Energy Storage in State RPSs
State-Federal RPS Collaborative Webinar

Hosted by Clean Energy States Alliance
December 19, 2011
Housekeeping

- All participants will be in listen-only mode throughout the broadcast.
- You can connect to the audio portion of the webinar using your computer’s speakers or a headset. You can also connect by telephone.
- You can enter questions for today’s event by typing them into the “Question Box” on the webinar console. We will pose your questions, as time allows, following the presentations.
- This webinar is being recorded and will be made available after the call on the CESA website at www.cleanenergystates.org/projects/state-federal-rps-collaborative
State-Federal RPS Collaborative

- With funding from the Energy Foundation and the US Department of Energy, the Clean Energy States Alliance facilitates the Collaborative.
- Includes state RPS administrators and regulators, federal agency representatives, and other stakeholders.
- Advances dialogue and learning about RPS programs by examining the challenges and potential solutions for successful implementation of state RPS programs, including identification of best practices.
- To get the monthly newsletter and announcements of upcoming events, sign up for the listserv at: www.cleanenergystates.org/projects/state-federal-rps-collaborative
Energy Storage and RPS

Presenters:

Dr. Imre Gyuk, Manager, Energy Storage Program, U.S. DOE

Jacquelynne Hernandez, Technical Staff, Sandia National Laboratories

Dhruv Bhatnagar, Technical and Policy Analyst, Sandia National Laboratories

Dr. Verne Loose, Senior Economist and Contractor to Sandia National Laboratories

www.cleanenergystates.org
Energy Storage Technology Advancement Partnership (ESTAP)

**Purpose:** Create new DOE-state energy storage partnerships and advance energy storage

**Focus:** Distributed electrical energy storage technologies (batteries, flywheels, supercapacitors, above-ground compressed air, micro pumped hydro)

**Outcome:** Near-term and ongoing project deployments across the U.S. with co-funding from states, project partners, and DOE

**Activities:**
- State and stakeholder listservs (ongoing)
- Surveys and interviews (ongoing)
- Webinars
- RFI (Q1 2012 and future)
- MOU

http://www.cleanenergystates.org/projects/energy-storage-technology-advancement-partnership/

Anne Margolis, Project Director (anne@cleanegroup.org)
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Warren Leon
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Email: WLeon@cleanegroup.org
Grid Energy Storage
The Big Picture

IMRE GYUK, PROGRAM MANAGER
ENERGY STORAGE RESEARCH, DOE
<table>
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<th>Storage Technology:</th>
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<td><strong>Devices</strong></td>
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<td>Cost, Cycle Life</td>
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<td>Ramp Speed</td>
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<td>Reliability, Safety</td>
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<td><strong>Applications</strong></td>
</tr>
<tr>
<td>Regulation, PV Ramping</td>
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<td>Load Shifting, Micro-grids</td>
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<td><strong>Field Tests</strong></td>
</tr>
<tr>
<td>Scaling, Systems</td>
</tr>
</tbody>
</table>
Recent Projects:

ARRA – Public Service NM:
500kW, 2.5MWh for smoothing of 500kW PV installation; Using EastPenn Lead-Carbon Technology Commissioned Sep. 2011

DOE Loan Guarantee – Beacon:
20MW Flywheel Storage for Frequency Regulation in NY-ISO
20MW commissioned July 2011
Regulatory Framework:

Federal
- FERC Rules → Order 890
- Tax Rebates → S3617

States
- State Mandates → AB2514
- RPM Consequences

PUC
- SDGE Rate Case, Hawaii, Texas
Energy Storage Project Database

Goal:
Create a publicly accessible database of energy storage projects, research, and state and federal legislation/policies.

Energy Storage Handbook

Goal:
Partner with EPRI and NRECA to develop an energy storage handbook:
• Details the current state of commercially available energy storage technologies.
• Matches applications to technologies
• Info on sizing, siting, interconnecting
• Includes a cost database

ES-Select: Energy Storage Selection Tool

Goal:
• Provide a tool for high-level decision makers to facilitate the planning process for ESS infrastructure:
  • High-level technical and economic review of storage technologies
  • Determine and size applicable energy storage resources
  • Develop a preliminary business case
• Educate potential owners, electric system stakeholders and the general public on energy storage technologies
• Developed by KEMA
OE Energy Storage Program

Aggressively Furthers Market Pull and Technology Push:
Demonstrations and Research
RECENT US POLICY AND LEGAL IMPLICATIONS FOR ENERGY STORAGE VIS-À-VIS RPS MANDATES

Jacquelynne Hernández
Sandia National Laboratories, New Mexico (USA)
December 2011

An UPDATE of Material Presented at the Electrical Energy Storage Applications & Technologies (EESAT) Conference
San Diego, California in October 2011
Statement of Problem
The Issues
Some Considerations
Recommendations
PROBLEMS & ISSUES

- There is **no** U.S. federal policy for RPS
- The regulations for RPS (about 40% of US electricity sales) **vary** from state to state or are non-existent;
- Importing Variable Energy Resources (VERs) into the **grid** affect reliability;
- Energy storage was not specifically written into the legislation for RPS; &
- There are **environmental** and **market** policies that affect the use of electrical energy storage at the federal, state, and local levels.

**Recent US Policy and Legal Implications for Energy Storage Vis-À-Vis RPS Mandates**

- There is no U.S. federal policy for RPS
- The regulations for RPS (about 40% of US electricity sales) vary from state to state or are non-existent;
- Importing Variable Energy Resources (VERs) into the grid affect reliability;
- Energy storage was not specifically written into the legislation for RPS; &
- There are environmental and market policies that affect the use of electrical energy storage at the federal, state, and local levels.

**California Renewables Portfolio Standard (RPS)**
Established in 2002 under Senate Bill 1078 and accelerated in 2006 under Senate Bill 107, California's Renewables Portfolio Standard (RPS) is one of the most ambitious renewable energy standards in the country. The RPS program requires investor-owned utilities, electric service providers, and community choice aggregators to increase procurement from eligible renewable energy resources by at least 1% of their retail sales annually, until they reach 20% by 2010.
Energy storage can play several roles in the vertical electricity delivery system: generation support, transmission or bulk distribution at the utility level. As a market function, storage can be part of a system’s energy management, bridging power, or as an ancillary service providing operators tools to ensure power quality, reliability, or stability. The challenges of grid integrate of renewable energy sources from the U.S. RPS mandates have brought to light a need to address legislative, regulatory, economic, and technical requirements related to energy storage.
U.S. RPS Mandate On-Track Status
Information collected by Institute of Energy Research, Dec 2010

<table>
<thead>
<tr>
<th>State</th>
<th>RPS Mandate (Quick Summary)</th>
<th>Non-Compliance Penalty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorado</td>
<td>30% RES by 2020 for IOUs, 10% for Coops &amp; MUNIs</td>
<td>PUC determines; utility may not recover cost from customers</td>
</tr>
<tr>
<td>Delaware</td>
<td>25% RES by 2025 with 3.5% PV</td>
<td>Penalty begins at $25 per MWh; it increases over time</td>
</tr>
<tr>
<td>Hawaii</td>
<td>40% RES by 2030</td>
<td>Discretion of PUC</td>
</tr>
<tr>
<td>Iowa</td>
<td>105 MW REW from two major facilities (MidAmerican and Alliant Energy), voluntary goal of 1,000 Wind</td>
<td>None</td>
</tr>
<tr>
<td>Michigan</td>
<td>10% RES by 2015</td>
<td>Purchase and/or production of RECs</td>
</tr>
<tr>
<td>Minnesota</td>
<td>25% RES by 2025 (Xcel Energy: 30% by 2020)</td>
<td>Minn. PUC – construction of facilities, purchase RECs</td>
</tr>
<tr>
<td>Montana</td>
<td>15% RES by 2015</td>
<td>$10 per MWh for RECs the utility failed to procure</td>
</tr>
<tr>
<td>New York</td>
<td>30% of consumption by 2015</td>
<td>NY PSC collects from elect. customers &amp; contracts directly w/renewable generators; therefore no penalty</td>
</tr>
<tr>
<td>North Dakota</td>
<td>GOAL: 10% sold by 2015</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Ohio</td>
<td>12.5% by 2025</td>
<td>Alternative compliance of $45 per MWh adjusted annually</td>
</tr>
<tr>
<td>Oregon</td>
<td>Large utilities: 25% by 2025; small- 10%, smallest 5%</td>
<td>Compliance payment ($50/MWh)</td>
</tr>
<tr>
<td>Texas</td>
<td>5,880 MW by 2015</td>
<td>Administrative penalty - $50 per MWh of renewable energy shortfall</td>
</tr>
<tr>
<td>Virginia</td>
<td>GOAL: 15% of 2007 sales (9,693,239 MWh) by 2025</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Washington</td>
<td>15% RES by 2030 (3% by 2012)</td>
<td>$50 per MWh of renewable shortfall</td>
</tr>
</tbody>
</table>
### State: Colorado

**Incentive Type:** Renewables Portfolio Standard  

**Eligible Technologies:** Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Recycled Energy, Anaerobic Digestion, Fuel Cells using Renewable Fuels  

**Applicable Sectors:** Municipal Utility, Investor-Owned Utility, Rural Electric Cooperative, (Only Municipal Utilities Serving 40,000+ customers)  

**Standard:** Investor-owned utilities: 30% by 2020  
Electric cooperatives: 10% by 2020  
Municipal utilities serving more than...  

**Technology Min:** Distributed Generation (IOUs only): 3% of retail sales by 2020. Half of requirement must be "retail distributed"  

**Credit Trading:** Yes (no third-party tracking system in place)  

**Web site:** [http://www.dora.state.co.us/PUC/rulem](http://www.dora.state.co.us/PUC/rulem)  

**Authority 1:**  
- CRS 40-2-124  
  - 11/2/2004  
  - 12/1/2004  

**Authority 2:**  
- 4 CCR 723-3-3650 et seq.  
  - 7/2/2006  

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**Notes**

Colorado became the first U.S. state to create a renewable portfolio by ballot initiative, Nov 2004  

According in the Code of Colorado Regulations 4 CFR 723-3  

3644. Renewable Distributed Generation  
(a) In conjunction with the renewable energy standard set forth in paragraph 3654(a), each investor owned QRU shall generate or cause to be generated (through purchase or by providing rebates or other form of incentive) renewable distributed generation...Section V – 3% of its retail electricity sales in Colorado for each of the compliance years beginning in 2020 and continuing thereafter...Section (b) Of the amount of renewable distributed generation
### State: Delaware

**Incentive Type:** Renewables Portfolio Standard  
**Applicable Sectors:** Municipal Utility, Investor-Owned Utility, Rural Electric Cooperative, Retail  
**Standard:** 25% by compliance year 2025-2026  
**Technology Min:** PV: 3.5% by compliance year 2025-2026  
**Credit Trading:** Yes (PJM-GATS)  
**Credit Trading Accepted From:** MIRECS into PJM-GATS  
(Refers to tracking system compatibility only, not RPS eligibility. Please see statutes and regulations for information on facility eligibility)  
**Web site:** [http://depsc.delaware.gov/electric/delrps.shtml](http://depsc.delaware.gov/electric/delrps.shtml)

**Authority 1:** 26 Del. C. § 351 et seq.  
07/21/2005 (subsequently amended)  
**Authority 2:** 26 Del. C. § 351 et seq.  
07/21/2005 (subsequently amended)  
**Authority 3:** CDR § 7-100-106  
08/11/2006  
**Authority 4:** DE PSC Order No. 7933  
03/22/2011  
**Authority 5:** D.E. SB 124  
7/7/2011

### CONSIDERATIONS

**On-Track Comments**

### NOTES

- MUNIs and Coops allowed to opt out of RPS requirements if they establish a voluntary green power program and a green energy fund  
- Beginning CY 2014-15, and in each year afterward, the PSC may (itself) accelerate or decelerate the schedule for renewable targets in the scheduled implementation according to certain market conditions  
- RPS allows energy output from Qualified Fuel Cell Producer. A QFCP is defined as a commercial operation which manufacturers of fuels capable of running on renewable fuels and is designated as an economic development opportunity.
## State: Hawaii

**Incentive Type:** Renewables Portfolio Standard

**Eligible Efficiency Technologies:** Heat pumps, CHP/Cogeneration, Ice storage, Rate-payer


**Applicable Sectors:** Investor-Owned Utility, Rural Electric Cooperative

**Standard:** 40% by 2030

**Technology Min:** No

**Credit Trading:** No

**Web site:** [http://www.hawaii.gov/dbedt/info/energy/](http://www.hawaii.gov/dbedt/info/energy/)

**Authority 1:** HRS § 269-91 et seq., 2001, subsequently amended 12/31/2003

**Authority 2:**

Hawaii’s renewable portfolio standard (RPS) was significantly expanded by legislation passed in 2009. HB 1464, signed by the governor in June 2009, increased the amount of renewable electrical energy generation required by utilities to 40% by 2030.

### NOTES

For electricity generation, currently there are two sets of renewable energy goals: (1) the Renewable Portfolio Standards (RPS) established initially by Act 272, SLH 2001, and expanded by Act 155, SLH 2009, requires 40% of the net electricity sales by December 31, 2030; and (2) The Hawaii Clean Energy Initiative (HCEI) in 2008 established an overall goal for the electricity sector to meet 40% of the electricity demand by 2030. The primary difference between the two in the electricity sector is on the denominator. The RPS measurement is based on electricity sales while HCEI is based on electricity demand. Electricity demand is defined as the sum of electricity sales and efficiency savings.
### State: Iowa

**Incentive Type:** Renewables Portfolio Standard

**Eligible Technologies:** Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Municipal Solid Waste, Anaerobic Digestion

**Applicable Sectors:** Investor-Owned Utility

**Standard:** 105 MW of renewable generating capacity

**Technology Min:**

**Credit Trading:** No

**Web site:**

**Authority 1:** Iowa Code § 476.41 et seq.  

**Authority 2:** IAC 199-15.11(1)

**Authority 3:** Iowa Utilities Board Order, Docket No. AEP-07-1  
11/21/2007

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**NOTES:**

Iowa does not have an energy-based RPS requirement. Iowa’s statutory alternate energy production (AEP) requirements are found in Iowa Code §§ 476.41 through 476.45 and were adopted before energy-based RPS standards achieved widespread use in other states.

Iowa’s requirement is capacity-based and relates to specific AEP facilities either owned or contracted by utilities, rather than an energy-based portfolio requirement.
**State:** Michigan

<table>
<thead>
<tr>
<th>Incentive Type</th>
<th>Renewables Portfolio Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable Sectors</td>
<td>Municipal Utility, Investor-Owned Utility, Rural Electric Cooperative, Retail Supplier</td>
</tr>
</tbody>
</table>
| Standard | All utilities: 10% by 2015  
Detroit Edison: 300 MW of new renewables by 2013 and 600 MW by 2015  
Consumers Energy: 200 MW of new renewables by 2013 and 500 MW by 2015 |
| Technology Min | No |
| Credit Trading | Yes (MIRECS) |
| Credit Transfers Accepted From | PJM-GATS, M-RETS into MIRECS  
(Refers to tracking system compatibility only, not RPS eligibility. Please see statutes and regulations for information on facility eligibility) |
| Credit Transfers Accepted To | MIRECS into PJM-GATS, NAR  
(Refers to tracking system compatibility only, not RPS eligibility. Please see statutes and regulations for information on facility eligibility) |
| Web site | [http://www.michigan.gov/mpsc/0,1607,7-159-16393_53570--,00.html](http://www.michigan.gov/mpsc/0,1607,7-159-16393_53570--,00.html) |
| Authority 1 | MCL § 460.1001 et seq.  
10/06/2008  
10/06/2008 |
| Authority 2 | E.O No. 2011-4  
02/23/2011  
04/23/2011 |

**NOTES**

ACT 295 of 2008/ 460.1039,  
Section 39

(c) 1/5 renewable energy credit for each megawatt hour of electricity generated from a renewable energy system during off-peak hours, stored using advanced electric storage technology or a hydroelectric pumped storage facility, and used during peak hours. However, the number of renewable energy credits shall be calculated based on the number of megawatt hours of renewable energy used to charge the advanced electric storage technology or fill the pumped storage facility, not the number of megawatt hours actually discharged or generated by discharge from the advanced energy storage facility or pumped storage facility.
## RECENT US POLICY AND LEGAL IMPLICATIONS FOR ENERGY STORAGE VIS-À-VIS RPS MANDATES

### On-Track Comments

<table>
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<th>State: Minnesota</th>
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<tbody>
<tr>
<td><strong>Incentive Type:</strong> Renewables Portfolio Standard</td>
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<tr>
<td><strong>Eligible Technologies:</strong> Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Municipal Solid Waste, Hydrogen, Co-Firing, Anaerobic Digestion</td>
</tr>
<tr>
<td><strong>Applicable Sectors:</strong> Municipal Utility, Investor-Owned Utility, Rural Electric Cooperative</td>
</tr>
</tbody>
</table>
| **Standard:** Xcel Energy: 30% by 2020  
Other utilities: 25% by 2025 |
| **Technology Min:** Wind or Solar (Xcel only): 25% by 2020; maximum of 1% from solar |
| **Credit Trading:** Yes (M-RETS); some limitations apply |
| **Transfers Accepted From:** None |
| **Transfers Accepted To:** M-RETS into MiRECS, NAR, NC-RETS  
(Refers to tracking system compatibility only, not RPS eligibility. Please see statutes and regulations for information on facility eligibility) |
| **Web site:** |
| **Authority 1:** Minn. Stat. § 216B.1691  
02/22/2007 (subsequently amended)  
02/22/2007 |
| **Authority 2:** PUC Order, Docket E-999/CI-04-1616  
12/18/2007  
12/18/2007 |
| **Authority 3:** PUC Order, Docket E-999/CI-04-1616  
12/03/2008  
2007 Compliance Year |
| **Authority 4:** S.F. 1197  
05/27/2011  
05/28/2011 |

### NOTES

CHAPTER 97--S.F.No. 1197, An Act
Sec. 3. Minnesota Statutes 2010, section 116C.779, subdivision 3  
Subd. 3. Initiative for Renewable Energy and the Environment. (a)  
Beginning July 1, 2009, and each July 1 through 2011, $5,000,000 must be allocated from the renewable development account to fund a grant to the Board of Regents of the University of Minnesota for the Initiative for Renewable Energy and the Environment for the purposes described in paragraph (b)  
(4) energy storage technologies;  
(5) analysis of policy options to facilitate adoption of technologies that use or produce low-carbon renewable energy.
## State: Montana

<table>
<thead>
<tr>
<th>Incentive Type:</th>
<th>Renewables Portfolio Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable Sectors:</td>
<td>Investor-Owned Utility, Retail Supplier</td>
</tr>
<tr>
<td>Standard:</td>
<td>15% by 2015</td>
</tr>
<tr>
<td>Technology Min:</td>
<td>No</td>
</tr>
<tr>
<td>Credit Trading:</td>
<td>Yes (M-RETS, WREGIS)</td>
</tr>
<tr>
<td>Credit Transfers Accepted From:</td>
<td>None</td>
</tr>
<tr>
<td>Credit Transfers Accepted To:</td>
<td>M-RETS into MIRECS, NAR, NC-RETS</td>
</tr>
<tr>
<td>(Refers to tracking system compatibility only, not RPS eligibility. Please see statutes and regulations for information on facility eligibility)</td>
<td></td>
</tr>
<tr>
<td>Web site:</td>
<td></td>
</tr>
<tr>
<td>Authority 1:</td>
<td>MCA 69-3-2001 et seq. 4/2005</td>
</tr>
<tr>
<td>Authority 2:</td>
<td>MONT. ADMIN. R. 38.5.8301 6/2/2006</td>
</tr>
</tbody>
</table>

### NOTES:

**CODE 69-3-2003**

While cooperative utilities and municipal utilities are generally exempt from these requirements, cooperative and municipal utilities with 5,000 or more customers must implement a renewable-energy standard that recognizes the "intent of the legislature to encourage new renewable-energy production and rural economic development, while taking into consideration the effect of the standard on rates, reliability and financial resources."

(10) "Eligible renewable resource" means a facility either located within Montana or delivering electricity from another state into Montana that commences commercial operation after January 1, 2005, and that produces electricity from one or more of the following sources:

(j) compressed air derived from any of the sources in this subsection (10) that is forced into an underground storage reservoir and later released, heated, and passed through a turbine generator.
**State:** New York

**Incentive Type:** Renewables Portfolio Standard


**Applicable Sectors:** Investor-Owned Utility

**Standard:** 29% by 2015

**Technology Min:** Customer-Sited: Target of ~6.0% of the annual incremental requirement (0.4092% of state sales in 2015)*

**Credit Trading:** No (currently under discussion)

**Web site:** [http://www3.dps.state.ny.us/W/PSCWeb.nsf/All/1008ED2F934294AE8525](http://www3.dps.state.ny.us/W/PSCWeb.nsf/All/1008ED2F934294AE8525)

**Authority 1:** NY PSC Order, Case 03-E-0188  
09/24/2004  
09/24/2004

**Authority 2:** NY PSC Order, Case 03-E-0188  
04/14/2005  
04/14/2005

**Authority 3:** NY PSC Order, Case 03-E-0188  
01/08/2010  
01/08/2010

**Authority 4:** NY PSC Order, Case 03-E-0188  
04/02/2010  
04/02/2010

**NOTES**

The remainder will be derived from new, eligible resources centrally procured by the New York State Energy Research and Development Authority (NYSERDA). Eligible new renewable resources fall into two tiers -- a Main Tier (roughly 94% of incremental renewables generation) and a Customer-Sited Tier (roughly 6%). Under the original standard, the CST was set at 2% of the incremental renewable generation required to meet the standard, but was expanded in April 2010 as part of the expansion of the RPS from 25% by 2013 to 30% by 2015.

**CASE 03-E-0188 -4-**

**CUSTOMER-SITED TIER**

**Overall Program**

Since the inception of the RPS program, the Customer-Sited Tier has been designed to encourage customers to install their own "behind-the-meter" renewable energy production systems. This gives customers an opportunity to directly affect the generation source of the electricity they consume.
**State:** North Dakota

**Incentive Type:** Renewables Portfolio Standard

**Eligible Technologies:** Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Hydrogen, Electricity from Waste Heat, Anaerobic Digestion

**Applicable Sectors:** Municipal Utility, Investor-Owned Utility, Rural Electric Cooperative

<table>
<thead>
<tr>
<th>Standard</th>
<th>Goal: 10% by 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology Min:</td>
<td>No</td>
</tr>
<tr>
<td>Credit Trading:</td>
<td>Yes (M-RETS)</td>
</tr>
<tr>
<td>Credit Transfers Accepted From:</td>
<td>None</td>
</tr>
<tr>
<td>Credit Transfers Accepted To:</td>
<td>M-RETS into MIRECS, NC-RETS, NAR</td>
</tr>
</tbody>
</table>

(Refers to tracking system compatibility only, not RPS eligibility. Please see statutes and regulations for information on facility eligibility)

**Web site:**

**Authority 1:** ND Century Code § 49-02-24 et seq.
08/01/2007

**Authority 2:** ND Admin. Code 69-09-08
07/01/2006

**Authority 3:** ND PSC Order, Case No. PU-07-318
06/04/2008

**NOTES:**

PUBLIC SERVICE COMMISSION
STATE OF NORTH DAKOTA
Renewable Electricity and Recycled Energy Tracking
Case No. PU-07-318
Miscellaneous ORDER
June 4, 2008

On July 13, 2007, APX, Inc. (APX) filed a letter with the Commission requesting that the Commission designate it as Program Administrators of the Midwest Renewable Energy Tracking System (M-RETS).

M-RETS tracks renewable generation located within the state and provincial boundaries of Iowa, Manitoba, Minnesota, Montana, North Dakota, South Dakota, and Wisconsin. It also tracks Renewable Resource Credits for the State of Wisconsin.
**State:** Virginia  

**Incentive Type:** Renewables Portfolio Standard


**Applicable Sectors:** Investor-Owned Utility

**Standard:** Goal: 15% of base year (2007) sales by 2025

**Technology Min:** No

**Credit Trading:** Yes

**Credit Transfers Accepted From:** None

**Credit Transfers Accepted To:** M-RETS into MIRECS, NC-RETS, NAR  
(Refers to tracking system compatibility only, not RPS eligibility. Please see statutes and regulations for information on facility eligibility)

**Web site:**

**Authority 1:** Va. Code § 56-585.2  
4/11/2007 (later amended)

**Authority 2:** H.B. 1022  
04/02/2010  
07/01/2010

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**NOTES:**

"Renewable energy" shall have the same meaning ascribed to it in § 56-576, provided such renewable energy is (i) generated or purchased in the Commonwealth or in the interconnection region of the regional transmission entity of which the participating utility is a member, as it may change from time to time; (ii) generated by a public utility providing electric service in the Commonwealth from a facility in which the public utility owns at least a 49 percent interest and that is located in a control area adjacent to such interconnection region; or (iii) represented by certificates issued by an affiliate of such regional transmission entity, or any successor to such affiliate, and held or acquired by such utility, which validate the generation of renewable energy by eligible sources in such region. "Renewable energy" shall not include electricity generated from pumped storage, but shall include run-of-river generation from a combined pumped-storage and run-of-river facility.
The regulations for RPS (about 40% of U.S. electricity sales) vary from state to state or are nonexistent. Importing Variable Energy Resources (VERs) into the electric grid affects reliability. Consider roles of FERC & NERC. The Federal Energy Regulatory Commission (FERC) is the U.S. federal agency with jurisdiction over interstate electricity sales, wholesale electric rates, hydroelectric licensing, natural gas pricing, and oil pipeline rates. The North American Electric Reliability Corporation (NERC), a nonprofit corporation based in Atlanta, GA, was formed on March 28, 2006, as the successor to the North American Electric Reliability Council (also known as NERC). It was established to promote the reliability and adequacy of bulk power transmission in the electric utility systems of North America.

Energy storage was not specifically written into the original legislation by the states that wrote mandates for RPS. Further, environmental and market policies...
RECENT US POLICY AND LEGAL IMPLICATIONS FOR ENERGY STORAGE VIS-À-VIS RPS MANDATES

Technical & Legal Challenges

Wind Resources and Transmission Lines

Transmission Lines
Voltage (kV)
- 345 - 499
- 500 - 699
- 700 - 799
- 1000 (DC)

Source: PowerMap, powermap.pala.com, ©2007 Plata, a division of the McGraw-Hill Companies

The remaining states use data from the 1987 "Wind Energy Atlas of the United States".

Wind Power Classification

<table>
<thead>
<tr>
<th>Wind Power Potential</th>
<th>Power Density at 50 m</th>
<th>Wind Speed at 50 m</th>
<th>Wind Speed at 50 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Marginal</td>
<td>200 - 300 W/m²</td>
<td>5.6 - 6.4 m/s</td>
<td>12.5 - 14.3 mph</td>
</tr>
<tr>
<td>3 Fair</td>
<td>300 - 400 W/m²</td>
<td>6.4 - 7.0 m/s</td>
<td>14.3 - 16.5 mph</td>
</tr>
<tr>
<td>4 Good</td>
<td>400 - 500 W/m²</td>
<td>7.0 - 7.5 m/s</td>
<td>15.7 - 18.0 mph</td>
</tr>
<tr>
<td>5 Excellent</td>
<td>500 - 600 W/m²</td>
<td>7.5 - 8.0 m/s</td>
<td>16.5 - 17.9 mph</td>
</tr>
<tr>
<td>6 Outstanding</td>
<td>600 - 900 W/m²</td>
<td>8.0 - 8.8 m/s</td>
<td>17.3 - 19.7 mph</td>
</tr>
<tr>
<td>7 Superb</td>
<td>800 - 1600 W/m²</td>
<td>8.8 - 11.1 m/s</td>
<td>19.7 - 24.8 mph</td>
</tr>
</tbody>
</table>

*Wind speeds are based on a Weibull k value of 2.0

U.S. Department of Energy
National Renewable Energy Laboratory

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Source: PowerMap, powermap.pala.com, ©2007 Plata, a division of the McGraw-Hill Companies

NREL Updated Maps:
- California (2002)
- Connecticut (2001)
- Delaware (2002)
- Idaho (2002)
- Illinois (2001)
- Indiana (2004)
- Maine (2001)
- Maryland (2002)
- Massachusetts (2001)
- Missouri (2000)
- Montana (2002)
- Nebraska (2005)
- New Jersey (2002)
- New Hampshire (2001)
- New Mexico (2005)
- North Dakota (2003)
- Ohio (2004)
- Oregon (2002)
- Pennsylvania (2002)
- Rhode Island (2001)
- South Dakota (2001)
- Texas mesas (2000)
- Utah (2003)
- Vermont (2001)
- Virginia (2002)
- West Virginia (2002)
- Wyoming (2002)
Technical & Legal Challenges

Direct Normal Solar Radiation (Two-Axis Tracking Concentrator)

Model estimates of monthly average daily total radiation using inputs derived from satellite and/or surface observations of cloud cover, aerosol optical depth, precipitable water vapor, albedo, atmospheric pressure and ozone resampled to a 4km resolution. See http://www.nrel.gov/gis/sol_csp.html documentation for more details.

Produced by the Electric & Hydrogen Technologies & Systems Center - May 2004
Energy storage experts, system operators, utility managers, and other stakeholders can work together to develop policy positions and propose industry standards that define the boundaries of energy storage – in particular regulated functionality versus market functionality.

Policy Challenge (Example)

135 FERC 61,240
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION
18 CFR Chapter 1
[Docket Nos. RM11-24-000 and AD10-13-000]
Third-Party Provision of Ancillary Services
Accounting and Financial Reporting for New Electric Storage Technologies
(June 16, 2011)
AGENCY: Federal Energy Regulatory Commission
ACTION: Notice of Inquiry
SUMMARY:
In this Notice of Inquiry (NOI), the Commission seeks comment on two sets of separate, but related issues. First, we seek comment on ways in which we can facilitate the development of robust competitive markets for the provision of ancillary services from all resource types. Second, the Commission is interested in issues unique to storage devices in light of the role they play in providing multiple services, including ancillary services. As demonstrated by recent cases that have come before the Commission, there is growing interest in rate flexibility by both purchasers and sellers of ancillary services. A variety of resources are poised to provide ancillary services but may be frustrated from doing so by certain aspects of the Commission’s market-based rate policies coupled with a lack of access to the information that could help satisfy the requirements of those policies. Those with an obligation to purchase ancillary services have raised concerns with the availability of those services. In reviewing ways to foster a more robust ancillary services market, the Commission identified certain issues regarding the use of electric storage as an ancillary service resource that warranted consideration. Over time, those issues expanded into more global questions as to the role that electric storage may play in a competitive market, including how electric storage should be compensated for the full range of services it provides under the Federal Power Act, and transparency issues regarding the Commission’s current accounting and reporting requirements as applied to electric storage.
RECENT US POLICY AND LEGAL IMPLICATIONS FOR ENERGY STORAGE VIS-À-VIS RPS MANDATES

Back to California

CPUC Energy Storage Proceeding R.10-12-007

CPUC Identification of Energy Storage Adoption Barriers

1. Lack of definitive operational needs
2. Lack of cohesive regulatory framework
3. Evolving markets and market product definition
4. Resource Adequacy accounting
5. Lack of cost-effectiveness evaluation methods
6. Lack of recovery policy
7. Lack of cost transparency and price signals (wholesale & retail)
8. Lack of commercial operating experience
9. Lack of well-defined interconnection process

12 December 2011

The California Public Utilities Commission issued a summary for the Energy Storage Framework Staff proposal in response to Assembly Bill 2514 which directs the CPUC to determine the appropriate targets for each load-serving entity to procure viable and cost-effective energy storage systems.

The Administrative Law Judge ruling to identify issues and implementation barriers.
Questions?

The question is:

What is required of energy storage to create a more responsive market for investors while also addressing policy, legal challenges, and technological innovations?
Energy Storage and Renewable Portfolio Standards

CESA RPS Storage Webinar
December 19, 2011

Dhruv Bhatnagar
Verne Loose
Energy Storage and Transmission Analysis
Sandia National Laboratories
Classical Application of Energy Storage

- Load Leveling or Peak Shaving
- Pumped hydro energy storage
- Widely used in Japan, Europe
- Less used in USA
Renewables Penetration

- Introduces a degree of variability and uncertainty.

- Irradiance and PV system AC output A typical partly cloudy day in July
  - PV system rating: 1,300 kW ac, presently limited to 400 kW ac (intentionally)
High Renewables Penetration

- No renewables
- 11% renewables
- 23% renewables
- 35% renewables

What Energy Storage Provides

End-Use
• Power Quality/Reliability
• Peak Load Reduction
• Distributed Generation & Smart Grid Support

Renewable Penetration
• Reduced Variability
• Ramp rate control
• Load time shifting
• Reserves
• Dispatchability

Transmission and Distribution
• Line and Transformer Deferral
• Stability
• Voltage/Frequency Regulation

Generation
• Spinning Reserve
• Capacity Deferral
• Voltage/Frequency Regulation
• Load Leveling

End-Use
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Generation
• Spinning Reserve
• Capacity Deferral
• Voltage/Frequency Regulation
• Load Leveling
Evolution of Key Concepts

- Stacked benefits
- Modular storage systems
- Distributed energy storage

*Sharing of benefits – Problematic for vertically integrated electric companies*
### Hawaii Battery Projects

(29 MW/32.5 MWh)

<table>
<thead>
<tr>
<th>Location</th>
<th>Size (MW/MWh)</th>
<th>Application</th>
<th>Owner</th>
<th>Vendor</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaheawa - I, Maui</td>
<td>1.5 MW/1 MWh</td>
<td>Wind smoothing, Curtailment mitigation</td>
<td>First Wind</td>
<td>Xtreme Power</td>
<td>2009</td>
</tr>
<tr>
<td>Kahuku, Oahu</td>
<td>15 MW/10 MWh</td>
<td>Wind smoothing, Curtailment mitigation, Voltage regulation</td>
<td>First Wind</td>
<td>Xtreme Power</td>
<td>2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Commissioned, Performance testing underway</td>
</tr>
<tr>
<td>La Ola PV Plant, Lanai</td>
<td>1.125 MW/0.5 MWh</td>
<td>PV ramp rate control, Droop response control and PF correction</td>
<td>Castle &amp; Cooke</td>
<td>Xtreme Power</td>
<td>mid- 2011</td>
</tr>
<tr>
<td>Kaheawa - II, Maui</td>
<td>10 MW/20 MWh</td>
<td>Wind smoothing, Curtailment mitigation, Freq. regulation, spinning reserve and AGC response</td>
<td>First Wind</td>
<td>Xtreme Power</td>
<td>late- 2011</td>
</tr>
<tr>
<td>Koloa Substation, Kauai</td>
<td>1.5 MW/1 MWh</td>
<td>PV smoothing, additional ancillary services to be determined</td>
<td>KIUC</td>
<td>Xtreme Power</td>
<td>Fall 2011</td>
</tr>
</tbody>
</table>
Hawaii Battery Projects

(29 MW/32.5 MWh)
Energy Storage Technologies

- Pumped Hydro
- Compressed Air Energy Storage (CAES)
- Batteries
  - Sodium Sulfur (NaS)
  - Flow Batteries
  - Lead Acid
  - Advanced Lead Carbon
  - Lithium Ion
- Flywheels
- Electrochemical Capacitors

Pumped Hydro (Taum Sauk) 400 MW
Sodium Sulfur Battery 2 MW
Flywheels 1 – 20 MW
Storage system costs are not consistent

“Cost Estimates” of emerging technologies are difficult to estimate

Ask three questions:
1. Smallest module size – ac to ac?
2. How many have been field tested; by whom, data released?
3. Has the manufacturing plant been built, its throughput?

“Value” can be determined only for specific applications and specific sites
System Costs: New Systems

- **Xtreme Power storage system**
  - 1 MW, 500 kWh; Installed in Lanai
  - Probably $1.3 - $1.6 million

- **NAS Battery**
  - 1 MW, 6 MWh
  - Probably $3 – 4 million

- **S&C PureWave**
  - 2 MW, 30 seconds
  - Probably $400,000
## EPRI Storage Costs

**Table 4-12: Bulk Energy Storage Options to Support System and Large Renewable Integration**

<table>
<thead>
<tr>
<th>Technology Option</th>
<th>Maturity</th>
<th>Capacity (MWh)</th>
<th>Power (MW)</th>
<th>Duration (hrs)</th>
<th>% Efficiency (total cycles)</th>
<th>Total Cost ($/kW)</th>
<th>Cost ($/kW-h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumped Hydro</td>
<td>Mature</td>
<td>1680-5300</td>
<td>280-530</td>
<td>6-10</td>
<td>80-82 (&gt;13,000)</td>
<td>2500-4300</td>
<td>420-430</td>
</tr>
<tr>
<td></td>
<td>S400-14,000</td>
<td>900-1400</td>
<td>6-10</td>
<td></td>
<td></td>
<td>1500-2700</td>
<td>250-270</td>
</tr>
<tr>
<td>CT-CAES (underground)</td>
<td>Demo</td>
<td>1440-3600</td>
<td>180</td>
<td>8</td>
<td>60</td>
<td>960</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20</td>
<td></td>
<td>1150</td>
<td>60</td>
</tr>
<tr>
<td>CAES (underground)</td>
<td>Commercial</td>
<td>1080</td>
<td>135</td>
<td>8</td>
<td>80</td>
<td>1000</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20</td>
<td></td>
<td>1250</td>
<td>60</td>
</tr>
<tr>
<td>Sodium-Sulfur</td>
<td>Commercial</td>
<td>300</td>
<td>50</td>
<td>6</td>
<td>75</td>
<td>3100-3300</td>
<td>520-550</td>
</tr>
<tr>
<td>Advanced Lead-Acid</td>
<td>Commercial</td>
<td>200</td>
<td>50</td>
<td>4</td>
<td>85-90 (2200)</td>
<td>1700-1900</td>
<td>425-475</td>
</tr>
<tr>
<td></td>
<td>Commercial</td>
<td>250</td>
<td>20-50</td>
<td>5</td>
<td>85-90 (4500)</td>
<td>4600-4900</td>
<td>920-980</td>
</tr>
<tr>
<td></td>
<td>Demo</td>
<td>400</td>
<td>100</td>
<td>4</td>
<td>85-90 (4500)</td>
<td>2700</td>
<td>675</td>
</tr>
<tr>
<td>Vanadium Redox</td>
<td>Demo</td>
<td>250</td>
<td>50</td>
<td>5</td>
<td>65-75 (&gt;10000)</td>
<td>3100-3700</td>
<td>620-740</td>
</tr>
<tr>
<td>Zn/Br Redox</td>
<td>Demo</td>
<td>250</td>
<td>50</td>
<td>5</td>
<td>60 (&gt;10000)</td>
<td>1450-1750</td>
<td>290-350</td>
</tr>
<tr>
<td>Fe/Cr Redox</td>
<td>R&amp;D</td>
<td>250</td>
<td>50</td>
<td>5</td>
<td>75 (&gt;10000)</td>
<td>1800-1900</td>
<td>360-380</td>
</tr>
<tr>
<td>Zn/air Redox</td>
<td>R&amp;D</td>
<td>250</td>
<td>50</td>
<td>5</td>
<td>75 (&gt;10000)</td>
<td>1440-1700</td>
<td>290-340</td>
</tr>
</tbody>
</table>

### Barriers: Costs

**Comparing a Simple Cycle CT to a Lead Acid Battery for Peaking**

<table>
<thead>
<tr>
<th></th>
<th>Gas Simply Cycle CT</th>
<th>Lead Acid Battery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Energy</td>
<td>$492/MWh</td>
<td>$377/MWh</td>
</tr>
<tr>
<td>Cost of Capacity</td>
<td>$203/KW-yr</td>
<td>$155/KW-yr</td>
</tr>
</tbody>
</table>

Source: California Energy Storage Alliance, Energy Storage- a Cheaper and Cleaner Alternative to Natural Gas-Fired Peakers

**Comparing a Combined Cycle CT to a Flywheel for Regulation**

<table>
<thead>
<tr>
<th></th>
<th>Gas Combined Cycle CT</th>
<th>Flywheel</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRR</td>
<td>14.6%</td>
<td>25.7%</td>
</tr>
<tr>
<td>Payback Period</td>
<td>8.1 years</td>
<td>3.9 years</td>
</tr>
</tbody>
</table>

Source: California Energy Storage Alliance: *Energy Storage- a cheaper, faster, and Cleaner Alternative to Conventional Frequency Regulation*
PUC Rate Dockets

**Texas**

- **Case:** Presidio, TX Sodium Sulfur (NaS) Battery Installation
  - **Applicant:** Electric Transmission Texas (ETT)
  - **Status:** Approved: April 2009

**California**

- **Case:** San Diego Gas & Electric Overall Rate Case (Smart Grid Section)
  - **Applicant:** San Diego Gas and Electric (SDG&E)
  - **Status:** In Progress
California

Case: Compressed Air Energy Storage Proposal
  • Applicant: Pacific Gas & Electric (PG&E)
  • Status: Approved: January 2010

Case: Southern California Edison Tehachapi Wind Storage Project as part of California’s Smart Grid Rule Making Process
  • Applicant: Southern California Edison (SCE)
  • Status: Approved: July 2010

Case: California Rule Making for Energy Storage AB2514
  • Status: In Progress
New Jersey

Case: Proposal for Four Small Scale/Pilot Demand Response Programs: Energy Storage Program
- Applicant: Jersey Central Power & Light Company
- Status: In Progress
The Definition of Energy Storage

- Lack of operational definitions and goals:
  - Is storage a novel technology providing a new service, or is it just another grid asset providing similar service (as others)?

- In the Texas PUC case for the Presidio NaS battery, this issue was of significance:
  - Interveners and PUC staff brought up asset classification as an issue:
    - Is it a generation asset?
    - Is it a transmission asset?
    - Is it a distribution asset?
    - Is it a combination of assets?
Ensuring that the question of necessity is appropriately answered before approving recovery cases that may burden ratepayers is a critical issue.

Can the necessity be proven?

- Integration Studies (renewables integration)
- Capacity/Energy calculations
- Historical Data (reliability)
Cost-Effectiveness of Storage

- Is an energy storage investment cost-effective?

- Energy storage technologies have a large number of potential benefits that may apply in different situations.

- In order to prove cost-effectiveness, benefits must be quantified.
  - Markets are not present for most of these benefits.
  - For those that are: any existing markets have been developed for traditional grid resources.

- Benefit Quantification issues in the Jersey Central Power and Light Company (JCP&L) demand response filing.
  - Can benefits without markets be quantified?
Other Issues Brought Up

- Utilization and Operation of Storage Devices
- Funding Issues
- Market Issues
- Mandates and Incentives -> RPS
- Evaluation Metrics
Differing & Evolving Organizational Structures
Grid Services Required or Desired

**Generation:**
- Spinning Reserve
- Capacity Deferral
- Area/Frequency Regulation
- Load Leveling

**Transmission & Distribution:**
- Line and Transformer Deferral
- Stability
- Voltage Regulation

**Renewable Support:**
- Time Shifting generation
- Control and Integration
- Reserve

**End-Use:**
- Power Quality/Reliability
- Peak Load Reduction
- Distributed Generation Support

Most of these services can be provided by most grid assets
# Means to Manage System Imbalance

<table>
<thead>
<tr>
<th>Resources</th>
<th>Operations</th>
<th>Flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Energy Storage Systems Investment</td>
<td>• Balancing Area Consolidation (ISO formation)</td>
<td>• The variable resource itself (regulation down and up if spilling)</td>
</tr>
<tr>
<td>• Investment in Transmission</td>
<td>• Generator Schedule Compression</td>
<td>• Expansion of system flexibility (expanded ramp rates, start up times, etc)</td>
</tr>
<tr>
<td>• Demand response</td>
<td>• Dynamic scheduling of loads and resources</td>
<td>• Optimization of hydro resources (in coordination with environmental constraints)</td>
</tr>
<tr>
<td>• Smart charging EVs</td>
<td>• Improved forecasts for wind, solar, and load</td>
<td></td>
</tr>
<tr>
<td>• Residential</td>
<td>• Improved (stochastic) commitment process</td>
<td></td>
</tr>
<tr>
<td>• Industrial</td>
<td>• Improved market protocols (performance)</td>
<td></td>
</tr>
<tr>
<td>• Commercial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Legacy generation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Challenge: Select Least Cost Resource Portfolio Resulting in Grid Needs Being Fulfilled

<table>
<thead>
<tr>
<th>Grid Services (that need to be fulfilled)</th>
<th>Within hour balancing</th>
<th>Frequency Regulation and Inertia</th>
<th>Voltage Support</th>
<th>Stability Support</th>
<th>Scheduled short-term Capacity</th>
<th>Scheduled long-term capacity</th>
<th>Lowering nodal prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resources that can be used to provide services</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combustion Turbine</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Flywheel Storage</td>
<td></td>
<td></td>
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<tr>
<td>Flow Battery</td>
<td></td>
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<tr>
<td>FACTS Power Electronics</td>
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<tr>
<td>Transmission Lines</td>
<td></td>
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<tr>
<td>Demand Response</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Orange cells indicate that the resource can meet the need. Cost information is absent.

This table is not complete, and intended only to demonstrate the principle stated in the title.
Storage Advantages and Drivers

Advantages

• Flexibility in scale of application
  • Replication and modularity
  • Deploy in distribution system
• Rapid response
  • Recent CAISO study on frequency response
• Accurate response
  • Market context—access new revenue streams
  • FERC’s pay for performance

Drivers

• Renewables comprise increased portion of capacity
• Load becoming more “peaky”
• Decline of system inertia
Unique Feature of Energy Storage Technologies

Move energy through time to take advantage of price differentials-helps load leveling
Challenges to Energy Storage Deployment

- Differing organizational structures in the electric industry

- Lack of experience with energy storage devices on the part of most entities in the system—PUCs, FERC, utilities, others

- Complexity of optimizing energy storage devices in a market context—difficulty formulating bidding strategy

- Asset Classification issue leading to jurisdictional issue—FERC regulates interstate commerce in electric power versus state regulation of vertically integrated utilities

- Relative economics of energy storage devices and competing alternatives
Questions?

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Energy Storage and Transmission Analysis
Sandia National Laboratories