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Energy Storage Evaluation Tools

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Presented to the NM PRC



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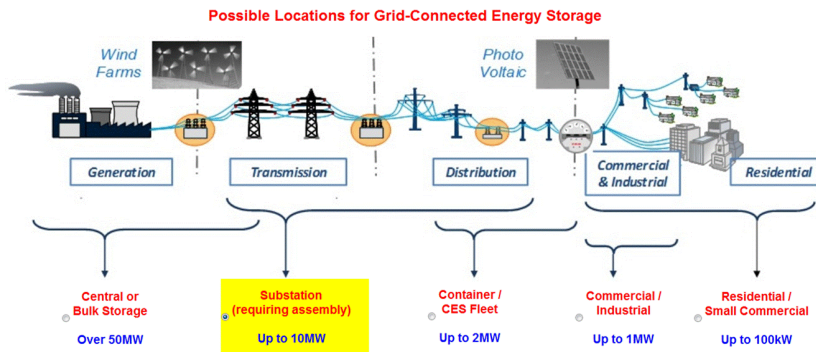
Sandia Energy Storage Evaluation Tools

- 1) ES-Select: Energy Storage Selection Tool
- 2) Energy Storage Handbook
- 3) Energy Storage Database
- 4) Energy Storage Optimization Tool

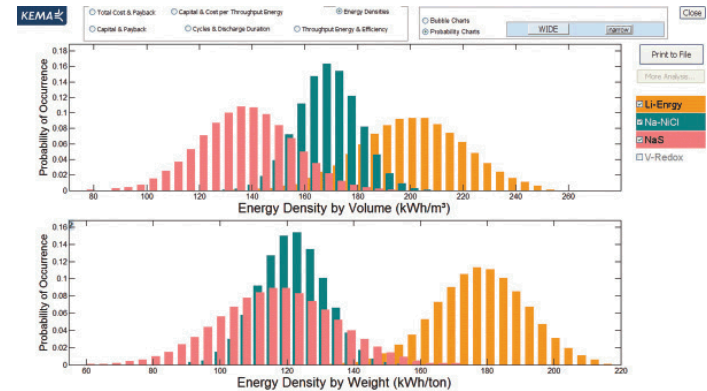
All tools will be available at sandia.gov/ess

ES-Select: Energy Storage Selection Tool

- ES-Select provides the first step to determine the technologies that can economically address grid issues: removes the uncertainty and hesitation associated with new technology adoption.
- Informs decision makers about the value of energy storage technologies and how they compare to one another.
 - Understand and accurately compare the costs and benefits of various energy storage technologies
 - Determine applicable energy storage resources
 - Develop a preliminary business case for specific applications
 - Educate potential owners, electric system stakeholders and the general public on energy storage technologies



NOTE: Each location imposes restrictions on both the number of applications available for that location as well as the ES technologies appropriate for the site. Click on "Location Constraints" for more details.



Site = Sample Site 1. Storage = 5MM. Project life = 10 years. Cost of charging = 30 (\$/MWh)

ES-Select: Energy Storage Selection Tool

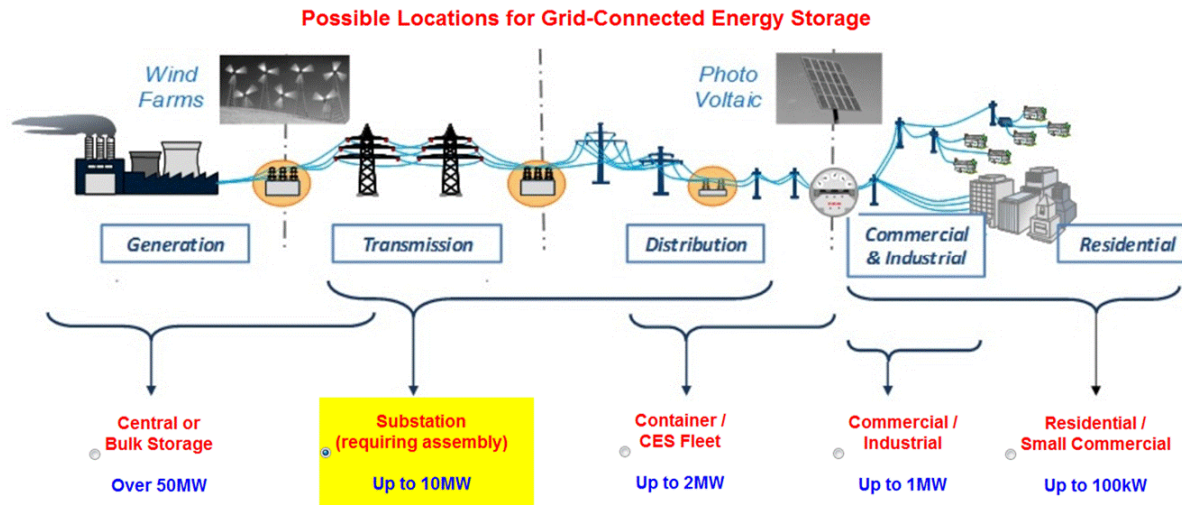
1) Select storage location

ES-Select™: Location and Size of Grid Storage. BETA VERSION.



Introduction **Select Location** Select Main Application Select Other Applications Select Storage Options Run Monte Carlo Compare Storage Options

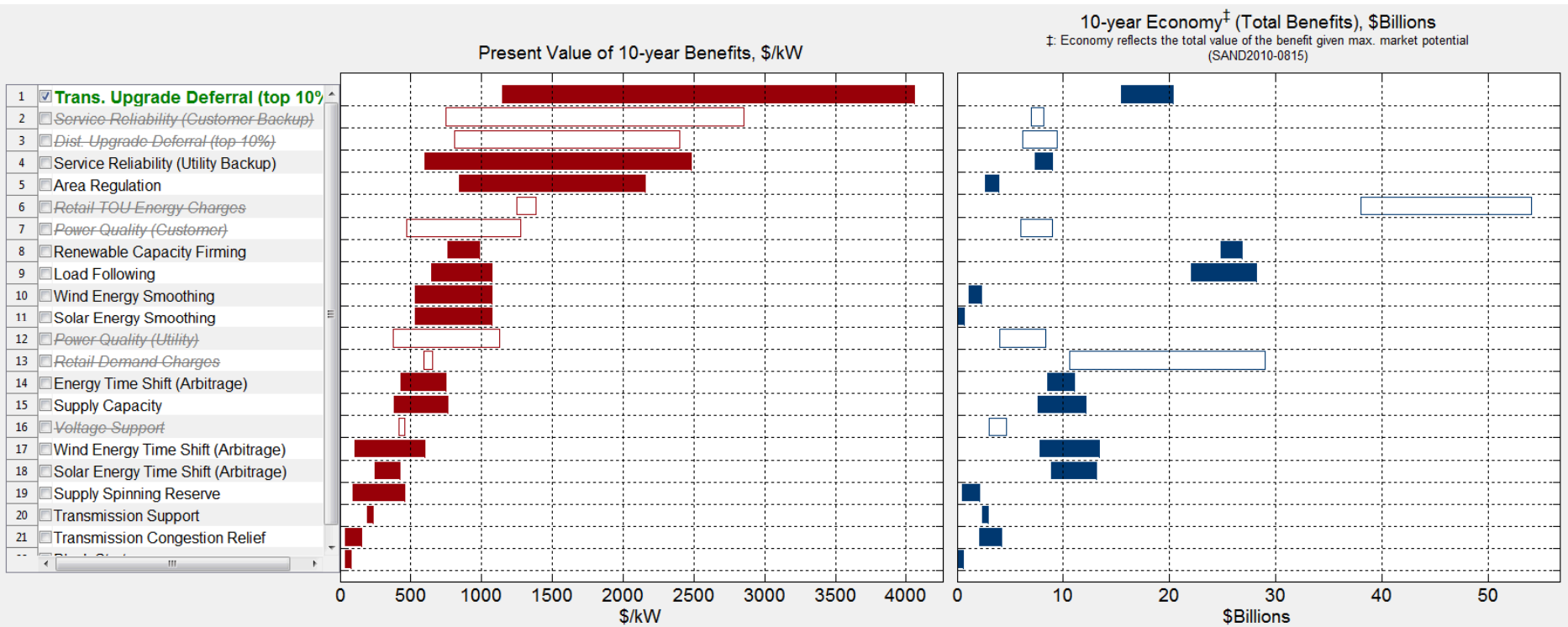
KEMA This power grid depicts major locations for Energy Storage. Please choose from the five (5) radiobuttons located below the power grid.



NOTE: Each location imposes restrictions on both the number of applications available for that location as well as the ES technologies appropriate for the site. Click on "Location Constraints" for more details.

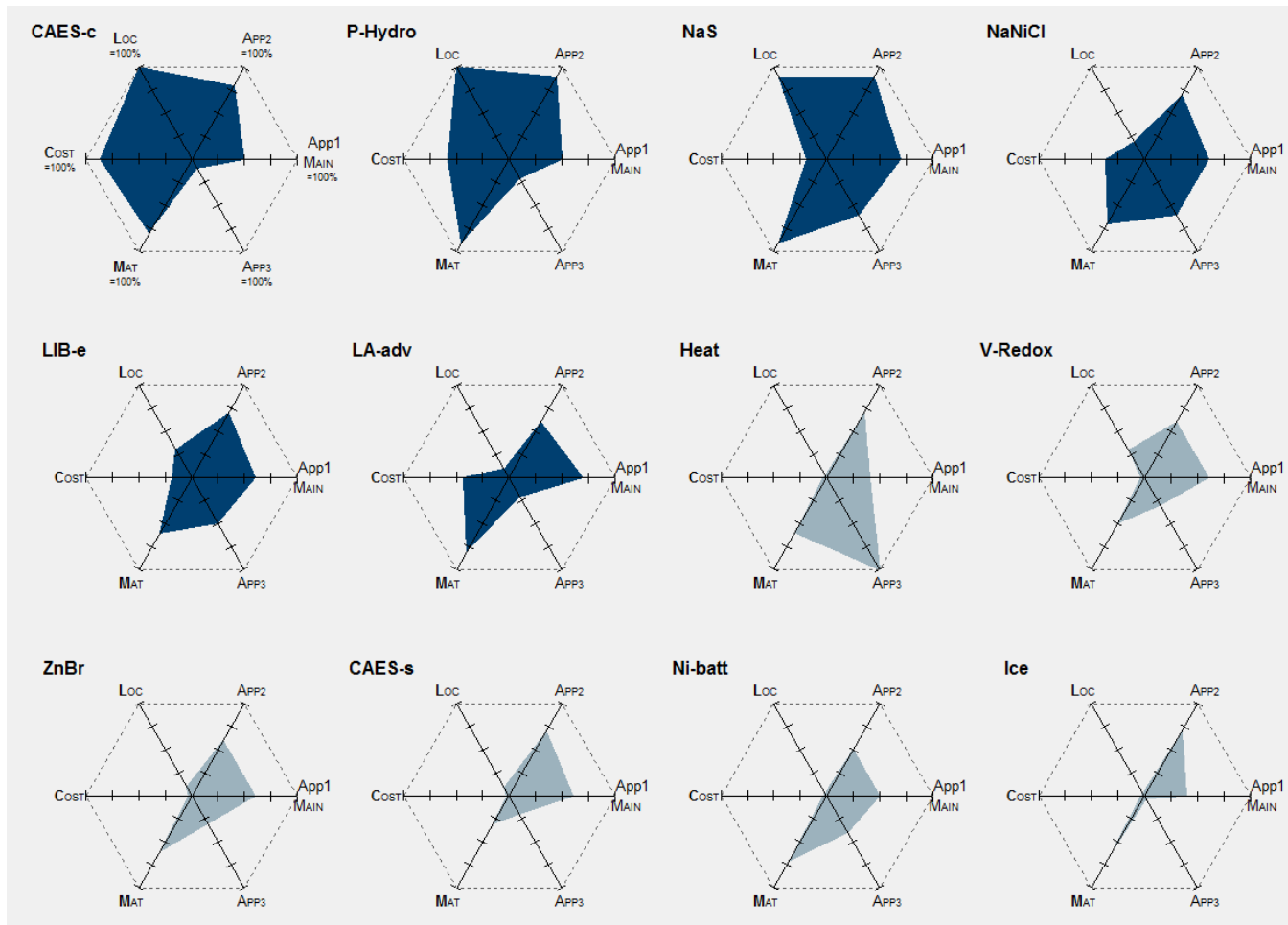
ES-Select: Energy Storage Selection Tool

2) Select storage application



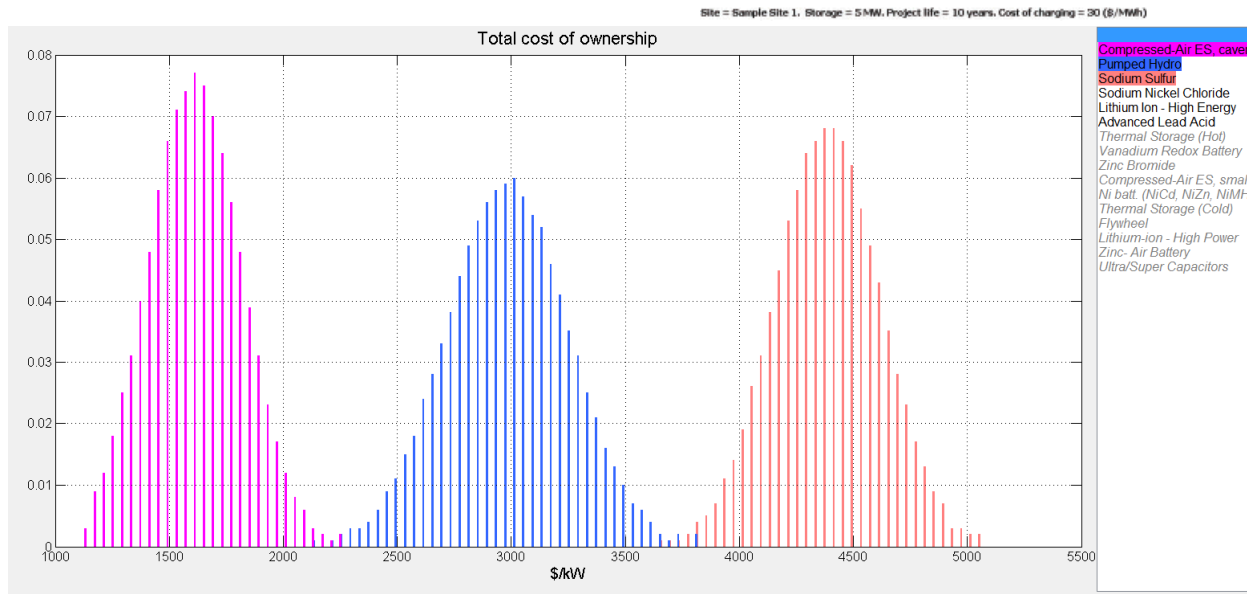
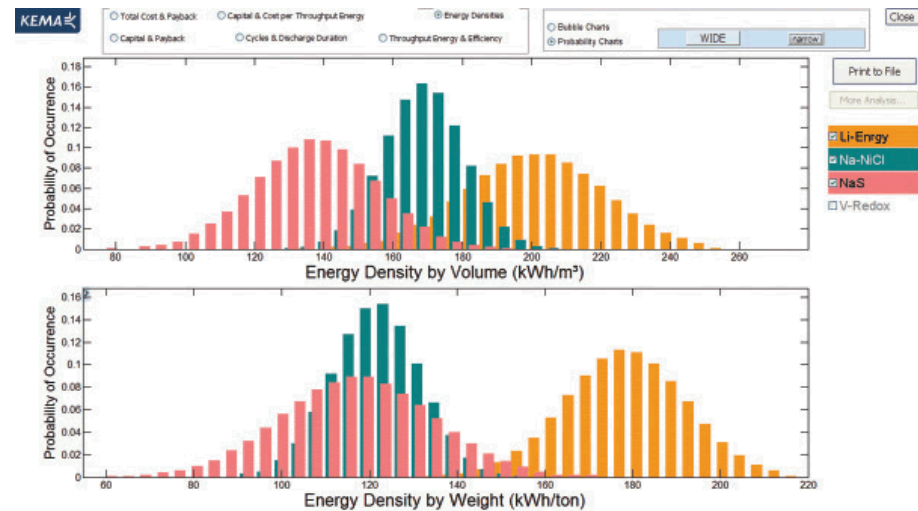
ES-Select: Energy Storage Selection Tool

3) Select storage technologies to serve the application



ES-Select: Energy Storage Selection Tool

4) Results: Evaluate technologies for the application



Energy Storage Handbook

- Partnership of Sandia, EPRI (Electric Power Research Institute) & NRECA (National Rural Electric Cooperative Association)
- Details the current state of commercially available energy storage technologies and their applications.
- Provides a cost survey of all available energy storage technologies (commercial, demo, and R&D)
 - Includes system costs
 - Installation cost estimates

Energy Storage Handbook

- Chapter 1: Electricity Storage Applications and Benefits
 - Applications and benefits
 - Energy storage versus other grid solutions
 - Policy and regulatory framework

- Chapter 2: Electricity Storage System Cost and Performance Data
 - Storage technologies: batteries, flywheels, CAES, pumped storage
 - Cost and performance data

- Chapter 3: Evaluating Electricity Storage Impacts and Benefits
 - Financial modeling tools
 - Electrical modeling tools

- Chapter 4: Electricity Storage Project Development
 - Acquisition considerations: application functional requirements for storage
 - Specifications, permitting, RFI/RFP Templates
 - Development of standards and test protocols
 - Past and present projects

Energy Storage Project Database

- A publicly accessible database of energy storage projects, research, and state and federal legislation/policies.



The screenshot shows the homepage of the DOE Energy Storage Database. The header features the Department of Energy logo and the text "DOE Energy Storage Database" on the left, and the Sandia National Laboratories logo on the right. A navigation menu on the left includes "Home", "PROJECTS" (with sub-links for "Basic Search" and "Advanced Search"), "US POLICIES" (with sub-links for "Basic Search" and "Advanced Search"), "UPLOAD INFORMATION" (with sub-links for "New Project" and "New Policy"), and "Contact Us". The main content area features a world map with several location pins (orange and green) indicating project or policy locations. Below the map are two buttons labeled "Projects" and "Policies". To the right of the map, a text block states: "The DOE Energy Storage Database provides free, up-to-date information on grid-connected energy storage projects and relevant state and federal policies." Below this, a smaller text block reads: "All information is vetted through a third-party verification process. All data can be exported to Excel or PDF. Our hope is that this site will contribute to the rapid development and deployment of energy storage technologies." The footer contains copyright information and links for "Contact Us", "Glossary of Terms", "Terms of Use", "DMCA Notification", "Download Disclosure", and "Privacy Notice".

Available at: <http://www.energystorageexchange.org/>

Energy Storage Project Database

Home

PROJECTS

[Basic Search](#)

[Advanced Search](#)

US POLICIES

[Basic Search](#)

[Advanced Search](#)

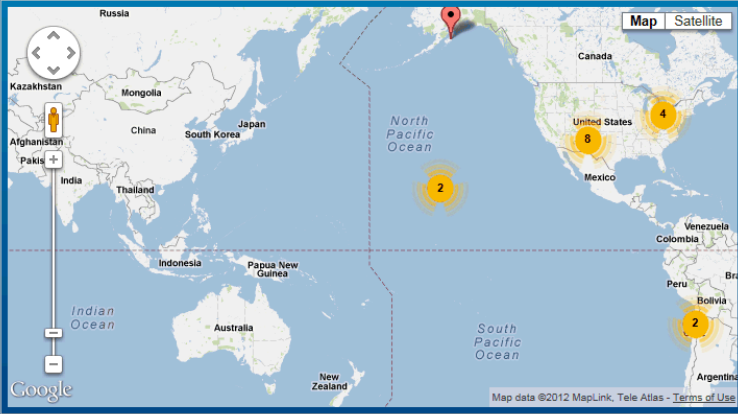
UPLOAD INFORMATION

[New Project](#)

[New Policy](#)

[Contact Us](#)

Projects



Map Satellite

Map data ©2012 MapLink, Tele Atlas - [Terms of Use](#)

Search Filters

Technology Type

Country

State/Province

Rated Power

Duration

Benefit Stream

Ownership Model

Status

Grid Interconnection






Reset Filters

[Export to Excel](#)

[Export to PDF](#)

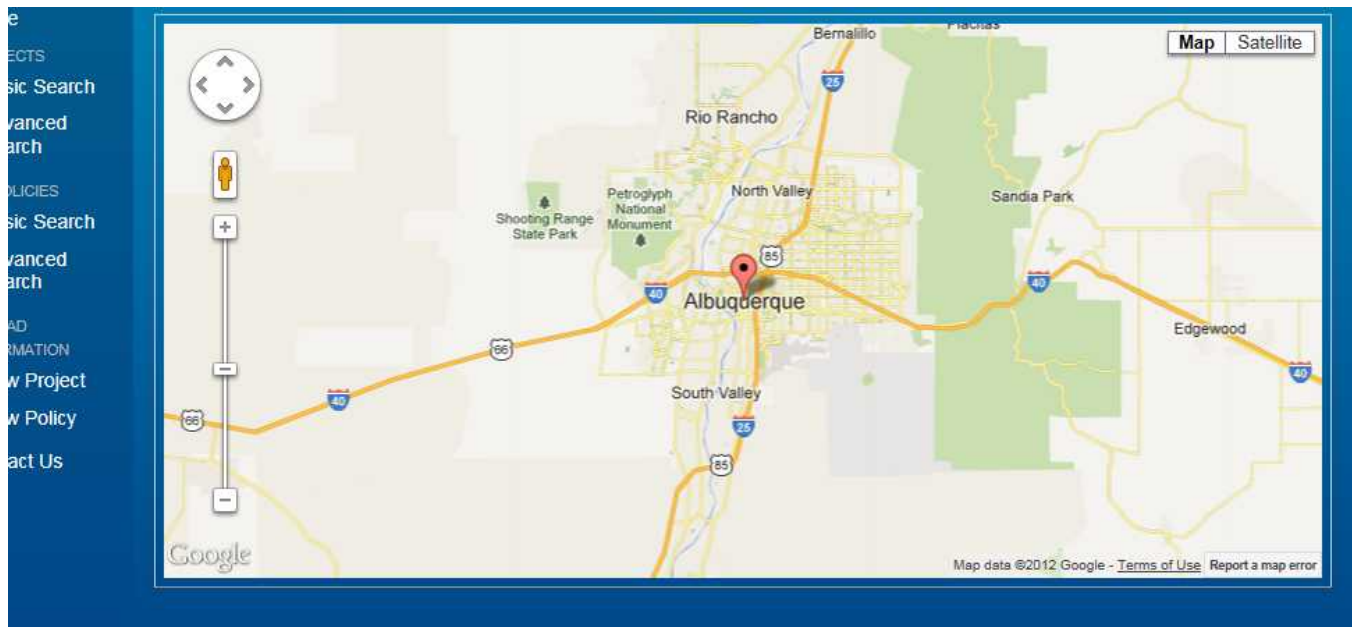
[Advanced Search](#)

Use Table Scroll Bar to View Results, Click Header Rows to Sort

Name	Description	Technology	Rated Power (kW)	Duration (HH:MM)	Location	Status
 Montpelier Nut Corporation Flow Battery Demo Project	This project is designed to demonstrate a prototype flow battery system with an intermittent renewable energy source - a helios dual-axis tracker photovoltaic system. The project will combine a proven redox flow battery chemistry with a unique, patented design to yield an energy storage system that meets the combined safety, reliability, and cost requirements for distributed energy storage. The project is supported by a U.S. DOE Office of Electricity ARRA grant.	Iron Chromium Redox Flow Battery	250	4:00	Denair, California, United States	Contracted
 Los Andes	The Los Andes project provides critical contingency services to maintain the stability of the electric grid in Northern Chile, an important mining area. The project continuously monitors the condition of the power system and if a significant frequency deviation occurs, such as the loss of a generator or transmission line, the Los Andes system provides up to 12MW of power nearly instantaneously. This output can be maintained for 20 minutes at full power, allowing the system operator to resolve the event or bring other standby units online.	Lithium Ion Battery	12,000	0:20	Copiapo, Atacama, Chile	Operational
 Laurel Mountain	AES installed a wind generation plant comprised of 98 MW of wind generation and 32 MW of integrated battery-based energy storage. The project is supplying emissions-free renewable energy and clean, flexible, operating reserve capacity to the PJM Interconnection, the largest power market in the world.	Lithium Ion Battery	32,000	0:15	Elkins, West Virginia, United States	Operational
 Pillar Mountain Wind Project	Xtreme has been hired by the Kodiak Electric Association to install a 3MW Advanced Lead Acid energy storage system on a 70MW grid to respond to grid voltage and frequency fluctuations from local wind generation. The energy storage will help to increase reliable wind integration from 4.5 MW to 9MW.	Advanced Lead Acid Battery	3,000	0:15	Kodiak, Alaska, United States	Contracted
 Detroit Edison Community Energy Storage Project	This project is designed to demonstrate a proof of concept for aggregated Community Energy Storage Devices in a utility territory.	Lithium Ion Battery	1,000	2:00	Detroit, Michigan, United States	Operational

Scroll to view more results / Click underlined header row items to sort records

Energy Storage Project Database



PNM Prosperity Energy Storage Project

Technology Type

Advanced Lead Acid Battery

Rated Power (kW)

500

Duration at Rated Power (HH:MM)

5:36

Description

This project is demonstrating how a 2.8MWh Advanced Lead Acid battery along with a sophisticated control system turns a 500kW solar PV installation into a reliable, dispatchable distributed generation resource. This hybrid resource will mitigate fluctuations in voltage normally caused by intermittent sources such as PV and wind and simultaneously store more energy for later use when customer demand peaks. The project is supported by an ARRA grant from the U.S. Department of Energy, Office of Electricity.

Web Link

<http://www.smartgrid.gov/sites/default...>

Energy Storage Optimization Tool

- Optimization tool for Valuing Energy Storage in arbitrage and the regulation market
 - Determine the maximum potential revenue from participation in arbitrage and the regulation market
 - In a deregulated wholesale energy and ancillary services market
 - LP (linear programming) Optimization:

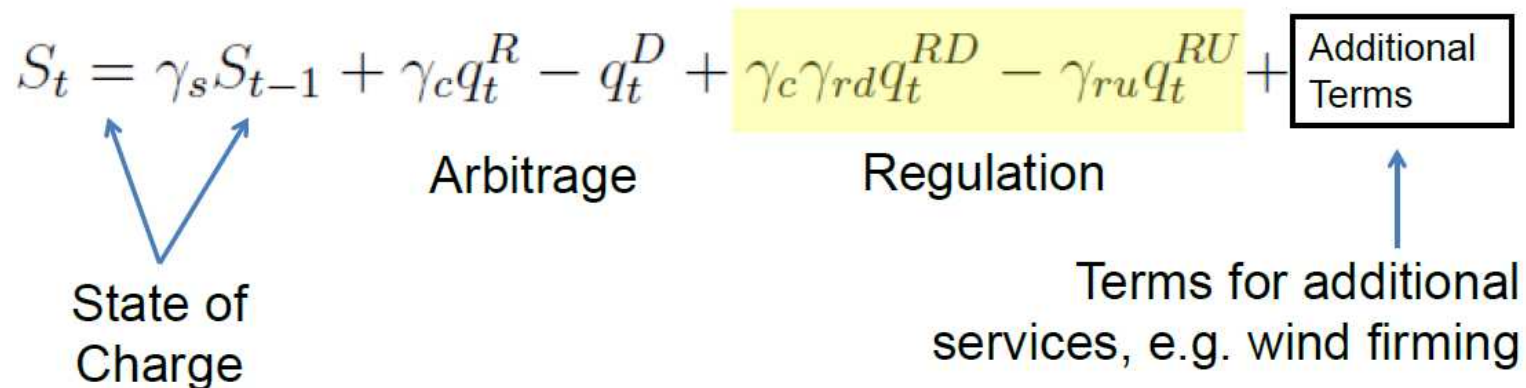
$$S_t = \gamma_s S_{t-1} + \gamma_c q_t^R - q_t^D + \gamma_c \gamma_{rd} q_t^{RD} - \gamma_{ru} q_t^{RU} + \text{Additional Terms}$$

State of Charge

Arbitrage

Regulation

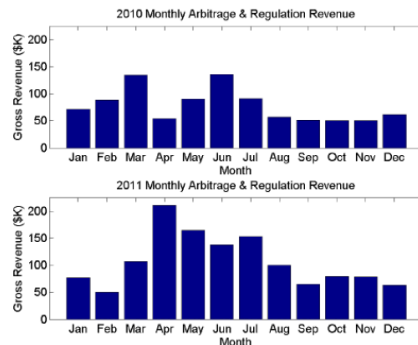
Terms for additional services, e.g. wind firming



Energy Storage Optimization Tool

1) Determine share of arbitrage and regulation (and other services) for maximum revenue

2) Evaluate different trading strategies.



Year	Charge Time (%)	Discharge Time (%)	Regulation Up Time (%)	Regulation Down Time (%)	Revenue
2010	4.71%	0.64%	81.10%	85.80%	\$935,975
2011	6.72%	0.78%	81.94%	79.60%	\$1,288,431

Strategy	Year	Revenue	% Maximum
(1) Arbitrage only, last year's hours	2011	\$218,718	65.88%
(2) Arbitrage only, yesterday's hours	2010	\$162,602	81.99%
(2) Arbitrage only, yesterday's hours	2011	\$285,874	86.11%
(3) Regulation only	2010	\$893,544	95.47%
(3) Regulation only	2011	\$1,218,173	94.55%

Contacts

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