Energy Storage
State Programs and the RPS

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Clean Energy States Alliance

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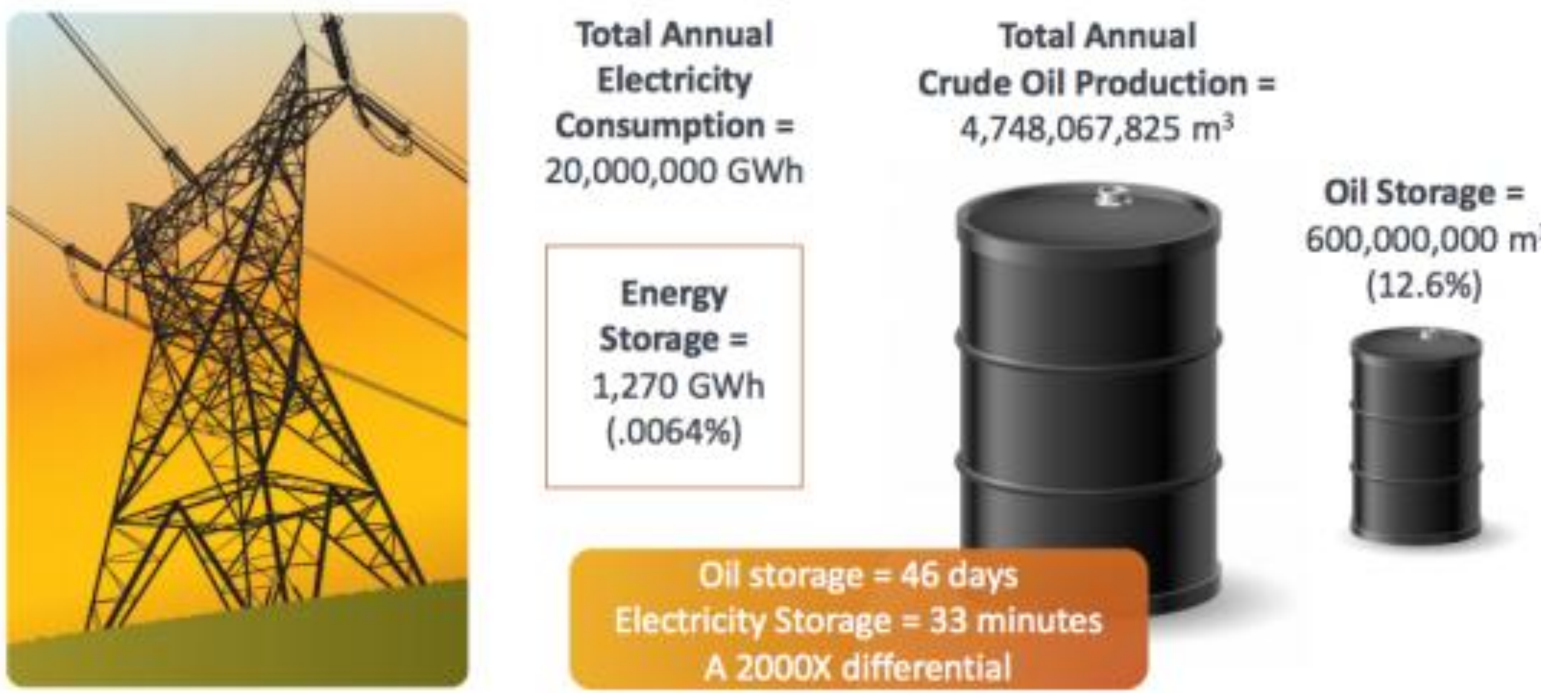
The current total electricity storage capacity of the US and of the globe is less than 1% (mostly pumped hydro)



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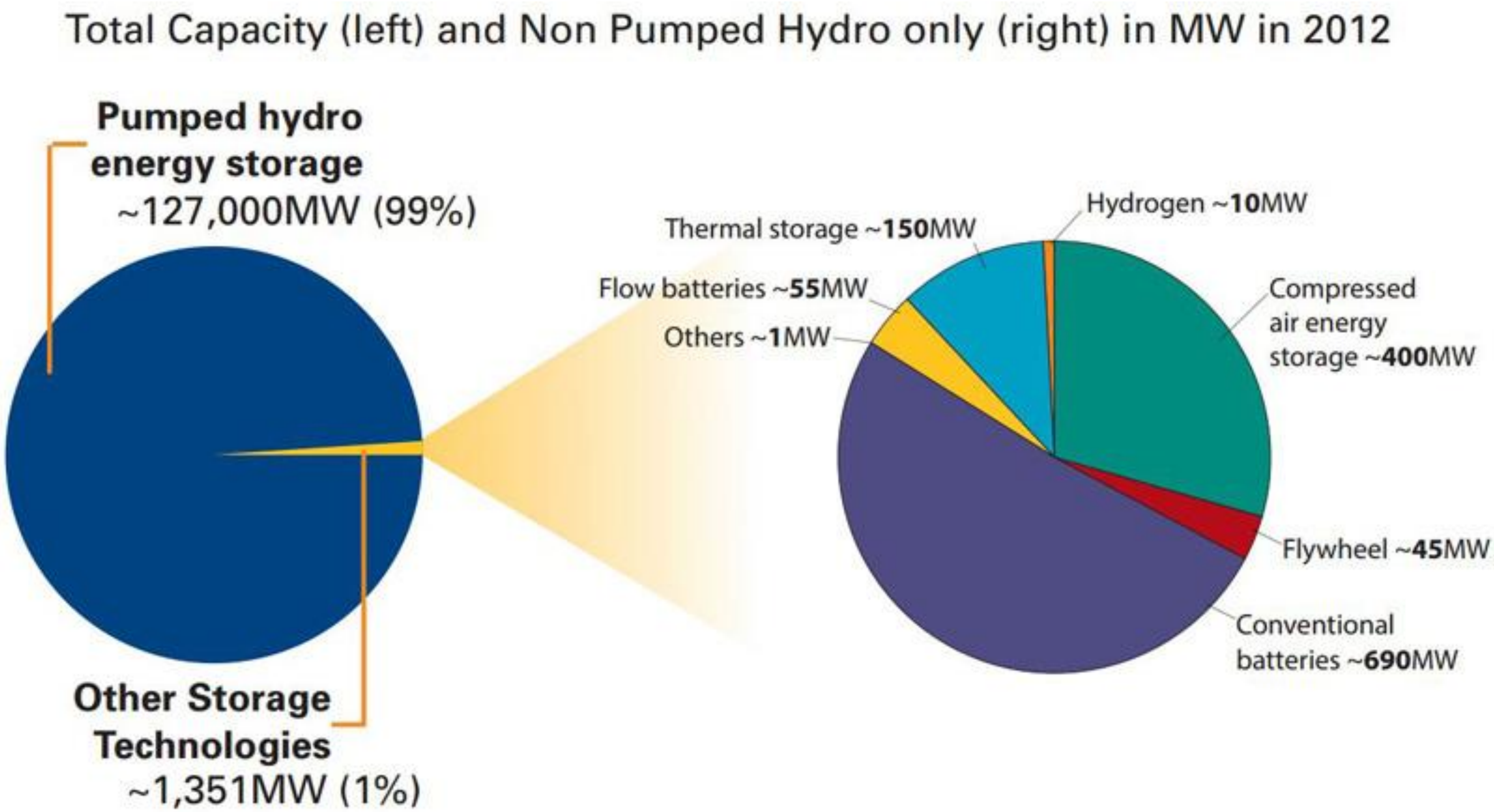
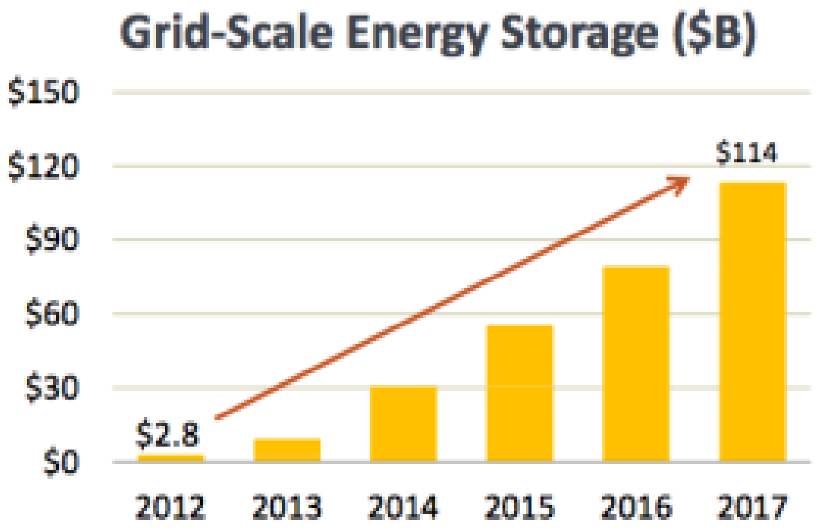
Global Electricity Storage Capacity



Energy Storage Market Potential



- Lux Research – $114 B by 2017
- Piper Jaffrey – $600 B market over 10-12 years
- Boston Consulting Group – $400 B market by 2020
- EPRI/DOE – annual savings of $50 billion/year via energy storage

Energy storage is a key enabling technology for variable resources like wind and solar

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Energy Storage Services

	POWER (<15min)		ENERGY (>1hr)
LOAD	PQ, Digital Reliability UPS	Spinning reserve/Load Following, UPS	Peak Shaving, Load Shifting
GRID	Voltage Support, Transients, Regulation	Dispatchability for Renewable Energy Resources	T&D Congestion Mitigation, Time of Use Arbitrage, Upgrade
	seconds	minutes	hours

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Grid Services Valued Differently in Different Locations

Market Evaluated	Location	Years Evaluated	Annual Value ($/kW)	Assumptions
Energy Arbitrage	PJM[a]	2002-2007	$60-$115	12 hour, 80% efficient device. Range of efficiencies and sizes evaluated[15]
	NYISO[b]	2001-2005	$87-$240 (NYC) $29-$84 (rest)	10 hour, 83% efficient device. Range of efficiencies and sizes evaluated.
	USA[c]	1997-2001	$37-$45	80% efficient device, Covers NE, No Cal, PJM
	CA[d]	2003	$49	10 hour, 90% efficient device.
Regulation	NYISO[b]	2001-2005	$163-248	
	USA[e]	2003-2006	$236-$429	PJM, NYISO, ERCOT, ISONE
Contingency Reserves	USA[e]	2004-2005	$66-$149	PJM, NYISO, ERCOT, ISONE

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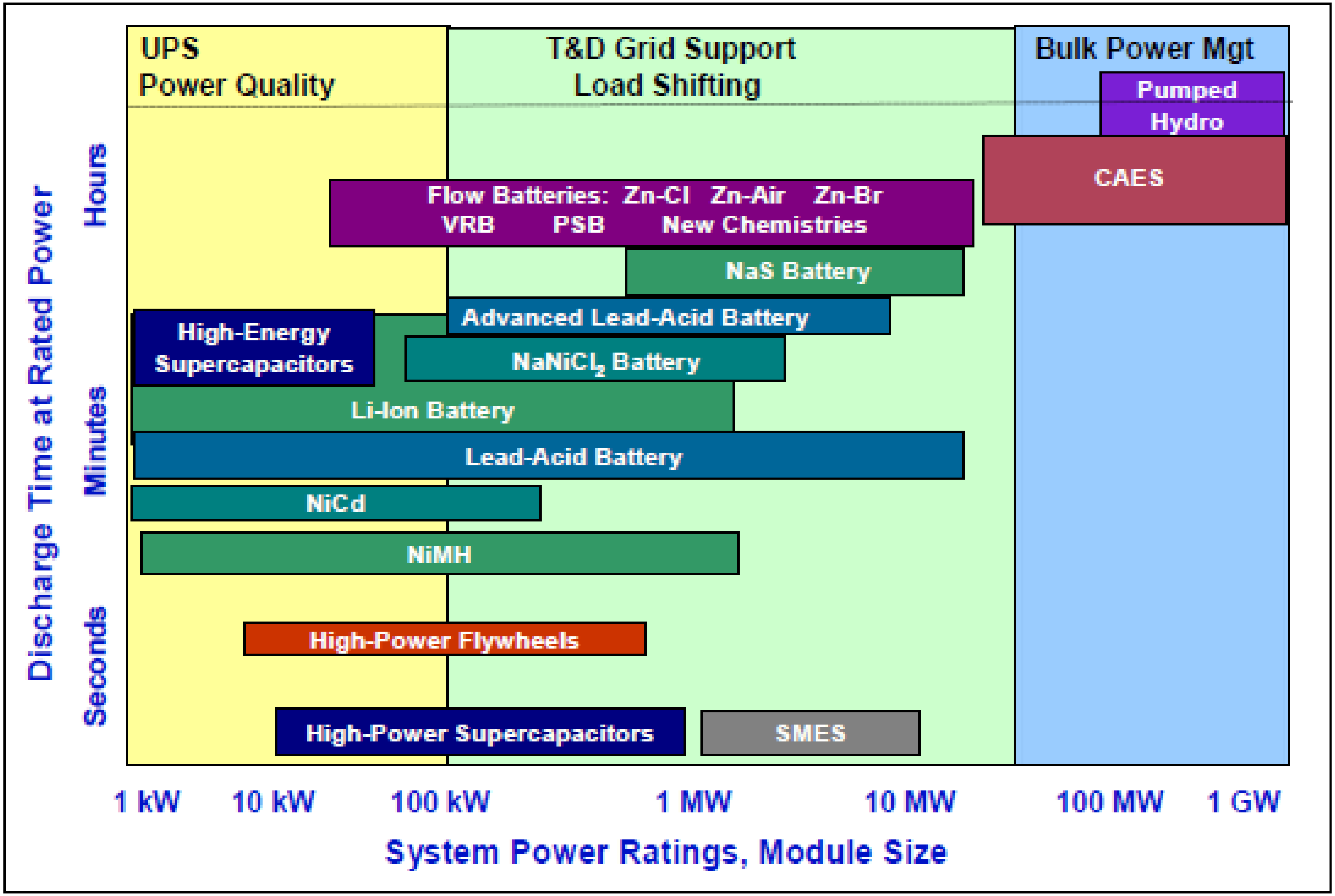
Choose the Right Technology for the Service!



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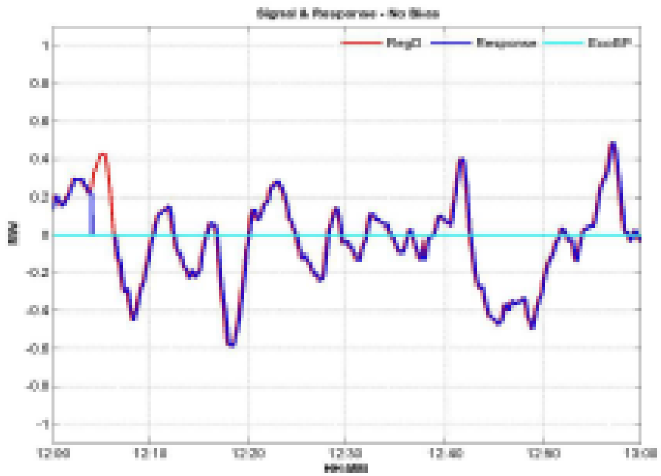
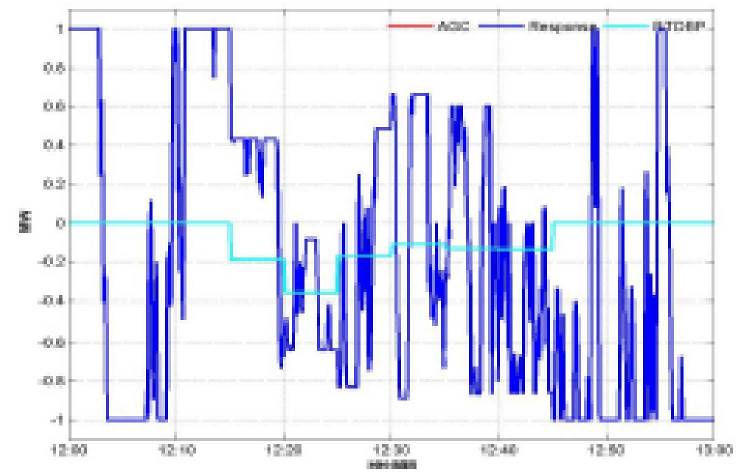
Each Service Area Is Operated Differently…

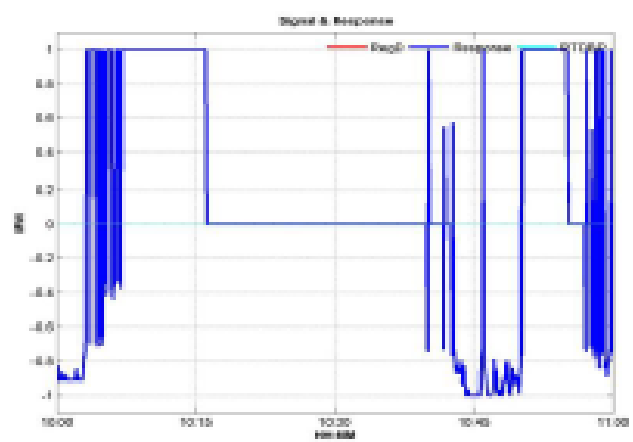
PJM



NY ISO



CAISO



Different signals in each ISO have significantly different impact on dispatch, cycles, life of a storage resource.

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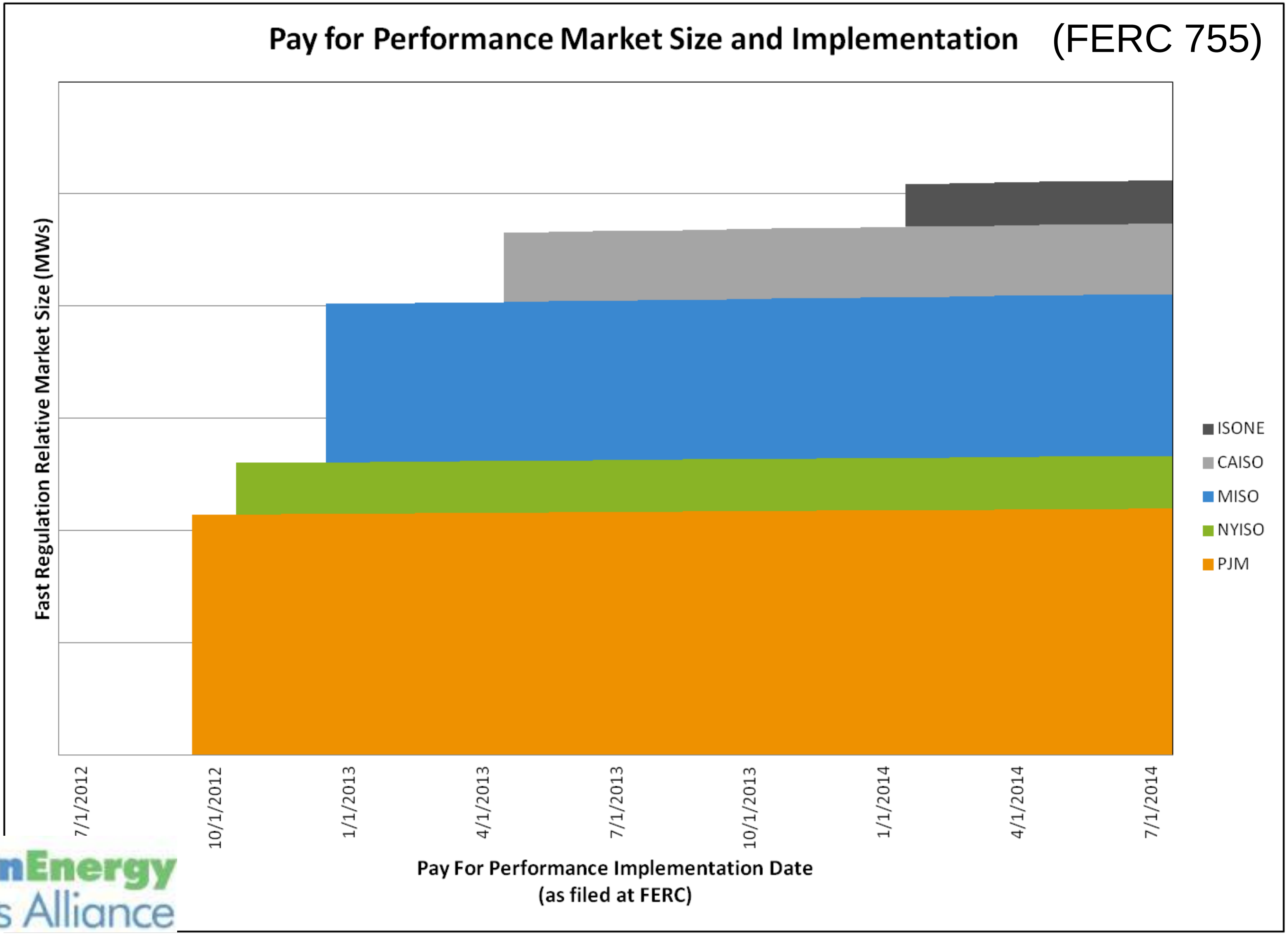
...And They Operate Under Different Rules!



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Why are states interested in energy storage?

Two Main Drivers:

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1) Integration of Renewables

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2) Resilient Power Solution

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Why are states interested in energy storage?

Two Main Drivers:

1) Integration of Renewables **(Utility Scale)**
2) Resilient Power Solution **(Facility/Campus/ Microgrid Scale)**

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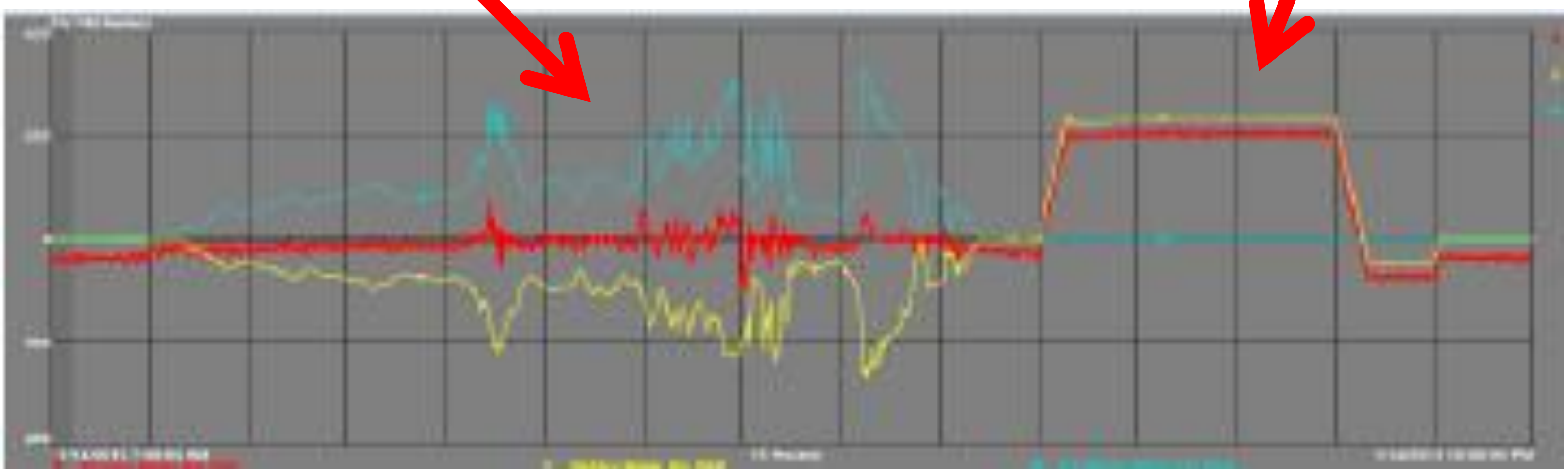
1) Integration of Renewables: Increasing penetration of variable renewables on grid, spurred by RPSs, requires an integration solution

Peak Shifting

Smoothing



Key: Yellow = Battery Output | Red=System Output | Blue=PV Output

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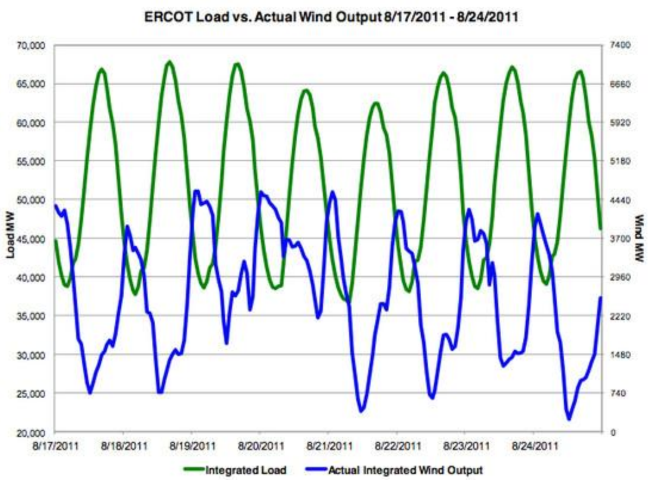
Wind Generation Does Not Match Well With Electricity Demand Cycles, Hourly Or Seasonally



Electricity demand peaks during daytime hours

Wind generation peaks at night, falls during daytime hours

Solar does better, but still not a perfect match

Demand peaks during summer; wind generation falls during summer, peaks during winter

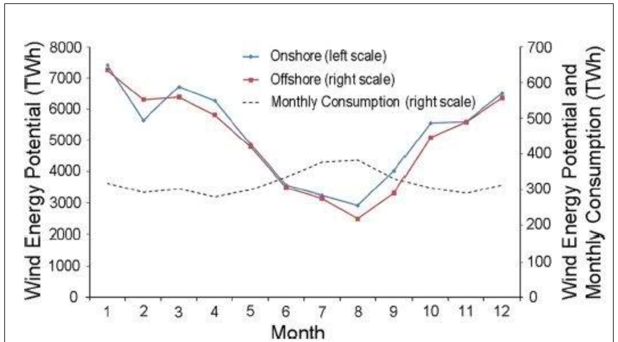
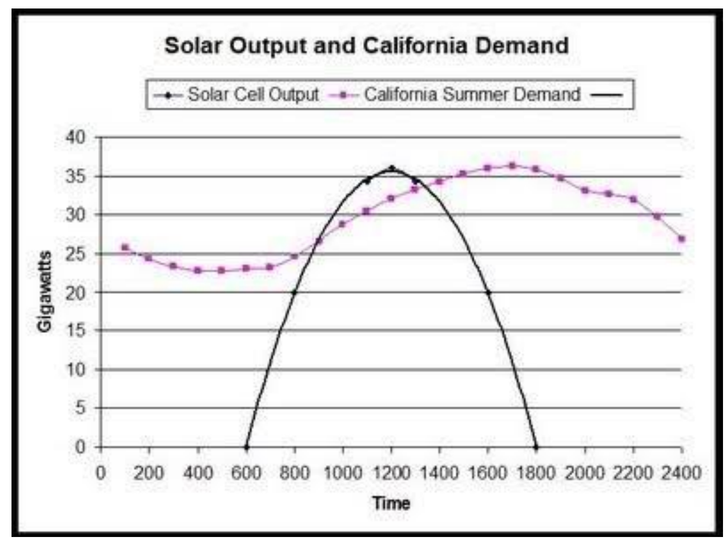


Fig. 4. Monthly wind energy potential for the contiguous U.S. in 2006 with monthly electricity consumption for the entire U.S.



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Example: ERCOT has ~13% Wind Penetration (installed capacity).

Two Problems:

1. **Under-Generation:** On February 26, 2008, a Stage 2 emergency was declared when wind production fell from more than 1,700 MW to 300 MW; ERCOT system operators curtailed power to interruptible customers to shave 1,100 MW of demand within 10 minutes.
2. **Over-Generation:** From December 2008 to December 2009, ERCOT curtailed 500 MW - 2,000 MW wind power daily on average, at times up to 3,900 MW. In 2009, average annual wind curtailment was around 16%.

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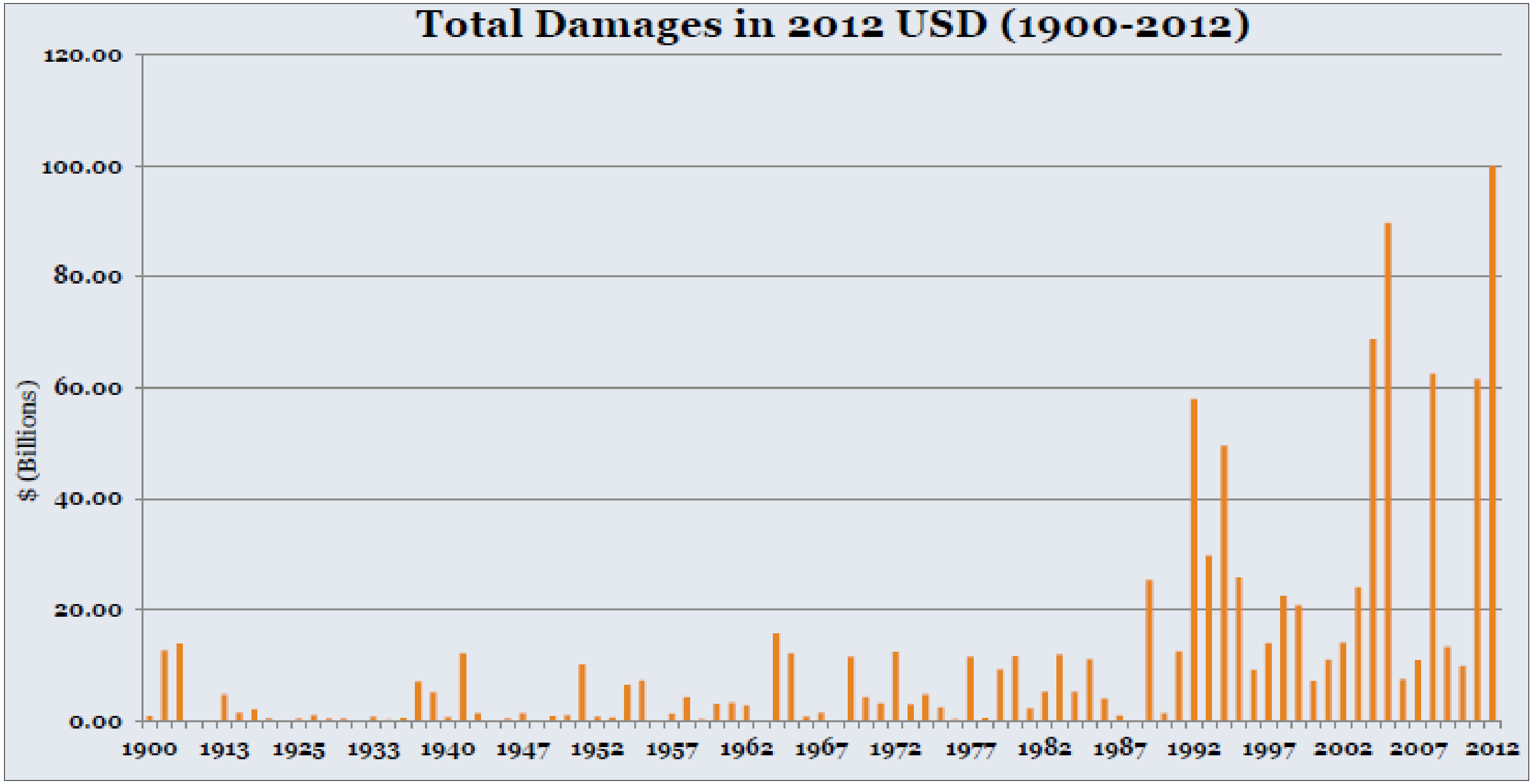
2) Resilient Power Solution: Increasing Severe Storms Cause Increasing Damage



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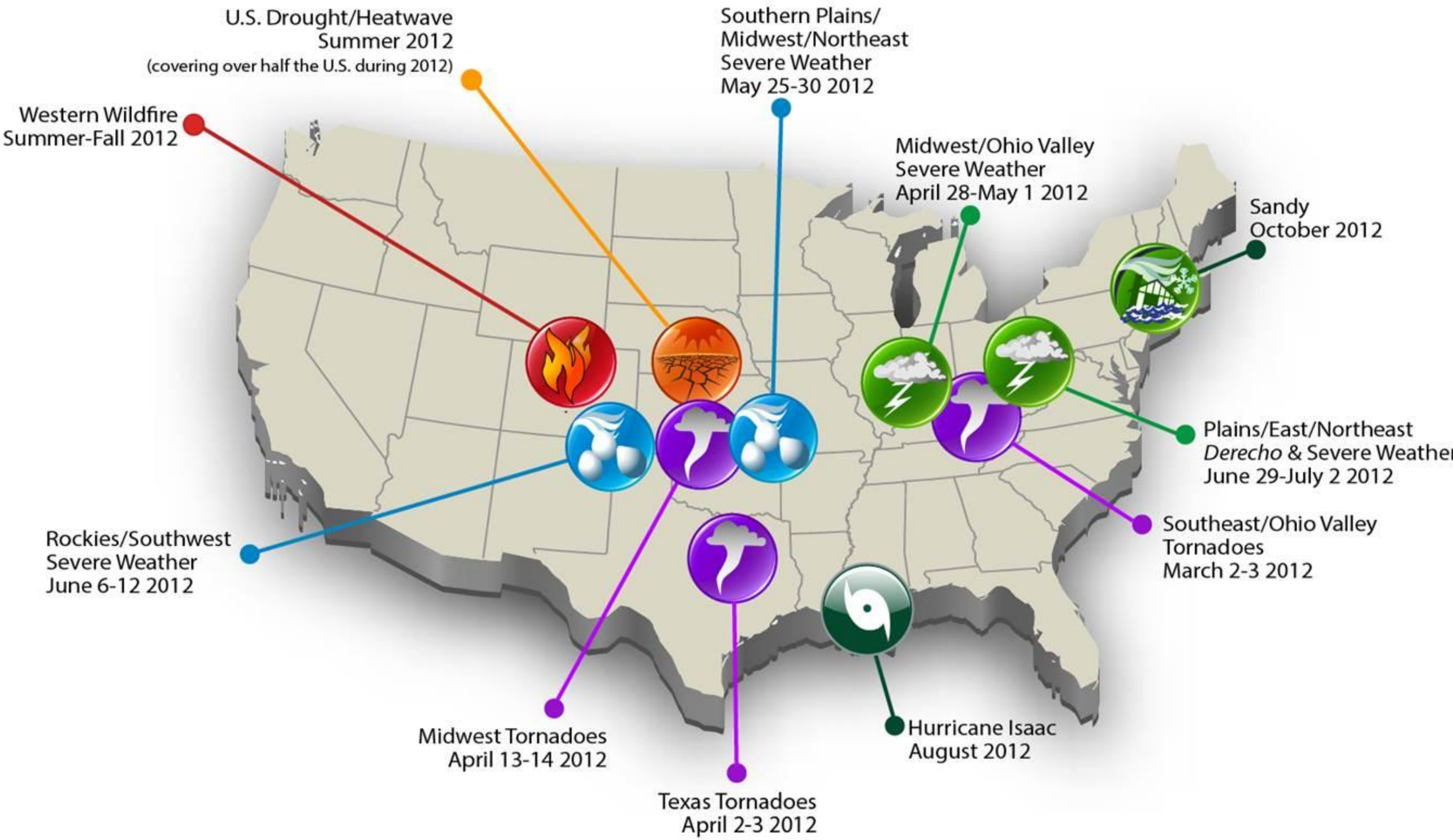
U.S. 2012 Billion-dollar Weather and Climate Disasters



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NOTE: Does not include earthquakes

Energy Storage Can Help With Both Problems!

… But What About Cost?

EPRI "Cost Effectiveness of Energy Storage in California" Cost-Benefit Analysis for California PUC

Prioritized Use Cases (Highlighted)

Categories	Use Cases
Transmission-Connected Energy Storage	Bulk Storage System (aka Peaker Substitution)
	Ancillary Services
	On-Site Generation Storage
	On-Site Variable Energy Resource Storage
Distribution-Level Energy Storage	Distributed Peaker
	Distributed Storage Sited at Utility Substation
	Community Energy Storage
Demand-Side (Customer-Sited) Energy Storage	Customer Bill Management
	Customer Bill Management w/ Market Participation
	Behind the Meter Utility Controlled
	Permanent Load Shifting
	EV Charging

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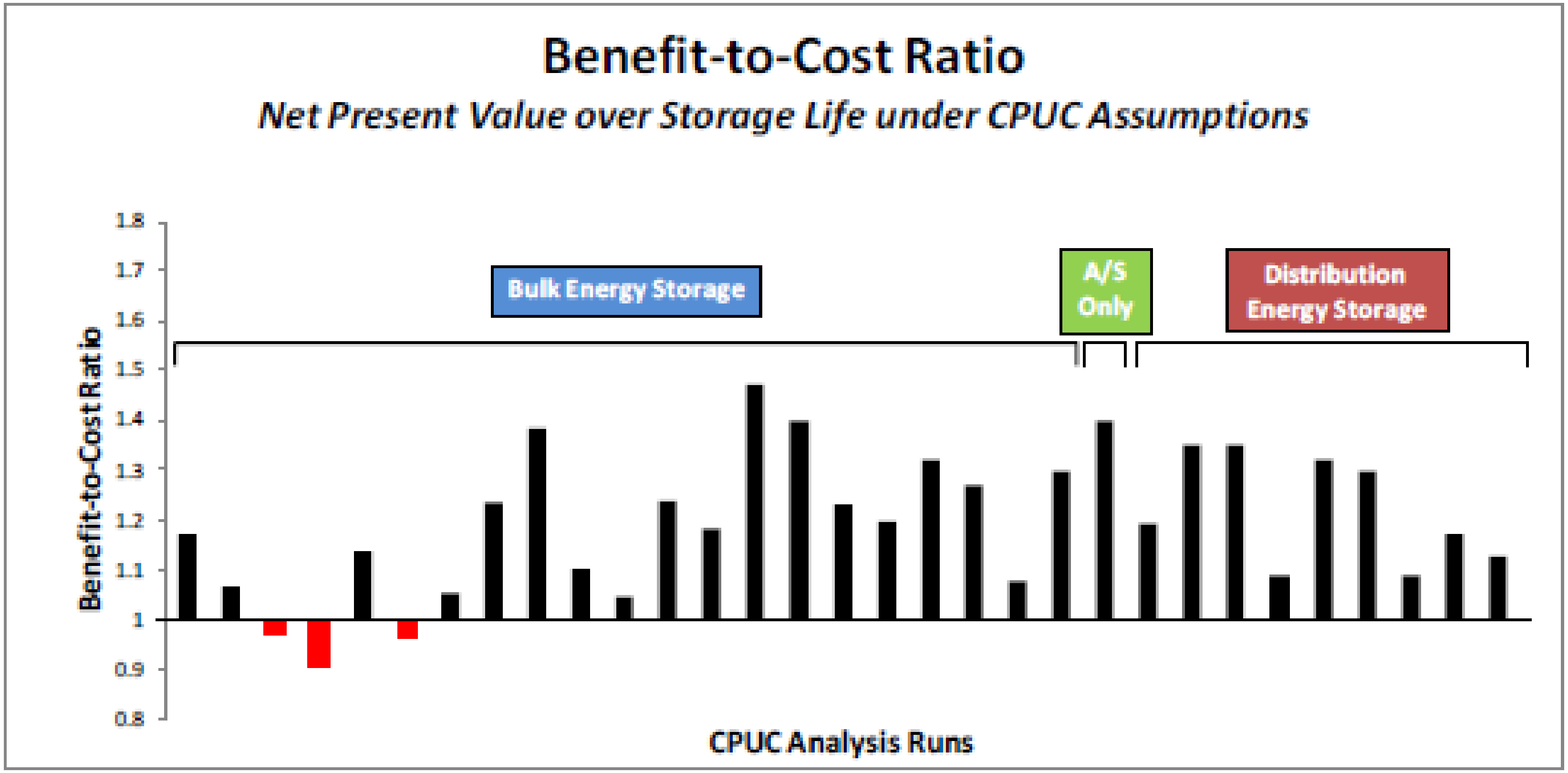
EPRI: “Cost Effectiveness of Energy Storage in California” Results



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Facility-, Campus- or Microgrid-Scale Energy Storage May Find Higher Value Uses

… Especially for Critical Infrastructure Resilient Power/Disaster Preparedness

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The Role of Clean Energy States Alliance (CESA) and Clean Energy Group (CEG)

Two projects address energy storage directly:

1) Energy Storage Technology Advancement Partnership (ESTAP)
2) Resilient Power Project

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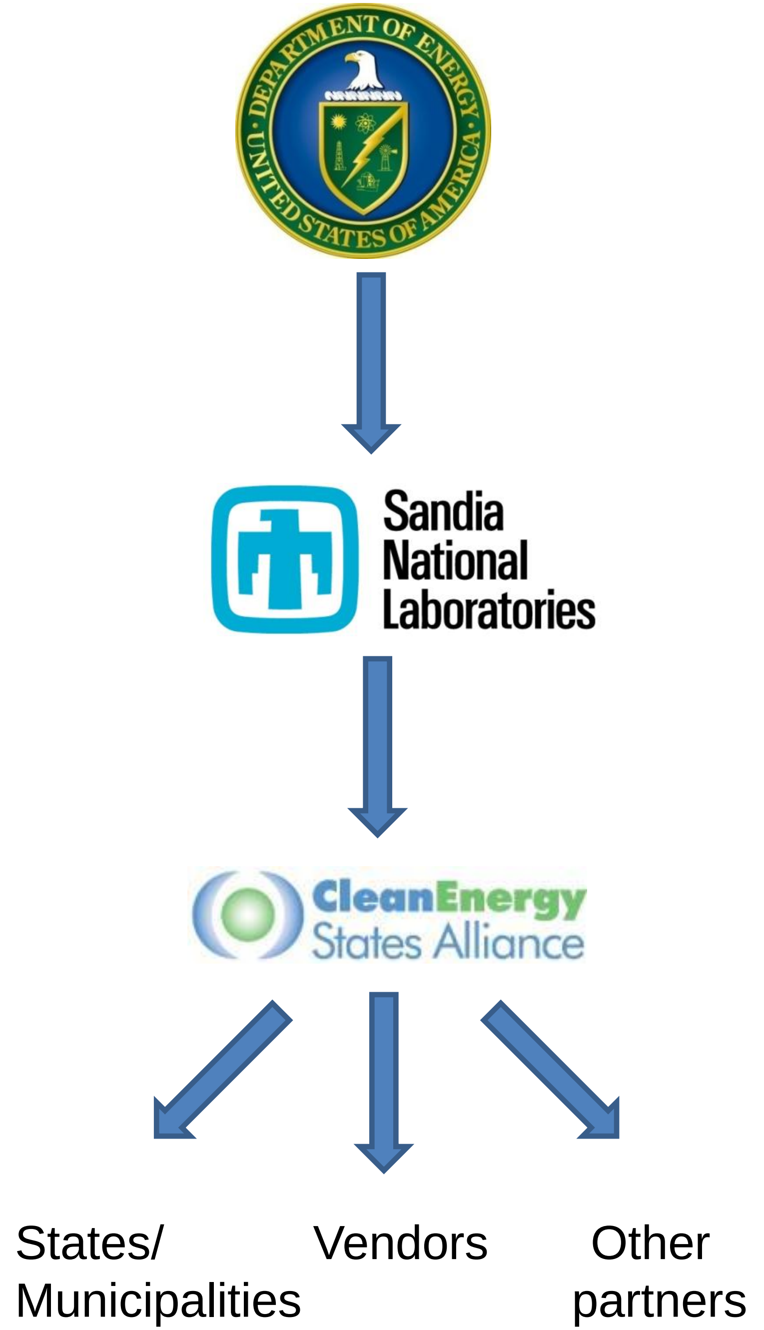
ESTAP* Overview

Purpose: Create new DOE-state energy storage partnerships and advance energy storage, with technical assistance from Sandia National Laboratories

Focus: Distributed electrical energy storage technologies

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

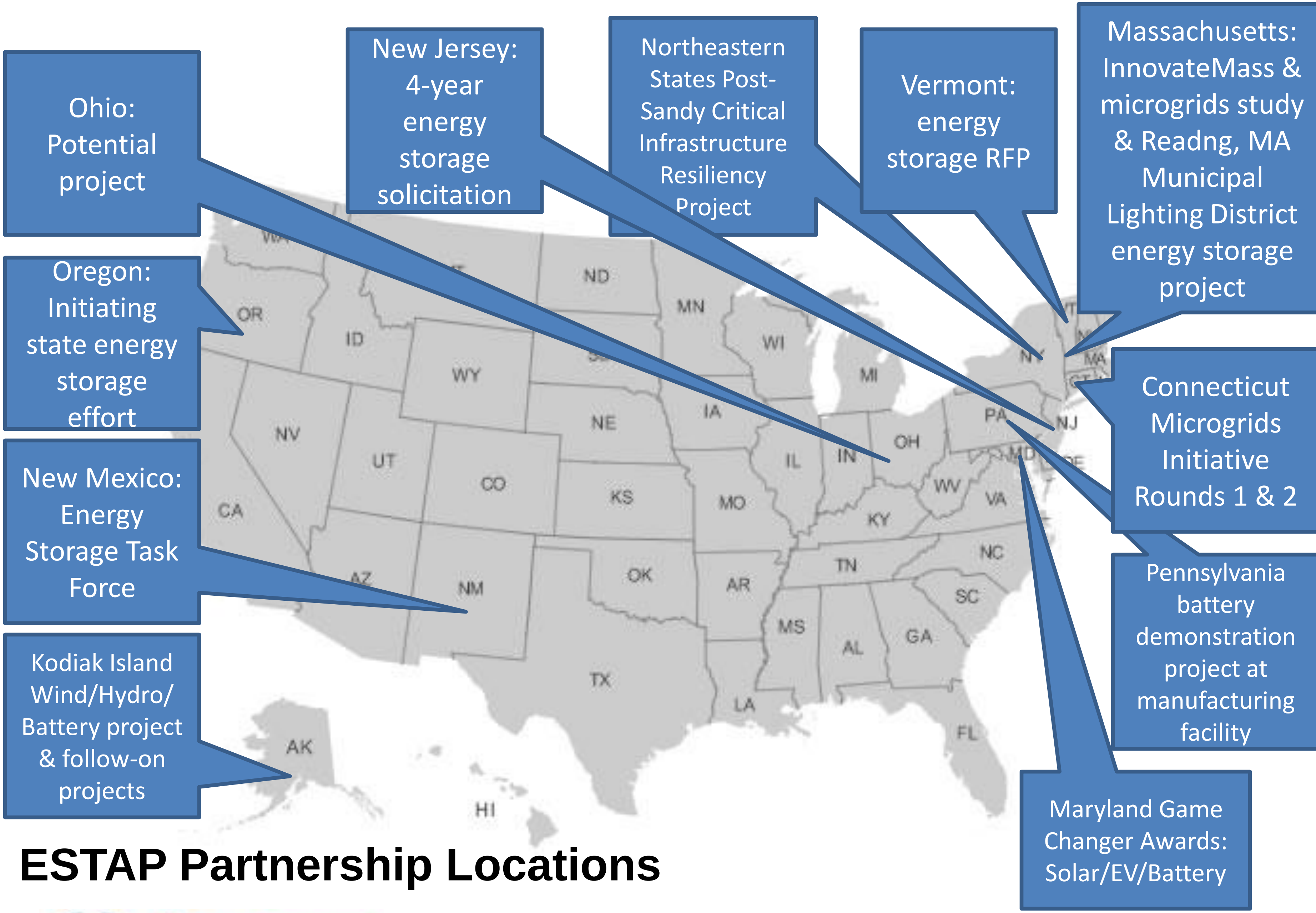


* (Energy Storage Technology Advancement Partnership)

ESTAP Key Activities

1) Disseminate information to stakeholders

2) Facilitate federal/state partnerships to support energy storage project development



ESTAP Partnership Locations

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ESTAP Federal/State partnerships

- Partnership on **Projects**
  - Alaska
  - Maryland
  - Massachusetts
  - Pennsylvania
  - Vermont

- Partnership on **Programs**
  - Connecticut Microgrid Grant and Loan Pilot Program
  - New Jersey Energy Storage Working Group
  - New Mexico – emerging program
  - Oregon – emerging program

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Vermont

Connecticut Microgrid Grant and Loan Pilot Program

- Three year resiliency program
- $15 million/year, $45 million total state allocation
- Round 1 concluded with 9 project grants awarded
- Round 2 RFP under development
- DOE/Sandia/CESA role:
  - Assist in RFP development
  - Help to evaluate project proposals
  - DOE $ contribution to support qualifying projects
  - Monitor and evaluate project performance once complete

Connecticut DEEP Microgrid Grant and Loan Pilot Program First Round Results

Project	Facilities	Generation	Grant Value
UConn Depot Campus/Storrs	Campus Buildings	400 kW fuel cell, 6.6 kW PV	$2,144,234
City of Bridgeport-City Hall/Bridgeport	City hall, Police Station, Senior Center	(3) 600 kW natural gas microturbines	$2,975,000
Wesleyan/Middletown	Campus, Athletic Center (Public Shelter)	(1) 2.4 MW and (1) 676 kW Natural Gas Combined Heat and Power Reciprocating Engine	$693,819
University of Hartford-St. Francis/Hartford	Dorms, Campus Center, Operation Building	(2) 1.9 MW diesel (existing), 250 kW diesel, 150 kW diesel	$2,270,333
SUBASE/Groton	Various Buildings and Piers	5 MW cogen turbine, 1.5 MW diesel	$3,000,000
Town of Windham/Windham	2 Schools (Various Public Purposes)	(2) 130 kW natural gas, 250 kW solar, 200 kWh battery; (2) kW diesel,	$639,950
Town of Woodbridge/Woodbridge	Police Stations, Fire Station, Department of Public Works, Town Hall, High School, Library	1.6 MW natural gas, 400 kW fuel cell	$3,000,000
City of Hartford-Parkville Cluster/Hartford	School, Senior Center, Library, Supermarket, Gas station	600 kW natural gas	$2,063,000
Town of Fairfield-Public Safety/Fairfield	Police Station, Emergency Operations Center, Cell Tower, Fire Headquarters, Shelter	50 kw natural gas recip engine, 250 kW natural gas recip engine, 27 kW PV, 20 kW PV	$1,167,659

New Jersey Energy Storage Working Group

- Effort led by NJ Board of Public Utilities
- Four year energy storage initiative
- $10 million total state investment ($2.5M/year)
- Focus on resilient power applications
- ES to be paired with renewable generation
- Round 1 RFP forthcoming March 2014
- DOE/Sandia/CESA role:
  - Assist in RFP development
  - Help to evaluate project proposals
  - DOE $ contribution to support qualifying projects
  - Monitor and evaluate project performance once complete

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New Jersey Four-Year
Energy Storage Incentive Program

NJ BPU priorities include:

- Emphasis on spending for projects that can be completed within 1 year.
- Desire to build a sustainable market that does not rely on NJCEP funding.
- Presence of storage can firm PV production to allow facilities to participate in other available incentive programs such as demand response, etc.
- Explore the role of energy storage as means of ensuring the operation of critical facilities during power outages.

VERMONT CLEAN ENERGY DEVELOPMENT FUND
Electrical Energy Storage Demonstration Program

- State has issued solicitation, received and reviewed proposals: award announcement and contract pending
- Energy storage system to be rated > 200 kW, 400 kWh
- Primary objective: to support the integration of renewables into the grid
- DOE/Sandia role:
  - Assist in RFP development
  - Help to evaluate project proposals
  - DOE/Sandia contribution to project cost
  - Monitor and evaluate project performance once complete

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Resilient Power Project

With foundation support, Clean Energy Group is working with a core group, consisting primarily of Northeastern states that were hit hard by Superstorm Sandy, and are seeking resilient power solutions:

- Connecticut
- Massachusetts
- New Jersey
- New York
- Rhode Island
- California
- Maryland
- Ohio
- Oregon

There is interest from other states as well, and we intend to grow this into a national effort

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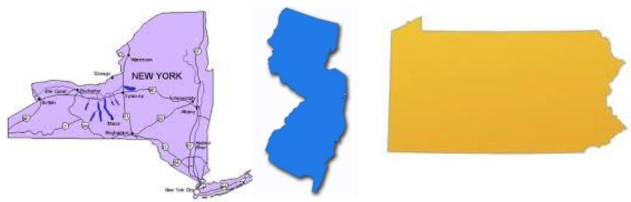
A Modest Proposal:

In FERC-compliant service territories, such as PJM and NYISO, states could incentivize third-party energy storage developers to co-locate with PV at designated critical infrastructure, install islanding equipment, and provide a local resiliency benefit when the grid goes down.



State designates critical facilities, provides incentives

PV vendor provides PV, sells power

Result: Islandable critical facility powered by solar PV and energy storage, provides community benefits

Storage vendor provides battery and inverter, sells services to grid, agrees to provide resiliency to host site in event of grid failure

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Thank You

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