RICE** **Short Capacity**	2022	No Exit	**Large RICE:** • 2017- 18 MW; 2025- 18 MW; 2030- 18 MW **Solar PV:** • 2017- 25 MW; 2025- 25 MW; 2030- 25 MW	LAPP Summer: 9% LAPP Winter: -5%
S9: **Solar with Storage** **Short Capacity**	2022	No Exit	**Solar with Storage (onsite)**: • 2017- 13 MW; 2025- 8 MW • 2030- 6 MW	LAPP Summer: -11% LAPP Winter: -26%
S10: **SMR, Solar with Storage** **Short Capacity**	2022	No Exit	**Solar with Storage (onsite)**: • 2017- 13 MW; 2025- 4 MW **Nuclear (offsite)**: • 2026- 16 MW	LAPP Summer: -9% LAPP Winter: -23%

Source: LAC, Pace Global.

OTHER KEY FINDINGS OF IRP QUESTIONS

- **Post 2025 ECA Strategy:** The IRP preliminary analysis shows that ECA extension post 2025 provides lower Net Present Value (NPV) costs for the combined entity than if both parties agreed to separate. However, the current allocation method does not appear to be optimal, since LANL benefits from joint operation while LAC benefits from separation. Since the savings to LANL exceed the higher costs for LAC, there are opportunities for both parties to benefit from continued joint operation with a different allocation scheme. Additional analysis should be conducted once some major uncertainties are resolved and LAPP has finalized the Preferred Resource Plan.
- **SJGS 4 Retirement:** Due to prospects for continued low gas prices, it is economic to retire SJGS 4 in 2022.
- **LRS Exit Strategy:** Due to relatively lower fuel cost, slightly better heat rate, moderate fixed costs, and its must-run status relative to San Juan and other coal units in the region, LRS remains a cost competitive (though marginal) resource during the planning horizon.
- **CFPP SMNR Investment Option:** The CFPP SMNR project sponsored by UAMPS could provide clean baseload power to replace LAC's coal fired generation resources in meeting energy demand and 2040 carbon neutral goal. Participation in the UAMPS CFPP using SMNR resulted in higher NPV costs in the stochastic analysis and introduces development risks. However, if the

contract PPA price could be capped at acceptable levels and the development risks could be mitigated, the SMNR could be considered especially if local land becomes unavailable for solar PV. LAC and LANL should continue to pursue risk mitigation measures and other price reductions to protect ratepayers from cost overruns and schedule delays and improve its overall economics relative to solar.

- **Capital Investments:** The current market outlook does not reward building portfolios with excess capacity above load that would be sold into the market. A phased approach to purchasing some share of its needs in the market and add smaller and incremental capacity resources on an as needed basis provides overall lower cost benefits for LAC and preserves the flexibility in the face of future uncertainties. Beyond building new renewable/ clean energy capacities to meet the carbon neutral goal and renewable objectives, additional gas-fired generation capacity (Combined Cycle or RICE) involves upfront capital investment in a soft market, and is not advised unless control of resources is a priority to LAPP. For an operational perspective, RICE could be considered for firming or balancing purposes.
- **New Solar Generation:** The most balanced portfolio that meets renewable goals and carbon reduction targets is a portfolio that relies on solar PV and battery storage (based on current indicative bids and market expectations). However, there are uncertainties whether sufficient local federal land for utility scale solar PV resources.
- **Relying on Market Purchases:** The RIRP results show that relying on some market purchases result in lower NPV costs in the current low market price environment. Adding no new capacity, however, not only compromises LAC and LANL's goals of increasing renewable generation, but also results in unacceptably high negative reserve margins to ensure a reliable means of serving load.
- **Spinning Reserve:** LAPP currently purchases spinning reserves from the balancing area, with estimated costs ranging $18 to $22/MW. Assuming an average price of $20/MW, a reserve (spinning and non-spinning) requirement of 7 MW amounts to over $1 million annual costs. Based on Pace Global's estimates, building medium sized RICE units on site could provide spinning reserve at similar costs to market purchases. Our recommendation is to continue rely on market purchase and evaluate building onsite RICE unit if the prices increase significantly from current ranges.

LAC AND LANL EXISTING RESOURCES

LAC PROFILE

Los Alamos County has a population of approximately 17,682 (2014 census) people, with two communities: the town-site of Los Alamos with approximately 10,500 residents and White Rock (southeast of Los Alamos) with approximately 5,600 residents. LANL is the largest employer in the County. Exhibit 3 summarizes the resources owned by LAC and LANL that are included in this IRP analysis.

Exhibit 3: LAPP Existing and Planned Supply Resources

LAC Resources	Summer Capacity MW	Winter Capacity MW	Status/Model Treatment	Ownership/ PPA	VOM 2016$/MWh	FOM 2016$/kW-yr	Heat Rate Btu/KWh
San Juan Generating Station Unit 4	36.00	36.00	Online	Own	2.5	80-84	11,000
Laramie River Station	10.00	10.00	Expire 2042	PPA	6.0	61	10,205
El Vado	8.80	2.00	Online	Own	-	57	-
Abiquiu	15.00	2.00	Online	Own	-	40	-
Solar	1.00	1.00	Online	Own	-	-	-
Western	0.50	0.90	Expire 2024, extension afterwards	PPA	-	-	-
LAC Total	71.30	51.90					
LANL Resources	**Summer Capacity MW**	**Winter Capacity MW**	**Staturs/Model Treatment**	**Ownership/ PPA**	**VOM 2016$/MWh**	**FOM 2016$/kW-yr**	**Heat Rate Btu/KWh**
TA-3 Combustion Turbines	21.00	25.00	Online, converted to CC after 2020	Own	-	19	10,242
Western	9.25	10.00	Expire 2024, extension afterwards	PPA	-	-	-
LANL Total	30.25	35.00					
LAPP Total	**101.55**	**86.90**					

Note: Fixed operating and maintenance costs (FOM) were estimated at $80/kW-year for retirement date of 2022, and $84/kW-year for retirement dates of 2028 and 2033.

Source: LAC, LANL, Pace Global.

LAC COAL GENERATION FACILITIES AND PPA

LAC has positions in two coal-fired power plants. It has a partial ownership of 7.2 percent of unit 4 (36 MW) in San Juan Generation Station (SJGS) Unit 4, which has a total capacity of 507 MW and is operated by Public Service Company of New Mexico (PNM). LAC's current Plant Participation Agreement with other co-owners of SJGS expires on June 30, 2022. LAC needs to decide by June 30, 2018 whether to allow its interest in SJGS to expire in 2022 or negotiate an extension. This IRP will evaluate economic impacts of SJGS Unit 4 exit in 2022 versus negotiate an extension till 2028 or 2033. Based on the SJGS Unit 4 budgets provided by LAC, Pace Global estimated the variable operating and maintenance costs (VOM) of San Juan Unit 4 at $2.50/MWh. Fixed operating and maintenance costs (FOM) were estimated at $80/kW-year for retirement date of 2022, and $84/kW-year for retirement dates of 2028 and 2033. Delivered coal prices to the SJGS unit 4 are estimated at $2.20/MMBtu.

LAC has a 10 MW power purchase agreement (PPA) with Laramie River Station (LRS) through the life of the plant. Based on 10-year LRS plant budget provided by LAC, the VOM and FOM of LRS are estimated at $6.00/MWh and $61/kW-year respectively. Estimated transmission cost is about $2.5/MWh. The delivered coal prices are estimated at $1.07/MMBtu in 2017 to $1.13/MMBtu in 2026. In light of the carbon neutral goal, LAC would like to evaluate a potential sale of the LRS PPA. This IRP evaluates the economic impacts of LRS exits in the near- or mid-term, or continuing its "take or pay" contract for the life of the plant.

LAC HYDROELECTRIC GENERATION FACILITIES

LAC owns two local hydroelectric power plants. Abiquiu Hydroelectric Plant, contains two 6.9 MW generators and a newer (2011) 3 MW Low Flow Turbine Generator. Pace Global models the Abiquiu plant with an estimated summer capacity of 15 MW and winter capacity of 2 MW. The El Vado Hydroelectric Plant has an estimated summer capacity of 8.8 MW and winter capacity of 2 MW[1]. These two hydroelectric plants have historically provided more than half of LAC's electricity needs; however, their output varies considerably and will decline if the drought conditions persist. The debt services on both plants have been fully paid off, providing renewable and low cost power to the LAC and LANL.

LAC EXISTING SOLAR FACILITY

In addition to the coal and hydro resources, LAC has a solar project with a current capacity of 1 MW.

LANL GENERATION FACILITIES

LANL's TA-3 combustion turbine with a winter capacity of 25 MW is expected to be converted to a 45 MW combined cycle gas turbine in 2020. Exhibit 4 provides the estimated parameters of the planned new combined cycle. LANL also has TA-3 steam turbine and a diesel engine which are primarily used for emergency purposes. Based on discussions with LAC and LANL, these emergency units are excluded in the IRP analysis, which are long-term planning in nature.

Exhibit 4: LANL New Combined Cycle Assumptions

Technology	Summer Capacity MW	Winter Capacity MW	Commercial on Line Date	Ownership/PPA	VOM, 2016$/MWh	FOM, 2016$/kW-yr	Heat Rate Btu/kWh
TA3 CC	45	45	2020	Own	2.19	35.59	7,000

Source: Pace Global, LANL.

In addition to above mentioned owned and contracted generation resources, LAC purchases approximately 1 MW of hydro power from Western Area Power Administration (WAPA), and LANL purchases approximately 10 MW of hydro power from WAPA. Both power purchase contracts with WAPA expire in 2024, but are expected to be extended. Exhibit 5 present the terms of the WAPA contracts considered in the IRP.

[1] El Vado Hydroelectric Plant is typically offline during November to March.

Exhibit 5: WAPA Contract Summary

	Begin Date	End Date	Energy Contracted Price ($/MWh)	Capacity Contracted Price ($/KW-month)	Summer Capacity (MW)	Winter Capacity (MW)
LAC	1/1/2017	12/31/2024*	12.19	5.18	0.5	0.9
LANL	1/1/2017	12/31/2024*	12.19	5.18	9.25	10

Note:

(1) The current WAPA PPA contract expires in 2024 and post 2025 the PPA is expected to be extended.

(2) The contracted capacity price applies to the contract rate of the delivery (CROD) quantities, which are about 18 MW for LANL. The 10 MW in above table for LANL reflects the expected schedule amount.

Source: LAC, LANL, WAPA.

SPINNING RESERVE

LAPP currently purchases spinning reserve from the balancing area, with estimated costs of $18/MW to $22/MW in 2016, which has increased from $10/MW to $12/MW in 2010. Assuming an average price of $20/MW, a reserve (spinning and non-spinning) requirement of 7 MW amounts to over $1 million annual cost.

System operators typically require a specific level of operating reserves to ensure adequate unused generating capacity is available on short notice to meet unexpected demand in case of supply or demand interruptions. These reserves could be provided through plants that are operating below full capacity (spinning reserves) as well as through plants that are not currently operating but that can be brought online quickly (non-spinning reserves). The spinning reserves are intended to help the system respond quickly (within 10 minutes) to forced outages or other contingency events. The resource providing spinning reserve must be synchronized with the grid and must be able to run for at least one hour when called upon. With increasing penetration of intermittent resources such as wind and solar as well as distributed generation projected to be added in the WECC region, the demand for spinning reserve is expected to rise, further driving up the cost of spinning reserves.

To provide spinning reserve using onsite resources creates additional energy costs. In some cases a generator that can provide energy more cheaply than the market must back down to provide the reserve, thus increase the cost of energy supply. In other cases a generator may be kept online to provide reserve even though it is out of money on the energy market, thus operates at a loss. In this IRP, Pace Global evaluates the tradeoffs of having owned onsite resources to provide spinning reserve vs. purchasing it from the market.

LAC IRP OBJECTIVES AND METRICS

To properly evaluate resource decisions, LAC, LANL and Pace Global identified the planning objectives very early in the resource planning process. Even with the appropriate metrics identified for each planning objective, the tradeoffs associated with resource decisions represent the biggest challenge for resource planning. Exhibit 6 displays four competing objectives, identified as priorities. As is shown, focus on any one objective can move the resource plan away from focus on the others. In the IRP process, a wide range of metrics were used to rank portfolios to evaluate the tradeoffs associated with different portfolio options and, ultimately, arrive at a resource plan that balances many competing goals.

Exhibit 6: LAC Competing Stakeholder Objectives

Objectives			Metrics
Cost	Cost	Minimize power supply costs	2017-2036 cost NPV
Risk	Cost Stability	Achieve cost stability	2017-2036 95th percentile cost NPV
Environmental	Environmental Stewardship	Increase renewable generation	2017-2036 renewable generation percentage
Operational	Transmission/ Largest Contingency	Reliance on transmission	Largest generation units depending on transmission
	Development Risks	Minimize project development risks	Project development uncertainties
	Control	Ensure reliability requirements with native capacity	2017-2036 reserve margin
	Weather Dependency	Decrease weather dependency	Availability of other generation resources during prolonged weather events

Source: Pace Global

COST OBJECTIVE

Preserve Competitive Rates

Preserving competitive rates is a common objective for utilities. The objective is to select the lowest-cost supply options and, therefore, minimize the rate impact on its customers. Pace Global used portfolio cost minimization as a proxy for maintaining competitive rates. For comparative purposes, different portfolio options were evaluated based on the net present value (NPV) of all generation-related costs associated with serving the load (in millions of dollars). The IRP cost metric included the variable cost of generation, fixed costs, executed contracts costs, capital costs, and the cost of net market transactions (purchases minus sales).

RISK OBJECTIVE

Maintain Stable Rates (95th Percentile NPV Risk)

Rate stability can be measured by different metrics. For this analysis, portfolios were evaluated against statistically derived distributions on key market drivers like natural gas prices, coal prices, energy demand, carbon prices, power market prices, and capital costs. Rather than recording portfolio costs under one set of assumptions, Pace Global measured costs under a distribution of the key assumptions drivers. The 95th percentile cost NPV metric shows how wide the cost distribution could become for each portfolio (as a measure of how costly a portfolio might achieve under the most extremely negative conditions – only 5 percent of conditions were worse than this outcome). The lower the value of this measure (i.e. the 95 percentile value), the less exposed the portfolio is to market uncertainty.

ENVIRONMENTAL OBJECTIVE

LAC Carbon Neutral Goal

LAC Board of Public Utilities established in 2013 a goal for LAC's Department of Public Utilities to be a carbon-neutral electrical energy provider by 2040. The 2017 IRP set interim goals for LAC to progress towards the 2040 carbon neutral goal as shown in Exhibit 7.

LANL Onsite Renewable Generation Goal

LANL's requirement for onsite renewable energy resources is 10 percent by 2016-2017, 15 percent by 2018-2019, 20 percent 2020-2021, 25 percent in 2022-2023, and 30 percent by 2025 and after.

OPERATIONAL OBJECTIVES

Transmission/ Largest Contingency

The largest contingency measure determines which portfolios are most impacted by the loss of the single largest transmission or generation sites. Portfolios that rely most on one transmission line or the largest single plant site are most exposed to the loss of that source of power.

Control Risk – Average Reserve Margin

To assess the associated operational risk and the ability for LAC to meet the demand with owned or contracted resources, LAC's 20 years average reserve margin, which is calculated as the supply resource availability as a percentage of peak load during 2017-2036, was used as an operational metric for each portfolio. Portfolios most exposed to the market with insufficient capacity to meet native load were most at risk because LAC was not in control of meeting its load.

Minimize Development Risks

The ability to secure certain portfolio options (such as participating in a large Combined Cycle project or the CFPP SMNR development project) is uncertain and out of LAC's control. In contrast, LAC has greater control of the building smaller generation resources that is closely tailored to its contracting positions, load profile and coal retirement dates.

Weather Dependent Risk

When only adding solar with storage as new resources, these portfolios are exposed to the market when there are a succession of cloudy or rainy days. Such risks could be managed with adding either fossil or nuclear generation in addition to solar.

LAC AND LANL RENEWABLE GOALS

LAC CARBON NEUTRAL GOAL

LAC Board of Public Utilities (BPU) established in 2013 a goal for LAC's Department of Public Utilities to be a carbon-neutral electrical energy provider by 2040. Future Energy Resources Committee (FER) recommends by 2040, electricity distributed to Los Alamos County consumers[2] is generated or purchased from sources that in their normal operation cause no net release of carbon dioxide, methane, or other greenhouse gases to the atmosphere. "No net release of carbon dioxide" means that purchases or generation of carbon-based electrical energy, necessary when carbon-free supplies are not practically available to supply LAC consumers, will be fully offset from previous sales of surplus carbon-free electricity to other entities. For IRP purposes, LAC will set the goal of achieving 90 percent carbon neutral by 2036. Exhibit 7 outlines the LAC carbon neutral goal baseline, IRP interim goal and end goal by 2040.

Exhibit 7: Los Alamos County Carbon Neutral Goal

	Estimated Baseline	IRP Interim Goals			End Goal (not evaluated by IRP)
Year	2017	2025	2030	2036	2040
Interim Carbon Neutral Goal	44%	50%	70%	90%	100%

Source: Pace Global, LAC.

Currently, out of LAC's current annual energy demand of 124 GWh, about 44 percent of total is served by renewables, including El Vado, Abiquiu, and additional hydro power from WAPA contract. Pace Global projects 159 GWh energy is needed by 2036, thus 88 GWh additional renewable energy needs to be generated or acquired through contracts to meet the carbon-neutral goal.

Exhibit 8: Los Alamos County Carbon Neutral Goal Baseline

El Vado	Abiquiu (Excluding Unit 3)	WAPA	Total Renewable Generation	Total Demand	Renewable Percentage
MWh	MWh	MWh	MWh	MWh	%
27,907	21,467	5,092	54,466	123,735	44%

Note:
(1) El Vado generation is based on average levels of 2012-2013.
(2) Abiquiu generation is based on average levels of 2012-2013.
(3) WAPA contract generation is based on FY 2016 total.
(4) Total demand is based on FY 2016 total.

Source: Pace Global, LAC, LANL.

[2] "Los Alamos County customers" means those customers scheduled in the Los Alamos County, which does not include DOE/LANL.

LANL ONSITE RENEWABLE GENERATION GOAL

LANL's requirement for onsite renewable energy resources is 10 percent by 2016-2017, 15 percent by 2018-2019, 20 percent 2020-2021, 25 percent in 2022-2023, and 30 percent by 2025 and after as shown in Exhibit 9.

Exhibit 9: LANL Onsite Renewable Energy Goal

Year	2017	2018	2019	2020	2021	2022	2023	2025-2036
LANL Renewable Energy Goal	10%	15%	15%	20%	20%	25%	25%	30%

Source: Pace Global, LAC, LANL.

Currently, the 1 MW Solar Project at LANL TA-61 site, together with Abiquiu Unit 3, provides about 21 GWh of energy in a typical year. Since these two renewable projects are located on federal land, they qualify for double renewable energy credits (RECs) for LANL and would equate 42 GWh or 8 percent of the total load. By 2025, assuming total LANL energy needed is 873 GWh, renewable need will be 262 GWh. Assuming a solar plant factor of 22 percent, 136 MW of additional solar capacity would be required. If the project were constructed on Federal land, it could be sized at 68 MW recognizing it would be eligible for double RECs.

Exhibit 10: LANL Onsite Renewable Energy Goal Baseline

Abiquiu Unit 3	PV Landfill	Total Renewable Generation	Total Renewable Generation (with double credit applied)	Total Demand	Renewable Percentage
MWh	MWh	MWh	MWh	MWh	%
18,510	2,108	20,618	41,235	546,201	8%

Note:
(1) Abiquiu (Unit 3) generation is based on average levels of 2012-2013.
(2) PV Landfill generation is based on FY 2016 total.
(3) Total demand is based on FY 2016 total.

Source: Pace Global, LAC, LANL.

NEW RENEWABLE RESOURCES GENERATION ALLOCATION

For any new on site renewable resources LANL adds to the pool, LANL will get credits for double the renewable generation, and for any excess credits, could share with LAC. For any new on site renewable resources LAC adds to the pool, LAC will take credits for generation needed to meet its carbon neutral interim goals and share any excess with LANL.

CLEAN POWER PLAN CASES

The EPA released the draft performance standards, also known as the Clean Power Plan (CPP), for existing generating units under §111(d) of the Clean Air Act on time on June 2, 2014. The final rule was released on August 3, 2015. The CPP established state by state emission targets for affected existing generation units. States drive the approach to meet their goal, including choosing to comply as a rate goal (lb CO_2/MWh) or a mass goal (short tons of CO_2). Overall, the aggregate state goals (on a mass basis) would reduce emissions from affected sources by an estimated 32 percent below 2005 levels by 2030. The initial compliance period under the rule would begin in 2022 with the final reduction goal to be achieved by 2030. Trading between states would be encouraged under the CPP.

On February 9, 2016, the Supreme Court of the United States granted a request to stay the Clean Power Plan, after the D.C. Circuit Court denied this request initially. As a result, the CPP is not in effect at this time until the D.C. Circuit Court rules on the pending legal challenges and the stay is lifted. The deadlines for states to submit compliance plan milestones, the earliest of which would have been September of 2016, are uncertain at this time. There is a great deal of uncertainty over whether and how the states will formulate their compliance plans as well as the extent to which legal challenges or congressional action will change the proposed regulations. The current administration is trying to reverse the plan, though New Mexico could operate on its own to implement something on a statewide basis. Despite these uncertainties, Pace Global assumes that the rule is implemented with a two-year delay and two different compliance options that New Mexico appears likely to adopt based on their goal defined in the final rule and the expected future generation mix of the state. These two compliance options for New Mexico are a mass-based approach to compliance with New Mexico only allowing for intrastate trading amongst affected entities within the state and a mass-based approach to compliance whereby New Mexico opts into a national trading scheme.

New Mexico appears to be well positioned to comply with its goal prescribed under the CPP under either a rate or mass approach. The announced retirements of San Juan units (2 and 3) result in a significant reduction in projected emissions from existing generating sources covered under the CPP relative to the baseline. Adopting a mass-based approach to CPP compliance is viewed as many to be less complicated and therefore favorable, if from an administrative standpoint only, over a rate approach. For this reason, Pace Global assumes mass-based compliance for New Mexico for both CPP compliance cases. In either case, the compliance cost is low in New Mexico.

- **Mass-based with intrastate trading:** New Mexico adopts a mass-based goal but does not opt into national trading. Trading is a compliance option for affected generators located in the state but only with other in-state parties. Carbon value is based on the marginal cost to comply for New Mexico only.
- **Mass-based with interstate trading:** New Mexico adopts a mass-based goal and opts into the national trading program. Allowances are freely traded amongst all states that also opt into the mass-based federal trading program, regardless of geographic location. Carbon value is based on the marginal cost to comply for all states in the trading program. New Mexico is expected to be in a net long position for allowances and therefore can sell additional allowances to buyers outside of the state.

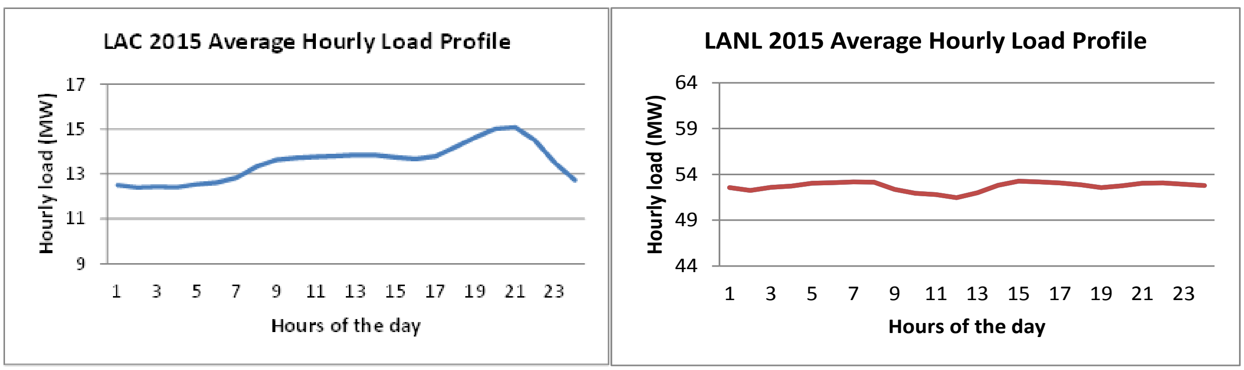
LOAD FORECAST

As part of the 2017 IRP process, Pace Global performed a long-term load forecast for resource planning studies.

HISTORICAL LOAD PROFILE FOR LAC AND LANL

The Los Alamos Power Pool (LAPP) electrical load consists of the Los Alamos County (LAC) and Los Alamos National Laboratory (LANL). Exhibit 11 presents the different hourly load profiles of LANL and LAC. LANL loads typically peak during the afternoon, when the air conditioning and the laboratory equipment are in use. On the other hand, LAC loads are entirely different with peak in the evening, with an overnight base load in the range of 10 MW to 13 MW.

Exhibit 11: 2015 Average Hourly Load Profile for LAC and LANL

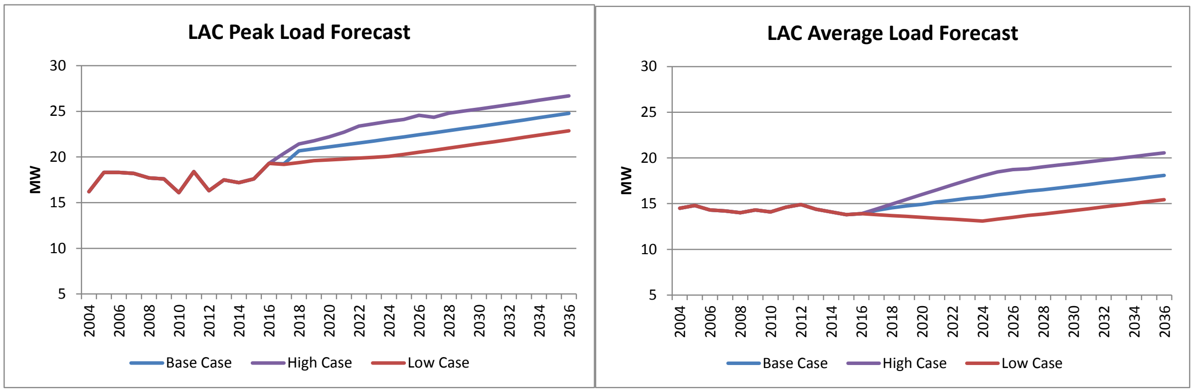


Source: Pace Global, LAC, LANL.

LAC LOAD FORECAST

Based on historical load data since 2004, LAC's projected load for the period of 2017-2024, and historical capacity additions in solar PV for the residential and commercial customers in the County, Pace Global developed LAC load forecasts for Base, High and Low cases as presented in Exhibit 12. The load forecasts take into consideration key drivers including population growth, limited land space for additional housing, economic activities, penetration by distributed energy resources (DER), and increases in electric vehicle demand. The load forecasts in the High and Low Cases reflect load growths that achieves two standard deviations above and below expected load levels by 2025 and bookends a wide range of load growth conditions.

Exhibit 12: LAC Peak and Average Load Forecast - Base, Low and High Cases



Source: Pace Global, LAC.

Distributed Energy Resources

The LAC load forecast considers current and future solar PV installations. LAC currently 0.5 MW of distributed solar. The solar PV installation has grown significantly over the past years, with 89 installations since 2005 with 26 installations in 2016 alone. The DER penetration is constrained by the amount that could be safely integrated with the distribution grid. LAC's forecasts a moderate utility served load growth net of expected DER impact as presented in Exhibit 12.

Electric Vehicle Demand

Total U.S. sales of plug-in electric vehicles (PEVs) have increased in recent years. EV now represents a large potential source of load growth for utilities. Pace Global developed EV forecast for the Los Alamos County assuming population growth from 18,000 to 20,000 during the period of 2016-2036 in the Los Alamos County, the typical household of 2.58 people and two cars. Goldman Sachs and Bloomberg Energy Finance have forecasted the EV penetration rate of 22 percent by 2025 and 40 percent by 2045. Based on these estimates, Pace Global forecasted the utility EV charging load in the county to be 0.63 MW by 2036, which assumes EV penetration rate of 30 percent by 2036.

LAC Demand Side Management (DSM)

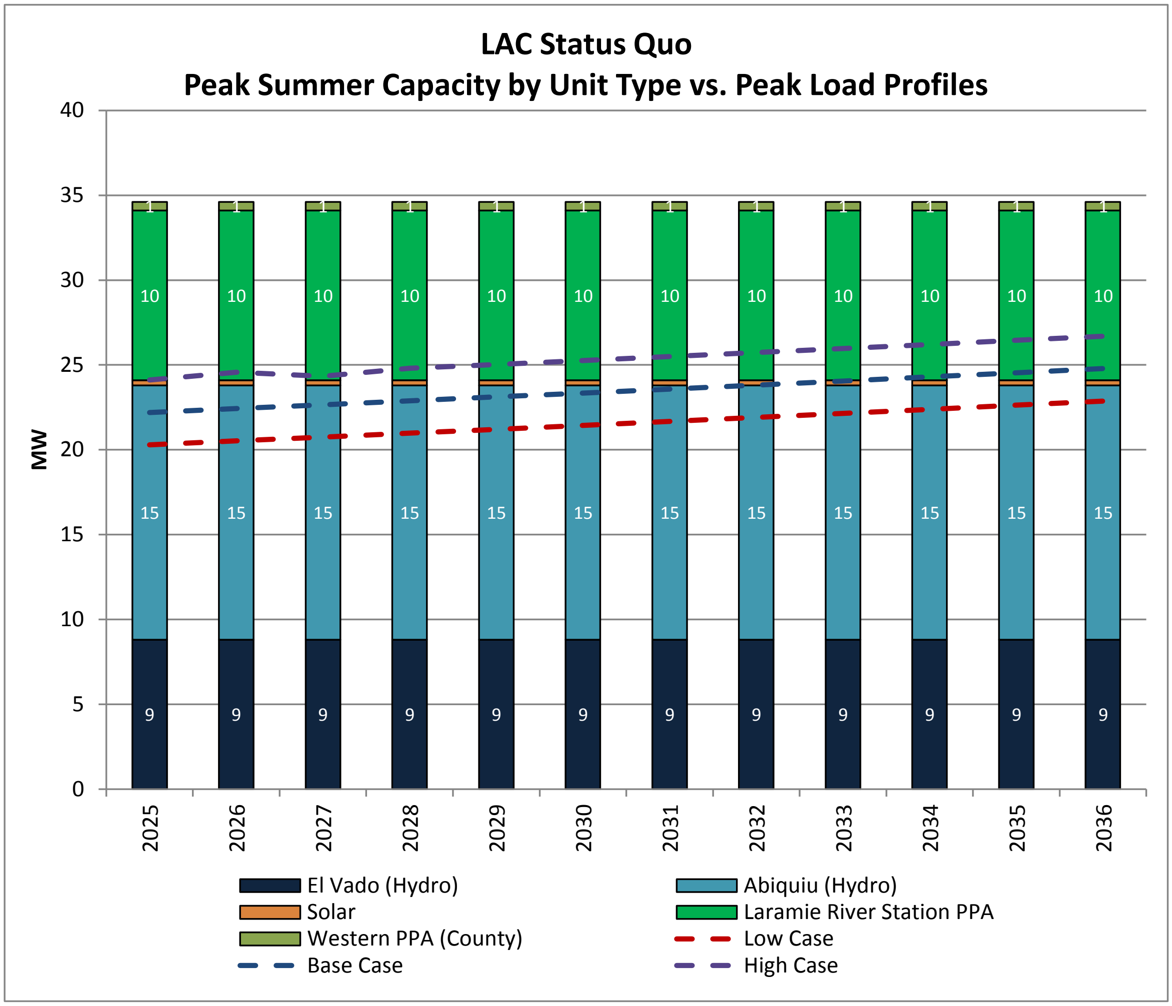
Los Alamos County has actively pursued demand side management with a budget of $30,934 in 2016. LAC is looking into upgrading the smart meters and replacing aging transformers to reduce loss and improve energy conservation. In addition, a county ordinance has been adopted that mandates buildings over 5,000 square feet must meet Leadership in Energy and Environmental Design (LEED) silver requirements. For the IRP analysis, the DER is modeled as a reduction of the load and there are no official DSM programs with specific energy saving goal and cost metrics. For this reason, DSM will be excluded from the core IRP analysis, but may be included in the updated IRP if the more concrete DSM goals and cost estimates are developed by LAC in the future.

LAC Load and Resource Balances

LAC's existing generation resources and PPAs provide a total summer capacity of 71 MW and winter capacity of 52 MW. The seasonal variance is primarily caused by lower hydro capacity in the winter. Exhibit 13 shows the LAC existing resources summer capacity vs. projected peak load.

While the summer capacity currently covers the load in summer season, as load grows and expected retirement of San Juan unit 4, the LAC reserve margin is expected to decline to negative 39 percent in winter and positive 40 percent by 2032. Exhibit 14 shows the projected LAC reserve margin with only existing generation resources and PPAs.

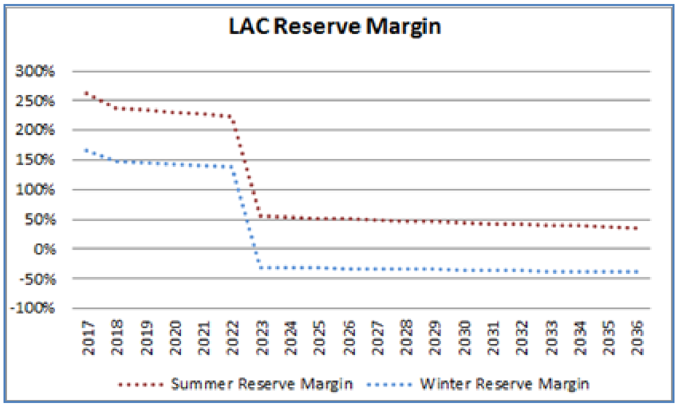
Exhibit 13: LAC Existing Resources Summer Capacity vs. Peak Load



Note: This chart assumes San Juan Unit 4 retirement in 2022 and LAC holds onto the Laramie River Station PPA for the plant of life.

Source: Pace Global, LAC.

Exhibit 14: LAC Reserve Margin Based on Existing Resources



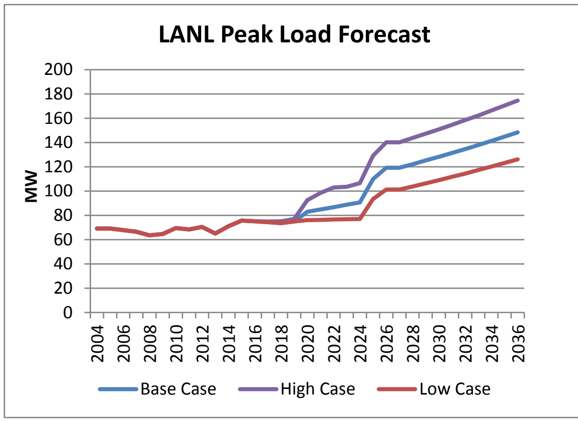
Note: This chart assumes San Juan Unit 4 retirement in 2022 and LAC holds onto the Laramie River Station PPA for the plant of life.

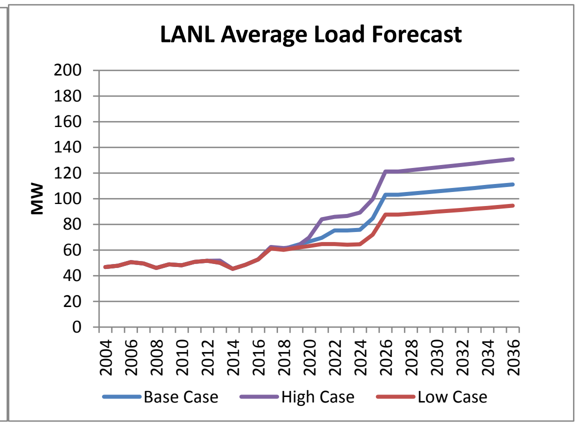
Source: Pace Global, LAC.

LANL LOAD FORECAST

LANL's electric energy demand averaged 420 GWh per year over the period of 2004-2014. Pace Global derived the LANL load forecast in the High Case based on the load precast provided by LANL because of the potential LANL activities that may or may not materialize. Historically, LANL's forecasted load increase have often failed to fully materialize, and realized load is typically around 15 percent lower than forecast. As a result, LANL's Base Case load forecast is approximately 15 percent below the High Case in the long term, and the Low Case load forecast is approximately 15 percent below the Base Case to reflect further downside load risk of project volatility.

Exhibit 15: LANL Peak and Average Load Forecast – Base, Low and High Cases



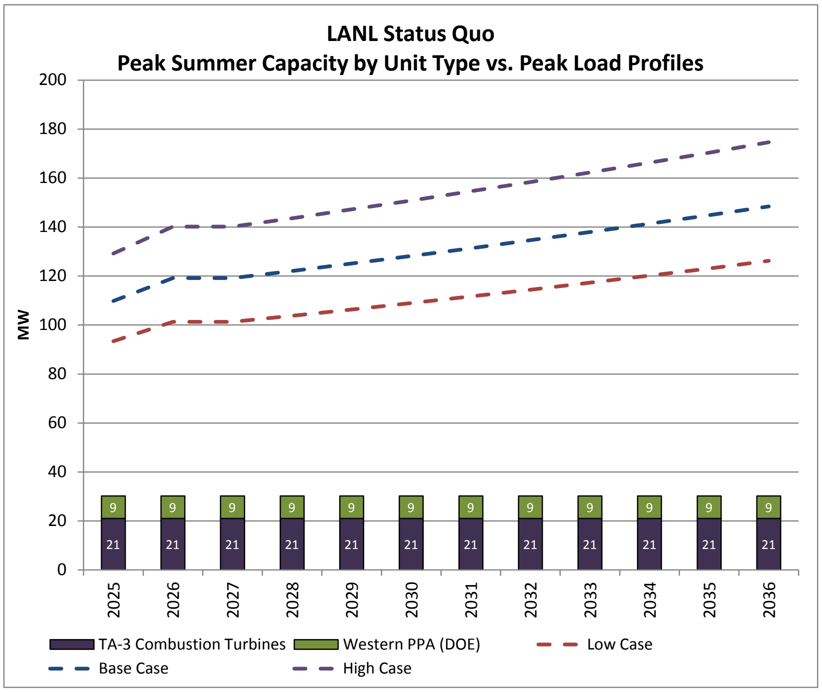


Source: Pace Global, LAC, LANL.

LANL Load and Resource Balances

LANL's existing generation resources and PPAs provide a total summer capacity of 30 MW and winter capacity of 35 MW. Exhibit 16 provides the existing resource summer capacity vs. peak load for LANL post 2025. Exhibit 17 shows the projected LANL reserve margin with only existing generation resources and PPAs. On a standalone basis, LANL faces significant shortage of generation resources to serve its load.

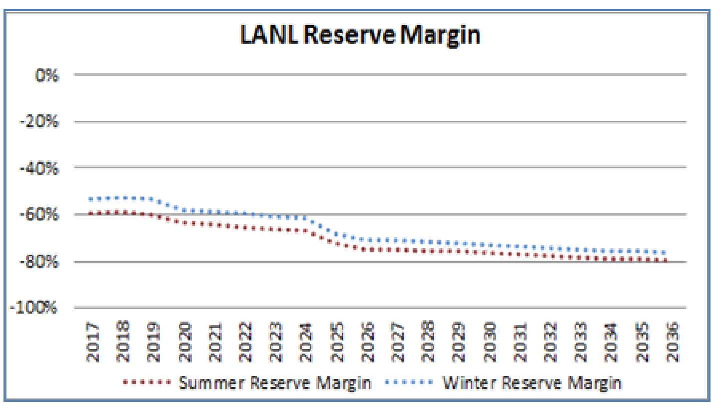
Exhibit 16: LANL Existing Resources Summer Capacity vs. Peak Load



Note: This chart excludes TA-3 steam turbine and a diesel engine which are primarily used for emergency purposes, but are excluded from this IRP analysis.

Source: Pace Global, LAC, LANL.

Exhibit 17: LANL Reserve Margin Based on Existing Resources



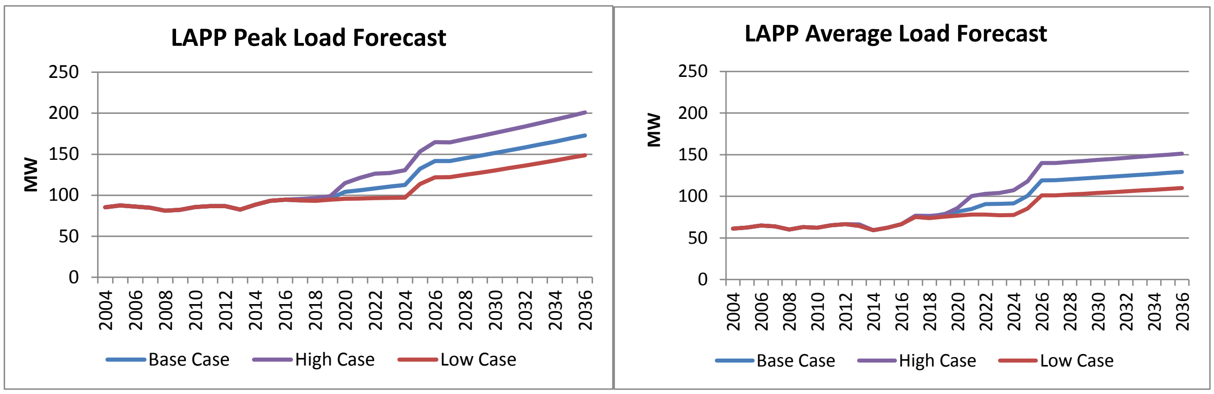
Note: This chart excludes TA-3 steam turbine and a diesel engine which are primarily used for emergency purposes, but are excluded from this IRP analysis.

Source: Pace Global, LAC, LANL.

LAPP LOAD FORECAST

LAPP peak demand is approximately 94 MW in 2016, and is projected to reach 104 MW by 2020, 151 MW by 2030, and 173 MW by 2036. This represents a compound annual growth rate (CAGR) of 3.1 percent during 2016-2036. Exhibit 18 shows the variation from the base, the low and high cases.

Exhibit 18: LAPP Load Forecast - Base, Low and High Cases



Source: Pace Global, LAC, LANL.

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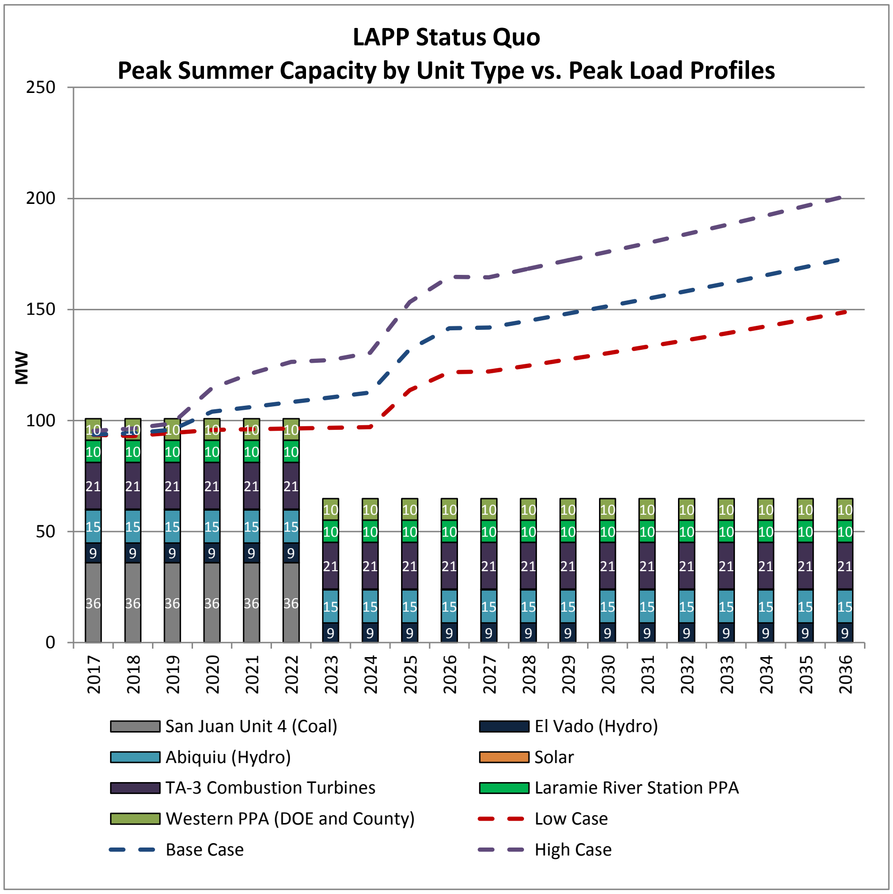
LAPP Load and Resource Balances

LAC and LANL's existing generation resources and PPAs provide a total summer capacity of 101.6 MW and winter capacity of 87 MW. The seasonal variance is primarily caused by lower hydro capacity in the winter. Exhibit 19 shows the LAPP existing resources summer capacity vs. projected peak load.

While the summer capacity currently covers the load in summer season, as load grows and expected retirement of San Juan unit 4, the LAPP reserve margin is expected to reach negative 71 percent in winter and negative 62 percent in summer by 2036 if no new generation resources or PPAs are added. Exhibit 20 shows the projected LAPP reserve margin with only existing generation resources and PPAs.

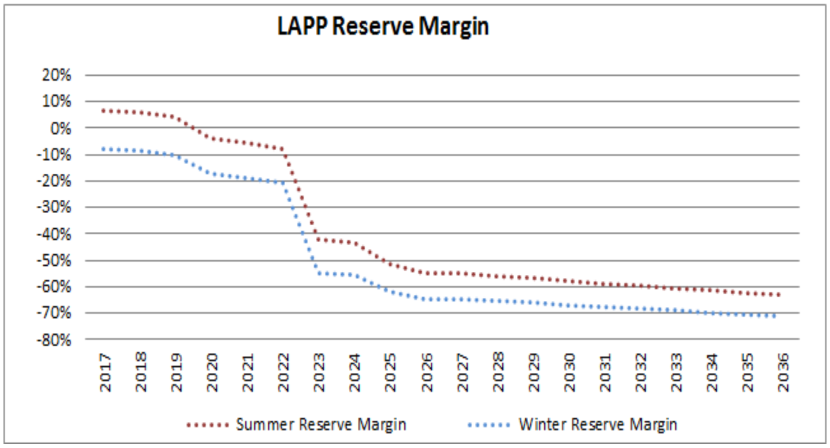
Exhibit 19: LAPP Existing Resources Summer Capacity vs. Peak Load



Note: This chart assumes San Juan Unit 4 retirement after 2022 and LAC holds onto the Laramie River Station PPA for the plant of life.

Source: Pace Global, LAC, LANL.

Exhibit 20: LAPP Reserve Margin Based on Existing Resources



Note: This chart assumes San Juan Unit 4 retirement after 2022 and LAC holds onto the Laramie River Station PPA for the plant of life.

Source: Pace Global, LAC, LANL.

STATE OF THE WORLD SCENARIOS

As part of the technology screening in the deterministic analysis, Pace Global evaluated the least cost resources under three "state of the world" scenarios to identify the new resources that perform the best across three different scenarios.

A Base Case forecast represents a "consensus" outlook of the most likely forecast of all key input parameters and reflects a reasonable level of growth. The base case forms a good basis for evaluating impacts of local effects that primarily affect LAC and LANL, but cannot fully capture the risk of possible deviations from "consensus" macroeconomic and regulatory outlooks that need to be considered in the portfolio planning process.

It is unrealistic to assume that base case forecasts will actually transpire because each of the key market drivers are uncertain. Based on our understanding of LAC and LANL objectives, Pace Global used the following there States of the World scenarios for the LAC IRP deterministic analysis: Base Case, High Case (High Regulatory/ Low Economy), and Low Case (Low Regulatory/ High Economy) scenarios as shown in Exhibit 21. These scenarios reflect three different but cohesive, plausible and internally consistent combinations of many robust macroeconomic, regulatory and technological change environments to capture many of these developments in a more realistic and rigorous way.

When developing the States of the World scenarios, Pace Global separately considers the overall environment for the short-term, mid-term and long-term. In the short-term, which covers 2017-2019, the momentum behind current market, regulatory, and technological conditions continue to dominate. Therefore, the short-term outlook begins with conditions similar to what we have seen in the recent past. Towards the end of the short-term period, the main macroeconomic, regulatory, and technological drivers, which the States of the World scenarios try to reflect, begin to take hold and the main market drivers begin to diverge from the consensus base case outlook. In the mid-term, which covers 2020-2025, the drivers take full effect and the market drivers reflect this. In the long-term, which covers 2026 and beyond, some market drivers reflect the permanent cumulative effect of the macroeconomic, regulatory, or technological change, while others flatten or revert back towards the Base Case.

Exhibit 21: Base, Low and High Case Definition

B=Base Case M=Moderate L=Low; H=High ST=Short-Term MT=Mid-Term LT=Long-Term	Base Case			High Case High Regulatory/ Low Economy			Low Case Low Regulatory/ High Economy		
Time Frame:	**ST**	**MT**	**LT**	**ST**	**MT**	**LT**	**ST**	**MT**	**LT**
Load Growth	B	↗	↗	B	L	L	B	H	H
Gas Prices	B	↗	→	B	M	L	B	H	H
CO2 Prices	B	↗	↗	B	H	H	B	L	L
Nuclear Capital Costs	B	↗	↗	H	H	H	B	B	L
Thermal Capital Costs	B	→	→	B	M	L	B	M	H
Renewable Capital Costs	B	→	→	B	M	H	B	M	M

Note: ST = 2017-2019; MT = 2020-2025; LT= 2026-2040
Source: Pace Global.

BASE CASE

The Base Case reflects a reasonable and balanced level of growth and drivers that lead to moderate market outcomes. Power market participants are able to adapt and adjust in a timely manner to changing market forces. The Base Case forms a good basis for evaluating impacts of local effects that primarily impact LAC and LANL, with little or no impact to the larger WECC market.

Short-Term (2017-2019)

The Base Case assumes positive sales growth over the next few years as the economy continues to improve and as LAC and LANL adds new customers to its base. Residential customer growth remains positive albeit lower than pre-recession levels, but this is partially offset by moderately declining average use per customer. Similarly, the customer base for small and large commercial and industrial (C&I) customers continues to grow but with a partial offset of this growth by increasing efficiency. As a result, energy sales grow at a moderate pace.

Natural gas prices remain very low through 2017 as oversupply continues to dominate. However, as LNG export terminals and new heavy industrial facilities begin to enter into service, this additional demand helps to tighten the market in the premium Gulf Coast market and push prices incrementally higher in 2018 and beyond. Gas prices in the Utica and Marcellus also recover in 2018 as several pipeline projects that provide takeaway capacity enter into service. Meanwhile, coal prices remain depressed in the near short-term as domestic markets remain soft, with a modest price recovery beginning in 2018, while CO_2 prices in the Regional Greenhouse Gas Initiative (RGGI) and California markets grow moderately as caps are tightened through 2020.

Market power prices and demand are expected to experience slight upward price increases over the next few years, based on future operating costs and associated revenue requirements. Increased revenue requirements are due to rising replacement and retrofit costs imposed by the Mercury and Air Toxic Standards (MATS) regulation as well as by declining LAC and LANL reserve margins that compel new builds. Capital costs for thermal and renewable technologies are expected to increase at a moderate pace. This results in increased costs for labor as the unemployment rate remains at a relatively competitive five percent and higher borrowing costs from rising interest rates, but tempered by lower costs for material as commodity prices remain broadly lower.

Coal plant retirements were high in 2016 driven by regulation including MATS, but continue at a comparatively much more moderate pace in the next few years. Meanwhile, capacity additions in the form of efficient natural gas combined cycle plants continues at a healthy pace as merchant plants and utilities continue to take advantage of actual and expected low gas prices.

Medium-Term (2020-2025)

The Base Case assumes that most states will opt for a mass-based Clean Power Plan compliance approach due to the expected broader trading opportunities and as this is seen as a more optimal compliance approach for coal heavy states relative to the rate-based approach alternative. Specifically:

- It is considered simpler and easier to administer than a rate-based plan;
- Retirements of older inefficient plants that are occurring regardless of the CPP can be counted toward compliance; and
- States will feel pressure to join together to create the most liquid market and largest possible pool of trading partners for emissions reductions.

In the medium-term, demand-side management and energy efficiency mostly offset the theoretical growth in energy sales from a growing residential customer base. Natural gas prices at the Henry Hub do increase to $4/MMBtu and above as markets tighten significantly on the Gulf Coast. Midwest gas prices continue to benefit from proximity to the Utica and Marcellus shale plays, helping to keep gas price growth to a more moderate level. Coal prices recover most strongly in the Illinois Basin to 2020, with more modest recoveries in the Appalachian region and the Powder River Basin, due to consolidation among producers, lowered production that tightens supply, and a modest export market.

CO_2 prices in California and in Northeast states participating in RGGI harmonize with the broader U.S. market as the CPP compliance period begins in 2022. Given that the CPP allows for interim goals for compliance, CO_2 prices are expected to increase moderately as states adapt to the compliance regime and carbon markets have time to adjust.

Market power prices continue to move upward moderately as the CPP compliance period begins, as fuel costs increase incrementally with new export demand markets, as the customer base continues to grow, and as operating costs continue to rise. Commodity markets recover in the medium-term, pushing up material costs and consequently capital costs. In addition, as the overall economy continues to make improvements and the unemployment rate remains around five percent, capital costs rise as competitive upward pressure remains on labor costs.

Coal-plant retirements mean no emissions from retired plants, which contribute to lowering total emissions under a mass-based regime. Through the years after the CPP goes into effect in 2023, coal plant retirements will continue to be driven by plant-specific going-forward economics. Meanwhile, capacity additions largely come from NGCC, solar, and wind facilities.

Long-Term (2026-2040)

To 2040, the suite of market outcomes and drivers in the Base Case settle into a pattern of moderate growth based on a well-balanced market. Markets have sufficient time to adapt and adjust as the final CPP goal in 2030 nears and as regulation is expected to be extended to 2040 and beyond, helping keep CO_2 prices reasonable if growing. Energy demand grows as electric car sales take hold but are offset by continued gains in distributed generation and energy efficiency measures. Domestic shale gas and coal resources help to keep fuel cost growth to a moderate level. Capital costs increase at a measured pace as the GDP growth rate averages two percent or more. And capacity additions and retirements continue at a reasonable rate as the fleet of power plants maintains a healthy rate of turnover.

The Base Case reflects LAC and LANL base line expectation of the overall future macro-economic, regulatory and technological environments. It does not reflect larger disruptive influences that would impact WECC or the nation in general. As a result the Base Case forms a good basis for studying the impacts of future developments that are particular to LAC and LANL.

HIGH CASE

The High Case, i.e., High Regulatory/ Low Economy scenario envisions a future with an intrusive regulatory atmosphere across broad segments of the economy, and puts significantly more emphasis on mandates and command-and-control than what is currently seen. The Low Economy/High Regulatory scenario assumes:

- A generally higher cost for compliance with carbon control regimes, in part from less coordination among states that results in a mix of rate-based and mass-based compliance, but with many states not opting in to a national EPA backed program and in general more state-by-state command and control efforts for CO_2 emissions;
- Higher level of mandatory renewable energy penetration which pushes up capital cost.
- Additional environmental regulations causing higher carbon prices than the base case scenario
- Greater adoption of distributed generation in the form of solar and Combined Heat and Power (CHP);
- Restrictions on fracking and fugitive methane emissions that limit gas supply growth, drive up gas prices, and result in an additional push and economic case for renewable energy; and
- Low economic growth that provides justification and room for greater regulation.

Short-Term (2017-2019)

In alignment with the aims of the incoming administration, short-term markets will largely resemble the drivers in the Base Case. However, the stage is being set for greater market intervention in the medium- and long-term. The U.S. economy will continue to expand, albeit with signs that mid-term economic growth may be slower than in the Base Case. The customer base continues to grow, including among large commercial and industrial customers, with some initial attention being paid to the contribution from large-scale industrial facilities to carbon emissions.

Natural gas prices remain near current levels in the very short-term, forcing operators to continue to innovate to drive up efficiencies and drive down production costs or face bankruptcy. An ever greater share of U.S. gas production comes from shale gas, which is highly concentrated in Ohio, Pennsylvania, and West Virginia and thus susceptible to any potential interruption or curtailment of gas production growth out of this region. Coal prices remain depressed as in the Base Case but with an economic outlook for coal-fired generation in the mid-term that appears to be increasingly regulated. Meanwhile,

CO_2 prices in the California and RGGI markets begin to move upward in anticipation that these programs will be CPP compliant in the medium term.

Market penetration of solar and wind generation continues to grow at a fast rate, albeit from a relatively small base, with state- and federal-level mandates supporting their implementation through relatively inefficient and costly market mechanisms (e.g., net metering). As a result, a full recovery of costs to maintain national transmission and distribution grids remains difficult and underinvestment continues in modernizing the underlying power grid infrastructure. This manifests itself in continued interface limitations and price separations between ERCOT, the Eastern and the Western synchronous grids in the U.S. despite the potential expansion of some regional RTOs across grid boundaries.

In the short-term, these market forces do not indicate an overly heavy interventionist hand from the state. However, they do presage a higher regulatory level to come in the medium- to long-term as the economy grows relatively weakly, market power prices rise, and the state makes moves to intervene in an attempt to stabilize markets.

Medium-Term (2020-2025)

At the beginning of the CPP compliance period, little progress has been made among states to opt into efficient national trading mechanisms. States seek compliance individually or on a regional basis that results in the need for higher cost emission reductions and increases the overall compliance cost of the program. Power markets are also constrained by higher gas costs stemming from increased regulation on natural gas fracking and fugitive methane emissions from distribution pipelines and drilling operations. Environmental concerns over fracked gas (e.g., induced seismology, contaminated well sites) and a sustained public affairs campaign lead to national restrictions, higher production costs, and a lower supply base for natural gas. Export restrictions on oil, gas, and coal are reinstated or increased.

Coal-fired generation is highly disfavored due to tightening restrictions on plant emissions, leading to higher costs for coal-fired generation that results higher coal-fired plant retirements. The coal demand falls below critical levels, forcing rounds of mine closures and producer consolidations, which lead to higher coal prices from remaining coal suppliers.

The U.S. economy undergoes another major market correction and resulting recession, leading to sweeping market interventions that include reforms such as mandated improvements to energy infrastructure whose costs are passed along to consumers. This leads to a high rate of retirement of coal plants, replaced by costly renewables that require commensurate and costly investment in energy storage. It also includes costly upgrades to transmission and distribution (T&D) infrastructure to guard against cyberattacks. Strong targets for distributed generation penetration, energy conservation, demand-side management, and energy efficiency lead to increased costs and higher electricity rates for existing utility customers.

Long-Term (2026-2040)

The Low Economy/High Regulatory Scenario continues into the 2030s as de-carbonization efforts become ever more intensified and target all areas of the traditional energy market. A new round of global climate talks is successful and includes binding targets, which precipitates an ever increasing regulatory role of the government in the energy sector that help to keep CO_2 and power prices high.

However, toward the end of the forecast period, the scale of renewable penetration is such that fuel costs begin to move downward once again as fuel costs become less important and capital costs decline with massive economies of scale for renewable production and an efficient labor force experienced in distributed generation. The U.S. market experiences a period economic and load growth.

LOW CASE

The Low Case, i.e., Low Regulatory/ High Economy scenario is characterized by a robust and growing U.S. economy that keeps upward pressure on all of the major market outcome categories, including load growth, fuel costs, power prices, and capital costs. This growth is in the absence of a major technological breakthrough. Existing generation resources are needed to maintain this economic expansion, limiting the number of retirements while accelerating the number of capacity additions.

In addition, this scenario is characterized by an overarching laissez-faire attitude in which few new regulatory restrictions are put forward and those that are currently in motion (e.g., CPP) are delayed, scrapped, or implemented with less aggressive targets, consistent with sentiment expressed by the incoming administration. In this scenario there is no CO_2 price.

Short-Term (2016-2018)

In the next few years, the U.S. economy makes substantial gains in reducing the unemployment level while creating new jobs that bring discouraged workers back into the work force. The housing market continues to improve as do the commercial and industrial sectors. Commodity costs remain low in the short-term, helping to fuel this period of continued economic expansion. All planned capacity additions move forward in a timely manner, while fewer and fewer coal plants announce a planned retirement due to economic or regulatory conditions. In the short-term, regulation continues in a business-as-usual manner.

Medium-Term (2019-2025)

While the short-term outlook in this scenario began with many positive indicators that continue into the medium-term, the expansion of the economy becomes a partial victim of its own success. In other words, the strong economic growth in the U.S. market helps to push energy sales higher, which in turn pushes underlying fuel and capital costs higher. Accordingly, what began as very strong growth begins to become more restrained toward the end of the medium-term. As this balance is achieved in the medium- to long-term, fuel prices and capital costs reach a plateau that can be characterized as moderate.

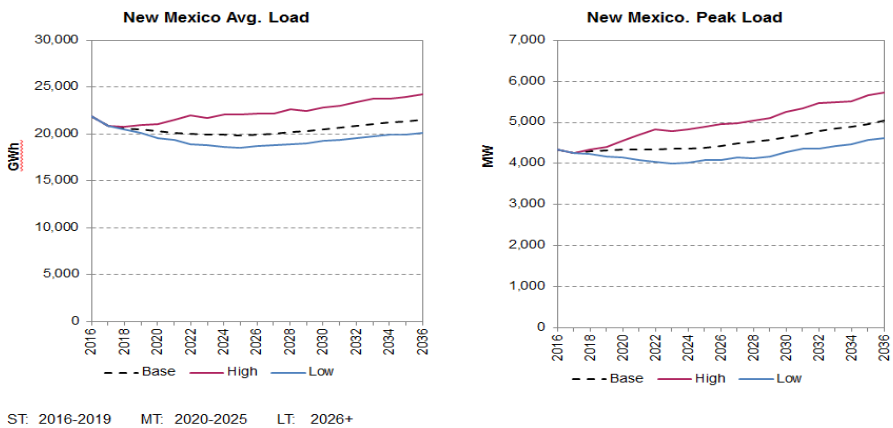
Existing technology continues to remain very important to maintaining the high rate of load growth. Accordingly, very few coal, gas, or other plants are retired for economic or regulatory reasons, while new plants are added on a relatively consistent basis.

Long-Term (2026-2040)

In the long-term, global economic activity begins to increase as developing markets such as India move to the forefront and drive growth. This global growth begins to apply upward pressure to global LNG and coal costs as well as commodity costs for materials, which in turn drives up market power prices here in the U.S. Energy sales growth remains strong, as do capacity additions, but tighter global markets put upward pressure on several of the other market outcomes. As a result, the long-term outlook in the High Economy/Low Regulatory scenario begins to push toward an era of high prices, high costs, high capacity additions, and high load growth. Given that the economy is doing well in this scenario in the long-term, market regulators feel they have greater latitude to implement additional regulations. This provides a modest feedback loop to slightly dampen U.S. GDP growth over time.

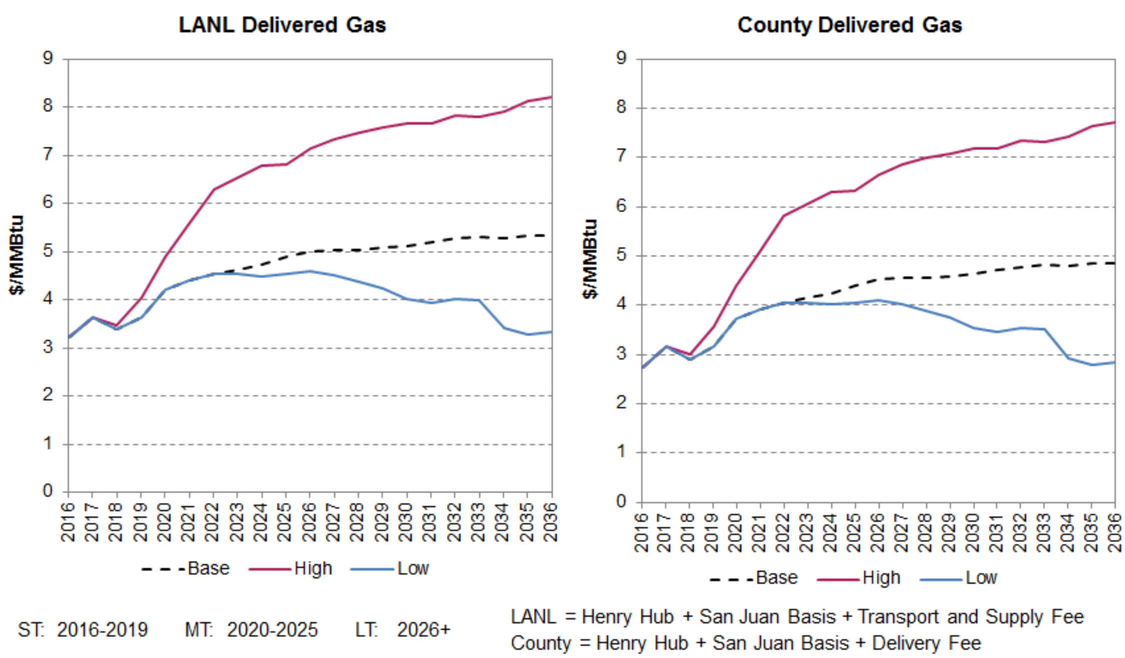
The major market drivers under the Base, High and Low cases, including New Mexico average and peak load, gas, coal, and capital costs are presented in Exhibit 22, Exhibit 23, Exhibit 24, and Exhibit 25.

Exhibit 22: New Mexico Load Assumptions



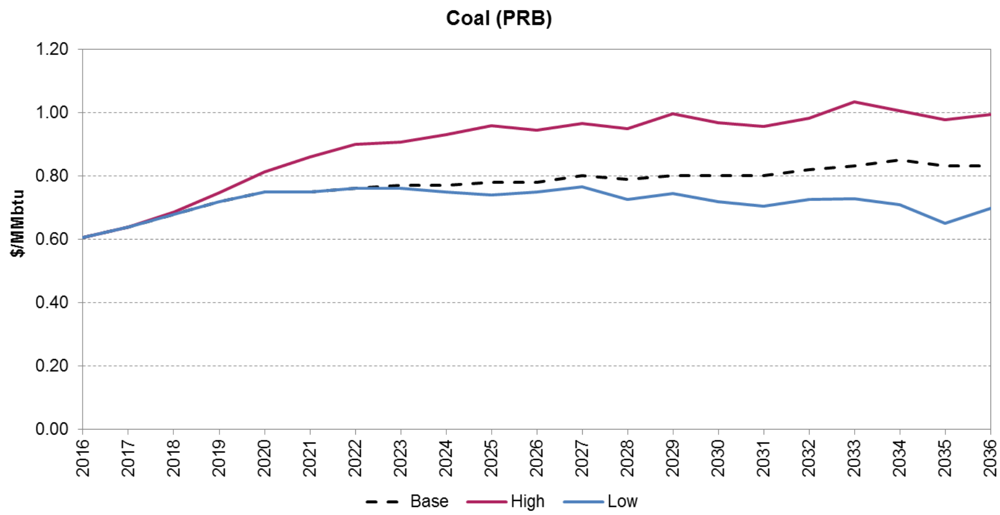
Source: Pace Global.

Exhibit 23: Delivered Gas Price Assumptions



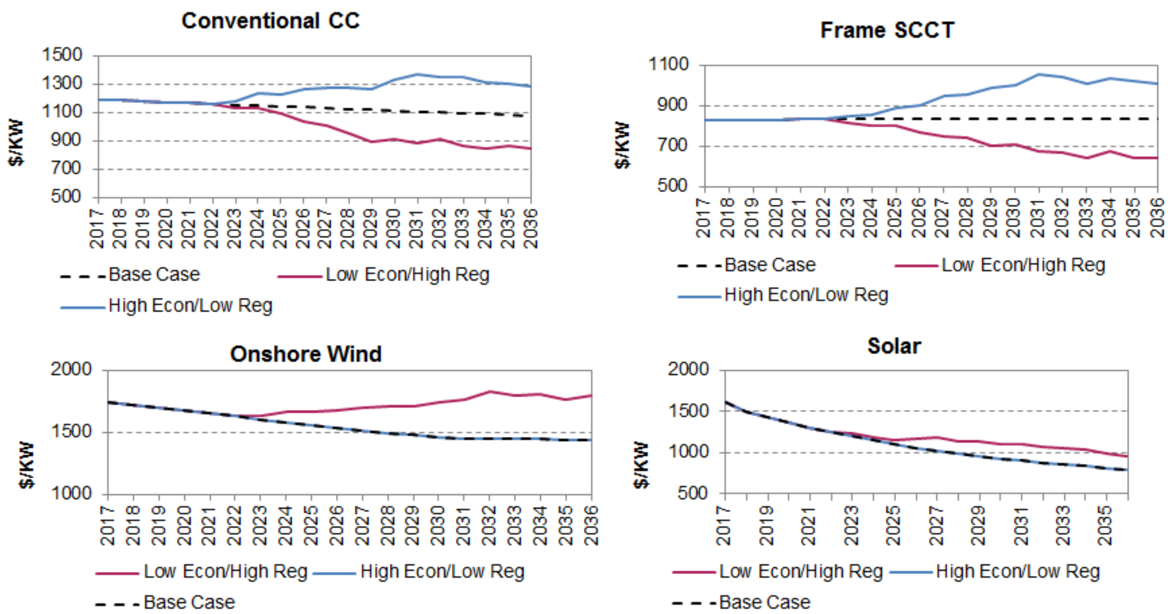
Source: Pace Global, LAC, LANL

Exhibit 24: Market Coal Price Assumptions



Source: Pace Global

Exhibit 25: Capital Costs Assumptions



ST: 2016-2019 MT: 2020-2025 LT: 2026+

Source: Pace Global.

TECHNOLOGY SCREENING

TECHNOLOGY SCREENING CONSIDERATIONS

Pace Global conducted technology screening to identify technically feasible and commercially viable generation resources that could be used as building blocks in constructing generation asset portfolios. For this reason, the technology screening focuses on resource options that could meet Los Alamos Power Pool's new generation resource requirements, including:

- Size of the new generation resource, which is informed by factors including load profile, existing resources retirement, and PPA expiration, etc.
- Resource type: base load, intermediate, intermittent, or peaking resources
- Characteristics: ramping rates, ability to provide voltage support, flexibility
- Fuel type: fossil-fueled or renewable generations
- Local considerations: altitude, pressure, natural wind or solar resources, etc.

The technology selection considered a combination of dispatchable fossil-fueled generation resources and renewable technologies. Fossil-fueled resources included combustion turbines (CTs), combined cycle gas turbines (CCGTs) and Reciprocating Internal Combustion Engines (RICE). For renewables, though both wind and solar are possible in Los Alamos County area, marginal wind resources, attractive solar resources, and rapidly declining solar costs favor solar assets.

Since the capacity and heat rate of gas turbine-based power plants significantly decreases with high altitude and temperature, Pace Global considered LAC's local conditions (approximately 7,320 feet elevation) to derive site specific rated capacity and heat rate of gas-fired turbines.

Performance and costs were estimated for several technologies which could become part of the Los Alamos Power Pool's future power generation portfolio. For each technology, capital costs were estimated to include EPC contract, required owner's costs, and construction financing costs. The estimated capital costs were somewhat higher than might be expected in the broader market areas because (1) the smaller unit size resulted in a diseconomy of scale relative to larger units, and (2) the site elevation conditions resulted in a substantial unit derate for gas turbines, which in turn would require Los Alamos Power Pool to purchase a larger unit at a higher cost than might otherwise be necessary to generate the required capacity.

A variety of gas and renewable technologies were considered and all were sized to meet the Los Alamos Power Pool's potential demand. Adjusted (for local conditions) performance and current capital cost estimates for the technologies are provided as following and are used as the basis for portfolios construction in this IRP.

Finally, when Pace Global selected new generation options for inclusion in portfolios, a particular unit design based on an actual product is chosen as representative of a class of similar units. In all cases, there is at least one additional unit available from a different manufacturer with similar enough characteristics that competitive bidding will be possible at the time a project is implemented.

BASELOAD THERMAL

For baseload thermal, LAC has the option of purchasing a share from existing or new combined cycle plants off the site or build small 1X1 combined cycle on site. Exhibit 26 summarizes the base load combined cycle assumptions.

Exhibit 26: Large and Small Combined Cycle Technology Assumptions

Technology	Ownership Share	Block Size, MW	Site Heat Rate, Btu/kWh net (HHV)	Unit Site Capacity Rating, MW	Capex, Site Rating, 2016$/kW	VOM, 2016$/MWh	FOM, 2016$/kW-yr
Small Aero CC	Full	70	7,177	54	2,961	2	31
Small Frame CC	Full	66	6,770	57	1,816	4	35

Technology	Ownership Share	Block Size, MW	Heat Rate, Btu/kWh net (HHV)	Unit ISO Capacity Rating, MW	Capex, Site Rating, 2016$/kW	VOM, 2016$/MWh	FOM, 2016$/kW-yr
Conventional CC	Partial	790	6,650	790	1,191	3	9

Source: Pace Global.

BASELOAD NUCLEAR SMALL MODULAR REACTORS

Nuclear fission power provides carbon-free baseload power. Many current efforts to develop new reactor technologies and plant designs that are safe and less expensive to build are based on SMNR. LAC recently became a member of the Utah Associated Municipal Power Systems (UAMPS), which serves municipal utilities in eight western states. UAMPS is proposing to develop the Carbon Free Power Project (CFPP), a nuclear power plant, which would be comprised of up to a dozen 50-MW pressurized light water reactor modules at the Idaho National Engineering Laboratory in Idaho Falls. The project plans to be on line by 2026, but the development schedules are uncertain. The cost of the construction is estimated at about 2.8 billion by UAMPs. LAPP has the opportunity to acquire partial ownership (8-16 MW) of the plant, where LAC shares 8 MW. Based on the project developer, the energy-only PPA price is expected to be $56-$62/MWh for a 40-year contract term. DOE has secured $317 million grants to NuScale, and DOE's Loan Programs Office (LPO) has $12 billion in loan guarantee authority available for Advanced Nuclear Energy. Exhibit 27 shows the SMNR technical assumptions for this IRP.

Exhibit 27: CFPP Nuclear Technology Assumptions

Technology	Ownership Share	Block Size, MW	Site Heat Rate, Btu/kWh net (HHV)	Unit Site Capacity Rating, MW	Capex, Site Rating, 2016$/kW	VOM, 2016$/MWh	Fuel Cost, 2016$/MWh	FOM, 2016$/kW-yr
Small Modular Ractors	Partial/PPA	16	10,400	16	6,860	2	8.5	165

Source: LAC, Pace Global.

With consideration of the estimated fuel cost, variable and fixed operating costs, capital cost recovery, and estimated transmission cost at $5.30/MWh for point to point service on Pacific Corps system from Idaho to the San Juan Hub, Pace Global estimated the delivered cost of energy to San Juan Hub at

$71.4/MWh as presented in Exhibit 28. The capital cost is lowered due to the $317 million grant. Capital recovery is estimated at 3 percent interest rate due to low guarantee and municipal interest rate.

In the stochastic analysis, Pace Global created distributions of capital costs to fully evaluate the risks of potential cost overruns. In addition, given that LAC is actively pursuing mitigating the risks associated with the project, Pace Global evaluated the SMNR project with a potential cap of the energy prices at $71.4/MWh (including transmission cost to San Juan Hub).

Exhibit 28: CFPP Estimated Delivery Cost of Energy to San Juan Hub

Project Net Capacity	MW	570
FOM	$/kW-year	165
Capacity Factor	%	90%
VOM	$/MWh	2.1
Fuel Cost	$/MWh	8.5
Capital Cost	$/kW	6,860
Grant	$ million	317
Grant	$/kW	556
Capital Cost after Grant	$/kW	6,304
Capital Recovery over 40 Year	$/kW-year	273
Levelized Cost of Energy	$/MWh	66.1
Transmission Cost to San Juan Hub	$/MWh	5.3
Delivered Cost of Energy	**$/MWh**	**71.4**

Source: LAC, Pace Global.

BASELOAD "FIRM" RENEWABLE RESOURCES

Base load renewable resources including geothermal, solar firmed by battery, and wind firmed by reciprocating engines are considered in this IRP. The amount of solar and wind that could be beneficially used is limited by the storage or fast ramping fossil generation resources available to buffer short term fluctuations in the solar or wind generation profile. Under LAC's current agreements with PNM, which is the balancing authority, the pool incurs penalties any time its power consumption exceeds or falls short of the scheduled amount (day ahead) by 2 MW. In consideration of this, Pace Global considered renewable resources firmed by either battery storage or RICE units.

Geothermal Resources

There are no known geothermal resources underlying LAC and its immediate proximity. A possibility is to consider a PPA with the Cove Fort II, a 40 MW facility proposed by Enel Green Power, with an estimated commercial on line date in 2019. Cove Fort II is planned to be constructed next to Cove Fort I in Beaver, UT. Cove Fort II is in early development stage, with $160 million estimated project costs. Based on indicative discussions, LAC has the potential opportunity to sign PPA at an estimated cost of approximately $75/MWh for a capacity of approximately 16 MW and an estimated capacity factor of 97 percent.

Solar Firmed with Vanadium Flow Battery

Utility scale solar photovoltaic (PV) projects work the best for LANL's load as the peak generation matches the peak load patterns, however, for the LAC load, the peak demand occurs in the evening. Solar power plant, when combined with battery storage, is a more reliable green energy supply that can serve as dispatchable baseload renewable resources. LAC is in early discussions with a developer to provide a 60 MW solar PV system coupled with a 22 MW vanadium flow battery. It is planned to be potentially built on Federal Department of Energy land. The project could be contracted in a form of PPA, with an estimated price of $65/MWh for around-the-clock green energy over 20 years. The firmed solar PPA pricing is in line with Pace Global's expectations with similar technologies. Alternatively, the firming could be achieved through fast ramping gas-fired generation units.

Wind Firmed with RICE

LAC is also considering pairing the Reciprocating Internal Combustion Engine (RICE) with similar sized wind plants to create baseload renewable resources, in the following size considerations: 9 MW RICE with 10 MW wind, and 18 MW RICE with 20 MW wind. RICE units effectively provide a "firming" service to the wind resources. Exhibit 29 presents the baseload renewable technology assumptions for this IRP.

Exhibit 29: Baseload Renewable Technology Assumptions

Technology	Ownership Share	Renewable Block Size, MW	Battery/RICE size, MW	Capex, Site Rating, 2016$/kW	VOM, 2016$/MWh	FOM, 2016$/kW-yr
Geothermal	PPA	16	-	5,097		116
Baseload Solar	PPA	60	22	5,128		27
Baseload Wind Medium	Partial/PPA	10	9	2,969	7	51
Baseload Wind Large	Partial/PPA	20	18	2,717	7	51

Note: Above site capex estimates (2016$/kW) are calculated by using the total capital costs (including battery or RICE) divided by the capcity of the renewable resources.

Source: Pace Global.

PEAK THERMAL GENERATION RESOURCES

To meet LAPP's requirement for peak capacity, LAC considers RICE, Aero simple cycle combustion turbine, and frame simple cycle combustion turbine. While the combustion turbine and gas turbines are impacted by the high elevation, the RICE unit's performances are not significantly impacted by high elevation. Pace Global includes three sizes of RICE units: 5 MW, 9 MW, and 18 MW respectively in the screening analysis. The modular design allows for easy capacity additions and makes it simple to construct an optimally sized plant. Exhibit 30 presents the assumptions for peaking thermal technologies.

Exhibit 30: Peak Thermal Technology Assumptions

Technology	Ownership Share	Block Size, MW	Site Heat Rate, Btu/kWh net (HHV)	Unit Site Capacity Rating, MW	Capex, Site Rating, 2016$/kW	VOM, 2016$/MWh	FOM, 2016$/kW-yr
RICE Large	Full	18	7,686	18	1,227	7	19
RICE Medium	Full	9	7,704	9	1,507	7	19
RICE Small	Full	5	7,723	5	1,787	7	19
Aero SCCT	Full	50	8,056	41	1,426	4	27
Frame SCCT	Full	14	9,490	12	2,001	6	20

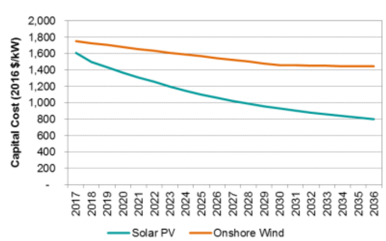
Source: Pace Global.

UTILITY SCALE RENEWABLE RESOURCES

Utility-scale renewables could be built onsite or off-site. LAC has identified nine large sites on the DOE property that could provide space for a peak capacity of more than 80 MW. LAC or LANL could request Power Purchase Agreement from third-party renewable energy developers to utilize the benefits of tax credits. Additionally, renewable projects located on federal land can qualify for double renewable energy credits (RECs) for LANL. Pace expects the cost of renewables, especially solar to decline quickly with time in the future. Exhibit 31 shows solar and wind technology assumptions.

Exhibit 31: Solar and Wind Technology Assumptions

Technology	Ownership Share	Block Size, MW	Unit Site Capacity Rating, MW	Capex, Site Rating, 2016$/kW	FOM, 2016$/kW-yr
Onshore Wind	Partial/PPA	10	10	1,613	33
Solar PV	Partial/PPA	10	10	1,480	21



Source: Pace Global.

Pace Global assumes tax credits based on current legislation. Solar facilities that commence construction prior to January 1, 2020 will qualify for the full amount of the Investment Tax Credit (ITC) at 30 percent; for solar facilities that commence construction during 2020, the amount of the ITC will be reduced to 26 percent; for solar facilities that commence construction during 2021, the amount of ITC will be reduced to 22 percent; and for solar facilities that commence construction during 2022 and after, ITC will be reduced to 10 percent. For wind projects that begin construction in 2017, the production tax credit (PTC) is at 80 percent of full value; in 2018, 60 percent PTC; and in 2019, 40 percent PTC.

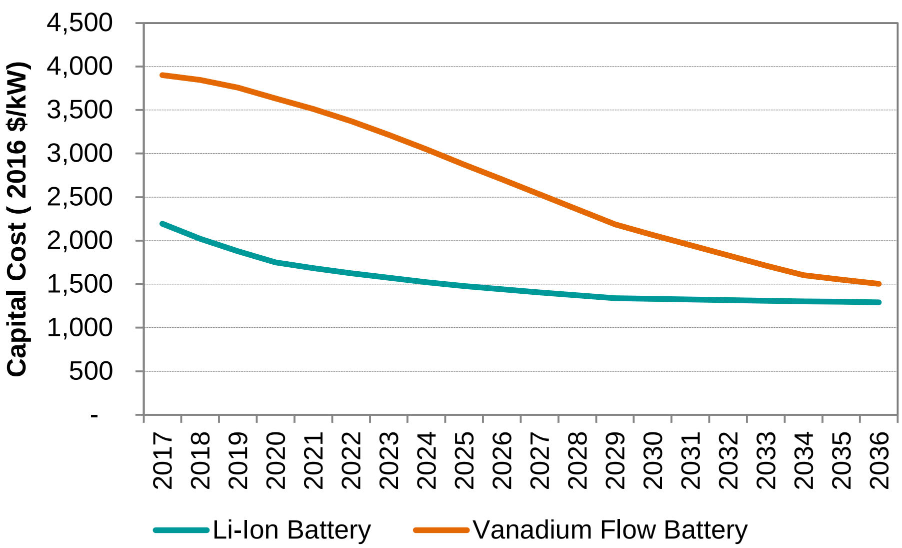
UTILITY SCALE STORAGE TECHNOLOGIES

Storage systems provide various benefits, such as deferring transmission and distribution buildout, increasing renewable integration, providing ancillary services, and so on. Despite the declining cost, batteries are still very expensive for utility scale storage. With more mandates to increase renewable generation and increased application of storage, the costs may decline considerably as battery production increases. If the cost competitiveness and performance improves, batteries could become a viable solution.

For this IRP, Pace Global considered both static and flow batteries. For static batteries, Pace Global considered lithium-ion (Li-ion) batteries, which features a high discharge rate, but require a fairly long time to recharge. For flow battery, Pace Global considered vanadium flow battery. Exhibit 32 presents the assumptions of the battery storage.

Exhibit 32: Battery Storage Technology Assumptions

Technology	Ownership Share	Block Size, MW	Capex, Site Rating, 2016$/kW	FOM, 2016$/kW-yr
Li-Ion Battery	Full	1 MW	2,018	27
Vanadium Flow Battery	Full	1 MW	3,588	30



Source: Pace Global.

We understand that PUC members have interest in exploring local pumped hydro storage options. However, cost of pumped hydro storage project varies widely depending on existing infrastructure and geological conditions. An engineering assessment of the probable cost of any specific pumped hydro storage project is out of the scope of this IRP assessment and pumped hydro storage project is excluded from this IRP analysis.

Integrated gasification combined cycle (IGCC), which uses a high pressure gasifier to turn coal into syngas and burns the syngas to drive a turbine is not considered in the LAC IRP study due to high cost and uncertainty of the commercial viability in today's market.

DETERMINISTIC PORTFOLIOS ASSESSMENT

The deterministic analysis are set to (1) to evaluate the best candidate portfolio resources under the three "state of the world" scenarios which are discussed in previous section; and (2) to address several questions that will set the foundation to construct the candidate stochastic portfolios. The questions addressed in the deterministic analysis include:

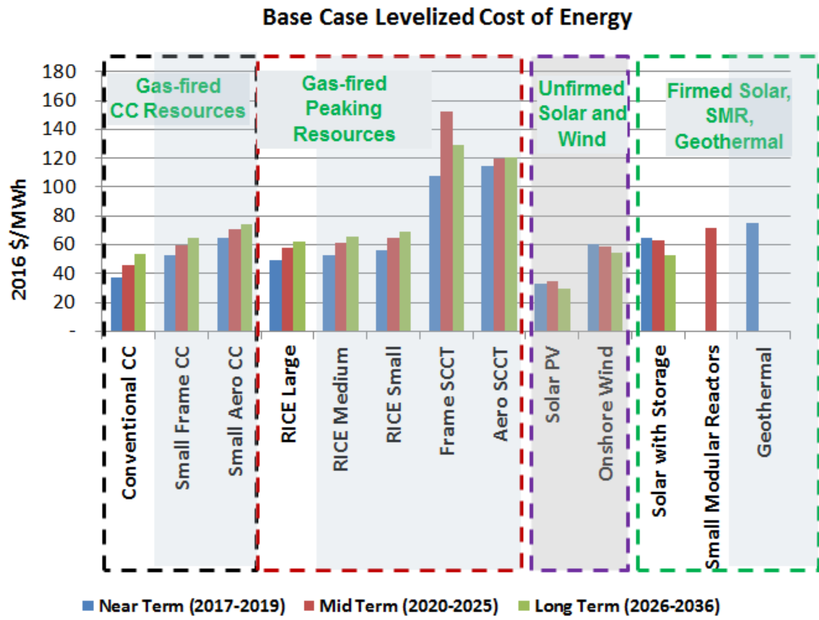
- SJGS 4 retirement
- LRS exit strategy
- Post 2025 ECA evaluation
- SMNR assessment
- Cost of freezing new build and relying on market purchases
- Cost of carbon neutral compliance

LEVELIZED COST OF ENERGY ASSESSMENT

As part of the deterministic analysis, Pace Global performed a levelized cost of electricity (LCOE) analysis of all candidate portfolio resources. LCOE measures the overall competiveness of different generating technologies. Key inputs to calculating LCOE include capital costs, fuel costs, fixed and variable operations and maintenance (FOM and VOM) costs, financing costs, and an assumed the capacity factor for each generation technology type given LAC local conditions.

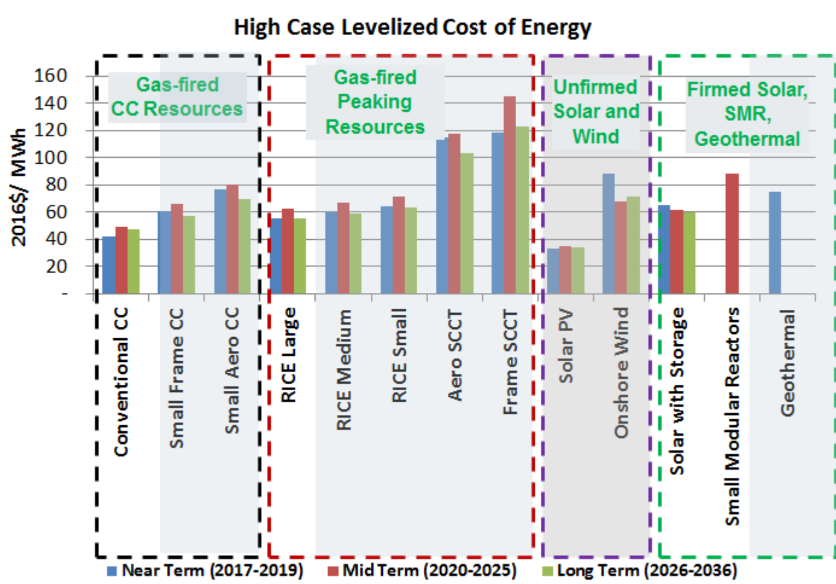
Exhibit 33 presents the LCOE for four different types of new resources, including gas-fired combined cycle resources, gas-fired peaking resources, unfirmed renewable resources, firmed renewable resources and SMNR under Base Case. Exhibit 34 and Exhibit 35 present the High Case and Low Case separately.

Exhibit 33: Base Case Levelized Cost of Energy



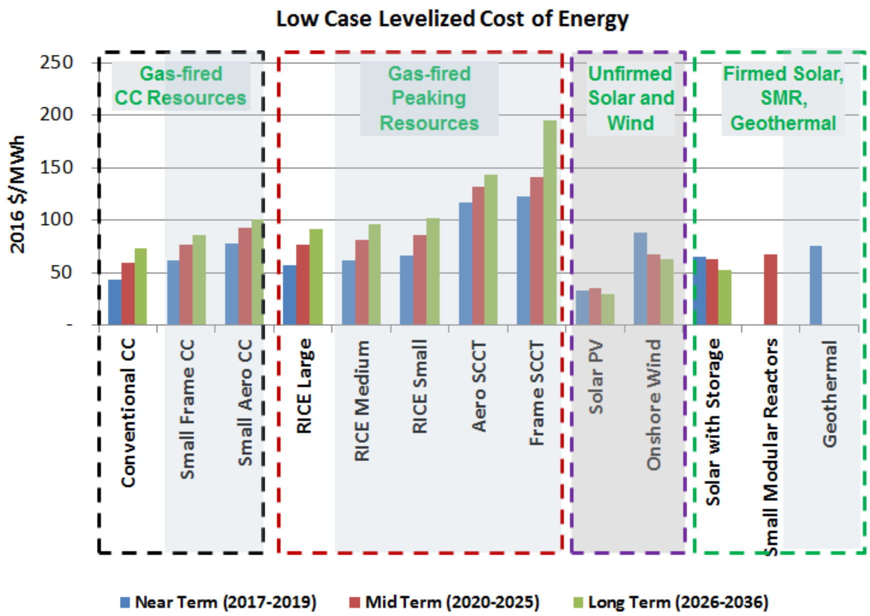
Source: Pace Global.

Exhibit 34: High Case Levelized Cost of Energy



Source: Pace Global

Exhibit 35: Low Case Levelized Cost of Energy



Source: Pace Global.

Pace Global further evaluated the new resource candidates under the high, base, and low cases in two separate groups: (1) gas-fired generation resources; and (2) SMNR and renewable energy resources. Exhibit 36 presents the levelized cost of energy summary of all resources under the Base, High and Low cases. Resources that performed well with low LCOE under the high, base and low cases received green light rating; resources with medium LCOE under the high, base and low cases received yellow light rating; resources with high LCOE under the high, base and low cases received red light rating.

In conclusion, the large conventional combined cycle performs the best from a cost perspective under all three scenarios, followed by RICE units in Base and Low Cases, and small frame combined cycle unit in the High case. In terms of renewable generation, solar with storage performs the best from a cost perspective under all three scenarios, followed by small modular reactor in Base and Low Cases, and geothermal in the High Case.

The large combined cycle, RICE units, solar with storage and SMNR are the resources that got either a green light or yellow light ranking in the LCOE analysis and are used to construct the stochastic portfolios.

Exhibit 36: Levelized Cost of Energy Summary

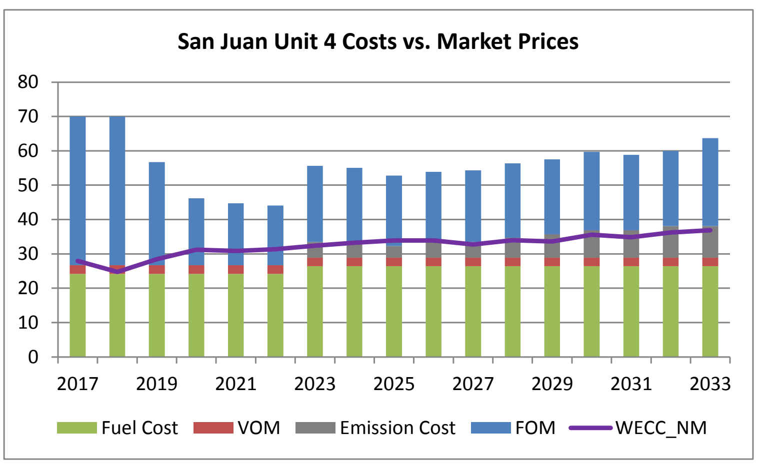
Gas-fired Generation Resources			
High Case	**Base Case**	**Low Case**	**Ranking/ Rational**
Conventional CC	Conventional CC	Conventional CC	Low LCOE
Small Frame CC	RICE Medium	RICE Medium	Medium LCOE
Small Aero CC	Small Aero CC	Small Aero CC	High LCOE
RICE Large	RICE Large	RICE Large	Low LCOE
RICE Medium	Small Frame CC	Small Frame CC	Medium LCOE
RICE Small	RICE Small	RICE Small	High LCOE
Aero SCCT	Frame SCCT	Aero SCCT	High LCOE
Frame SCCT	Aero SCCT	Frame SCCT	High LCOE
SMNR and Renewable Generation Resources			
High Case	**Base Case**	**Low Case**	**Ranking/ Rational**
Solar with Storage	Solar with Storage	Solar with Storage	Firmed, Low LCOE
SMNR	SMNR	SMNR	Medium to High LCOE
Geothermal	Geothermal	Geothermal	High LCOE
Solar PV	Solar PV	Solar PV	Unfirmed
Onshore Wind	Onshore Wind	Onshore Wind	Unfirmed, high LCOE

Source: Pace Global.

SJGS 4 RETIREMENT

SJGS 4 incurs high fixed costs and is not economic to dispatch under current market conditions. Exhibit 37 shows the SJGS 4 costs and market prices comparison.

Exhibit 37: SJGS 4 Costs and Market Prices Comparison

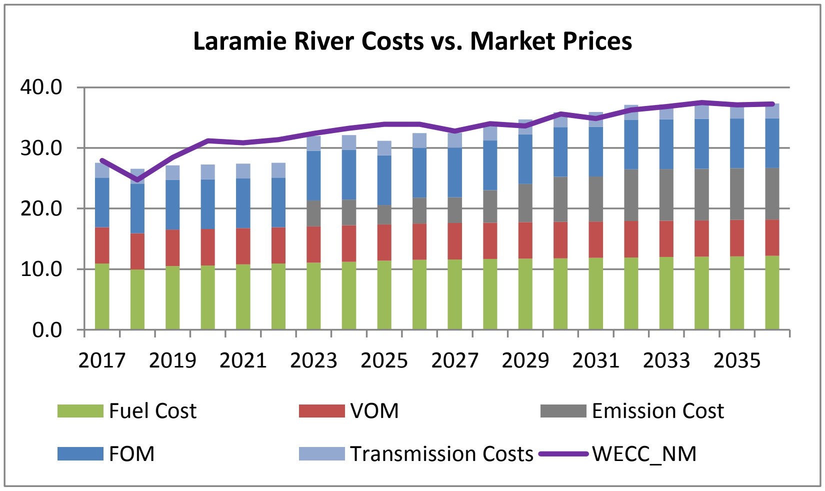


Note: SJGS 4 runs at minimum level during 2017-2033.
Source: Pace Global.

LRS EXIT STRATEGY

On the other hand, as a must-run unit, LRS costs are on par with market prices as shown in Exhibit 38. This indicates that LAC could hold on to LRS to serve its load.

Exhibit 38: LRS Costs and Market Prices Comparison

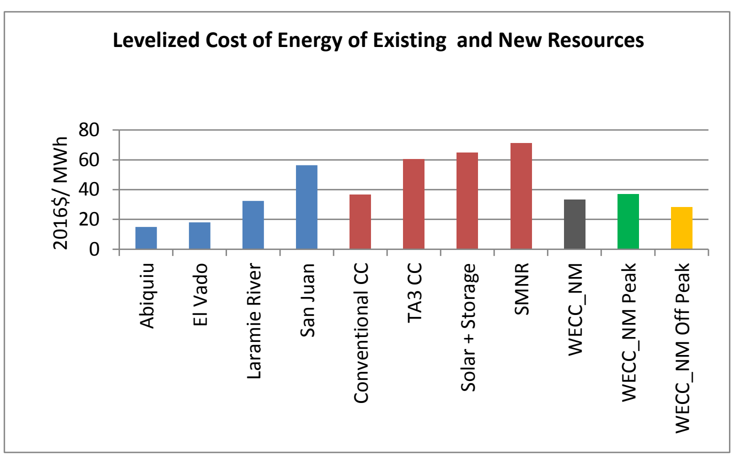


Note: Above costs are based on LRS as a "must-run" unit during 2017-2036.
Source: Pace Global.

LEVELIZED COST OF ENERGY OF EXISTING AND NEW RESOURCES

In summary, Exhibit 39 shows the LCOE of existing and select new resources relative to average WECC New Mexico prices during the IRP horizon. It should be noted that the average, peak and off peak WECC New Mexico prices shown in this chart do not include any premium or fees on block power purchases.

Exhibit 39: Levelized Cost of Energy of Existing and New Resources



Note: The average WECC New Mexico prices do not include any premium on block power purchases.
Source: Pace Global.

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POST 2025 ECA STRATEGY

LAC and LANL have pooled their generation resources under the ECA and shared the power outputs according to the LANL and LAC loads. The current ECA term is through June 30, 2025. Pace Global constructed portfolios to evaluate the strategy for LAC and LANL to move forward post 2025 as shown in Exhibit 40. The preliminary analysis shows that ECA extension post 2025 provides lower NPV costs for LAPP during the study period. However, LANL benefits from joint operation while LAC benefits from separation, suggesting a win-win with a different allocation scheme.

It should be noted that additional analysis should be conducted once some major uncertainties are resolved; LAC and LANL have finalized the Preferred Resource Plan identified through the stochastic analysis.

Exhibit 40: Combined Portfolio More Economic Than Split Portfolios

Portfolio	LAPP New Builds	Average Reserve Margin (2017-2036)	Total NPV Costs ($2016 Thousand)
D6 Base Portfolio	**Large CC:** • 2022- 50 MW • 2031- 30 MW **Solar with Storage**: • 2017- 13 MW • 2025- 8 MW • 2030- 6 MW	LAPP Summer:17% LAPP Winter: 3%	LAC : $ 63,993 LANL: $ 346,634 **Total : $ 410,627**
D7.1 (Split – LAC)	**Large CC:** • 2023- 5 MW **Solar with Storage:** • 2017- 3 MW; 2030- 6 MW	LAC Summer:85% LAC Winter: 9%	LAC: $ 56,883
D7.2 (Split – LANL)	**Large CC:** • 2023- 60 MW • 2031- 15 MW **Solar with Storage:** • 2017- 10 MW; 2025- 7 MW	LANL Summer:2% LANL Winter: 3%	LANL: $ 359,935
D7 (LAC + LANL)			LAC : $ 56,883 LANL: $ 359,935 **Total : $ 416,819**

Source: Pace Global.

SMNR INVESTMENT ANALYSIS

The Carbon Free Power Project (CFPP) sponsored by the Utah Associated Municipal Power Systems (UAMPS), which serves municipal utilities in eight western states. UAMPS proposed to build a nuclear power plant, which would be comprised of up to a dozen 50-MW pressurized light-water reactor modules, referred to as the NuScale Power Module (NPM) at the Idaho National Engineering Laboratory in Idaho Falls. Each of the 12 NPM will have its own dedicated steam turbine generator.

The project plans to be on line by 2026, but the development schedules are uncertain due to its “First of a Kind” design and other important development milestone hurdles such as Environmental Impact Statement, water rights acquisition, transmission solution, member subscription, and financing that are yet finalized.

The cost of the construction is estimated at about 2.8 billion by UAMPs. LAPP has the opportunity to acquire partial ownership (8-16 MW) of the plant, where LAC shares 8 MW. CFPP could provide clean baseload power to replace the coal fired generation in meeting energy demand and the 2040 carbon neutral goal.

Based on UAMPS' estimate, the energy-only PPA price is expected to be $56-$62/MWh for a 40-year contract term. DOE has secured $317 million grants to NuScale, and DOE's Loan Programs Office (LPO) has $12 billion in loan guarantee authority available for Advanced Nuclear Energy.

Pace Global constructed portfolios to evaluate the cost impact of pursuing the SMNR investment and found that the SMNR investment results in marginally (about 4 percent) higher costs in the Base Case. This initial analysis shows marginally higher cost to participate in CFPP SMNR project due to higher delivered cost of energy including transmission costs. This warrants further analysis in the stochastic portfolios.

Exhibit 41: SMNR Investment Analysis (Base Case)

Portfolio	LAPP New Builds	Average Reserve Margin (2017-2036)	2017-2036 NPV Costs ($2016 Thousand)
D6 Base Portfolio	**Large CC:** • 2022- 50 MW • 2031- 30 MW **Solar with Storage**: • 2017- 13 MW • 2025- 8 MW • 2030- 6 MW	LAPP Summer:17% LAPP Winter: 3%	$ 410,627
D8 (with SMR)	**Large CC:** • 2023- 50 MW • 2031- 14 MW **Solar with Storage**: • 2017- 13 MW • 2025- 4 MW **Nuclear**: • 2026- 16 MW	LAPP Summer:19% LAPP Winter: 5%	$ 425,032

Source: Pace Global.

MARKET PURCHASES

The Board of Public Utilities (BPU) wanted to assess the impact of relying on market purchases for energy. Pace Global constructed portfolios to evaluate the cost impact of freezing new builds and relying totally on market purchases to meet incremental load over the planning horizon as shown in Exhibit 42. The result shows that relying on market purchases results in lower NPV costs in the current low market price environment. However, freezing new builds not only compromises LAC and LANL's goals of increasing renewable generation, but also results in unacceptable negative reserve margins to reliably serve load.

It should be noted that relying on market purchases could involve several strategies, depending on the buyer's risk tolerance levels. A fully indexed spot purchase strategy that has the energy pricing tied to spot market offers flexibility to take advantage of market fluctuations, but very little budget certainty. Alternatively, a fixed energy pricing strategy involves engaging in counterparty to lock in power purchase prices. While this approach relieves the budget uncertainty, it typically involves a premium to the supplier to hedge the supplier's market risk.

Exhibit 42: Tradeoff of Relying on Market Purchases

Portfolio	LAPP New Builds	Average Reserve Margin (2017-2036)	2017-2036 NPV Costs ($2016 Thousand)
D6 Base Portfolio	**Large CC:** • 2022- 50 MW • 2031- 30 MW **Solar with Storage**: • 2017- 13 MW • 2025- 8 MW • 2030- 6 MW	LAPP Summer:17% LAPP Winter: 3%	$ 410,627
D10 (no new builds)	No Builds	LAPP Summer: -25% LAPP Winter: -40%	$ 365,627

Source: Pace Global.

SPINNING RESERVE

LAPP currently purchases spinning reserves from the balancing area, with estimated costs of $18 to $22/MW. Assuming an average price of $20/MW, a spinning reserve requirement of 7 MW amounts to over $1 million costs.

System operators typically require a specific level of operating reserves to have generators available within a short period of time to meet demand in case of supply or demand interruptions. These reserves could be provided through plants that are operating below full capacity (spinning reserves) as well as through plants that are not currently operating but that can be brought online quickly (non-spinning reserves).

The spinning reserves are intended to help the system respond quickly (within 10 minutes) to forced outages or other contingency events. It is synchronized with the grid and must be able to run for at least one hour. With increasing intermittent resources such as wind and solar as well as distributed generation projected to be added in the WECC region, the demand for spinning reserve is expected to rise, further driving up the cost of spinning reserves.

Based on Pace Global's estimates, building medium sized RICE units on site could provide spinning reserve at similar costs to market purchases as shown in Exhibit 43.

Exhibit 43: Providing Spinning Reserve with Owned Resources vs. Market Purchases

Estimated Costs of Spinning Reserve Purchase		
Spinning Reserve Requirement	MW	7
Average Price	$/MW	20
Annual Cost of Spinning Reserve	$	$1,226,400

Note: Price of spinning reserve for 2016 ranges $18-22/MW.

Building Medium Sized RICE Unit for Spinning Reserve		
Size	MW	9
Capital Cost	2016$/kW	1,507
Total Costs	2016$	13,562,640
FOM	2016$/kW-year	19
Capital Costs Recovery over 15 Year	2016$MW-year	$1,136,096
All-in Costs of Providing Spinning Reserve	2016$MW-year	$1,155,573

Note: Capital cost recovery is calculated at 3% over 15 years.

Source: Pace Global.

COST OF CARBON COMPLIANCE

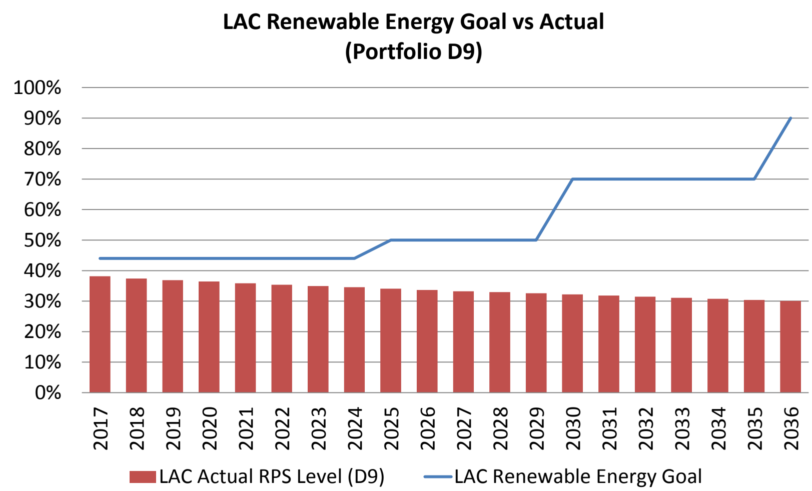
The Board of Public Utilites would like to assess the cost of carbon compliance for LAC. Pace Global's analysis shows that achieving carbon neutral compliance interim goals during the planning horizon results in about $12 Million (or about 3 percent) higher costs than the No Carbon Neutral Least Cost Portfolio as shown in Exhibit 44. However, the No Compliance Portfolio falls far short of Carbon Neutral Goal by 2040 as shown in Exhibit 45.

Exhibit 44: Cost of Carbon Neutral Compliance

Portfolio	LAPP New Builds	Average Reserve Margin (2017-2036)	2017-2036 NPV Costs ($2016 Thousand)
D6 Base Portfolio	**Large CC:** • 2022- 50 MW • 2031- 30 MW **Solar with Storage**: • 2017- 13 MW • 2025- 8 MW • 2030- 6 MW	LAPP Summer:17% LAPP Winter: 3%	$ 410,627
D9 (no Carbon Neutral Goal for LAC)	**Large CC:** • 2023- 50 MW • 2030- 37 MW **Solar with Storage:** • 2017- 10 MW • 2025- 5 MW	LAPP Summer:15% LAPP Winter: 1%	$ 397,980

Source: Pace Global.

Exhibit 45: Deterministic Portfolio 9 - Carbon Neutral Actual Level vs. Goal



Source: Pace Global.

STOCHASTIC ASSESSMENT OF CANDIDATE PORTFOLIOS

STOCHASTIC PORTFOLIOS CONSTRUCTION

Based on the findings of the deterministic assessment, the following assumptions were made in selecting final portfolios:

- San Juan retires in 2022
- The ECA is extended through the planning horizon
- Both LAC and LANL renewable requirements are met

The deterministic analysis came up with a "least cost" portfolio for the base case, which consisted of a key assumption that resource capacity would meet load. This portfolio was one of the portfolios considered in the final risk analysis. But we constructed other portfolios to test other objectives, such as whether a more diverse portfolio or whether portfolios with less capital expended that relied more heavily on the market were more effective. Finally LAC wanted to test whether "capped" or uncapped SMNRs would diversify and reduce the expected cost and risk of the portfolio.

LAC along with the other UAMPS members participating in the CFPP set a cap on the potential cost of energy in $/MWh from the SMNR project. Based on the current market conditions, the price ceiling is set at $65/MWh. This cap could move up or down responding to changing market drivers and will be considered before committing to the SMNR project along with mitigating other risks associated with the development of first of a kind small modular nuclear power plant.

Pace Global and LAC developed 11 stochastic portfolios as shown in Exhibit 46 test each of these issues over a wide range (200 iterations) of market conditions. Below is a summary of the key features of the stochastic portfolios.

- S1 and S2 include purchasing a share of large CC and contracting for onsite solar with storage. S1 has more capacity than the peak load; and S2 has less capacity than the peak load.
- S3 and S4 include onsite RICE to test the benefit of ownership and control.
- S5, S6 and S7 all includes SMNR to evaluate how a diversified portfolio with SMNR performs.
- S8, S9 and S10 are renewable and clean energy centric portfolios that only build enough renewable and clean resources to meet LAC and LANL renewable requirements. S8 builds onsite RICE units to firm the onsite solar PV; S9 contracts for onsite solar with storage; and S10 contracts for SMNR in addition to onsite solar with storage.
- S11 builds enough capacity matches the peak load, but LAC is out of compliance with renewable requirement.

Exhibit 46 provides a summary of the 11 stochastic portfolios. Detailed profile of each stochastic portfolio is presented in Appendix B.

Exhibit 46: Candidate Stochastic Portfolios

Focus	#	Capacity	New Builds
Least Cost	S1	Long	**Large CC (offsite):** 2023- 60 MW; 2031- 30 MW **Solar with Storage (onsite):** 2017- 13 MW; 2025- 8 MW; 2030- 6 MW
	S2	Short	**Large CC (offsite):** 2023- 50 MW **Solar with Storage (onsite):** 2017- 13 MW; 2025- 8 MW; 2030- 6 MW
Ownership Control	S3	At Load	**Large RICE (onsite):** 2023- 18 MW X 3; 2031- 18 MW **Solar with Storage (onsite):** 2017- 13 MW; 2025- 8 MW; 2030- 6 MW
	S4	At Load	**Large CC (offsite) and RICE (onsite):** 2023- 50 MW CC; 2031- 18 MW RICE **Solar with Storage(onsite):** 2017- 13 MW; 2025- 8 MW; 2030- 6 MW
Diversified Portfolios with SMR	S5	At Load	**Large RICE (onsite):** 2023- 18 MW X 3; 2031- 18 MW; **Solar with Storage (onsite):** 2017- 13 MW; 2025- 4 MW **Nuclear (offsite):** 2026- 16 MW
	S6	At Load	**Large CC (offsite) and RICE (onsite):** 2023- 50 MW CC; 2031- 18 MW RICE **Solar with Storage (onsite):** 2017- 13 MW; 2025- 4 MW **Nuclear (offsite):** 2026- 16 MW
	S7	Short	**Large CC (offsite) and RICE (onsite):** 2023- 20 MW CC; 2031- 18 MW RICE **Solar with Storage (onsite):** 2017- 13 MW; 2025- 4 MW; **Nuclear (offsite):** 2026- 16 MW
Renewable-Focused New Builds	S8	Short	**Large RICE**: 2017- 18 MW; 2025- 18 MW; 2030- 18 MW **Solar PV**: 2017- 25 MW; 2025- 25 MW; 2030- 25 MW
	S9	Short	**Solar with Storage (onsite)**: 2017- 13 MW; 2025- 8 MW; 2030- 6 MW
	S10	Short	**Solar with Storage (onsite)**: 2017- 13 MW; 2025- 4 MW **Nuclear (offsite)**: 2026- 16 MW
Cost of Compliance	S11	At Load	**Large CC (offsite):** 2023- 50 MW; 2031- 37 MW **Solar with Storage (onsite):** 2017- 10 MW; 2025- 5 MW

Source: Pace Global.

STOCHASTIC INPUTS

The stochastic analysis was performed to determine which portfolio performed most consistently with all of the prescribed metrics over a wide range of futures. Probabilistic distributions were developed for each of the key market drivers, each of which was uncertain:

- Load
- Fuel Costs
- Carbon prices
- Capital costs for technologies
- Power prices (resulting from the other four)

The stochastic inputs used in the risk integrated resource planning process were based on a combination of historic volatility and expectations for future market trends. Pace Global's market insight was used to develop a view on future market trends; statistical and modeling tools were then employed to quantify the uncertainty around the expected trends and evaluate the performance of each portfolio under different uncertainties. The stochastic analyses required that uncertainties in these forecasts be determined. The effects of the load, fuel prices, CO_2 prices, and capital costs uncertainty on the portfolios were quantified over the study horizon under 200 different simulations.

Stochastic Load Forecasts

For incorporation in the risk-integrated portfolio analysis, Pace Global developed a stochastic load forecast for the average and peak load. The load forecasting process consisted of two steps: Step 1, called the "Parametric forecast", was performed by building a regression model using weather and personal income as explanatory variables. This step consists of building the weather response functions for average and peak load. To forecast future weather, a random sampling of the past weather (from 17-years history) was performed. To predict future personal income, a Geometric Brownian Motion ("GBM") model was developed.

Step 2, called the "quantum forecast", was performed to quantify the additional uncertainty due to demand side management measures. This step captured the up and downside risks to the load forecast developed in Step 1. Downside potential stemmed from energy efficiency and demand response programs. Additional details on load forecast methodology can be found in Appendix A: Load Forecast Methodology.

The inputs used for the stochastic process were based on a combination of historical volatility and growth rate for personal income and population. They were also based on Pace Global's expectations for future load growth trends. Statistical and modeling tools were then employed to quantify the uncertainty around the expected trends. Exhibit 47 displays percentile bands for the average and peak load stochastic distributions.

Exhibit 47: LAPP's Average and Peak Load Percentiles (MW)

LAPP Peak Load (MW)					
	Mean	5th	25th	75th	95th
2017	94	88	91	96	104
2018	94	86	91	99	106
2019	96	88	92	101	111
2020	104	92	96	107	119
2021	106	95	101	113	129
2022	108	95	101	113	127
2023	110	97	103	116	136
2024	113	98	105	119	139
2025	132	111	120	138	164
2026	142	123	133	151	175
2027	142	125	133	152	175
2028	145	125	135	152	177
2029	148	128	136	157	181
2030	151	129	140	161	186
2031	155	133	143	164	191
2032	158	134	146	171	192
2033	162	138	149	174	203
2034	165	142	153	178	203
2035	169	145	156	184	208
2036	173	147	161	187	213

LAPP Average Load (MW)					
	Mean	5th	25th	75th	95th
2017	76	72	74	77	85
2018	75	71	72	77	85
2019	78	73	75	80	90
2020	82	74	77	84	95
2021	85	77	80	88	101
2022	91	82	85	94	108
2023	91	81	85	94	110
2024	92	81	85	95	112
2025	101	89	93	104	124
2026	119	105	111	123	146
2027	119	105	110	123	146
2028	120	106	111	126	147
2029	121	107	112	127	147
2030	123	108	113	128	149
2031	124	109	114	129	150
2032	125	109	115	132	150
2033	126	110	116	134	154
2034	127	111	117	135	156
2035	128	113	118	136	154
2036	129	113	120	137	156

Source: Pace Global, LAC, LANL.

Other Stochastic Inputs

Pace Global developed distributions of other key inputs to represent the probability of occurrence over a range of outcomes. Below are some of the key drivers of the stochastic analysis, with detailed inputs presented in Appendix C.

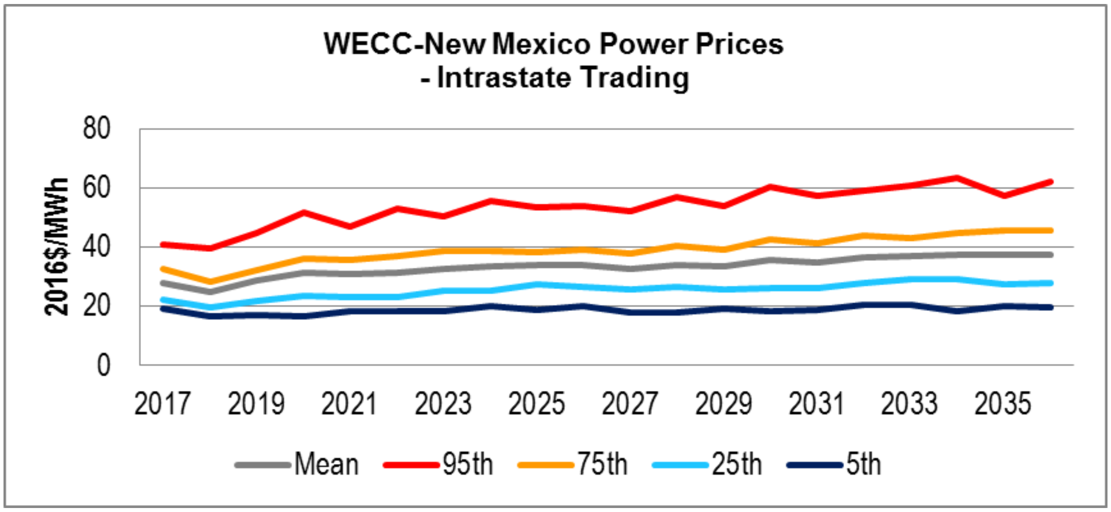
- Capital Costs: Capital cost uncertainty was evaluated by defining stochastic bands around the capital costs of each resource addition in the portfolio for each year of the study period, based on historical commodity cost volatility and breakdowns of capital costs for different generating technologies.
- Natural Gas Prices: Gas price projections were developed according to primary supply and demand drivers that influence domestic production costs as well as international market dynamics.
- CO_2 Price Projections: CO_2 price projections were developed according to expectations for state and federal policy and regulations.
- Coal Price Projections in the Region and for SJGS: Coal price projections were developed according to primary supply and demand drivers as well as plant-specific analysis at SJGS.

WECC New Mexico Power Prices

As a result of the various stochastic inputs described above, Pace Global utilized AURORA model to dispatch resources and generate distributions of Western Electricity Coordinating Council (WECC) New Mexico power prices. Power prices in New Mexico remain below $50/MWh in real 2016 dollar by 2036 in the 75th percentile. Exhibit 48 shows the average energy price probability bands for the New Mexico region.

While prices on the upper end of the distribution are driven by higher fuel and emission costs as well as above-average load growth, prices on the lower end are driven by new low variable cost generating capacity entering the market as well as low or negative load growth. Two CPP compliance scenarios were developed and simulated. First, Exhibit 48 displays simulated prices on the assumption that New Mexico self-contain in its own state based rate program. Under the alternative scenario, assuming that New Mexico participates in a larger regional mass-based trading program, it generally resulted in approximately 2 percent higher overall power prices across the summarized distribution than what is shown in Exhibit 48.

Exhibit 48: WECC New Mexico Power Prices



Source: Pace Global.

Pace Global's capacity price projections for the New Mexico region was embedded into the analysis. There is no formal capacity market in New Mexico but the capacity values can be considered to be monetized or purchased through PPA-based bilateral contracts to ensure appropriate amount of capacity is available to meet forecasted peak conditions. In order to quantify the forecasted capacity prices Pace Global analyzed the supply-demand balance (or reserve margin) in a region, the cost of new entry (CONE), and the energy revenues that can be realized by plants operating in the market.

STOCHASTIC ASSESSMENT RESULTS

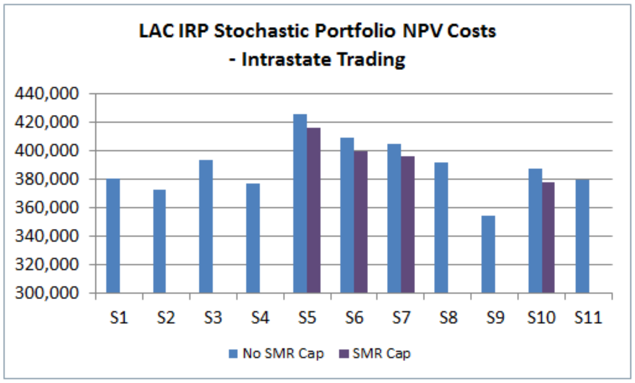
In performing the stochastic portfolio analysis, all cost, risk, environmental, and operational metrics outlined in Exhibit 6 were evaluated for each of the portfolio options. For the metrics that are quantifiable, Pace Global developed an index system that calculates the index number from 1 to 10, with 1 the most preferable and 10 the least preferable. Portfolios with an index number less than 3.33 receives a green rating, and bigger than 6.67 receives a red rating, and with index number between 3.34 and 6.67 receives a yellow rating.

Cost Metric

Pace Global evaluated the 20-year cost NPV for all the 11 stochastic portfolios across 200 iterations and used the average cost NPV as the cost metric. Portfolio S9, which only contract solar with storage to satisfy LAC and LANL renewable requirements, demonstrates the lowest cost NPV; while portfolios S5, S6 and S7 with SMNR showed the highest costs.

Pace Global also evaluated the cost impacts if the SMNR PPA price is capped at $71.4/MWh (including transmission cost to San Juan Hub) given that LAC is actively pursuing mitigating the pricing risks associated with the project. The results show that capping the SMNR PPA prices improves the cost performance of S5, S6, S7 and S10, but not sufficient to change the ranking order except for S7 (changing from red without cap to yellow with cap).

Exhibit 49: Cost Metric – 20-year Cost NPV



Stochastic Portfolios	
S1	CC, Solar with Storage
S2	CC, Solar with Storage
S3	RICE, Solar with Storage
S4	CC, RICE, Solar with Storage
S5	RICE, Solar with Storage, SMR
S6	CC, RICE, Solar with Storage, SMR
S7	CC, RICE, Solar with Storage, SMR
S8	RICE, Solar PV
S9	Solar with Storage
S10	Solar with Storage, SMR
S11	CC, Solar with Storage (LAC not in compliance)

Stochastic Portfolios - Intrastate Trading	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
NPV Costs without SMNR Cap (thousand $2016)	380,019	372,502	393,095	376,461	425,443	408,809	404,630	391,861	354,515	386,863	379,358
Percentage Above Lowest Cost Portfolio	7.2%	5.1%	10.9%	6.2%	20.0%	15.3%	14.1%	10.5%	0.0%	9.1%	7.0%
Index Ranking without SMNR Cap (0-10 Scale)	3.60	2.54	5.44	3.09	10.00	7.65	7.07	5.27	0.00	4.56	3.50
Assessment without SMNR Cap	Yellow	Green	Yellow	Green	Red	Red	Red	Yellow	Green	Yellow	Yellow
NPV Costs with SMNR Cap (thousand $2016)	380,019	372,502	393,095	376,461	416,401	399,767	395,587	391,861	354,515	377,821	379,358
Index Ranking with SMNR Cap (0-10 Scale)	4.12	2.91	6.23	3.55	10.00	7.31	6.64	6.03	0.00	3.77	4.01
Assessment with SMNR Cap	Yellow	Green	Yellow	Yellow	Red	Red	Yellow	Yellow	Green	Yellow	Yellow

20-year Cost NPV Ranking

Green: Index < 3.33 — Yellow: Index 3.34 – 6.67 — Red: Index > 6.67

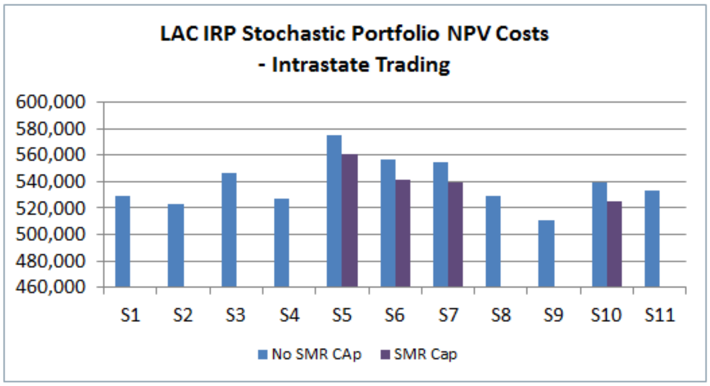
Source: Pace Global.

Risk Metric

Pace Global used the 95th percentile cost NPV to measure how wide the cost distribution could become for each portfolio (as a measure of how costly a portfolio might achieve under the most extremely negative conditions – only 5 percent of conditions were worse than this outcome). The lower the value of this measure (i.e. the 95 percentile value), the less exposed the portfolio is to market uncertainty. Across the 200 iterations and 11 stochastic portfolios, Portfolio S9, which only contract solar with storage to satisfy LAC and LANL renewable requirements, demonstrates the lowest 95th percentile cost NPV; while portfolios S5, S6 and S7 with SMNR showed the highest risks.

Pace Global also evaluated the cost impacts if the SMNR PPA price is capped at $71.4/MWh (including transmission cost to San Juan Hub) given that LAC is actively pursuing mitigating the pricing risks associated with the project. The results show that capping the SMNR PPA prices improves the risk performance of S5, S6, S7 and S10.

Exhibit 50: Risk Metric – 95th Percentile Cost NPV



Stochastic Portfolios	
S1	CC, Solar with Storage
S2	CC, Solar with Storage
S3	RICE, Solar with Storage
S4	CC, RICE, Solar with Storage
S5	RICE, Solar with Storage, SMR
S6	CC, RICE, Solar with Storage, SMR
S7	CC, RICE, Solar with Storage, SMR
S8	RICE, Solar PV
S9	Solar with Storage
S10	Solar with Storage, SMR
S11	CC, Solar with Storage (LAC not in compliance)

Stochastic Portfolios - Intrastate Trading	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
95th Percentile without SMNR Cap (thousand $2016)	528,741	523,005	546,323	526,736	575,261	556,977	554,652	528,887	510,798	539,720	532,761
Percentage Above Lowest Cost Portfolio	3.5%	2.4%	7.0%	3.1%	12.6%	9.0%	8.6%	3.5%	0.0%	5.7%	4.3%
Index Ranking without SMNR Cap (0-10 Scale)	2.78	1.89	5.51	2.47	10.00	7.16	6.80	2.81	0.00	4.49	3.41
Assessment without SMNR Cap	Green	Green	Yellow	Green	Red	Red	Red	Green	Green	Yellow	Yellow
95th Percentile with SMNR Cap (thousand $2016)	528,741	523,005	546,323	526,736	561,020	541,288	539,754	528,887	510,798	524,572	532,761
Index Ranking with SMNR Cap (0-10 Scale)	3.57	2.43	7.07	3.17	10.00	6.07	5.77	3.60	0.00	2.74	4.37
Assessment with SMNR Cap	Yellow	Green	Red	Green	Red	Yellow	Yellow	Yellow	Green	Green	Yellow

95th Percentile 20-year Cost NPV Ranking

Green: Index < 3.33 Yellow: Index 3.34 – 6.67 Red: Index > 6.67

Source: Pace Global.

Environmental Metric

Pace Global evaluated whether LAC is in compliance to achieve 90% carbon neutral goal by 2036. Portfolios that are in compliance receive green rating and portfolios that are out of compliance receive red rating as shown in Exhibit 51.

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Exhibit 51: Enviromental Metric – Renewable Portfolio Standards

Mass-based Interstate & Intrastate Trading

Stochastic Portfolios	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
LAC RPS Level in 2036	94%	94%	94%	94%	95%	95%	95%	91%	94%	95%	30%
Assessment (Green: LAC in compliance; red: LAC out of compliance)	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red

Stochastic Portfolios	
S1	CC, Solar with Storage
S2	CC, Solar with Storage
S3	RICE, Solar with Storage
S4	CC, RICE, Solar with Storage
S5	RICE, Solar with Storage, SMR
S6	CC, RICE, Solar with Storage, SMR
S7	CC, RICE, Solar with Storage, SMR
S8	RICE, Solar PV
S9	Solar with Storage
S10	Solar with Storage, SMR
S11	CC, Solar with Storage (LAC not in compliance)

Renewable Generation Share in 2036 Ranking

Green: In Compliance with Interim Carbon Neutral Goal; Red: Out of Compliance with Interim Carbon Neutral Goal

Source: Pace Global.

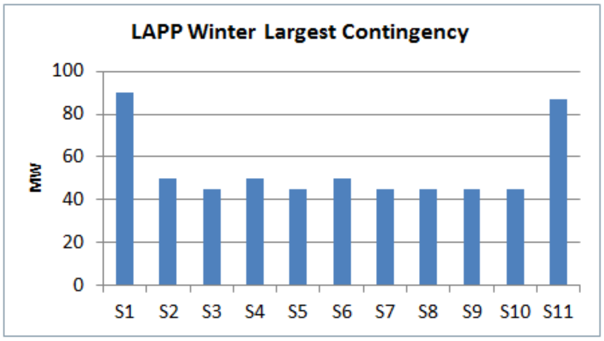
Operational Metrics

The operational metrics are evaluated across four areas of concern as discussed below.

Transmission and Largest Contingency Risk

The transmission and largest contingency measure determines which portfolios are most impacted by the loss of the single largest transmission or generation sites. Portfolios that rely most on one transmission line or the largest single plant site are most exposed to the loss of that source of power. Exhibit 52 shows the ranking of the transmission and largest contingency risk.

Exhibit 52: Operational Metric 1 - Transmission/Largest Contingency Risk



Stochastic Portfolios	
S1	CC, Solar with Storage
S2	CC, Solar with Storage
S3	RICE, Solar with Storage
S4	CC, RICE, Solar with Storage
S5	RICE, Solar with Storage, SMR
S6	CC, RICE, Solar with Storage, SMR
S7	CC, RICE, Solar with Storage, SMR
S8	RICE, Solar PV
S9	Solar with Storage
S10	Solar with Storage, SMR
S11	CC, Solar with Storage (LAC not in compliance)

- The largest contingency captures unit level generation risk and site level transmission risks in worst case scenarios.

Stochastic Portfolios	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
Largest Contingency	90	50	45	50	45	50	45	45	45	45	87
Percentage Above Best Portfolio	100%	11%	0%	11%	0%	11%	0%	0%	0%	0%	93%
Index Ranking (0-10 Scale)	10.00	1.11	0.00	1.11	0.00	1.11	0.00	0.00	0.00	0.00	9.33
Assessment (Green < 3.33; Yellow 3.34-6.67; Red > 6.67)	🔴	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🔴

Transmission/ Largest Contingency Ranking

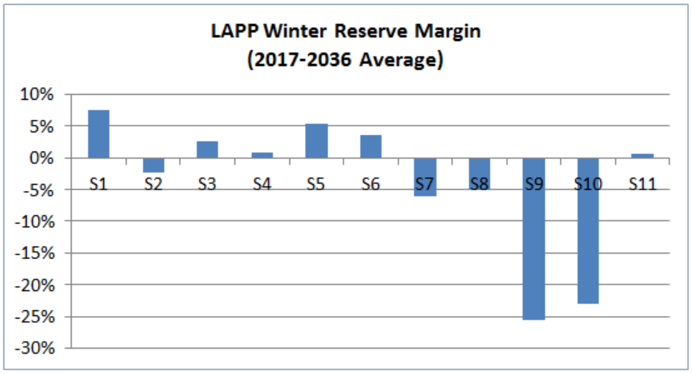
🟢 Index < 3.33 🟡 Index 3.34 – 6.67 🔴 Index > 6.67

Source: Pace Global.

Control Risk – Average Reserve Margin

To assess the associated operational risk and the ability for LAC to meet the demand with owned or contracted resources, LAC's 20 years average reserve margin, which is calculated as the supply resource availability as a percentage of peak load during 2017-2036, was used as an operational metric for each portfolio. Portfolios most exposed to the market with insufficient capacity to meet native load were most at risk because LAC was not in control of meeting its load. Exhibit 53 shows the ranking of the control risk of the stochastic portfolios.

Exhibit 53: Operational Metric 2 – Control Risk (Average Reserve Margin Ranking)



Stochastic Portfolios	
S1	CC, Solar with Storage
S2	CC, Solar with Storage
S3	RICE, Solar with Storage
S4	CC, RICE, Solar with Storage
S5	RICE, Solar with Storage, SMR
S6	CC, RICE, Solar with Storage, SMR
S7	CC, RICE, Solar with Storage, SMR
S8	RICE, Solar PV
S9	Solar with Storage
S10	Solar with Storage, SMR
S11	CC, Solar with Storage (LAC not in compliance)

Stochastic Portfolios	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
Winter Reserve Margin	8%	-2%	3%	1%	5%	4%	-6%	-5%	-26%	-23%	1%
Index Ranking (0-10 Scale)	0.00	3.00	1.48	2.04	0.66	1.22	4.10	3.84	10.00	9.18	2.07
Assessment (Green < 3.33; Yellow 3.34-6.67; Red > 6.67)	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Red	Red	Green

2017-2036 Average Reserve Margin Ranking

Green: Index < 3.33 | Yellow: Index 3.34 – 6.67 | Red: Index > 6.67

Source: Pace Global.

Development Risks

The ability to secure certain portfolio options (such as participating in a large Combined Cycle project or the CFPP SMNR development project) is uncertain and out of LAC's control. In contrast, LAC has greater control of the building smaller generation resources that is closely tailored to its contracting positions, load profile and coal retirement dates.

SMNR project adds development risk to the portfolio because of technology, regulatory, cost, financing, and schedule uncertainties. Portfolios with SMNR are rated red if development risk is un-mitigated and rated yellow-green if the development risk is mitigated. Exhibit 51 shows the development risk assessment of the stochastic portfolios.

Exhibit 54: Operational Metric 3 – Development Risk

Portfolio	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
New Resources	Solar	Solar	Solar	Solar	Solar	Solar	Solar	Solar	Solar	Solar	Solar
	Storage	Storage	Storage	Storage	Storage	Storage	Storage		Storage	Storage	Storage
	CC	CC		CC		CC	CC				CC
			RICE	RICE	RICE	RICE	RICE	RICE			
					SMNR	SMNR	SMNR			SMNR	
Development Risk Assessment	🟡	🟡	🟢	🟡	🔴 🟢/🟡	🔴 🟢/🟡	🔴 🟢/🟡	🟢	🟢	🔴 🟢/🟡	🟡

Stochastic Portfolios	
S1	CC, Solar with Storage
S2	CC, Solar with Storage
S3	RICE, Solar with Storage
S4	CC, RICE, Solar with Storage
S5	RICE, Solar with Storage, SMR
S6	CC, RICE, Solar with Storage, SMR
S7	CC, RICE, Solar with Storage, SMR
S8	RICE, Solar PV
S9	Solar with Storage
S10	Solar with Storage, SMR
S11	CC, Solar with Storage (LAC not in compliance)

Source: Pace Global.

Weather Dependent Risk

When only adding solar with storage as new resources, these portfolios are exposed to the market when there are a succession of cloudy or rainy days. Such risks could be managed with adding either fossil or nuclear generation in addition to solar. Portfolio S9 adds solar with storage as new resources and is exposed to the market when there is continued cloudy or rainy days. All other portfolios have either fossil or nuclear generation in addition to solar and are less weather dependent.

Exhibit 55: Operational Metric 4 – Weather Dependent Risk

Stochastic Portfolios	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
New Resources	Solar	Solar	Solar	Solar	Solar	Solar	Solar	Solar	Solar	Solar	Solar
	Storage	Storage	Storage	Storage	Storage	Storage	Storage		Storage	Storage	Storage
	CC	CC		CC		CC	CC				CC
			RICE	RICE	RICE	RICE	RICE	RICE			
					SMNR	SMNR	SMNR			SMNR	
Portfolio Weather Dependent Assessment	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🔴	🟢	🟢

Stochastic Portfolios	
S1	CC, Solar with Storage
S2	CC, Solar with Storage
S3	RICE, Solar with Storage
S4	CC, RICE, Solar with Storage
S5	RICE, Solar with Storage, SMR
S6	CC, RICE, Solar with Storage, SMR
S7	CC, RICE, Solar with Storage, SMR
S8	RICE, Solar PV
S9	Solar with Storage
S10	Solar with Storage, SMR
S11	CC, Solar with Storage (LAC not in compliance)

Source: Pace Global.

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Pace Global summarized the stochastic portfolios performances across the four operational risks areas to derive the overall operational metrics as shown in Exhibit 56.

Exhibit 56: Operational Metrics (1-4) Summary

Criteria		Transmission/Largest Contingency Risk	Control	Development Risk	Weather Risk	Operational Metrics Summary
S1	CC, Solar with Storage	Unfavorable	Favorable	Neutral	Favorable	Neutral
S2	CC, Solar with Storage	Favorable	Favorable	Neutral	Favorable	Favorable/Neutral
S3	RICE, Solar with Storage	Favorable	Favorable	Favorable	Favorable	Favorable
S4	CC, RICE, Solar with Storage	Favorable	Favorable	Neutral	Favorable	Favorable/Neutral
S5	RICE, Solar with Storage, SMNR	Favorable	Favorable	Favorable/Neutral	Favorable	Favorable/Neutral
S6	CC, RICE, Solar with Storage, SMNR	Favorable	Favorable	Favorable/Neutral	Favorable	Favorable/Neutral
S7	CC, RICE, Solar with Storage, SMNR	Favorable	Neutral	Favorable/Neutral	Favorable	Favorable/Neutral
S8	RICE, Solar PV	Favorable	Neutral	Favorable	Favorable	Favorable/Neutral
S9	Solar with Storage	Favorable	Unfavorable	Favorable	Unfavorable	Neutral
S10	Solar with Storage, SMNR	Favorable	Unfavorable	Favorable/Neutral	Favorable	Neutral
S11	CC, Solar with Storage (LAC not in compliance)	Unfavorable	Favorable	Neutral	Favorable	Neutral

Score Rating: Favorable Neutral Unfavorable

Source: Pace Global.

Balanced Score Card of Stochastic Portfolios

In conclusion, Pace Global considered the cost, risk, environmental and operational metrics to derive the balanced score card of the stochastic portfolios. Exhibit 57 provides a summary of the portfolio performance for the cost, risk, environmental, and operational metrics for the stochastic portfolios under the mass-based interstate trading case. Key findings and the preferred resource plan as a result of this balanced score card analysis is discussed in next two sections.

Exhibit 57: Balanced Score Card of Stochastic Portfolios

	Criteria	Cost	Risk	Environmental	Operational	Overall
S1	CC, Solar/ Storage	Neutral	Favorable	Favorable	Neutral	Favorable/Neutral
S2	CC, Solar/ Storage	Favorable	Favorable	Favorable	Favorable/Neutral	Favorable
S3	RICE, Solar/ Storage	Neutral	Neutral	Favorable	Favorable	Favorable/Neutral
S4	CC, RICE, Solar/ Storage	Favorable	Favorable	Favorable	Favorable/Neutral	Favorable
S5	RICE, Solar/ Storage, SMNR	Unfavorable	Unfavorable	Favorable	Favorable/Neutral	Unfavorable
S6	CC, RICE, Solar/ Storage, SMNR	Unfavorable	Unfavorable	Favorable	Favorable/Neutral	Unfavorable
S7	CC, RICE, Solar/ Storage, SMNR	Unfavorable	Unfavorable	Favorable	Favorable/Neutral	Unfavorable
S8	RICE, Solar PV	Neutral	Favorable	Favorable	Favorable/Neutral	Favorable/Neutral
S9	Solar/ Storage	Favorable	Favorable	Favorable	Neutral	Favorable
S10	Solar/ Storage, SMNR	Neutral	Neutral + Favorable	Favorable	Neutral	Neutral + Favorable/Neutral
S11	CC, Solar / Storage (LAC not in compliance)	Neutral	Neutral	Unfavorable	Neutral	Unfavorable

Score Rating: Favorable Neutral Unfavorable

Note: The 2nd light for Stochastic Portfolio reflects the rating if the SMNR project risks are mitigated and PPA prices are capped.

Source: Pace Global.

KEY FINDINGS

Key findings of the stochastic analysis include:

Two CPP Cases

Key findings of the stochastic analysis under the two CPP cases are fairly consistent. The New Mexico power prices are expected to be slightly higher (~2 percent) under the mass-based interstate trading case. The higher market prices affect LAC's market purchase position and result in lower overall costs.

CFPP SMNR Option

The CFPP SMNR project sponsored by UAMPS could provide clean baseload power to replace LAC's coal fired generation in meeting energy demand and the carbon neutral goal by 2040. Participation in the SMNR project resulted in higher NPV costs in the stochastic analysis and introduces development risks. However, if the contract PPA price could be capped at acceptable levels and the development risks could be mitigated, the SMNR could be considered especially if local land becomes unavailable for solar. LAC and LANL should continue to pursue risk mitigation measures to protect ratepayers from cost overruns and schedule delays.

Capital Investments

The current market outlook does not reward building portfolios with excess capacity above load that would be sold into the market. A phased approach to purchasing some share of its needs in the market and add smaller and incremental capacity resources on an as needed basis provides overall lower cost benefits for LAC and preserves the flexibility in the face of future uncertainties. Beyond building new renewable/ clean energy capacities to meet the carbon neutral goal and renewable objectives, additional gas-fired generation capacity (Combined Cycle or RICE) involves upfront capital investment in a soft market, and is not advised unless control of resources is a priority to LAPP. For an operational perspective, RICE could be considered for firming or balancing purposes.

New Solar Generation

The most balanced portfolio that meets renewable goals and carbon reduction targets is a portfolio that relies on solar and storage (based on current indicative bids). However, there are uncertainties whether sufficient local federal land for utility scale solar resources.

PREFERRED RESOURCE PLAN

The Preferred Resource Plan which is the most balanced portfolio (Stochastic Portfolio 9) that meets renewable goals and carbon reduction targets. It relies on contracting onsite solar and storage to achieve 90 percent carbon neutral by 2036 for LAC and 30 percent onsite renewable generation during 2025-2036 for LANL. The addition of the solar and storage could be tailored with the load growth and existing resources retirement schedules. A phased approach to add smaller and incremental capacity resources on a need basis provides overall lower cost benefits for LAPP as well as maintain flexibility in the face of future uncertainties. Exhibit 58 shows the key elements of the Preferred Resource Plan.

The firming mechanism could be either battery storage or onsite RICE units. Onsite RICE units are more expensive but allow more flexibility during prolonged weather events when solar PV does not generate.

If SMNR costs can be capped and development risks can be mitigated, it could be considered especially in the event that local land becomes unavailable for the amount of solar needed to achieve renewable goals.

Exhibit 58: Key Elements of the Preferred Resource Plan

Portfolio	San Juan 4 Exit Date	LRS Exit	LAPP New Builds	Reserve Margin (2017-2036)
S8: **Solar Firmed with RICE** **Short Capacity**	2022	No Exit	**Large RICE:** • 2017- 18 MW; 2025- 18 MW; 2030- 18 MW **Solar PV:** • 2017- 25 MW; 2025- 25 MW; 2030- 25 MW	LAPP Summer: 9% LAPP Winter: -5%
S9: **Solar with Storage** **Short Capacity**	2022	No Exit	**Solar with Storage (onsite)**: • 2017- 13 MW; 2025- 8 MW • 2030- 6 MW	LAPP Summer: -11% LAPP Winter: -26%
S10: **SMR, Solar with Storage** **Short Capacity**	2022	No Exit	**Solar with Storage (onsite)**: • 2017- 13 MW; 2025- 4 MW **Nuclear (offsite)**: • 2026- 16 MW	LAPP Summer: -9% LAPP Winter: -23%

Source: LAC, Pace Global.

APPENDIX A: LOAD FORECAST METHODOLOGY

LOAD FORECAST - HISTORICAL DRIVER ANALYSIS

Weather and economic data have historically explained changes in monthly average and peak load fairly well. This relationship, and the impacts of external direct and indirect impacts from the energy extraction industry, forms the basis for Pace Global's load uncertainty analysis. The basic premise of our model is that load can be expressed as follows:

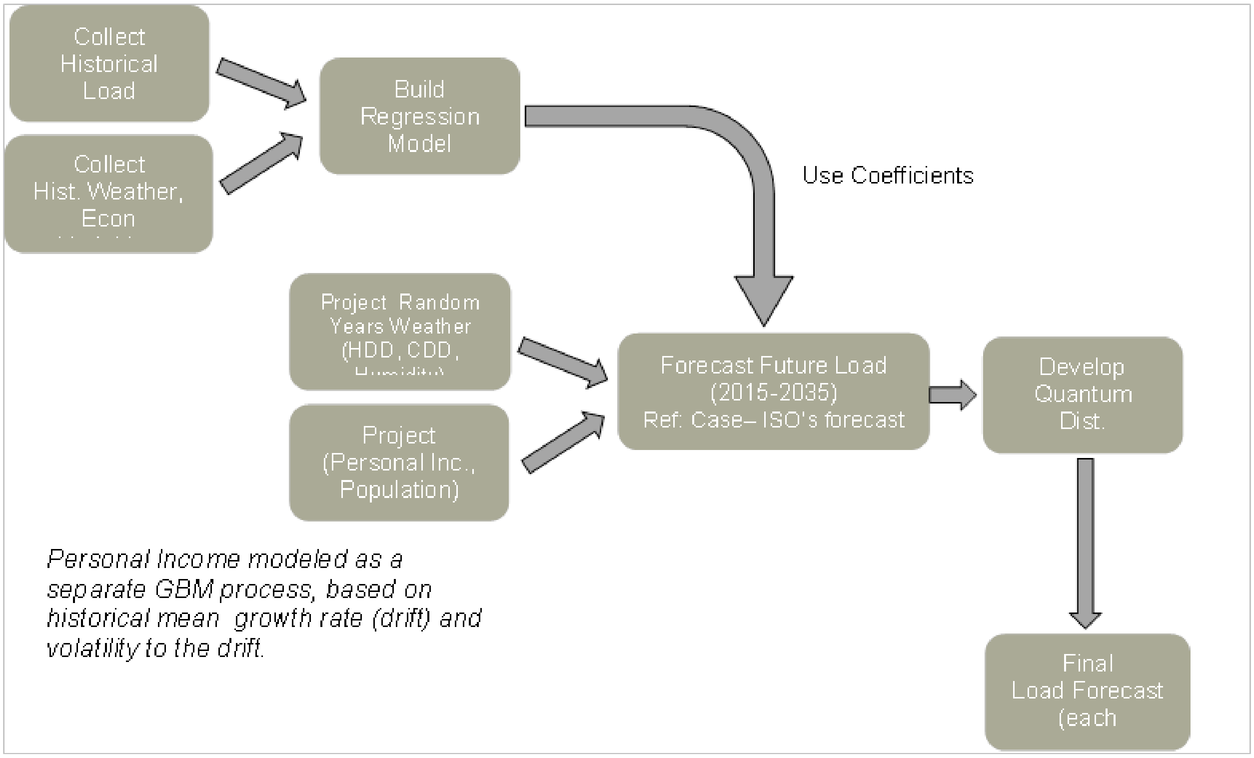
$$Load_t = \alpha + \beta_1 * HDD_t + \beta_2 * CDD_t + \beta_3 * HUM_t + \beta_4 * PI_t + \xi_t$$

Where:

- HDD (Heating Degree Days): 65 - Average daily temperature in degrees Fahrenheit or zero. HDD is never negative.
- CDD (Cooling Degree Days): Average daily temperature -65 in degrees Fahrenheit or zero. CDD is never negative.
- HUM (Humidity): Average daily percent humidity.
- PI: Personal Income
- ξ : A normally distributed variable with mean 0 and constant variance
- α : A constant derived from the regression analysis
- β_n: Coefficients derived from the regression analysis

A stepwise regression then calibrates this model to historic data. Load uncertainty can be driven by observed relationships as well as future efficiency, DSM Measures and Electrification opportunities. Exhibit 59 shows the over-arching load forecasting process. Exhibit 60 is the flow chart depicting the key elements considered in the load forecasting process.

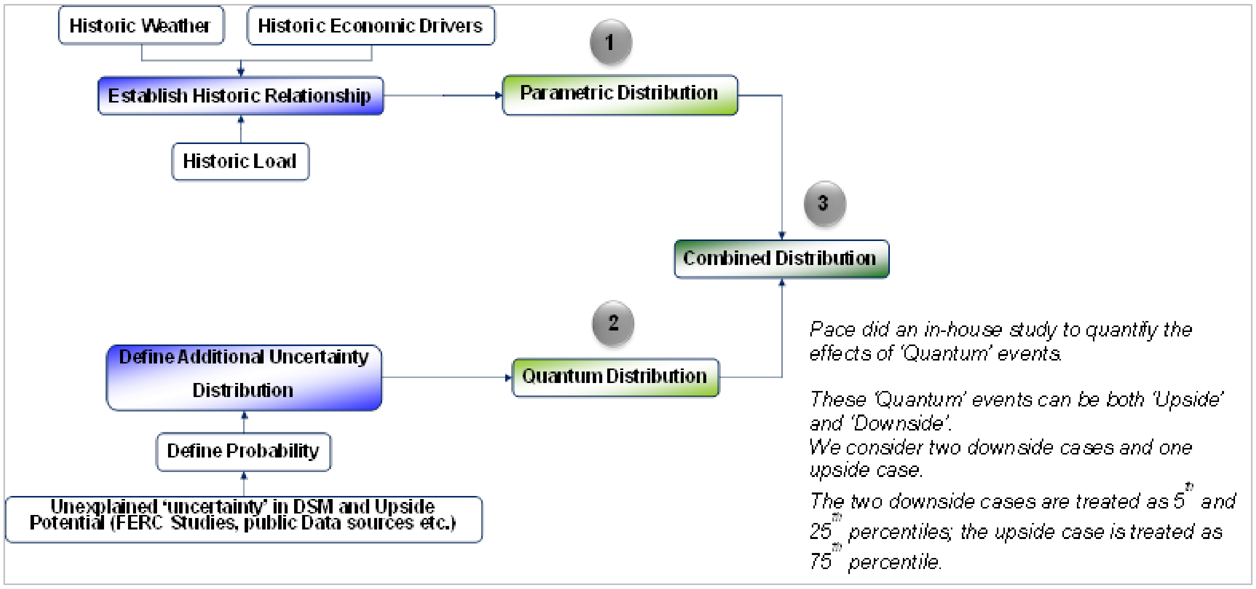
Exhibit 59: Load Forecast Process



Source: Pace Global.

Scenario Load Forecast Results

Exhibit 60: Flow Chart of the Key Elements in Load Forecasting



Source: Pace Global.

PARAMETRIC AND QUANTUM PROJECTIONS

Step 1: Weather and Economic Variability

To produce our load stochastics, Pace Global forecasts three independent random paths: weather data, personal income, and a residual.

Weather data includes heating and cooling degree days and humidity. To produce reasonable weather data projections, Pace Global samples actual yearly paths from history. On average, we use about 13 years' worth of historical data to perform the historical driver analysis. We aggregate around 35 additional years' worth of weather data to enrich the variability of our forecasts.

Personal income is assumed to follow Geometric Brownian Motion. This means that a normal distribution with constant mean and variance describes how the return on personal income will behave at any time. Historical personal income data produces a best guess for the relevant mean and variance of this process going forward.

$$dPI = (\mu.PI.dt) + (\sigma.dW.PI)$$

- dPI: Change in Personal Income
- µ: Mean drift rate
- σ: Variance to the drift
- dW: Weiner Process (Normally distributed random number N (0, 1))

Finally, to account for unexplained variation in the observed data, Pace Global adds a normally distributed residual with mean zero and standard deviation equal to the root mean squared error of the previously mentioned stepwise regression.

Step 2: Additional Variability

It is Pace Global's opinion that future power demand may differ substantially from past power demand. To accommodate for this possibility, we add an additional "Quantum (or Efficiency) Distribution" to our empirically derived distribution. The distribution is log-normally distributed. The fifth percentile of this distribution is taken primarily from NERC and FERC projections (or other relevant data sources) for statewide potential for load reduction from efficiency or other DSM measures. For example, these measures may include advanced metering infrastructure, appliance efficiency standards or other direct load control programs. The upper tail of this distribution is weighted to match Pace Global's analysis of historical high periods of load growth and our expert opinion. Note that the "Quantum Distribution" incorporates the potential for limited or no penetration of the expected increases in the energy efficiency of the economy embedded in the reference case. Examples include increasing residential plug load or high energy consumption technology breakthroughs.

Pace Global expects that changes attributable to the efficiency distribution will affect load growth on a large geographic scale. Accordingly, concurrent efficiency changes are highly correlated across areas. Additionally, we expect incremental efficiency changes to have persistence over time. Thus, the propagations have a high level of serial correlation as well.

APPENDIX B: CANDIDATE PORTFOLIOS PROFILES

Exhibit 61, Exhibit 62, Exhibit 63, Exhibit 64, Exhibit 65, Exhibit 66, Exhibit 67, Exhibit 68 and Exhibit 69 present the peak capacity vs. peak load for each of the candidate portfolios. In aggregate they total nine portfolios.

Exhibit 61: Stochastic Portfolio 1 Peak Capacity vs. Peak Load

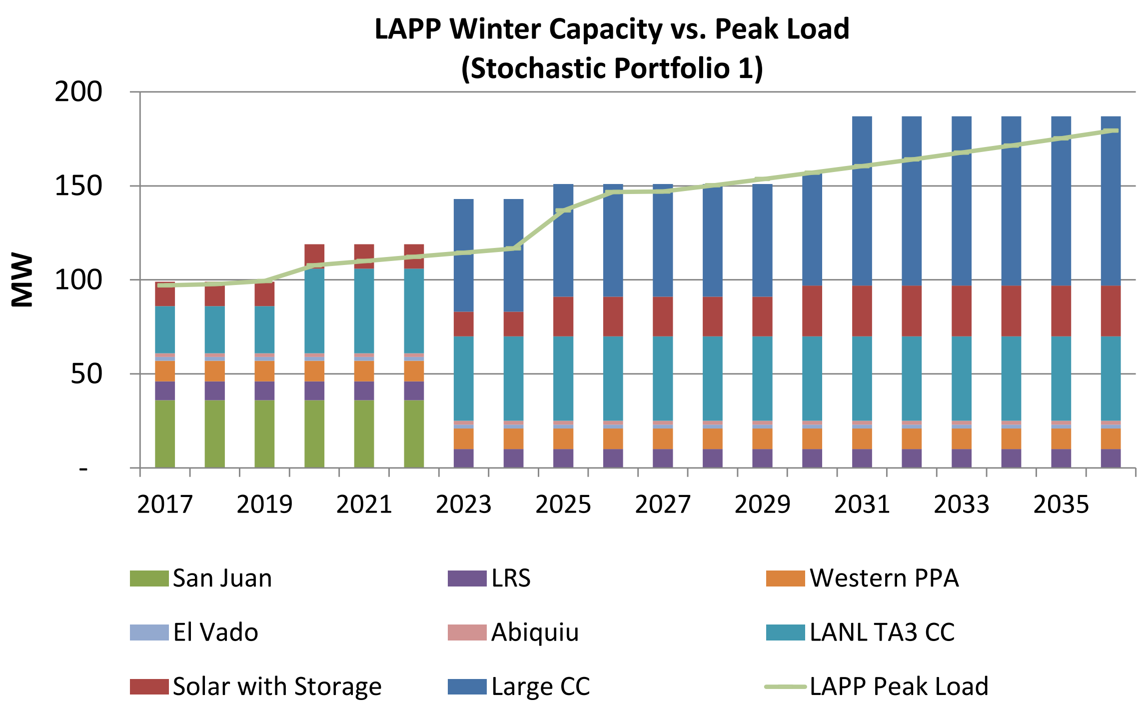


Exhibit 62: Stochastic Portfolio 2 Peak Capacity vs. Peak Load

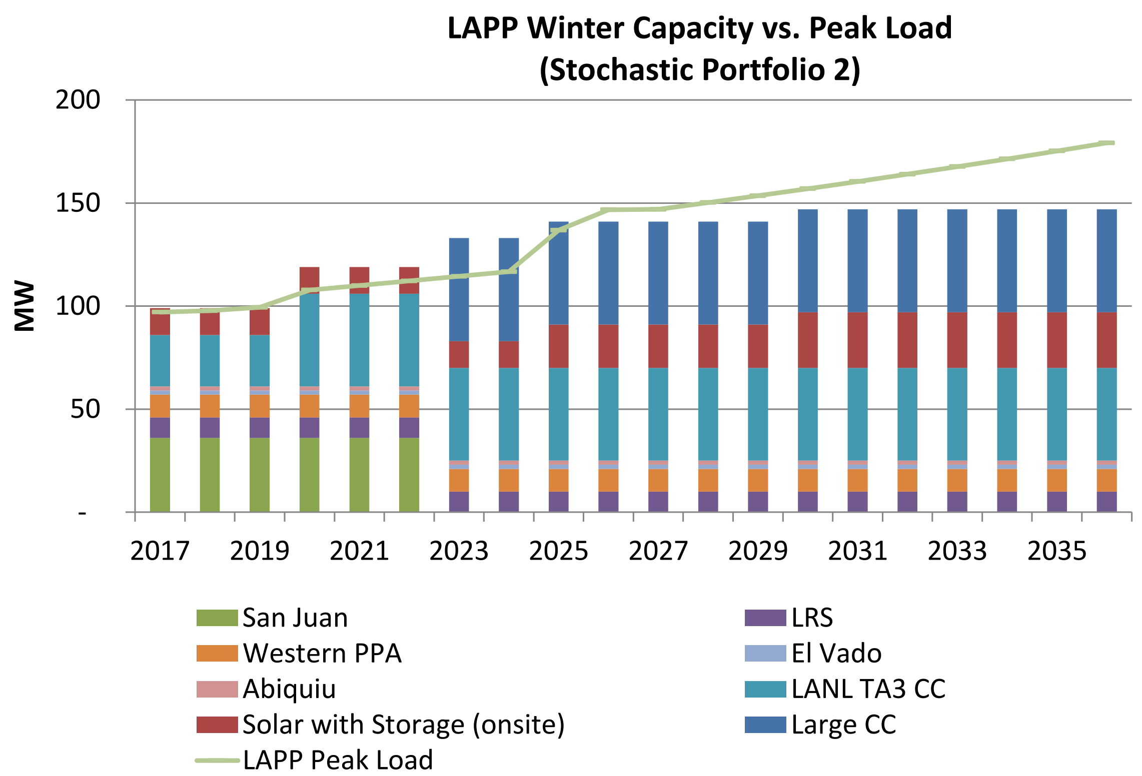


Exhibit 63: Stochastic Portfolio 3 Peak Capacity vs. Peak Load

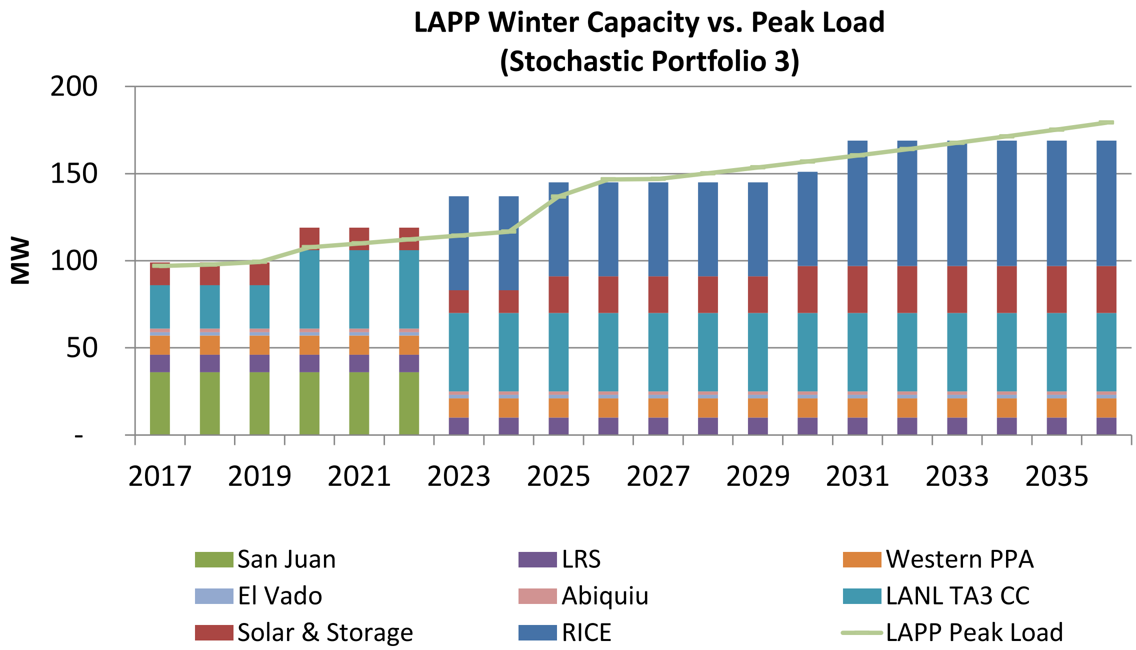


Exhibit 64: Stochastic Portfolio 4 Peak Capacity vs. Peak Load

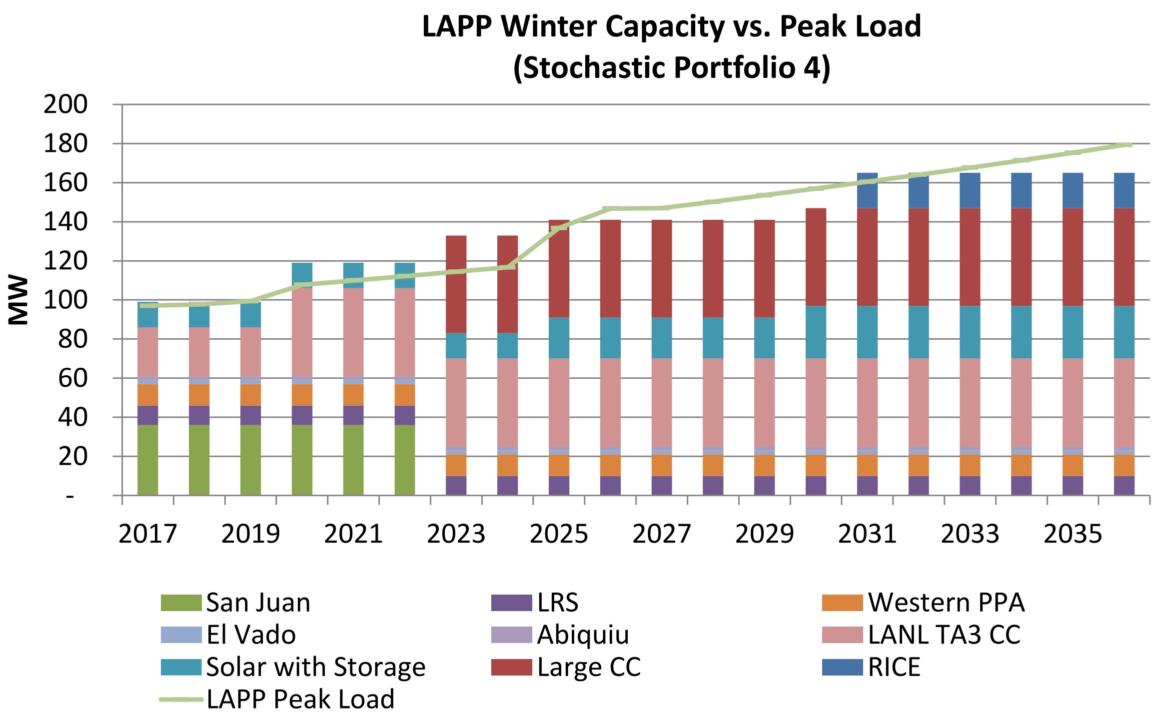


Exhibit 65: Stochastic Portfolio 5 Peak Capacity vs. Peak Load

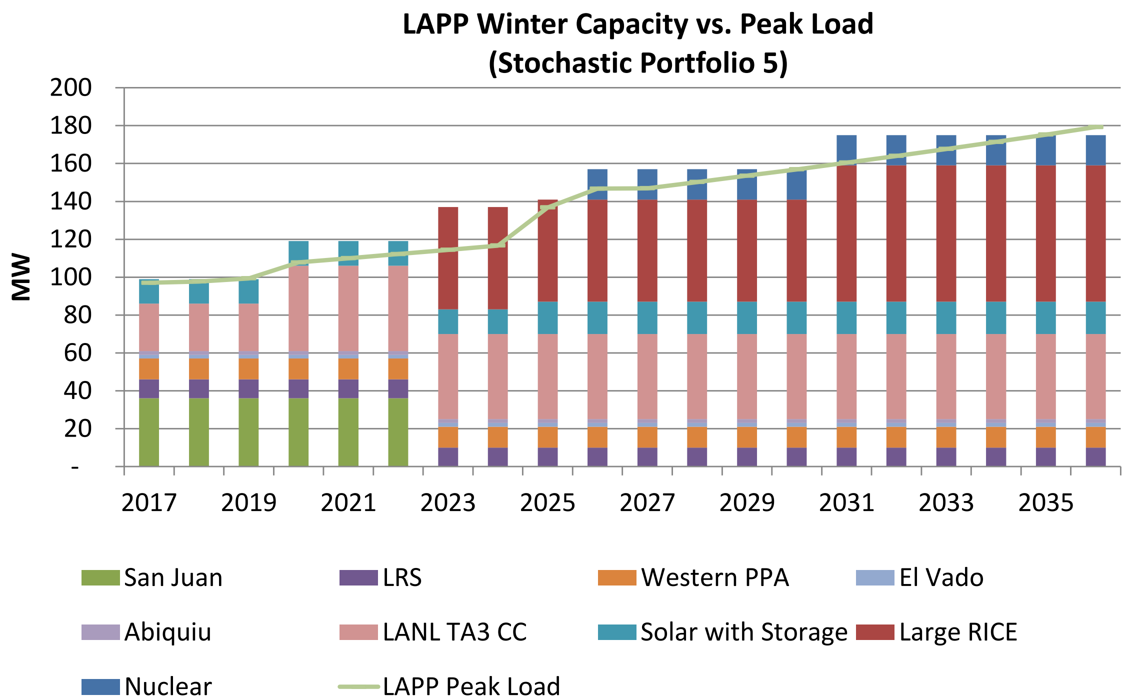


Exhibit 66: Stochastic Portfolio 6 Peak Capacity vs. Peak Load

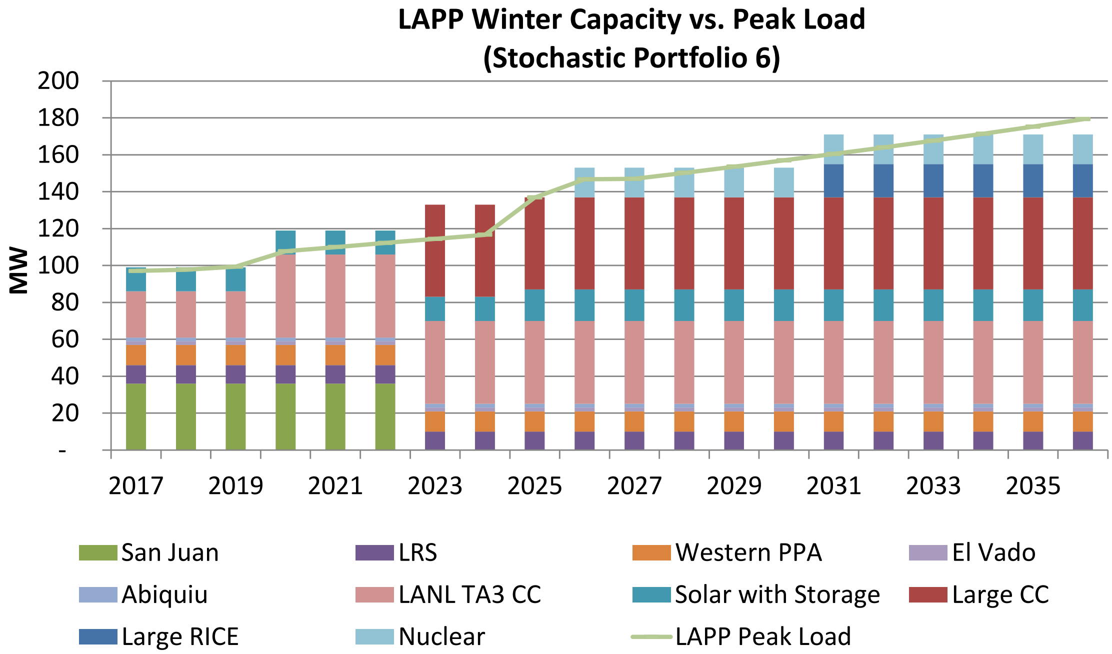


Exhibit 67: Stochastic Portfolio 7 Peak Capacity vs. Peak Load

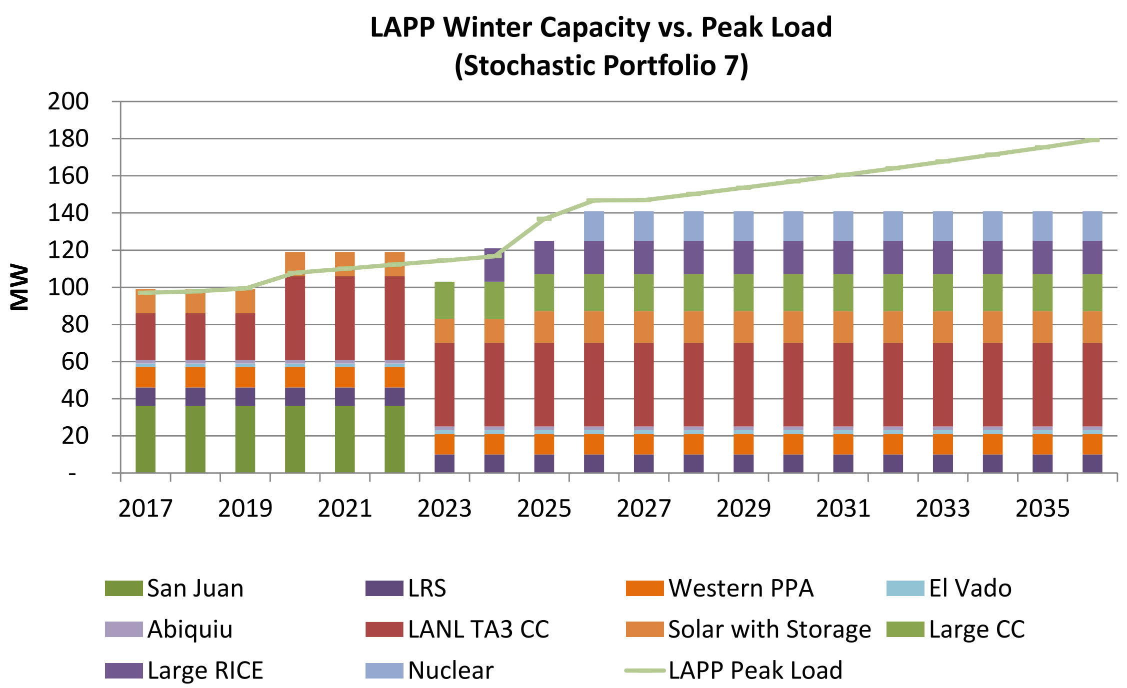


Exhibit 68: Stochastic Portfolio 8 Peak Capacity vs. Peak Load

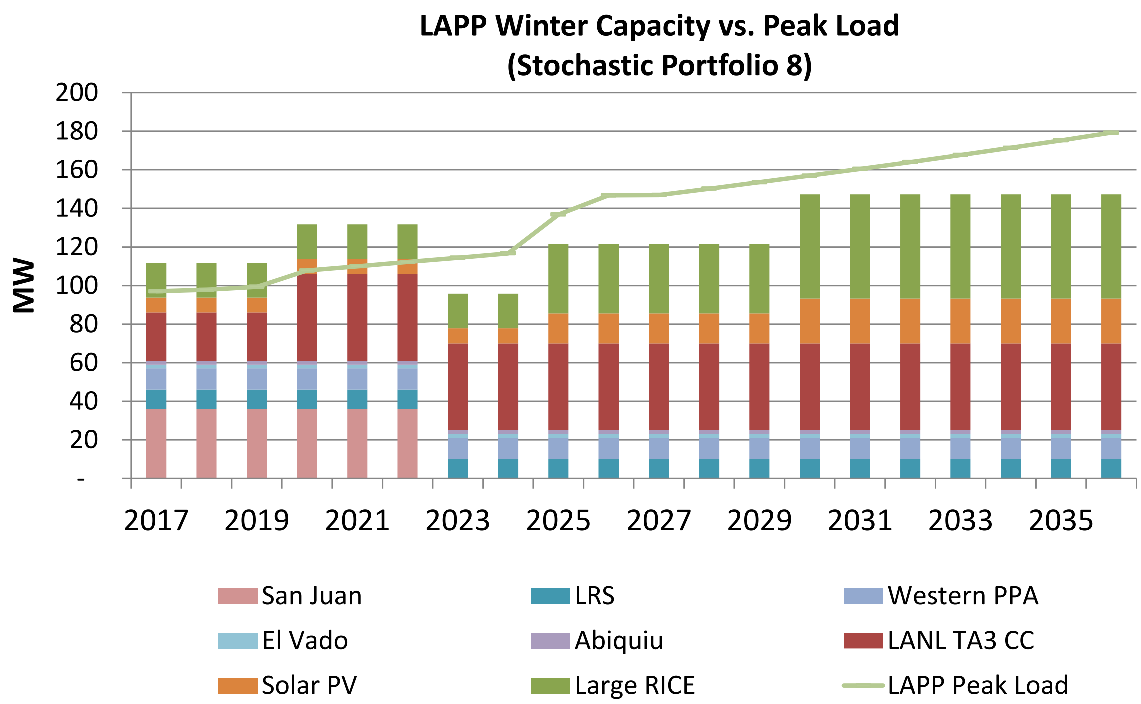


Exhibit 69: Stochastic Portfolio 9 Peak Capacity vs. Peak Load

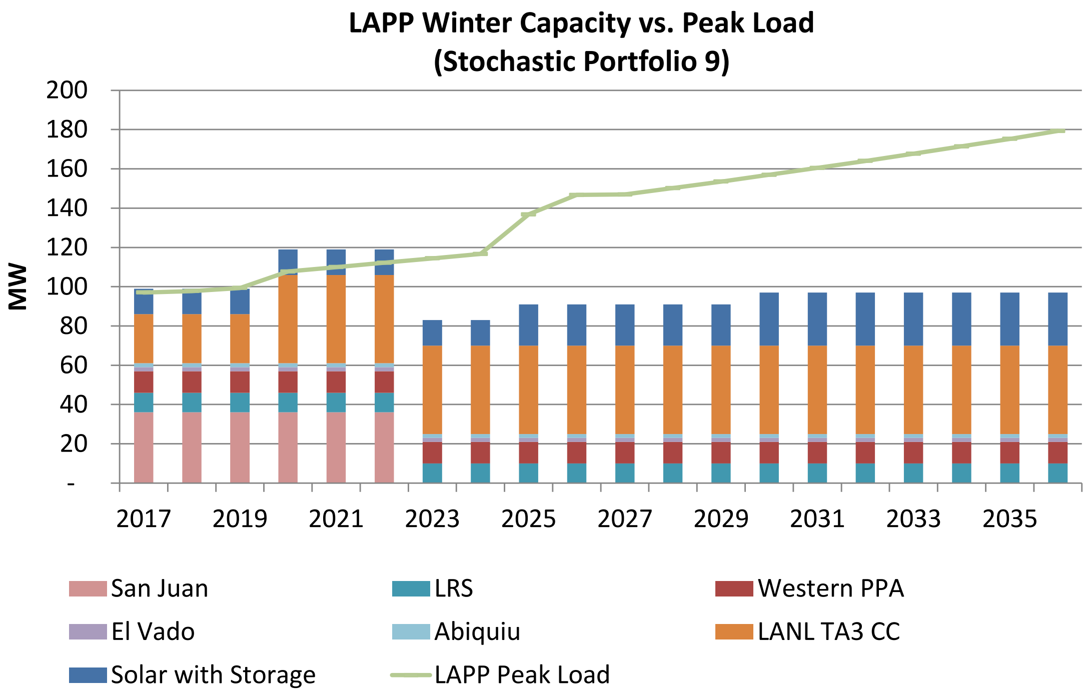


Exhibit 70: Stochastic Portfolio 10 Peak Capacity vs. Peak Load

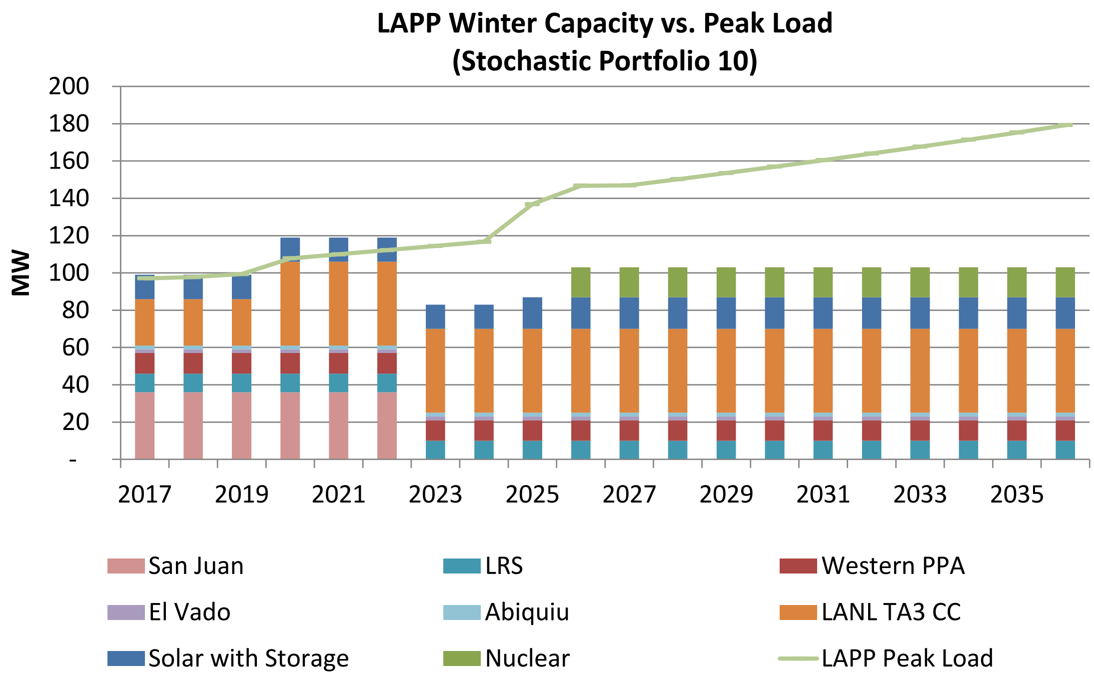
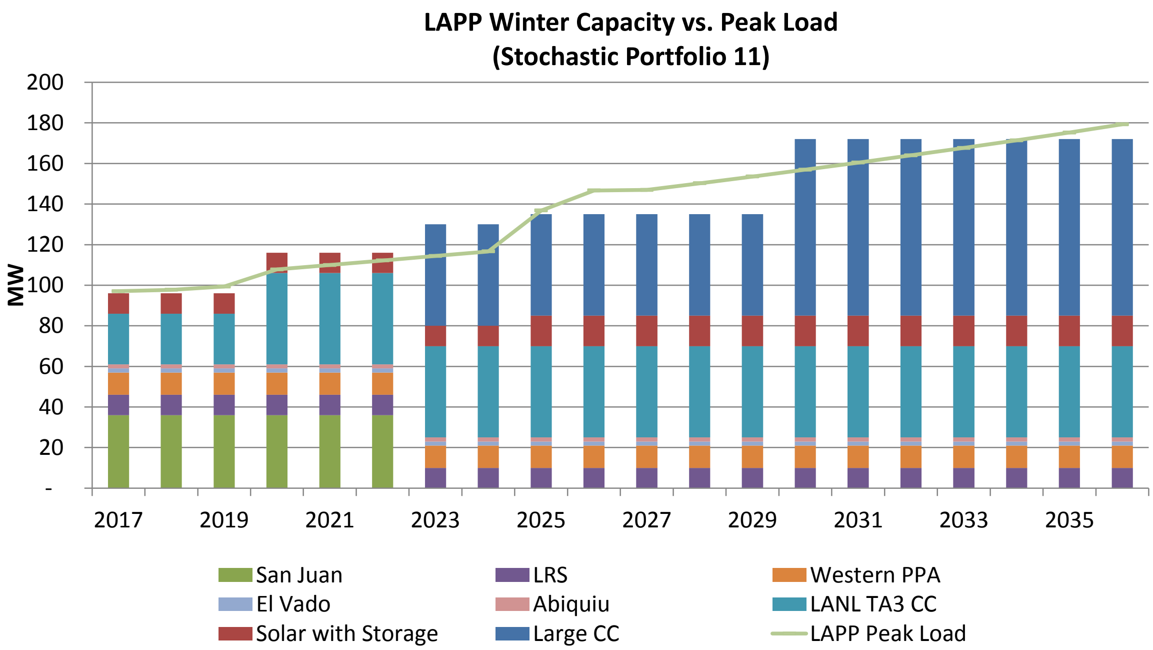


Exhibit 71: Stochastic Portfolio 11 Peak Capacity vs. Peak Load



APPENDIX C: POWER MARKET OVERVIEW AND KEY DRIVERS

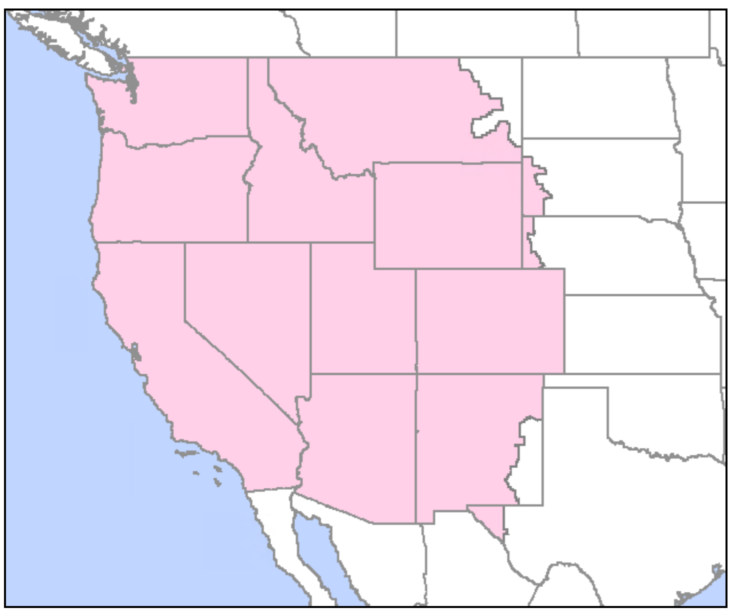
The RIRP portfolio analysis was centered on a fundamentals-based power market dispatch analysis that evaluated the LAPP system in the context of the wider region. This section provides an overview the region, notably the New Mexico region, and its market characteristics. Key market drivers in future are highly uncertain and to allow for this possibility, Pace Global derived distribution and incorporated them in the analysis. The section also summarizes the power price projections for the region through an integration of the market data and all key market drivers provided in this Appendix section.

NEW MEXICO MARKET OVERVIEW

Market Structure

New Mexico is part of the Desert Southwest (DSW), one of the eight sub-regions in the Western Electricity Coordinating Council (WECC). The entire WECC footprint is shown in Exhibit 72. The DSW region consists of Arizona, most of New Mexico, southern Nevada, and the westernmost part of Texas. Pace Global simulated the New Mexico market as part of the WECC power grid in our portfolio analysis.

Exhibit 72: Western Interconnect Coordinating Council (WECC) Footprint

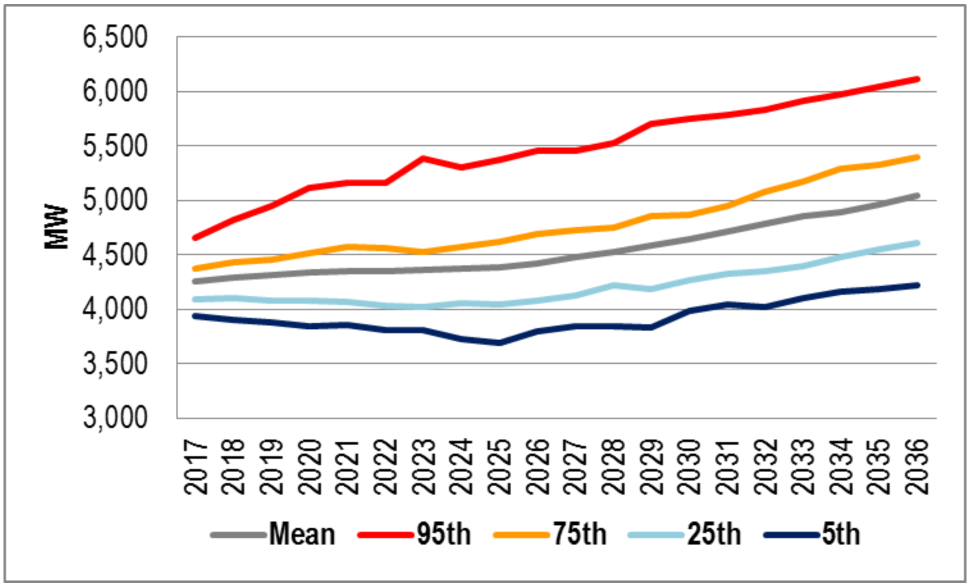


Source: Pace Global, Energy Velocity.

MARKET DEMAND PROFILE

Pace Global developed an independent demand forecast for New Mexico and the wider WECC region. This is to ensure reserve margin is observed not only for the New Mexico market but also the entire WECC region, including OWI (Oregon, Washington, Northern Idaho, and Northwest Montana), California, Arizona and Nevada. Exhibit 73 summarizes the energy demand projection from the analysis.

Exhibit 73: Expected Load Projections for New Mexico

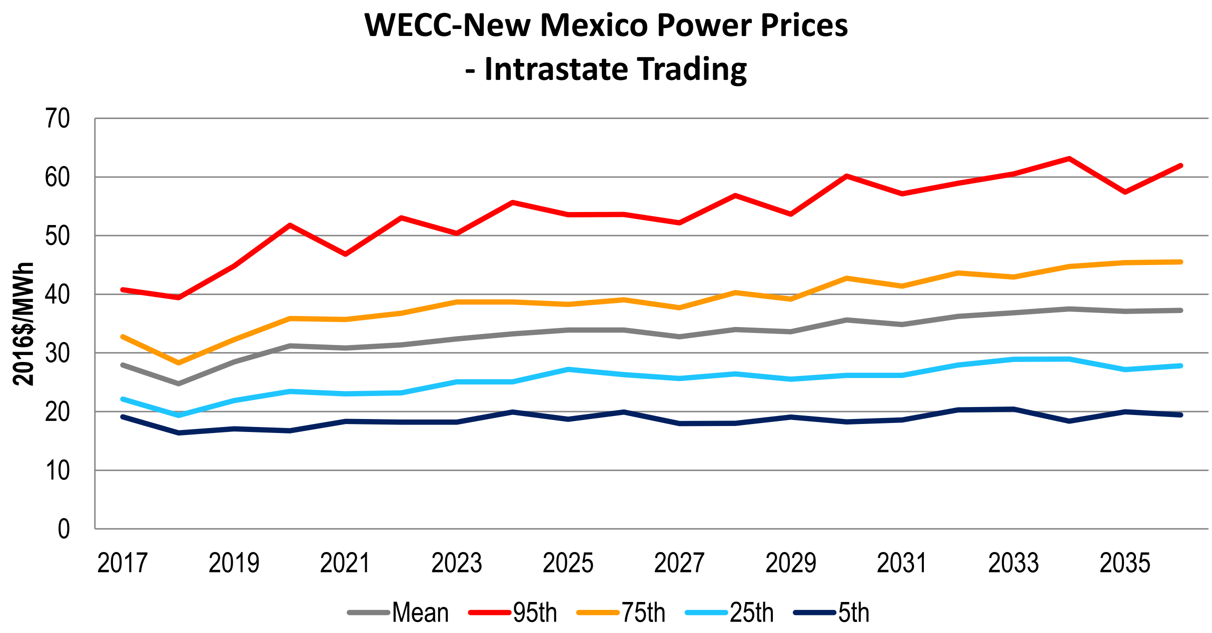


Source: Pace Global.

MARKET POWER PRICE PROJECTIONS

Exhibit 74 shows the average energy price probability bands for the New Mexico region. Generally the prices increase over time period primarily due to gradual increase in fuel and environmental compliance costs impact on power prices. While prices on the upper end of the distribution are driven by higher fuel and emission allowance costs as well as above-average load growth, prices on the lower end are driven by new low variable cost generating capacity entering the market as well as low or negative load growth. Two CPP compliance scenarios were developed and simulated. First, Exhibit 74 displays simulated prices on the assumption that New Mexico self-contain in its own state based rate program. Under the alternative scenario, assuming that New Mexico participates in a larger regional mass-based trading program, it generally resulted in a 2-3% higher overall power prices across the summarized distribution than what is shown in Exhibit 74.

Exhibit 74: Projected New Mexico Energy Prices



Source: Pace Global.

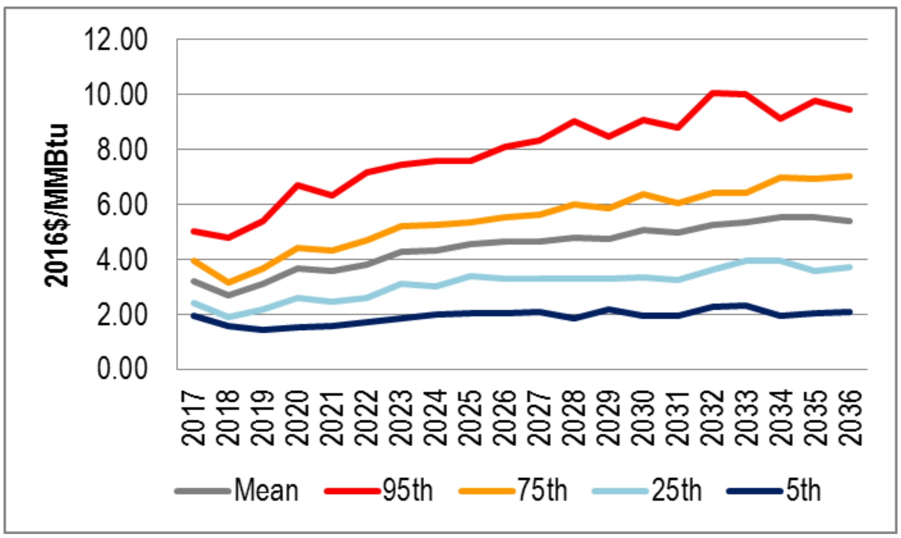
Pace Global's capacity price projections for the New Mexico region was embedded into the analysis. There is no formal capacity market in New Mexico but the capacity values can be considered to be monetized or purchased through PPA-based bilateral contracts to ensure appropriate amount of capacity is available to meet forecasted peak conditions. In order to quantify the forecasted capacity prices Pace Global analyzed the supply-demand balance (or reserve margin) in a region, the cost of new entry (CONE), and the energy revenues that can be realized by plants operating in the market.

STOCHASTIC INPUTS

Natural Gas Prices

Given the volatility in natural gas prices observed over the last several years and the significant uncertainty in potential price outcomes going forward, Pace Global's Henry Hub stochastic inputs (provided in Exhibit 75) are based on current market forwards, analysis of projected supply-demand fundamentals, and an examination of historical price volatility. Market drivers behind the fifth percentile include a significant renewable build out, low or negative load growth, continued strong shale gas production, and limited coal retirements. Markets drivers behind the ninety-fifth percentile include limited renewable generation subsidies, strong load growth, environmental regulations leading to significant coal retirements, and a supply choke resulting from strict drilling regulations.

Exhibit 75: Henry Hub Price Probability Bands

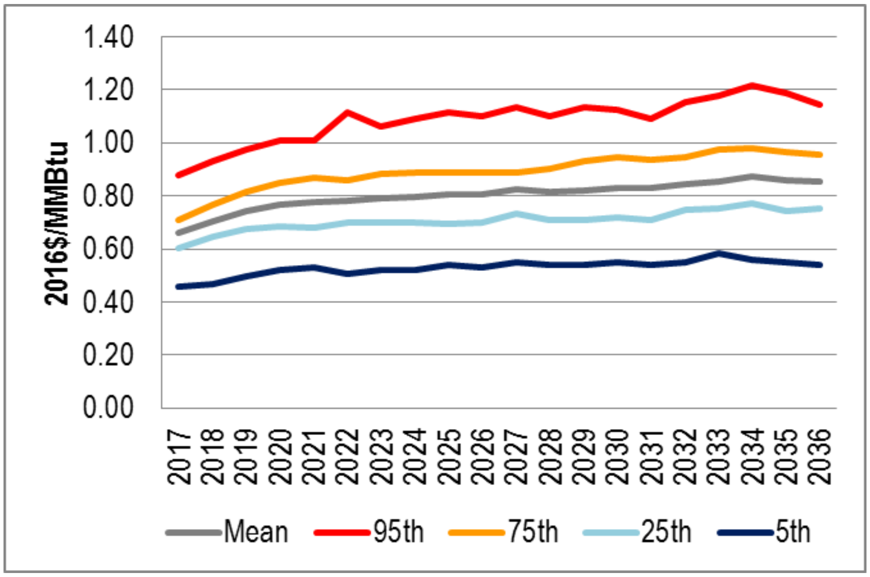


Source: Pace Global.

Coal Prices

The PRB price uncertainty bands in Exhibit 76 are based on current market forwards as well as an analysis of historical price volatility. Market drivers behind the fifth percentile include significant coal retirements, a large renewable build out, and limited power demand growth. Market drivers behind the ninety-fifth percentile include limited coal retirements that keep demand steady and/or rising, environmental regulations that make mining more expensive, and a limited renewable build out. Note that the values reflect basin prices only and transportation costs are added to calculate the delivered cost of coal.

Exhibit 76: PRB Basin Price Probability Bands

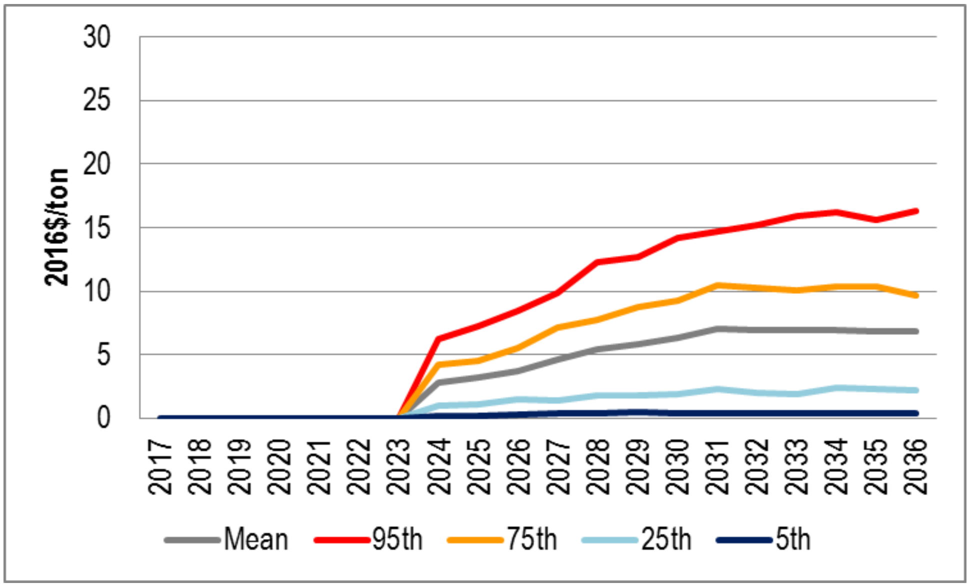


Source: Pace Global.

CO_2 Prices

Because the outlook for comprehensive federal carbon regulation in the U.S. remains very uncertain at this time, Pace Global projects a series of potential price outcomes based on fundamental analysis and our expert opinion of the likelihood of certain policy outcomes. Pace Global's distribution is based on a range of potential policy outcomes at the federal level (including the potential of no market price) with an internally consistent set of market feedbacks related to the demand and price responses in the natural gas and coal markets. The distribution of potential CO_2 prices assessed in the analysis is provided in Exhibit 77.

Exhibit 77: CO_2 Prices Probability Bands

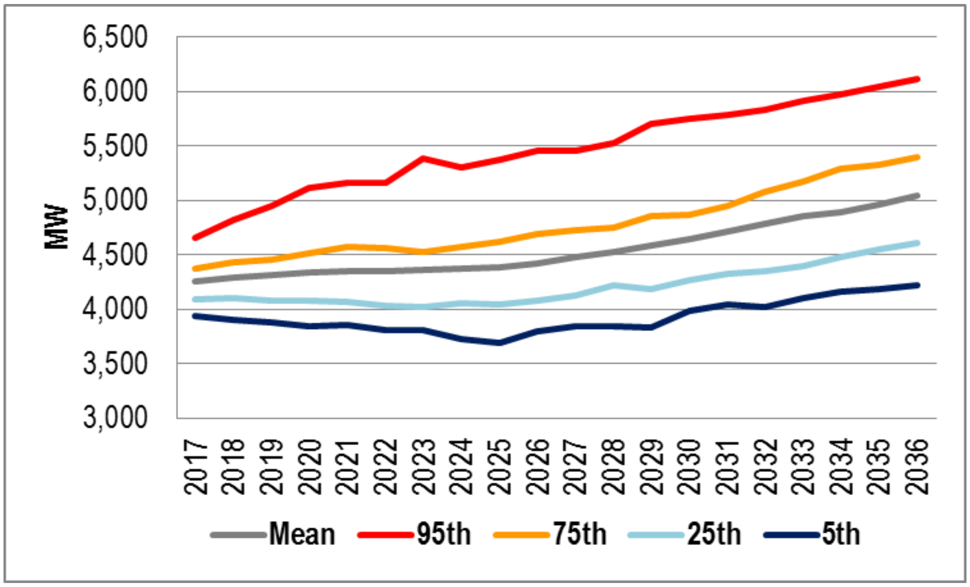


Source: Pace Global.

Load Growth

To capture the potential variability in load growth throughout relevant power market regions, Pace Global produces a distribution of monthly average and peak loads. The weather and economic data variables largely influenced the load projections and as an example we have summarized the peak forecast data, used in the analysis, in an annual probability bands for New Mexico in Exhibit 78.

Exhibit 78: New Mexico Peak Load Probability Bands



Source: Pace Global.

APPENDIX D: GLOSSARY OF TERMS

BPU (Board of Public Utilites): The Los Alamos Department of Public Utilities (DPU) operates the county-owned electric, gas, water & wastewater systems under the jurisdiction and control of the Board of Public Utilities (BPU). The BPU consists of five voting members appointed by County Council.

Btu (British Thermal Unit): A unit of energy measure that indicates the amount of heat required to raise the temperature of one pound of water by 1ºF at a constant atmospheric pressure.

Capital Cost: The cost of various sources of funds used in a financing an entity's operations.

CC (Combined Cycle): A form of power generation that captures exhaust heat often from a CT (or multiple CTs) to create additional electric power beyond that created by the simple CT and enhance the overall efficiency of the unit by producing more output for the same level of input.

CFPP (Carbon Free Power Project): CFPP is a nuclear power plant, which would be comprised of up to a dozen 50-MW pressurized light water reactor modules at the Idaho National Engineering Laboratory in Idaho Falls. The project is proposed by the Utah Associated Municipal Power Systems (UAMPS).

CPP (Clean Power Plan): The CPP is an Obama administration policy through the Environmental Protection Agency (EPA) to reduce carbon emissions from power plants.

Combustion Turbine (CT): A form of power generation that forces air into a chamber heated through the combustion of a type of fuel (often diesel or natural gas) which causes the heated air to expand and power the circulation of a turbine that spins an electric generator to produce electricity.

Debt service: The amount of capital required to repay principal and/or interest on issued debt over a given period of time. Such repayment typically follows a predetermined schedule.

DG (Distributed Generation): Electrical generation that is located on the distribution system (rather than the transmission system), often located at a customer's site on either the customer's or the utility's side of the electric meter.

DF (Duct Fire): Duct firing is firing of supplemental fuel in the gas turbine exhaust gas to raise its temperature entering the Heat Recovery Steam Generator, resulting in higher steam and power production.

Discount rate: The percentage at which future cash flows are discounted based on the risk and uncertainty of the receipt of such cash flows over time. The greater the uncertainty of future cash flows, the more such cash flows will be discounted (assigned a higher discount rate) in determining the value of that stream of cash flows.

EE (Energy Efficiency): Any number of technologies employed to reduce energy consumption. Examples include more efficient lighting, refrigeration, heating, etc.

EPC (Engineering, Procurement and Construction): EPC is a prominent form of contracting agreement in the construction industry. The engineering and construction contractor will carry out the detailed engineering design of the project, procure all the equipment and materials necessary, and then construct to deliver a functioning facility or asset to their clients.

ECA (Electric Energy and Power Coordination Agreement): The ECA is an agreement between Los Alamos County (LAC) and the Department of Energy (DOE) that commenced the Los Alamos Power Pool (LAPP) in July 1985. The agreement established a resource sharing and cost allocating accounting pool, whereby the two parties committed their resources to serve the combined power requirements of LAC and the Los Alamos National Laboratory (LANL).

FER (Future Energy Resources): The Los Alamos Future Energy Resources committee is an ad hoc citizens committee formed by Board of Public Utilites.

FOM (Fixed operations and maintenance expenses): Expenses incurred as a result of operations and maintenance that do not vary with operations.

Fossil fuel: A fuel source that is derived from the decomposition of plant and animal matter under the ground. Typically, coal, oil, and natural gas fall under the definition of fossil fuels.

GT (Gas combustion turbine): A form of power generation that forces air into a chamber heated through the combustion of a type of fuel (often diesel or natural gas) which causes the heated air to expand and power the circulation of a turbine that spins an electric generator to produce electricity.

Heat rate: The efficiency at which a generator converts input fuel to electric output, typically measured in Btu/kWh.

Hydroelectric generation: Electrical generation that converts the kinetic energy of moving water to electricity by turning a turbine.

IGCC (integrated gasification combined cycle): IGCC uses a high pressure gasifier to turn coal into syngas and burns the syngas to drive a turbine. Excess heat goes to power steam turbine.

IRP (Integrated Resource Plan): IRP is a comprehensive planning process for a utility to establish a road map to provide reliable and cost competitive service to its customers in the near, mid and long-term.

KW (Kilowatt): One thousand watts.

kWh (Kilowatt-hour): One thousand watts produced for one hour.

LAPP (Los Alamos Power Pool): Based on the Energy Coordination Agreement (ECA) in place since 1985, Incorporated County of Los Alamos (LAC) and Los Alamos National Laboratory (LANL) pool their generation resources together and operate in the Los Alamos Power Pool.

Load forecast: A forecast of expected future energy demand based on an analysis of underlying economic indicators and past correlation between energy consumption and such economic conditions.

Long position: In this IRP, long position means that total capacity of peak serving resources is more than the peak load.

LRS (Laramie River Station): The Laramie River Station, located east of Wheatland, WY, is one of the largest consumer-operated, regional, joint power supply ventures in the U.S. Laramie River Station has three coal-based units: Unit 1: 570 net megawatts; began operating in 1980; Unit 2: 570 net megawatts; began operating in 1981; Unit 3: 570 net megawatts; began operating in 1982.

MW (Megawatt): One million watts or 1,000 kilowatts.

MWh (Megawatt-hour): One million watts (or 1,000 kilowatts) produced for one hour.

MMBtu: One million Btus.

NPV (Net Present Value): A method of calculating the current value of a series of cash flows, which considers the time value of money, and discounts future cash flows based on a determined discount rate or cost of capital.

Operating reserves: Operating reserve is a portion of generating capacity available to the operator of a power system that may be increased or decreased in order to match short-term fluctuations in energy demand on the system.

PPA (Power Purchase Agreement): A contract by which energy is bought and sold at prices and over time periods specified by the contractual terms.

Purchased power: Power purchased from a third party used to meet retail or wholesale electric demand.

RECs (Renewable Energy Credits): Renewable Energy Certificates (RECs) are tradable and non-tangible energy commodities in the U.S. that represent proof that the electricity was generated from an eligible renewable energy sources. Solar Renewable Energy Certificates (SRECs) are RECs that are specifically generated by solar energy.

Regulation: An ancillary service product that provides extremely short term (intra-minute) upward and/or downward generation flexibility to meet fluctuations in load.

Renewable generation: Electric generation produced by a source that is considered to be readily renewable, including power generated by the wind, the sun (through photovoltaic processes or solar thermal processes), water (hydroelectric generation), biomass, etc.

Reserve Margin: A measure of available capacity over and above the capacity needed to meet normal peak demand levels.

RGGI (Regional Greenhouse Gas Initiative): The Regional Greenhouse Gas Initiative (RGGI) is the first mandatory market-based program in the United States to reduce greenhouse gas emissions. RGGI is a cooperative effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont to cap and reduce CO_2 emissions from the power sector.

RICE (Reciprocating Internal Combustion Engine): A generating unit type that utilizes the movement of pistons to convert pressure into a rotating motion, which can be used to turn an electric generator and produce electricity.

RIRP (Risk-integrated Resource Plan): Pace Global's process of projecting future energy demand, and analyzing current and future energy, transmission, and distribution resources utilizing a stochastic approach to plan to meet such future demand at minimized cost to the system owner/operator and its stakeholder.

RPS (Renewable Portfolio Standards): An energy policy which specifies the proportion of the energy mix that must come from renewable resources for an electricity provider. Typically, an RPS will require a certain percentage of renewables be used (on a capacity or energy basis) by a certain year in the future. Such policies will typically specify interim percentage targets in addition to final goals for renewable generation.

RTO (Regional Transmission Organization): A regional transmission organization is electric power transmission system operator which coordinates, controls and monitors a multi-state electric grid. The transfer of electricity between states is considered interstate commerce and electric grids spanning multiple states are therefore regulated by the Federal Energy Regulatory Commission (FERC).

PV (Photovoltaics): Solar PV converts solar energy into direct current electricity using semiconducting materials that exhibit the photovoltaic effect, a phenomenon commonly studied in physics, photochemistry and electrochemistry**.**

Short position: In this IRP, short position means that total capacity of peak serving resources is less than the peak load.

SJGS (San Juan Generation Station): The San Juan Generation Station is operated by PNM and owned by nine companies, including the Public Service Company of New Mexico (PNM). The plant has a net capacity of 1,683 megawatts: Unit 1 340 MW, Unit 2 340 MW, Unit 3 496 MW and Unit 4 507 MW. The oldest unit (Unit 2) went online in 1973, and the newest unit (Unit 4) went online in 1982.

SMR (Small Modular Reactors) or SMNRs (Small Modular Nuclear Reactors): SMRs or SMNRs are nuclear power plants that are smaller in size (300 MWe or less) than current generation base load plants (1,000 MWe or higher). These smaller, compact designs are factory-fabricated reactors that can be transported by truck or rail to a nuclear power site.

Spinning reserves: An ancillary services product that provides available capacity to a power system operator over short- to medium-term time intervals, typically within ten minutes.

Thermal generation: Power generation created through the creation of heat, as contrasted against many renewable generation technologies (biomass and biogas excepted), which do not rely on heat to produce electricity.

Transmission system: The series of towers and wires that transmit electricity from generation sources to the distribution system at higher voltages than the distribution system to minimize technical losses of transmitted electricity.

UAMPS (Utah Associated Municipal Power Systems): UAMPS is a political subdivision of the State of Utah that provides comprehensive wholesale electric-energy, transmission, and other energy services, on a nonprofit basis, to community-owned power systems throughout the Intermountain West.

VOM (Variable Operations and Maintenance Expenses): Operations and maintenance expenses that vary as a function of the amount of energy that is being produced.

WACC (Weighted Average Cost of Capital): A calculation of a firm's cost of capital in which each category of capital is proportionately weighted. All capital sources - common stock, preferred stock, bonds and any other long-term debt - are included in a WACC calculation.