Energy Storage in State RPSs

State-Federal RPS Collaborative Webinar

Hosted by Clean Energy States Alliance
December 19, 2011

CleanEnergy States Alliance

Housekeeping

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- 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

CleanEnergy States Alliance

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

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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

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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/

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CleanEnergy States Alliance

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Grid Energy Storage
The Big Picture

IMRE GYUK, PROGRAM MANAGER
ENERGY STORAGE RESEARCH, DOE

Storage Technology:

Devices	Cost, Cycle Life Ramp Speed Reliability, Safety
Applications	Regulation, PV Ramping Load Shifting, Micro-grids
Field Tests	Scaling, Systems

Recent Projects:

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

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

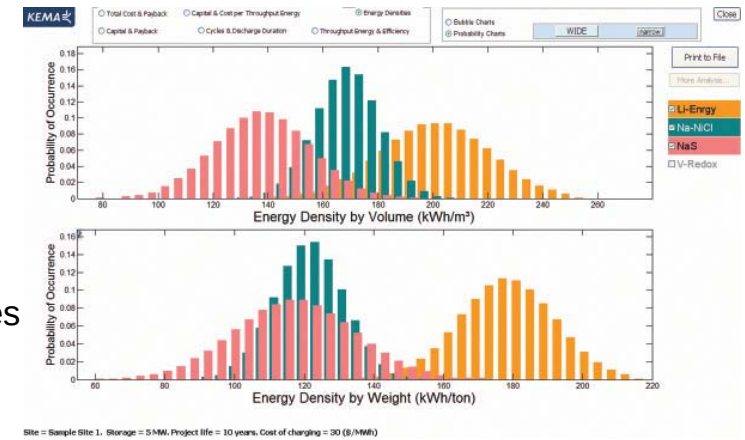
Partner with EPRI and NRECA to develop an energy storage handbook:

- 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

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Statement of

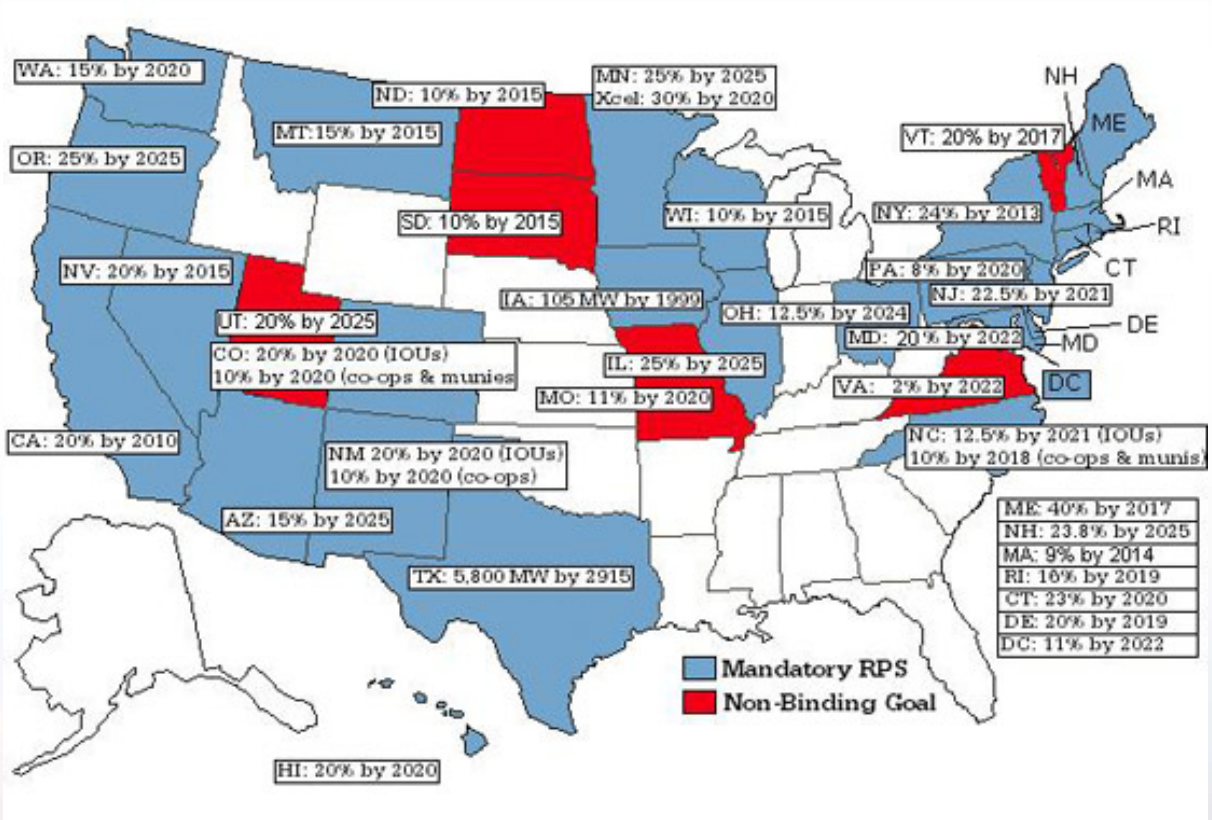
Problem

The **Issues**

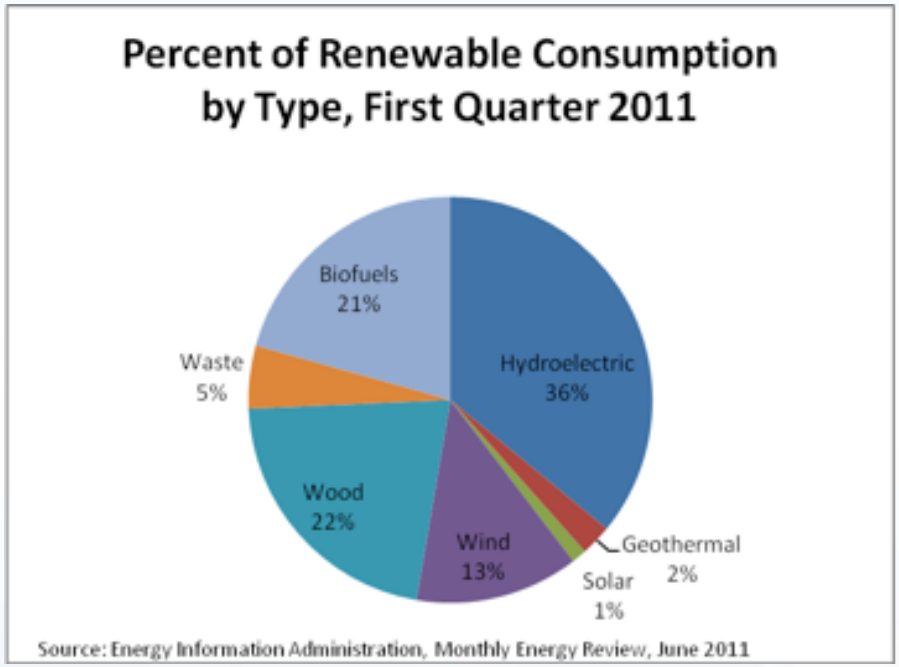
Some

Considerations

Recommendations



PROBLEMS & ISSUES



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.

- 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.

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RECENT US POLICY AND LEGAL IMPLICATIONS FOR ENERGY STORAGE VIS-À-VIS RPS MANDATES

Artwork by Mona Aragon of SNL/NM

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.

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U.S. RPS Mandate On-Track Status

Information collected by Institute of Energy Research, Dec 2010

Presentation Update: QUICK LOOK w/rt Energy Storage

NOTE: RPS GOALS

NOT Mandates

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

CONSIDERATIONS
On-Track Comments

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 tha

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

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

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

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

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CONSIDERATIONS
On-Track Comments

State: Delaware

Incentive Type: Renewables Portfolio Standard
Eligible Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal, Fuel Cells using Renewable Fuels
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
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

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.

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CONSIDERATIONS
On-Track Comments

State: Hawaii

Incentive Type: Renewables Portfolio Standard

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

Eligible Technologies: Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Geothermal Heat Pumps, Municipal Solid Waste, CHP/Cogeneration, Hydrogen, Seawater AC, Solar AC, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal, Ethanol, Methanol, Biodiesel, Fuel Cells using

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/

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

Authority 2: Summary

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.

CONSIDERATIONS
On-Track Comments

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.
1983 (amended 1991, 2003)

Authority 2: IAC 199-15.11(1)

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

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

CONSIDERATIONS
On-Track Comments

State: Michigan

Incentive Type: Renewables Portfolio Standard

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, CHP/Cogeneration, Coal-Fired w/CCS, Gasification , Anaerobic Digestion, Tidal Energy, Wave Energy

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

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

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.

CONSIDERATIONS
On-Track Comments

State: Minnesota

Incentive Type: Renewables Portfolio Standard

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Municipal Solid Waste, Hydrogen, Co-Firing, Anaerobic Digestion

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

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 ~~2012~~ 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.

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CONSIDERATIONS
On-Track Comments

State: Montana

Incentive Type: Renewables Portfolio Standard

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Compressed Air Energy Storage (From Eligible Renewables), Anaerobic Digestion, Fuel Cells using Renewable Fuels

Applicable Sectors: Investor-Owned Utility, Retail Supplier

Standard: 15% by 2015

Technology Min: No

Credit Trading: Yes (M-RETS, WREGIS)

Credit Transfers Accepted From: None

Credit 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: MCA 69-3-2001 et seq.
4/2005

Authority 2: MONT. ADMIN. R. 38.5.8301
6/2/2006

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.

CONSIDERATIONS
On-Track Comments

State: New York

Incentive Type: Renewables Portfolio Standard

Eligible Technologies: Solar Water Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Fuel Cells, CHP/Cogeneration, Anaerobic Digestion, Tidal Energy, Wave Energy, Ocean Thermal, Ethanol, Methanol, Biodiesel, Fuel Cells using Renewable Fuels

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

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.

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CONSIDERATIONS
On-Track Comments

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
Standard: Goal: 10% by 2015
Technology Min: No
Credit Trading: Yes (M-RETS)
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: ND Century Code § 49-02-24 et seq. 3/23/2007 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.

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CONSIDERATIONS
On-Track Comments

State: Virginia

Incentive Type: Renewables Portfolio Standard

Eligible Technologies: Solar Thermal Electric, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Energy from Waste, Anaerobic Digestion, Tidal Energy, Wave Energy

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

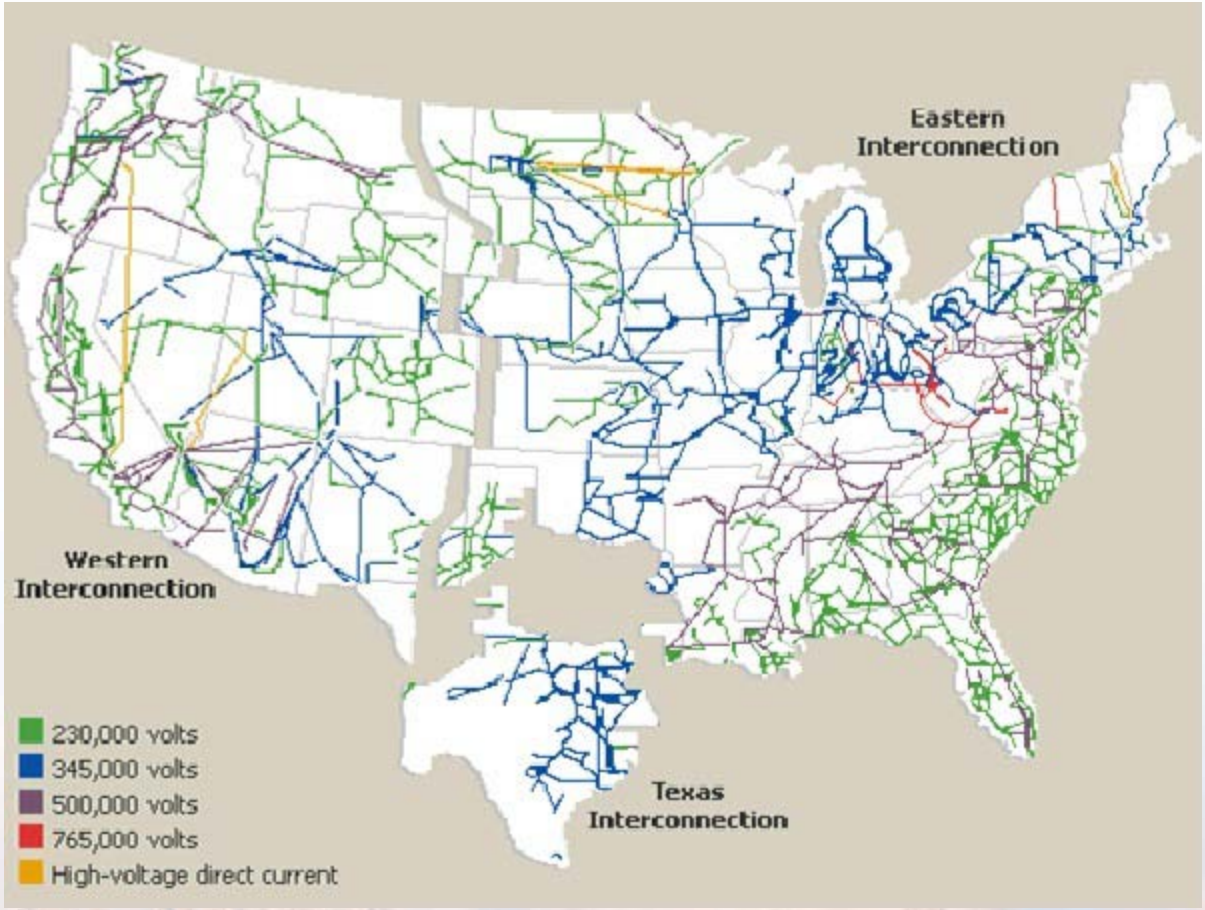
NOTES:

"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.

RECENT US POLICY AND LEGAL IMPLICATIONS FOR ENERGY STORAGE VIS-À-VIS RPS MANDATES

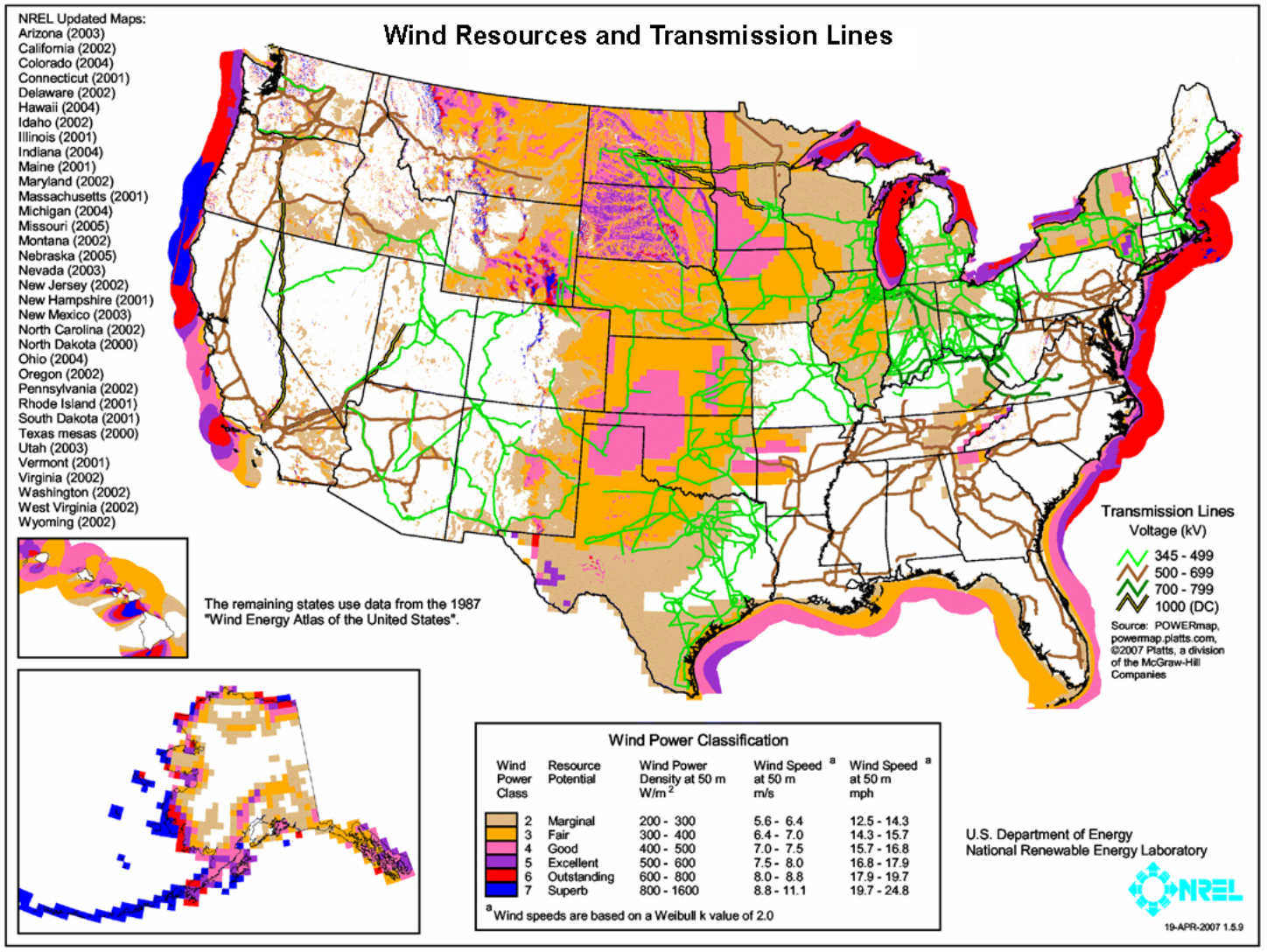
The regulations for RPS (about 40% of U.S. electricity sales) vary from state to state or are nonexistent. Importing Variable Energy Resources (VERs) into the electric grid affects reliability. Consider roles of FERC & NERCThe Federal Energy Regulatory Commission (FERC) is the U.S. federal agency with 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

Technical & Legal Challenges



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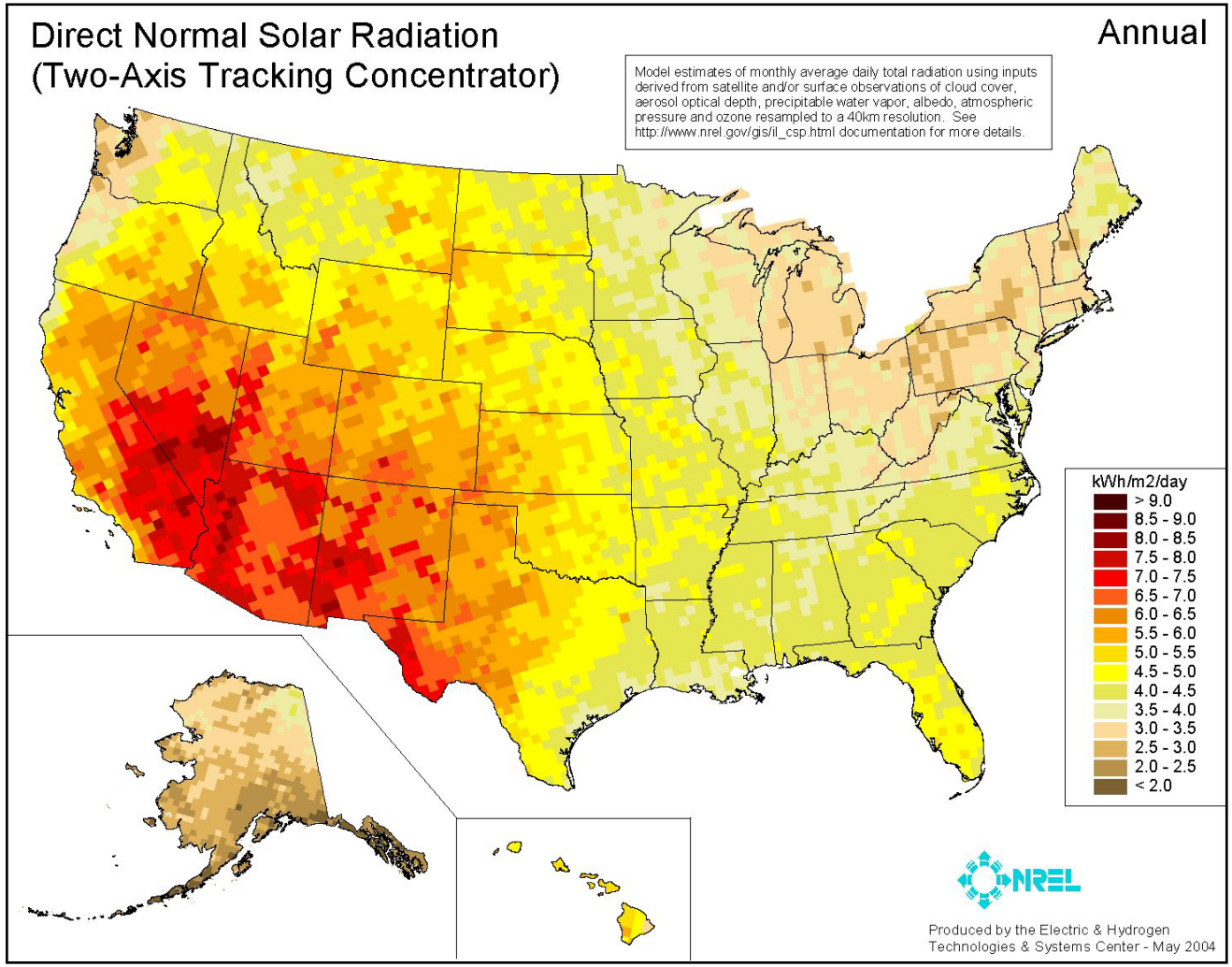
Technical & Legal Challenges



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RECOMMENDATIONS

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 COMMISSIOIN
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.

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?

Artwork by Mona Aragon of SNL/NM

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

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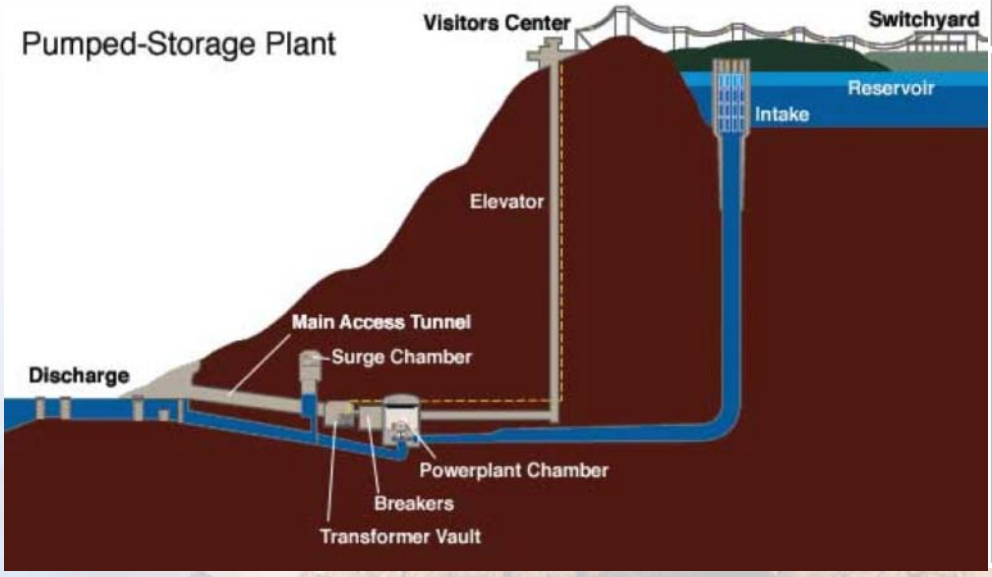
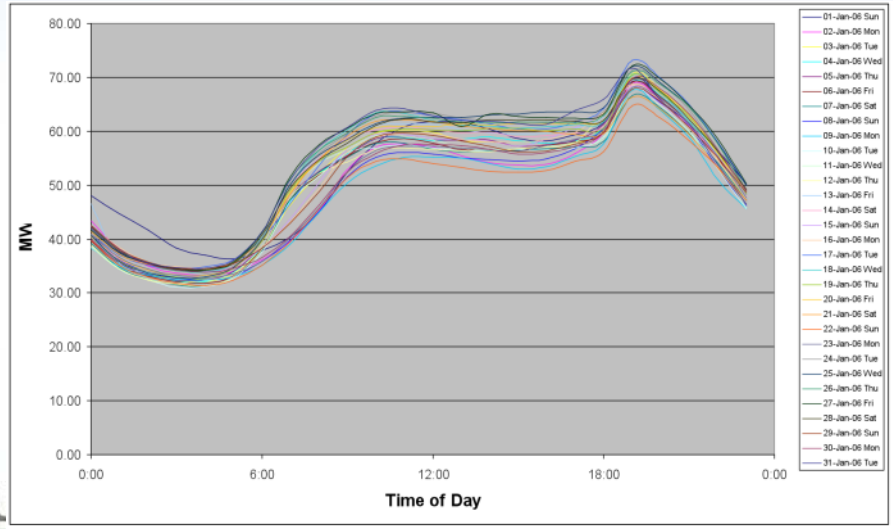
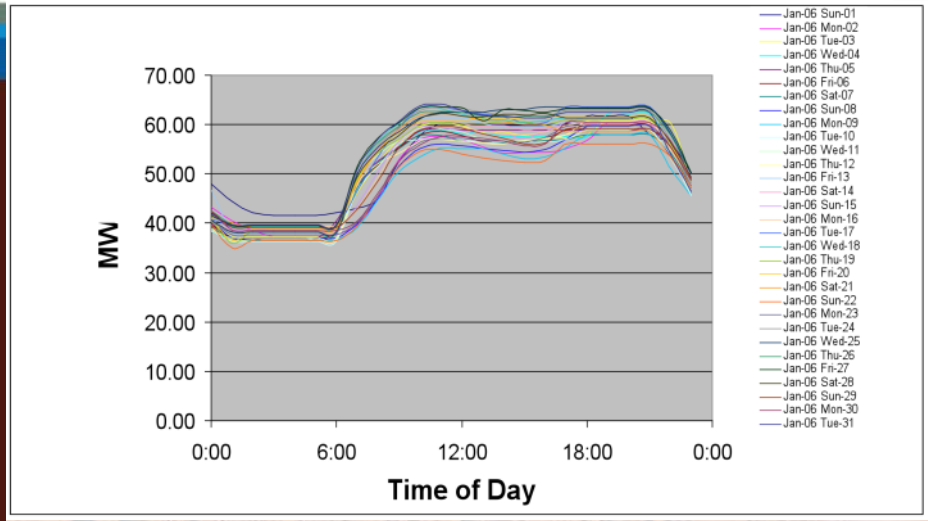
Classical Application of Energy Storage

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







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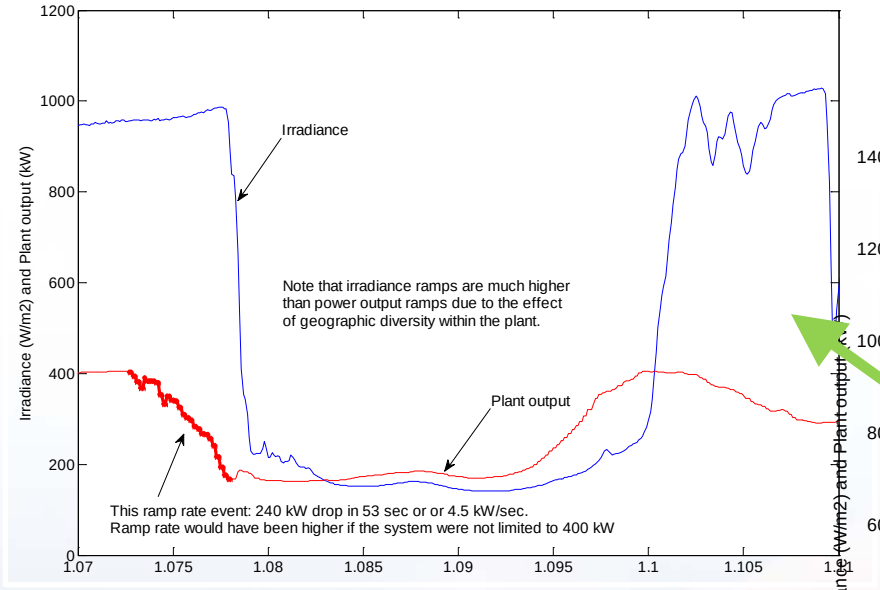
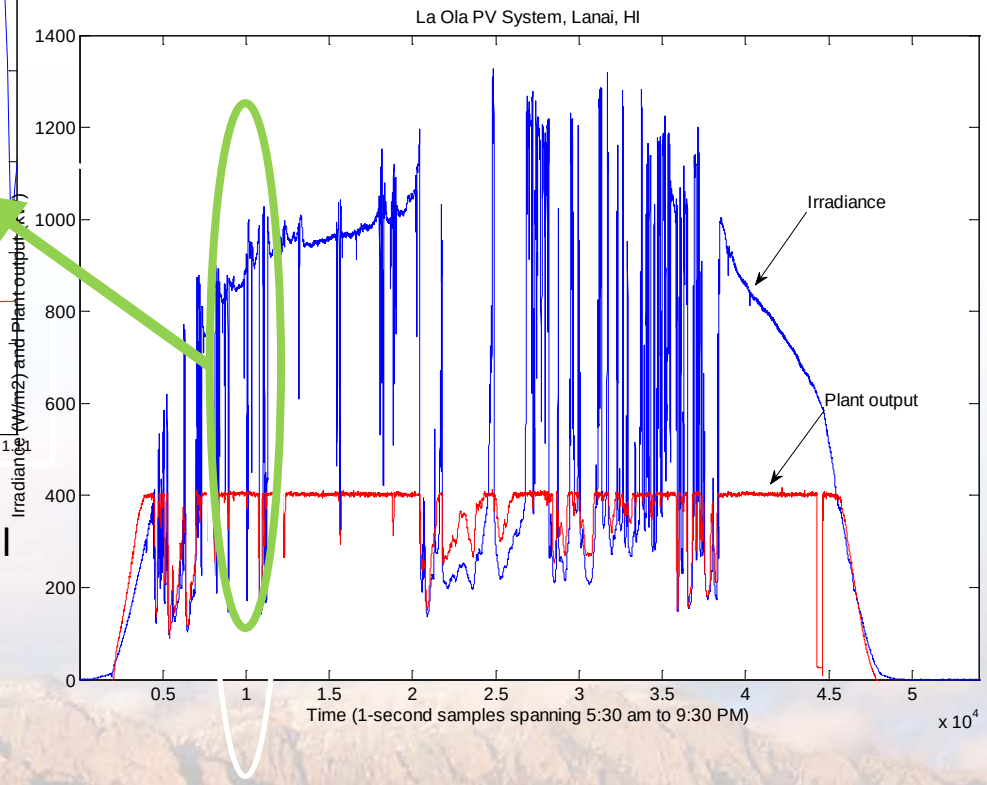
Renewables Penetration

- **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)

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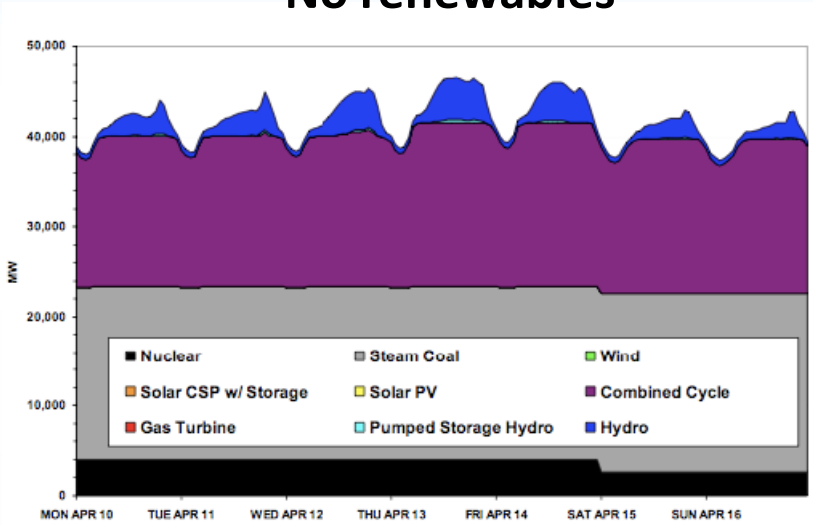
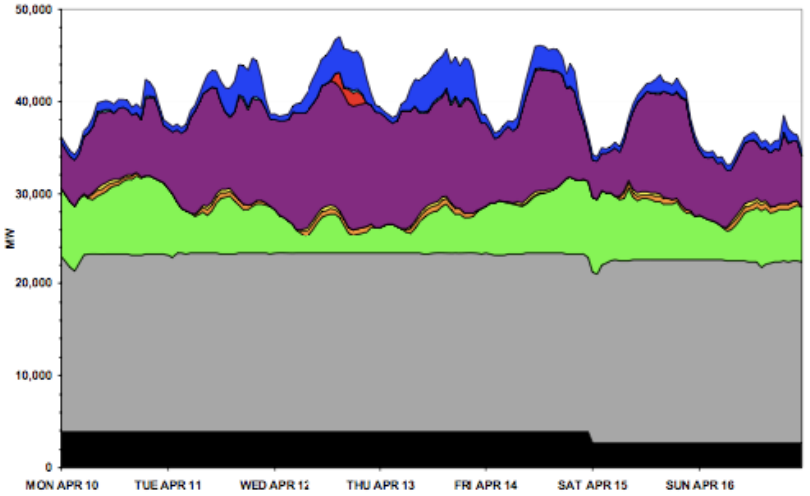
High Renewables Penetration

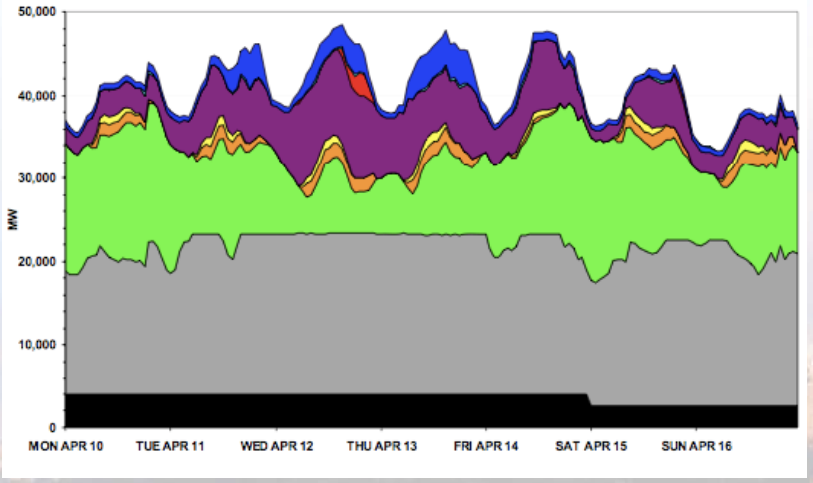
No renewables



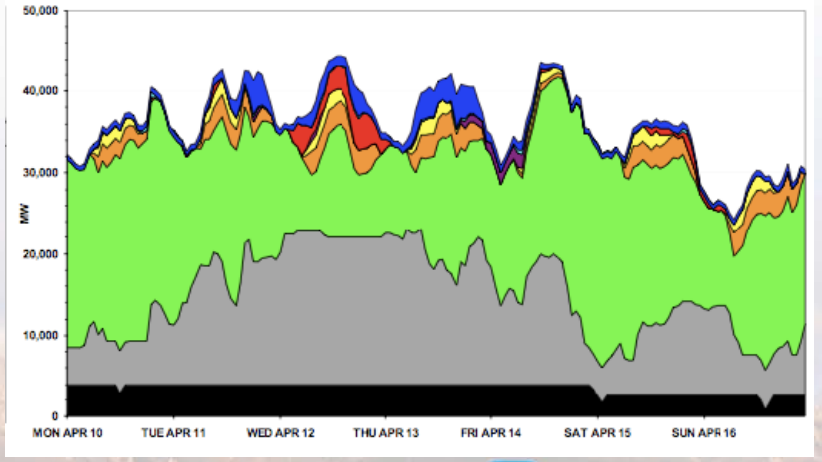
11% renewables



23% renewables



35% renewables



Lew et. al. "How do Wind and Solar Power Affect Grid Operations: The Western Wind and Solar Integration Study". National Renewable Energy Laboratory. (September 2009). p. 6

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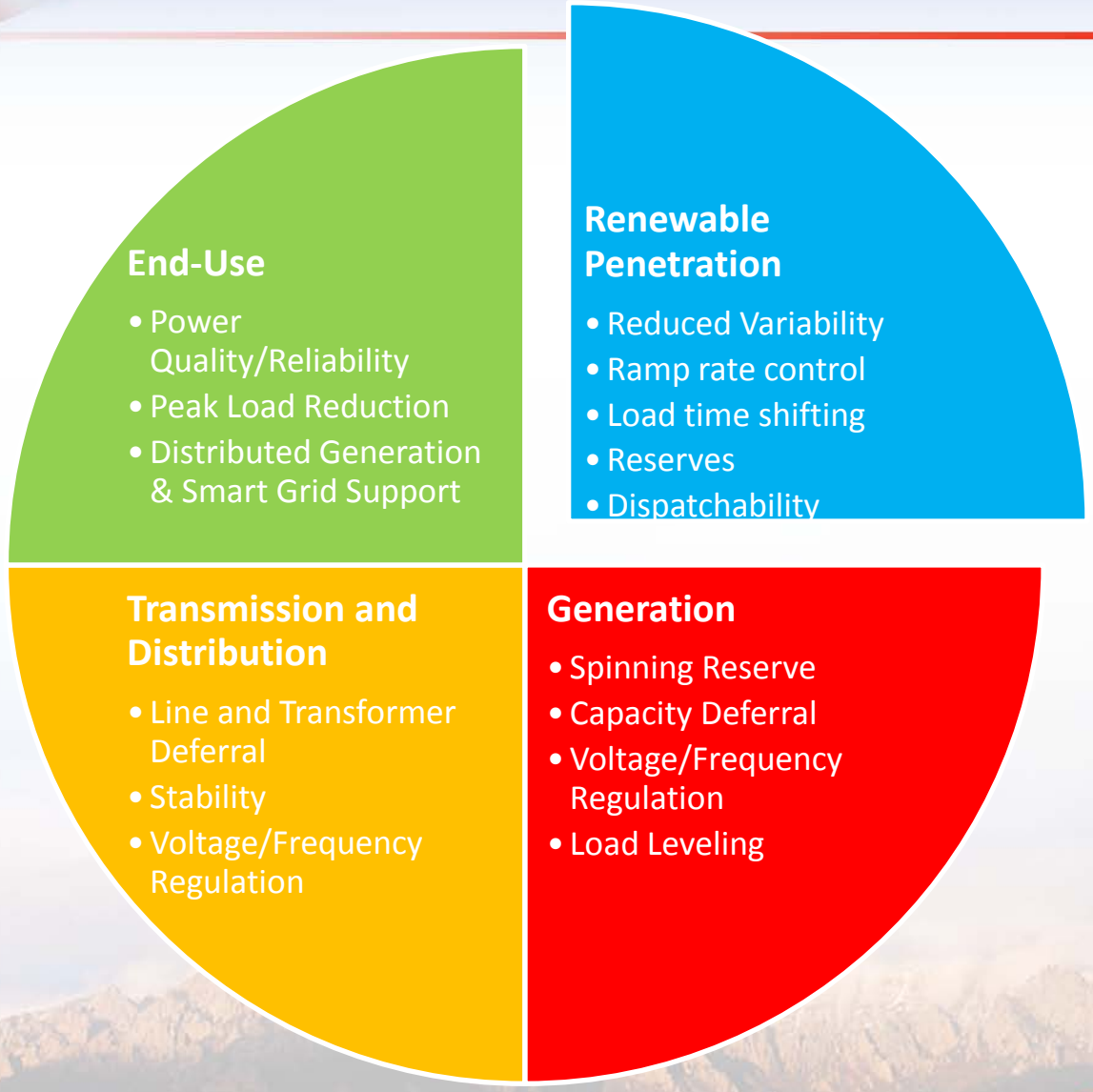
What Energy Storage Provides



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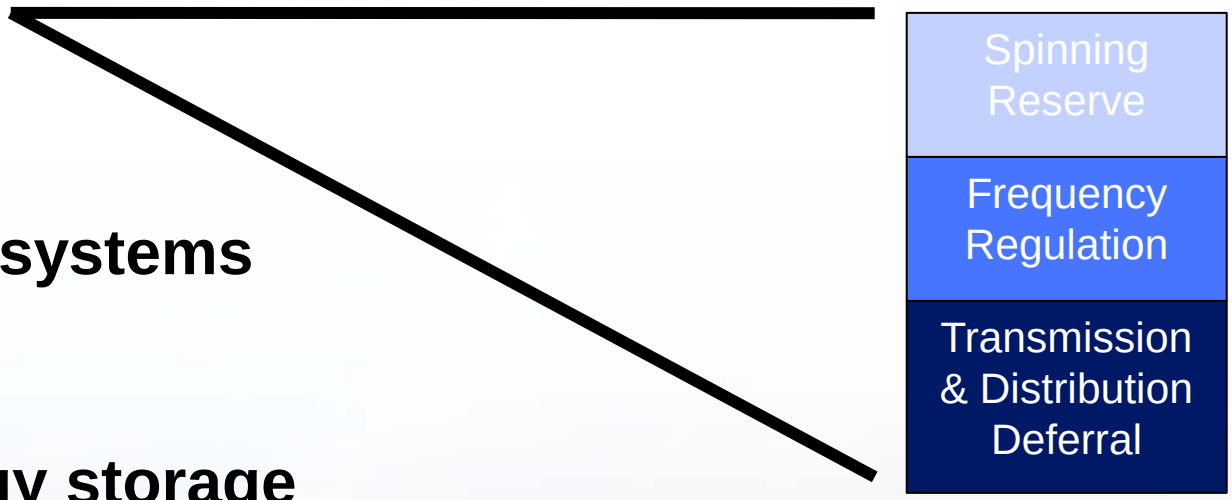
Evolution of Key Concepts

- **Stacked benefits**
- **Modular storage systems**
- **Distributed energy storage**



Sharing of benefits – Problematic for vertically integrated electric companies


PQ2000

Hawaii Battery Projects
(29 MW/32.5 MWh)

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

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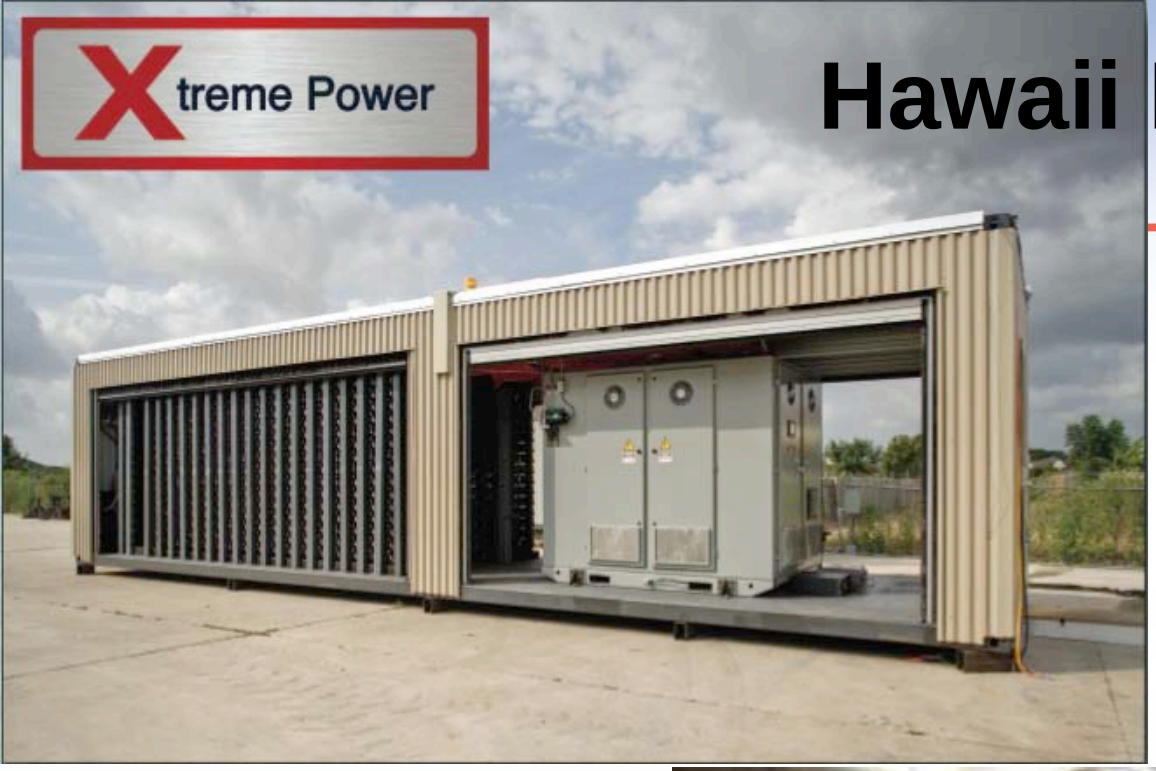
Hawaii Battery Projects

(29 MW/32.5 MWh)



Energy Storage Technologies

Energy

Power

- 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

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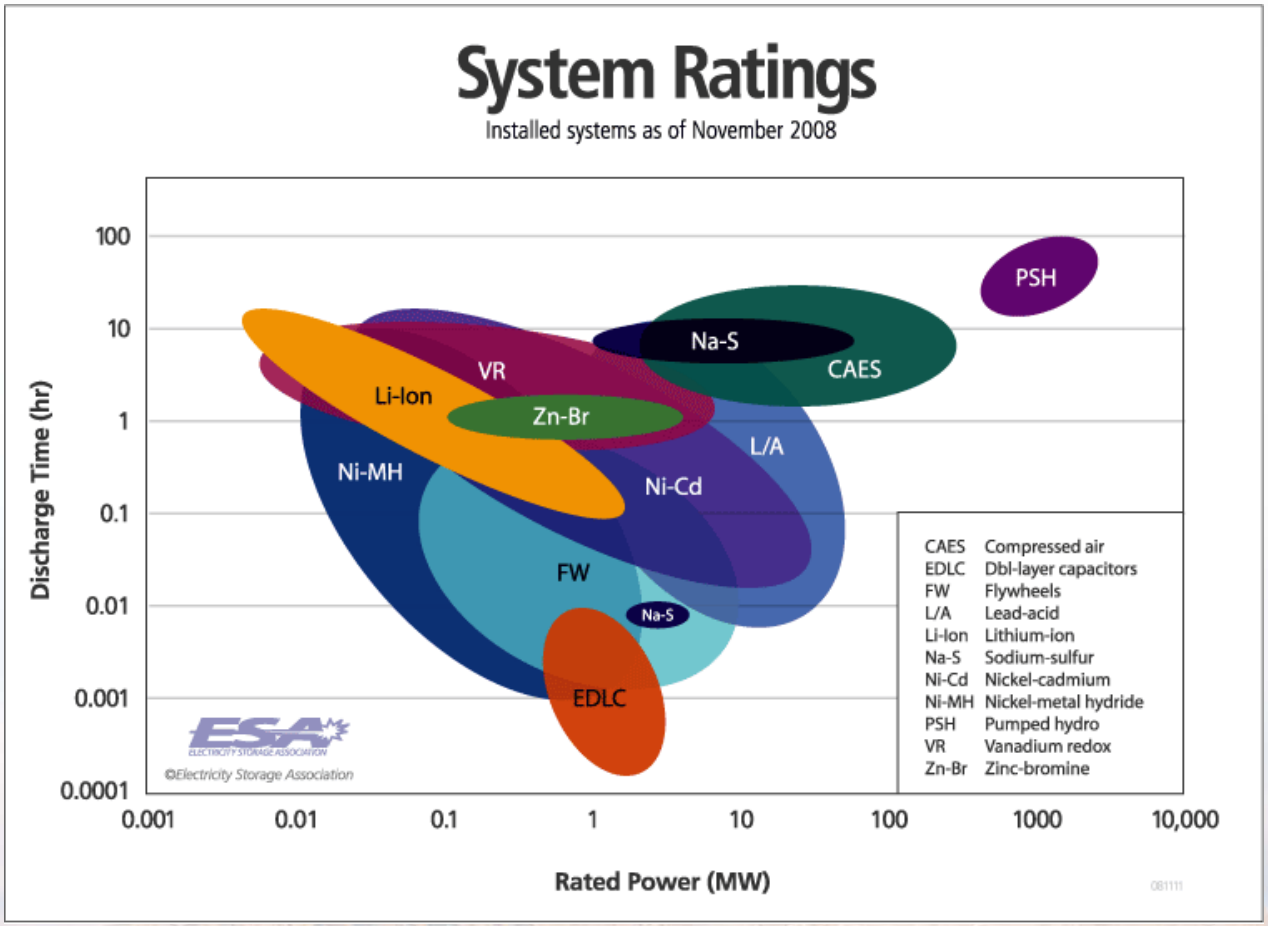
Technology Map – MW and MWh



Energy Storage System Costs and Value

- 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

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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

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EPRI Storage Costs

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

Applications:

- **Wholesale Markets**
- **Wind Integration**
- **Ancillary Services**

Technology Option	Maturity	Capacity (MWh)	Power (MW)	Duration (hrs)	% Efficiency (total cycles)	Total Cost ($/kW)	Cost ($/kW-h)
Pumped Hydro	Mature	1680-5300	280-530	6-10	80-82 (>13,000)	2500-4300	420-430
		5400-14,000	900-1400	6-10		1500-2700	250-270
CT-CAES (underground)	Demo	1440-3600	180	8	See note 1 (>13,000)	960	120
				20		1150	60
CAES (underground)	Commercial	1080	135	8	See note 1 (>13000)	1000	125
		2700		20		1250	60
Sodium-Sulfur	Commercial	300	50	6	75 (4500)	3100-3300	520-550
Advanced Lead-Acid	Commercial	200	50	4	85-90 (2200)	1700-1900	425-475
	Commercial	250	20-50	5	85-90 (4500)	4600-4900	920-980
	Demo	400	100	4	85-90 (4500)	2700	675
Vanadium Redox	Demo	250	50	5	65-75 (>10000)	3100-3700	620-740
Zn/Br Redox	Demo	250	50	5	60 (>10000)	1450-1750	290-350
Fe/Cr Redox	R&D	250	50	5	75 (>10000)	1800-1900	360-380
Zn/air Redox	R&D	250	50	5	75 (>10000)	1440-1700	290-340

Source: Electric Power Research Institute (EPRI) *White Paper on Energy Storage December 2010*

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Barriers: Costs

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

	Gas Simply Cycle CT	Lead Acid Battery
Cost of Energy	$492/MWh	$377/MWh
Cost of Capacity	$203/KW-yr	$155/KW-yr

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

	Gas Combined Cycle CT	Flywheel
IRR	14.6%	25.7%
Payback Period	8.1 years	3.9 years

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

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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*

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PUC Rate Dockets

- ***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*

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PUC Rate Dockets

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

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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?

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Necessity of Storage

- **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)

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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?

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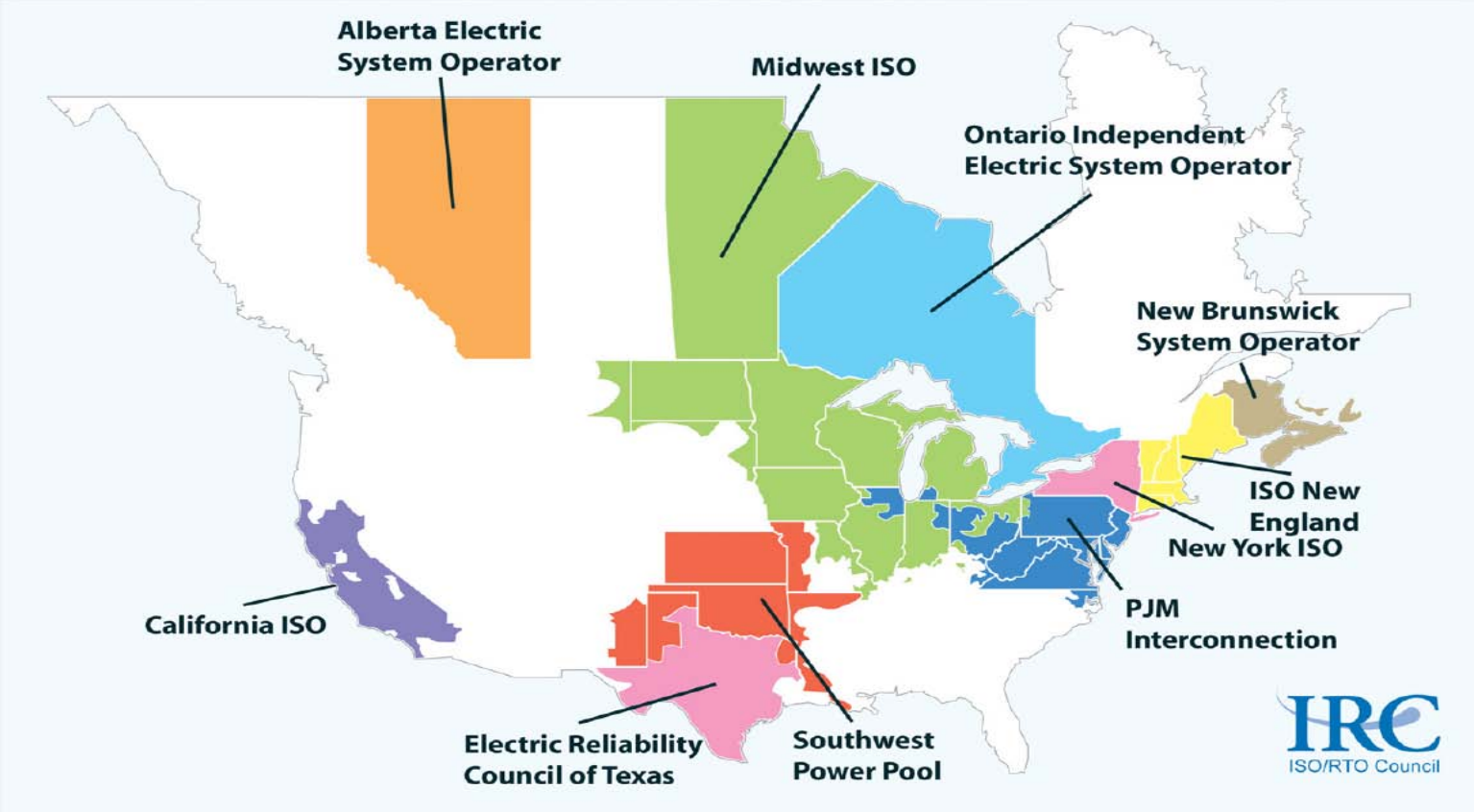
Other Issues Brought Up

- 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

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Means to Manage System Imbalance

Resources	Operations	Flexibility

• Energy Storage Systems Investment
• Investment in Transmission
• Demand response
  • Smart charging EVs
  • Residential
  • Industrial
  • Commercial
• Legacy generation
	• Balancing Area Consolidation (ISO formation)
	• Generator Schedule Compression
	• Dynamic scheduling of loads and resources
	• Improved forecasts for wind, solar, and load
	• Improved (stochastic) commitment process
	• Improved market protocols (performance)
		• The variable resource itself (regulation down and up if spilling)
		• Expansion of system flexibility (expanded ramp rates, start up times, etc)
		• Optimization of hydro resources (in coordination with environmental constraints)

Challenge: Select Least Cost Resource Portfolio Resulting in Grid Needs Being Fulfilled

Grid Services (that need to be fulfilled)

Resources that can be used to provide services

	Within hour balancing	Frequency Regulation and Inertia	Voltage Support	Stability Support	Scheduled short-term Capacity	Scheduled long-term capacity	Lowering nodal prices
Combustion Turbine							
Flywheel Storage							
Flow Battery							
FACTS Power Electronics							
Transmission Lines							
Demand Response							

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

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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

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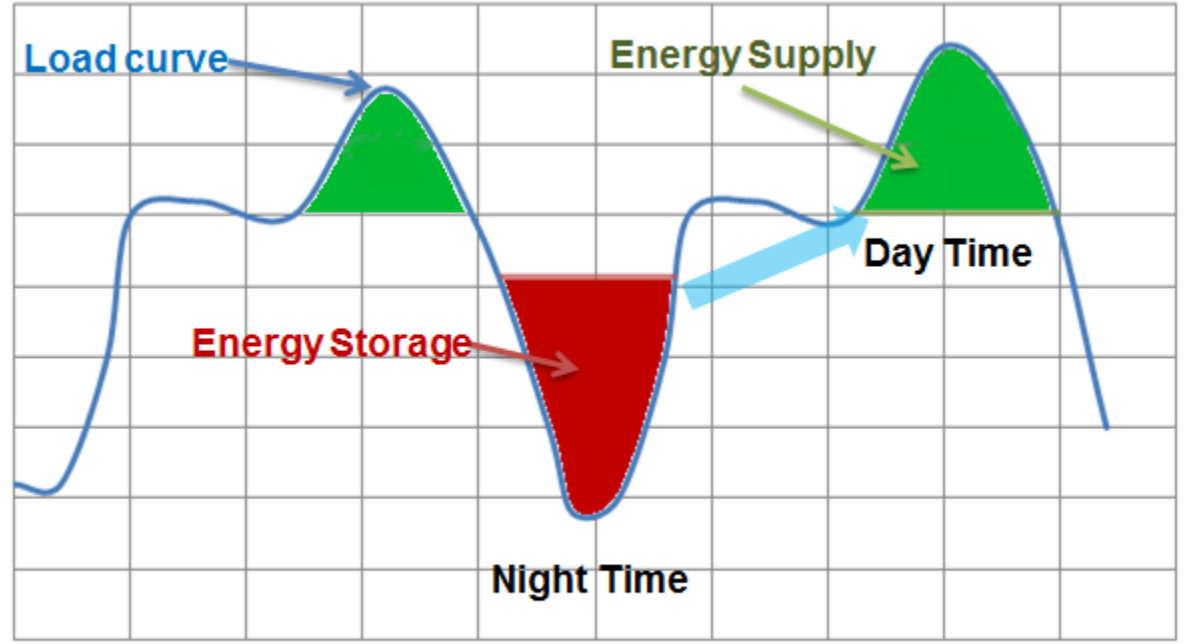
Unique Feature of Energy Storage Technologies



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

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Questions?


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