Integrated Resource Planning Preliminary Results Discussion

Presented to: Los Alamos County

June 16, 2017

Agenda

- Executive Summary
- IRP Approach
- Stochastic Inputs
- Stochastic Portfolio Assessment
  - Cost
  - Risk
  - Environmental
  - Operational
- Appendix

Executive Summary

Key Recommendations

- The County needs not to be in any rush to commit to new resources until several uncertainties regarding SMRs, solar and storage are resolved.
- San Juan cannot compete in the current market and should be retired early. Laramie River is an economic plant throughout the planning horizon.
- There are benefits to the partnership post 2025 that can create a win-win situation for LANL and LAC. But the current sharing arrangement would need to change to benefit both parties to the contract.
- 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).
- A portfolio with SMRs could be competitive, 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 SMR risk mitigation measures and preserve the ability to take advantage of declining solar and storage costs.
- Beyond building new renewable/ clean energy capacities to meet the carbon neutral goal and renewable objectives, additional gas-fired generation capacity (CC or RICE) involves upfront capital investment 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.

Balanced Score Card Summary

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

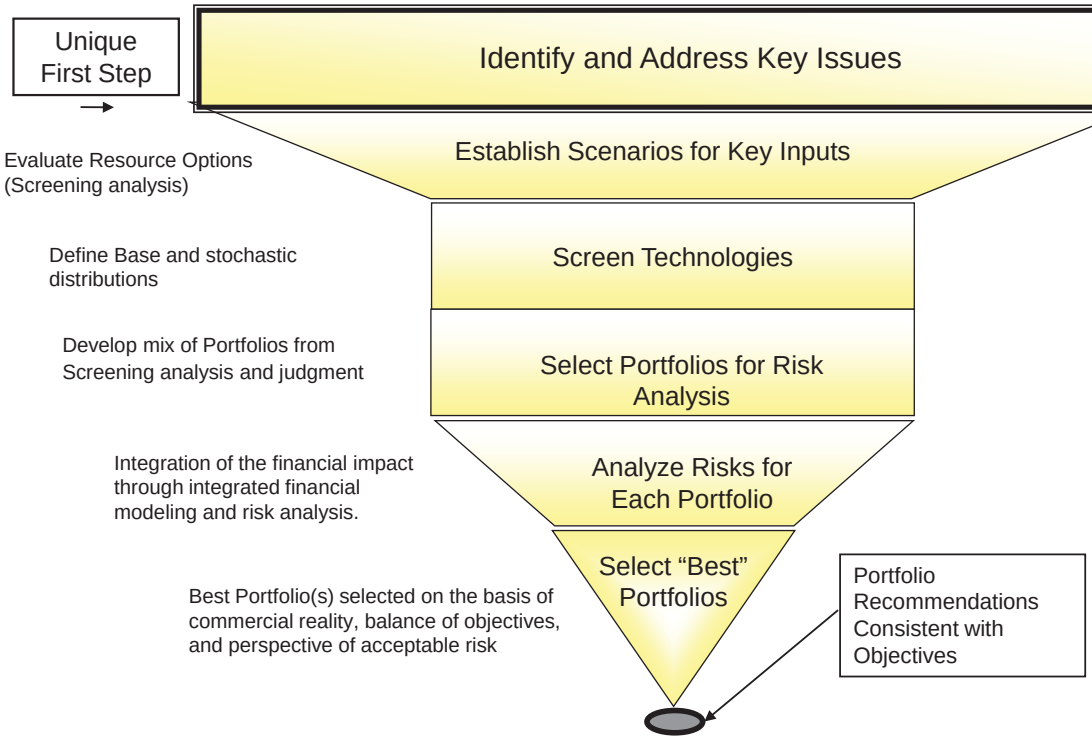
Score Rating: Favorable Neutral Unfavorable

Stochastic Portfolios 8, 9 and 10 Explore Renewable-Focused New Builds with Market Purchases

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%

- Staged new build of solar capacities is best to achieve 90 percent carbon neutral by 2036 for LAC and 30 percent on-site renewable generation during 2025-2036 for LANL.
- The firming mechanism could be either battery storage or on-site RICE units. On-site RICE units are more expensive but allow more flexibility during prolonged weather events when solar PV does not generate.
- 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.
- If SMR 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.

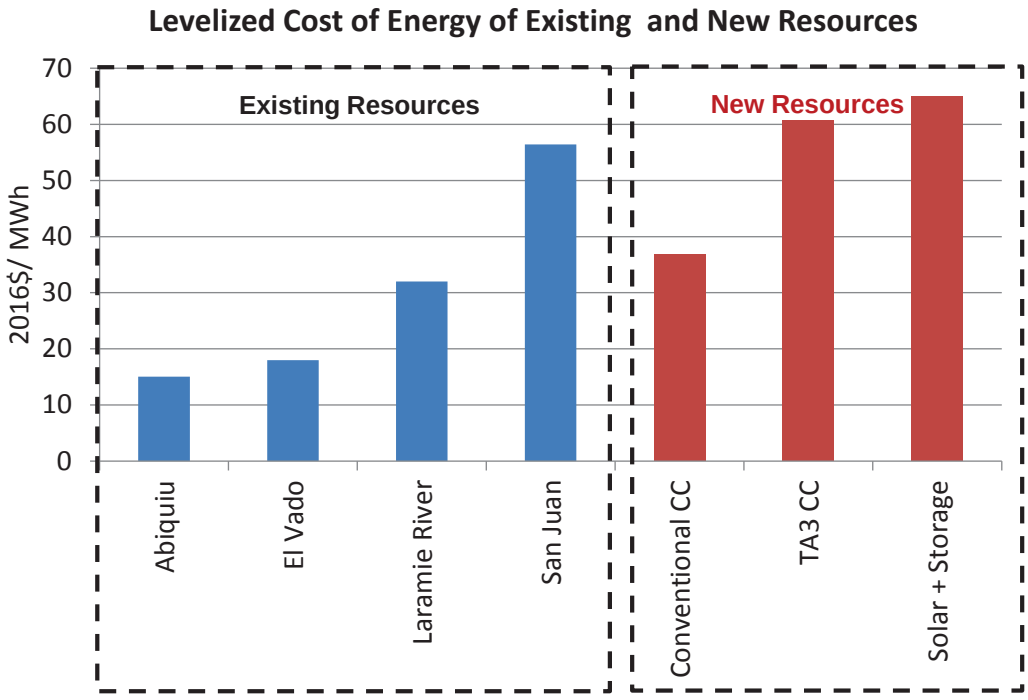
Pace Global's Structured RIRP Approach



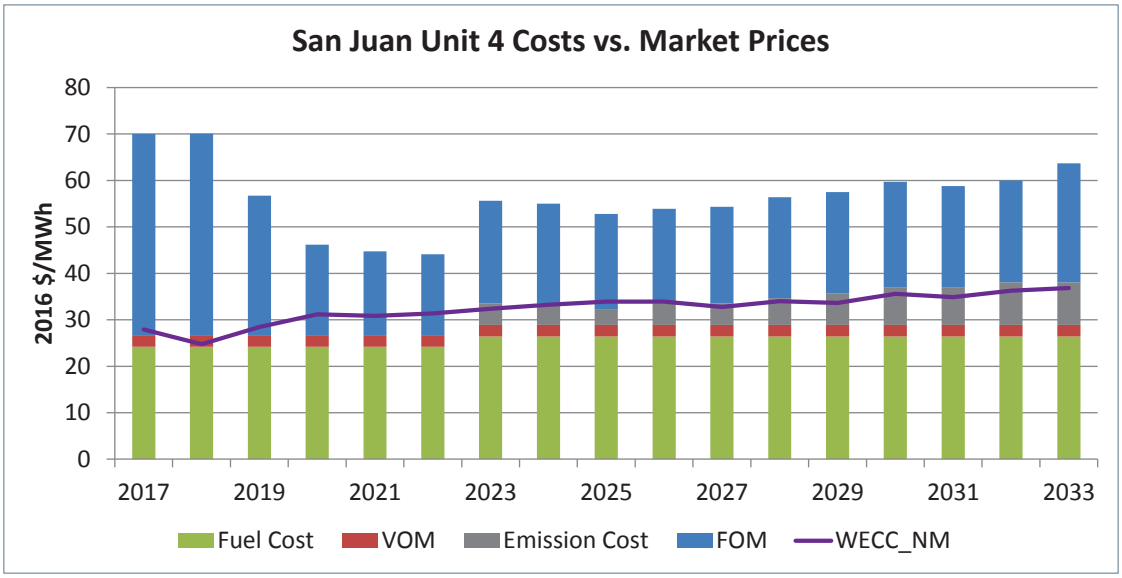
Step 1: Set Planning Objectives and Metrics

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

Issue 1: LCOE of Existing and New Resources shows LRS is in and SJGS 4 is out of the Money

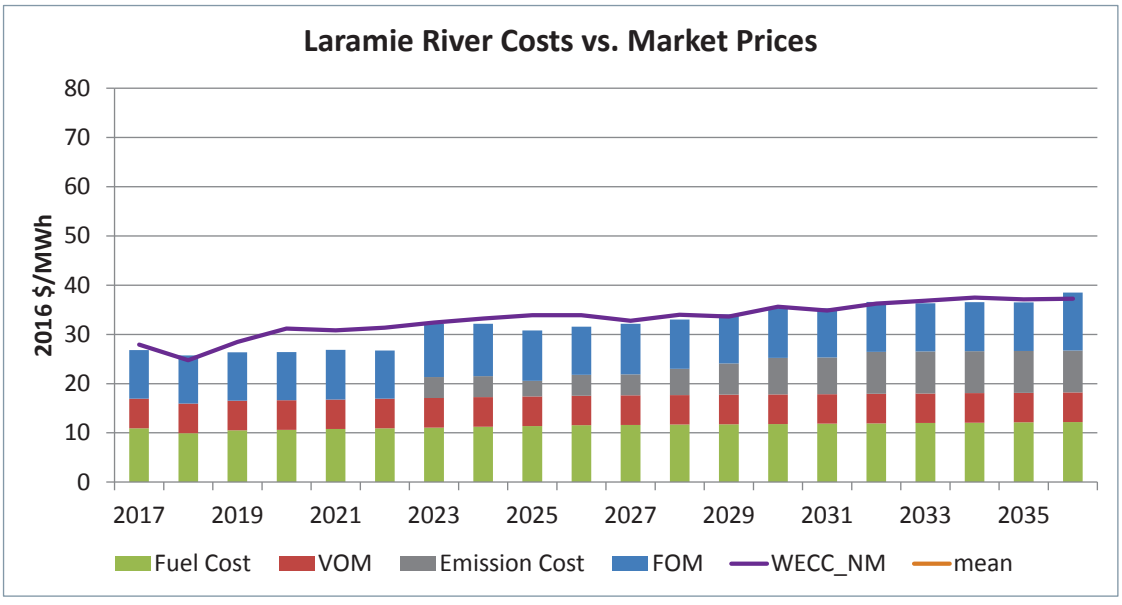


Issue 1a: SJGS 4 Early Exit is Economic Under Average Stochastic Market Prices



Note: San Juan unit 4 runs at minimum level during 2017-2033.

Issue 1b: LRS is Economic to Dispatch Under Average Stochastic Market Prices



Note: Laramie River is expected to run at an average capacity factor of 69% during 2017-2036.

Issue 2: Combined Portfolio is More Economic than Split Portfolios of LAC and LANL (Post 2025)

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**

- Splitting post 2025 results in lower costs for LAC, but higher costs for LANL. This suggests potentially different allocation of costs among the two parties for a win-win solution.

Issue 4: Spinning Reserve Could be Purchased From Market or Provided through Onsite Generation Resources

- Based on Pace Global's estimates, building medium sized RICE units on site could provide spinning reserve at similar costs to 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.

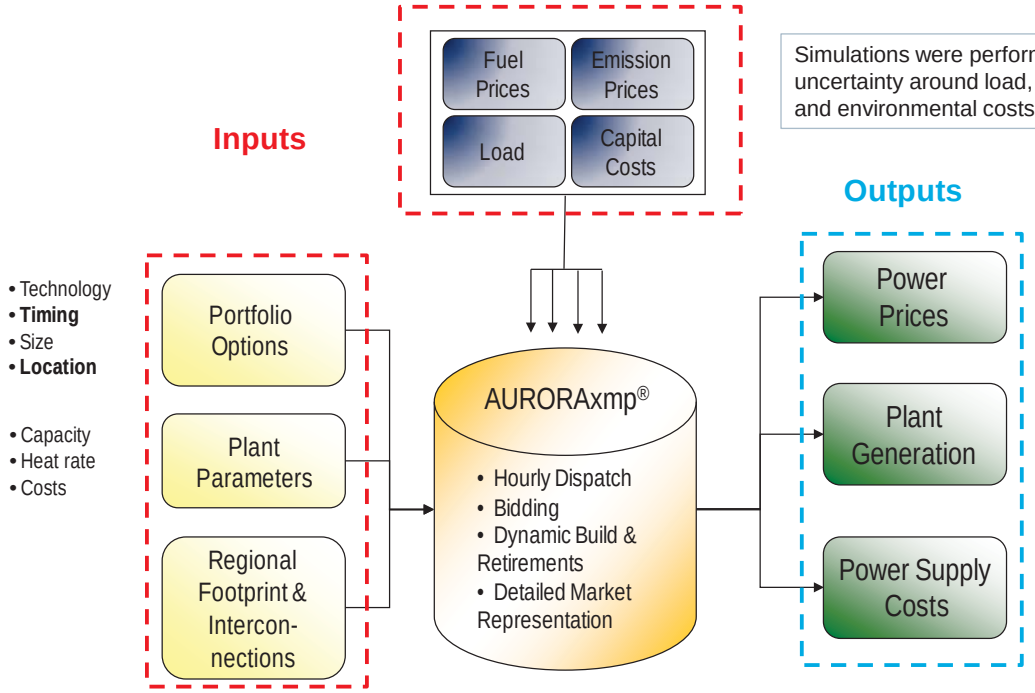
Building Medium Sized RICE Unit for Spinning Reserve		
Size	MW	9
Capital Cost	2016$/kW	1,507
Total Costs	2016$	13,562,640
FOM	2016$/kW-year	19
Capital Costs Recovery over 15 Year	2016$MW-year	$1,136,096
All-in Costs of Providing Spinning Reserve	2016$MW-year	$1,155,573

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

Step 4: Construct Candidate Stochastic Portfolios to Assess Remaining Core Issues in Risk Analysis

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

Step 5: Perform Stochastic Assessment



Stochastic Inputs & Relevant Driver Variables

1. Load

- Peak Load
- Average Load

Driver Variables:
- Weather
- GDP / Personal Income
- DSM/ DER studies
- Data on *Quantum* events

2. Natural Gas

- Henry Hub
- Transco Zone 6
- CC Gate
- SoCal

Modeling based on:
- Hist. Volatility
- Hist. Mean Reversion
- Hist. Correlation
- Expert view on low, mid & high cases

3. Coal

- CAPP
- NAPP
- ILB
- PRB

Modeling based on:
- Hist. Volatility
- Hist. Mean Reversion
- Hist. Correlation
- Expert view on low, mid & high cases

4. CO_2

- National CO_2
- Regional (California and RGGI) CO_2

Modeling based on:
- Expert view on low, mid & high cases
- The 3 cases considered as 5th, 50th and 75th percentiles.

5. Capital Cost

- All relevant technologies included

Modeling based on:
- Expert view on low, mid & high cases
- The 3 cases considered as 5th, 50th and 95th percentiles.

Feedback and Correlation Analysis

A separate process to consider the effects of Coal & CO_2 prices on Natural Gas prices. The effects are based on historical and projected statistical relationships between gas-coal demand switching

Customization:

If client-specific load forecast is provided, we make use of it to come up with distributions around it.

To develop load projections for a specific regional footprint, we consider the customer classification, economic activity, etc. as well.

Fuel Commodity Distributions:

Three sets of distributions for each of low, mid and high cases

Combine the three sets of distributions into one set using probabilities of 15%, 70% and 15% respectively

To capture high-side and low-side satisfactorily

Distributions:

The distributions developed also take into account the probability of CO_2 program not taking effect.

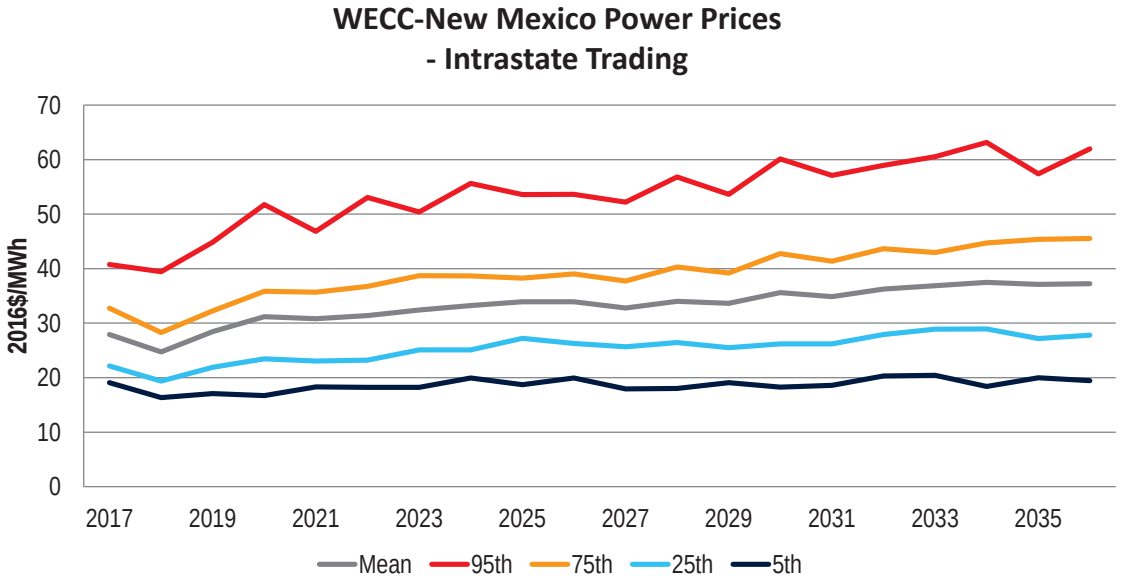
High and low expert opinions are undertaken to capture high-side and low-side satisfactorily in the final distribution.

Distributions:

Parametric distribution is modeled as a Geometric Brownian Motion (GBM) model.

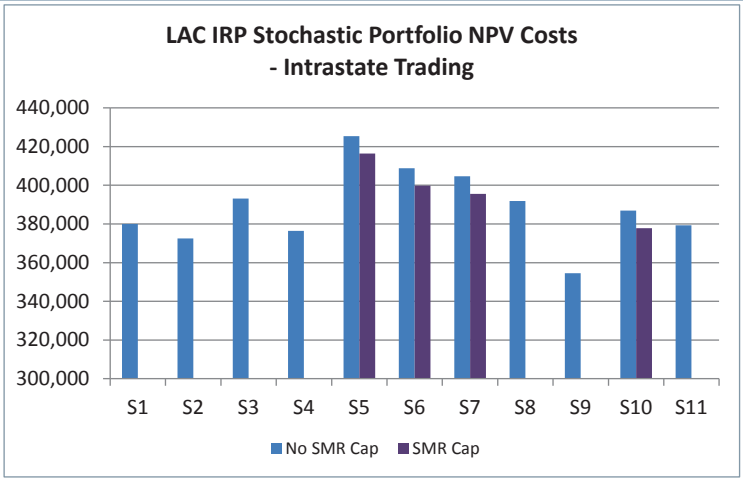
Quantum distribution is developed using the high and low cases in the expert opinion.

Pace Global Stochastic Analysis Indicates Power Prices in New Mexico Remain Below $50/MWh by 2036 (75th Percentile)



Note: The prices are under the mass-based intrastate stochastic results for the New Mexico power zone. The prices under the mass-based interstate stochastic results are similar but on average ~2% higher than what is shown in this slide.

Cost Metric: 20-year NPV Ranking



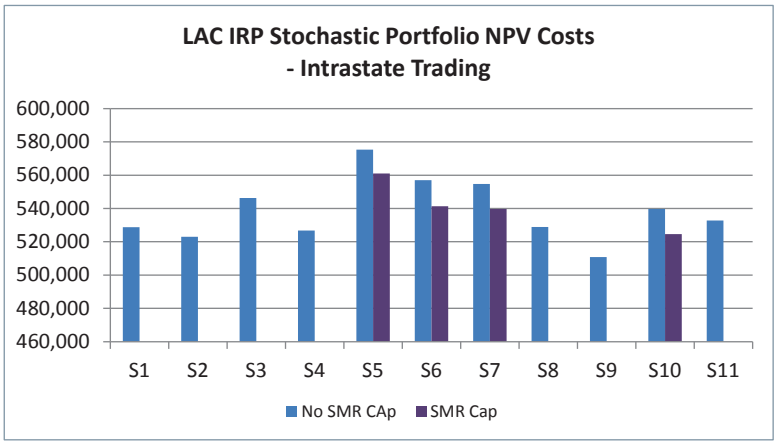
Stochastic Portfolios	
S1	CC, Solar with Storage
S2	CC, Solar with Storage
S3	RICE, Solar with Storage
S4	CC, RICE, Solar with Storage
S5	RICE, Solar with Storage, SMR
S6	CC, RICE, Solar with Storage, SMR
S7	CC, RICE, Solar with Storage, SMR
S8	RICE, Solar PV
S9	Solar with Storage
S10	Solar with Storage,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

Stochastic Portfolios - Intrastate Trading	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
NPV Costs without SMR 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 SMR 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 SMR Cap											
NPV Costs with SMR 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 SMR 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 SMR Cap											

20-year NPV Cost Ranking

Index < 3.33 Index 3.34 – 6.67 Index > 6.67

Risk Metric: 20-year NPV 95th Percentile Ranking



Stochastic Portfolios	
S1	CC, Solar with Storage
S2	CC, Solar with Storage
S3	RICE, Solar with Storage
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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 SMR 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 SMR 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 SMR Cap											
95th Percentile with SMR 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 SMR 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 SMR Cap											

95th Percentile 20-year NPV Cost Ranking

Index < 3.33 | Index 3.34 – 6.67 | Index > 6.67

LAC Renewable Generation Share Ranking in 2036

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)											

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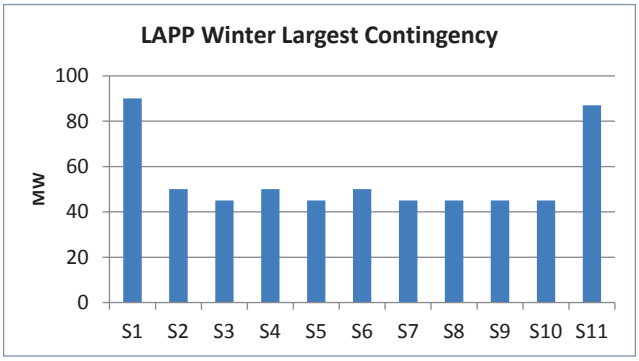
S7	CC, RICE, Solar with Storage, SMR
S8	RICE, Solar PV
S9	Solar with Storage
S10	Solar with Storage, SMR
S11	CC, Solar with Storage (LAC not in compliance)

Renewable Generation Share in 2036 Ranking

In Compliance with Interim Carbon Neutral Goal | Out of Compliance with Interim Carbon Neutral Goal

Transmission/Largest Contingency Risk Ranking



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S8	RICE, Solar PV
S9	Solar with Storage
S10	Solar with Storage, SMR
S11	CC, Solar with Storage (LAC not in compliance)

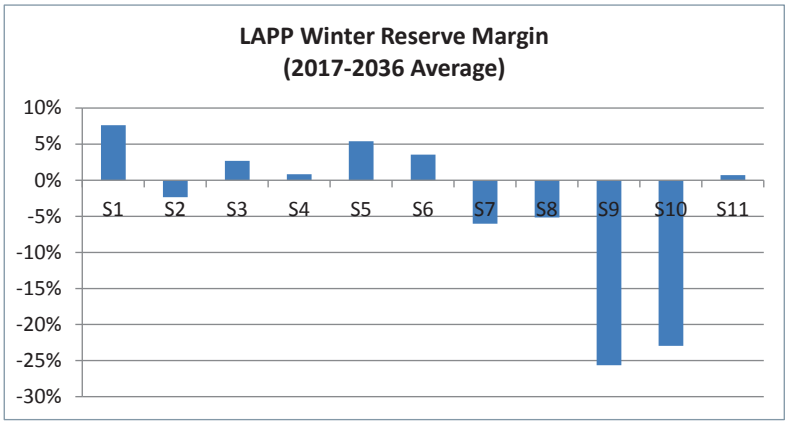
- The largest contingency captures unit level generation risk and site level transmission risks in worst case scenarios.

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

Control Risk - Average Reserve Margin Ranking



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S8	RICE, Solar PV
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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)											

2017-2036 Average Reserve Margin Ranking

Index < 3.33 Index 3.34 – 6.67 Index > 6.67

Development Risks Assessment

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			
					SMR	SMR	SMR			SMR	
Development Risk Assessment											

- Small Nuclear Reactor project adds development risk to the portfolio because of technology, regulatory, cost, financing and schedule uncertainties.
- Offsite large CC could potentially add development risk, but at a much moderate level in comparison to SMR.
- Portfolios S3, S8 and S9 utilizes new resources with proven technology to be built on site and therefore has the lowest development risk.

Stochastic Portfolios	
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S8	RICE, Solar PV
S9	Solar with Storage
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Weather Dependent Risks Assessment

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			
					SMR	SMR	SMR			SMR	
Portfolio Weather Dependent Assessment											

- Portfolio 9 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.

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Operational Metrics Balanced Score Card Summary

Criteria		Transmission/Largest Contingency Risk	Control	Development Risk	Weather Risk	Operational Metrics Summary
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					
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Score Rating: Favorable Neutral Unfavorable

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S10	Solar/ Storage, SMR					
S11	CC, Solar / Storage (LAC not in compliance)					

Score Rating: Favorable Neutral Unfavorable

Pivot Strategies

Strategy	Risk	Mitigation	Pivot Strategy
S9: Solar/ Storage	Land/ Storage cost	Consider SMR or RICE	Portfolios S8 (Add RICE) or S10 (Add SMR)
S10: SMR	Contract/Price caps	Replace SMR with Solar/Storage	Portfolio S9 (Solar with storage)
S8: Rice	High Gas Prices	Replace Gas with Solar/Storage	Portfolio S9 (Solar with storage)
	Need more control of resources	Building CC to fulfill load	Portfolio S2
	Land/Gas Prices	Replace Solar/Gas with SMR	Portfolio S10
	SMR/Gas Prices	Replace SMR/Gas with Solar	Portfolio S9
	SMR mitigation works	Focus on SMR	Portfolio S10