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# Los Alamos Energy Storage Analysis

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## Motivation

Los Alamos Department of Public Utilities provides the following services:

- Water
- Electricity
- Natural gas
- Waste services

And owns the following microgrid assets:

- 2 MW solar generation
- 8.3 MWh (1 MW, 6 MWh Sodium Sulphur battery + lead acid)

Question: can energy storage provide savings with respect to the PNM power purchase Tariff?

## Methodology

- Analyzed one year of data, March 9, 2014 through March 8, 2015
- Developed a production cost model of the Los Alamos system
- Used actual irradiance data
- Generated simulated 5-minute load data from hourly measurements
- Analyzed three scenarios:
  - ESS only providing to the reserve
  - ESS providing cost effective support to the load bandwidth constraint, and
  - ESS providing full support to the load bandwidth constraint.
- Three penalty scenarios:
  - minimum value 0.1 times the market value
  - medium value of 100 times the market value, and
  - maximum of 1000 times the market value

## Results

Table 1: LADPU Bulk Power Costs Under Three Load Bandwidth Penalty Scenarios (Base Case: No Use of ESS to Control Load Bandwidth)

All numbers in (000) USD	10% Bandwidth Excursion Penalty	1,000% Bandwidth Excursion Penalty	10,000% Bandwidth Excursion Penalty
<b>LAC Generation</b>	16,009	16,017	16,020
<b>Grid Generation</b>	2,027	2,031	2,033
<b>&gt; 2 MW Penalty</b>	0.570	570	5702
<b>&lt; -2 MW Penalty</b>	1.67	415	0
<b>TOTAL</b>	18,038	19,034	23,756

Table 2: LADPU Bulk Power Costs Under Both Soft and Hard Load Bandwidth Excursion Constraints (ESS Control Case: Using the ESS to Control Load Bandwidth)

All numbers in (000) USD	10% Soft Excursion Penalty	1,000% Soft Excursion Penalty	10,000% Soft Excursion Penalty	Hard Excursion Constraint
<b>LAC Generation</b>	16,010	16,013	16,013	16,013
<b>Grid Generation</b>	2,006	2,010	2,010	2,010
<b>Reserve Payments</b>	6.7	7.2	7.2	7.4
<b>&gt; 2 MW Penalty</b>	0.76	0.09	0.01	0
<b>&lt; -2 MW Penalty</b>	1.91	0	0	0
<b>TOTAL</b>	18,026	18,030	18,030	18,030



Courtesy: Los Alamos National Laboratory

Table 3: LADPU Bulk Power Cost Difference: ESS Control Scenarios (Table 2) minus Base Case Scenarios (Table 1)

All numbers in (000) USD	Soft Excursion ESS minus Base Case Scenarios			Hard Excursion ESS minus Base Case Scenarios		
Bandwidth Excursion Penalty Level	10%	1,000%	10,000%	10%	1,000%	10,000%
<b>LAC Generation</b>	0.88	(3.89)	(6.59)	4.33	(3.87)	(6.60)
<b>Grid Generation</b>	(20.19)	(21.80)	(23.50)	(17.03)	(21.90)	(23.50)
<b>Reserve Payments</b>	6.71	7.18	7.22	7.37	7.37	7.37
<b>&gt; 2 MW Penalty</b>	0.19	(570.19)	(5,702.80)	(0.57)	(570.28)	(5,702.81)
<b>&lt; -2 MW Penalty</b>	0.24	(414.98)	0	(1.67)	(414.98)	0
<b>TOTAL</b>	(12.17)	(1,003.68)	(5,725.67)	(7.57)	(1,003.66)	(5,725.54)

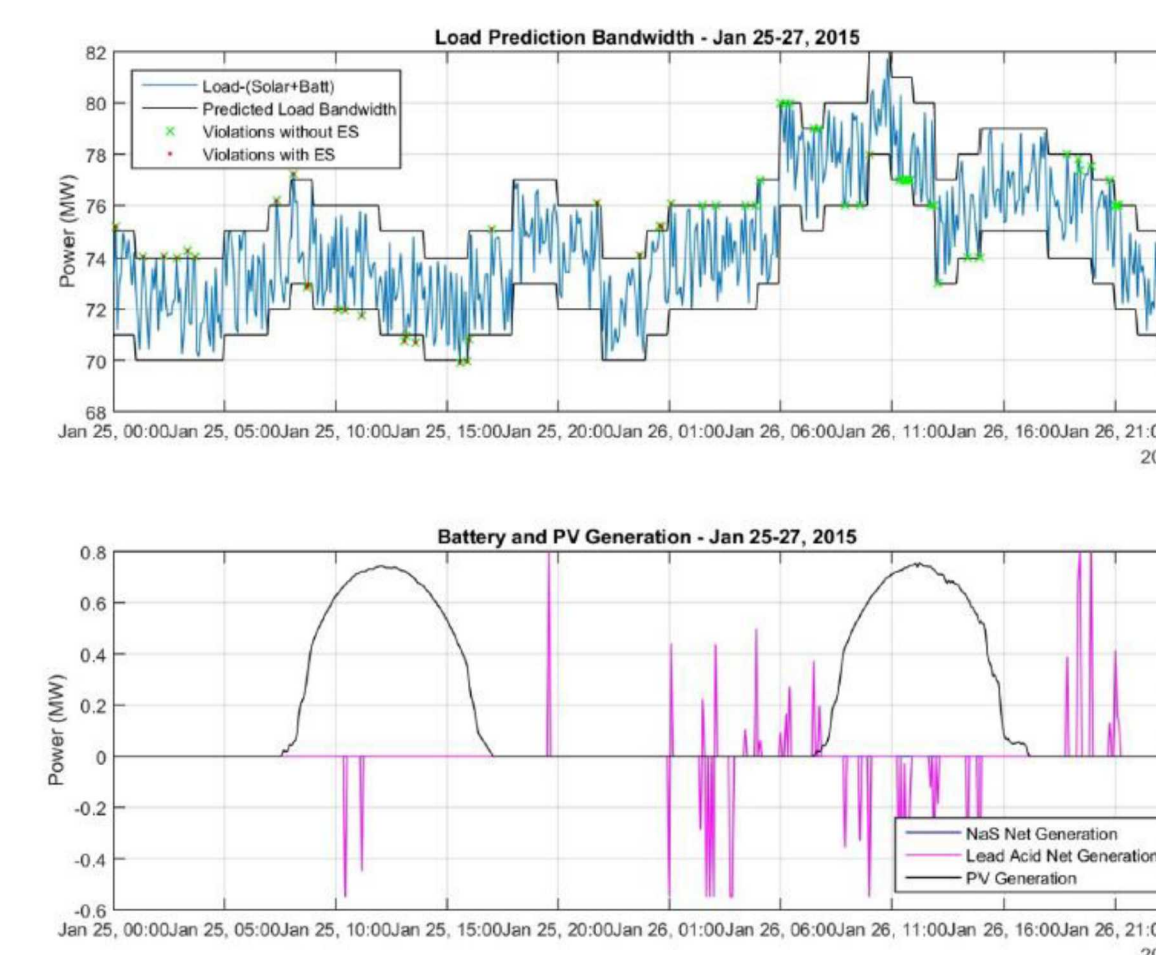


Figure 1 Bandwidth constraint behavior (top) and ESS generation (bottom) for two days with the minimum penalty and partial support from the ESS

The actual dispatch cost for deviations from scheduled dispatch is as follows:

$$\text{Actual Dispatch Cost/MWh} = \text{Actual Dispatch Cost of Last 10 MW/10MWh}$$

The difference between actual and scheduled load is:

$$\text{MWh Difference} = \text{MWh Actual Load (in a given hour)} - \text{MWh Scheduled Load (in same hour)}$$

If the hourly imbalance is under 2MW, then LADPU owes:

$$\text{Actual Dispatch Cost} * \text{MWh Difference}$$

If the hourly imbalance is between +2MW and +10MW, then LADPU owes:

$$110\% * \text{Actual Dispatch Cost} * \text{MWh Difference}$$

If the hourly imbalance is between -2MW and -10MW, then LAC is owed:

$$90\% * \text{Actual Dispatch Cost} * \text{MWh Difference}$$

If the hourly imbalance is greater than +10MW, then LADPU owes:

$$125\% * \text{Actual Dispatch Cost} * \text{MWh Difference}$$

If the hourly imbalance is less than -10MW, then LADPU is owed:

$$75\% * \text{Actual Dispatch Cost} * \text{MWh Difference}$$

In other words, a 10% penalty is assessed when the hourly imbalance is between 2MW and 10MW, and a 25% penalty when the hourly imbalance is greater than 10MW.



Courtesy: Kyocera, Inc



Lead Acid



Sodium-Sulfur

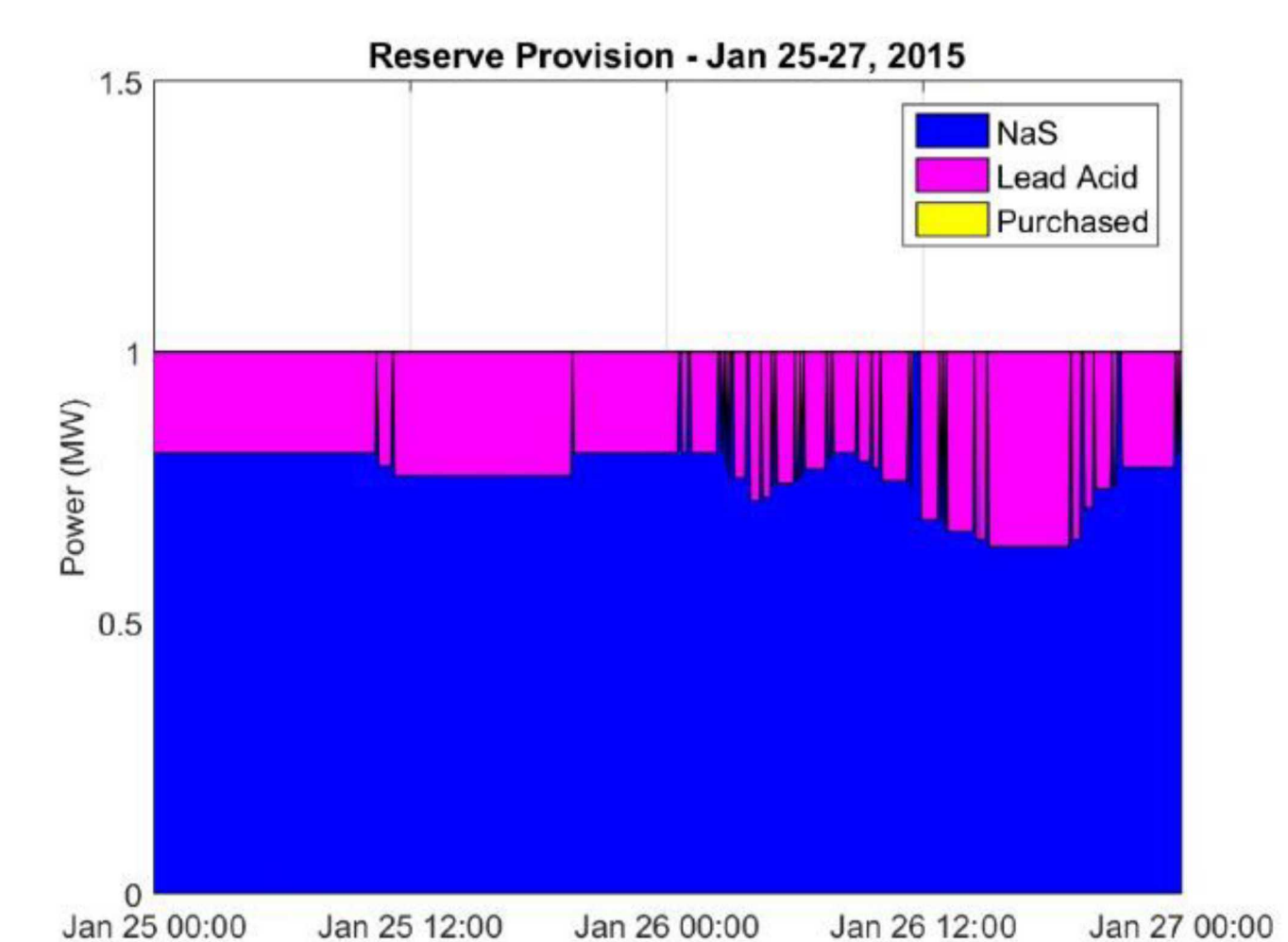


Figure 2 ESS reserve support for two days with partial support of bandwidth constraint

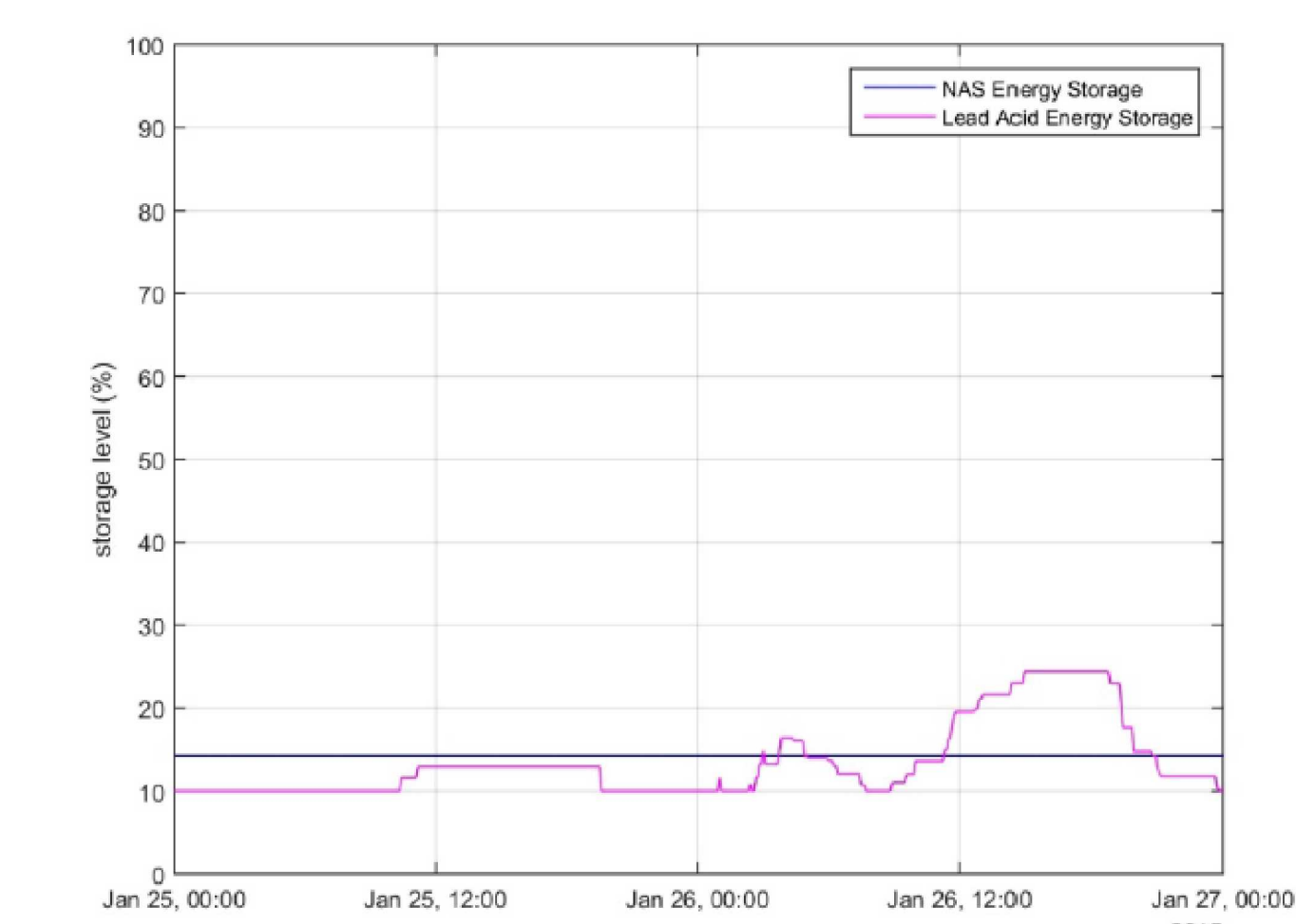


Figure 3 ESS state of charge for two days with partial support of bandwidth constraint

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