Energy Storage Technology Advancement Partnership (ESTAP)

Energy Storage Update

NESEA
March 9, 2016

Todd Olinsky-Paul
Project Director
Clean Energy States Alliance
Thank You:

Dr. Imre Gyuk
U.S. Department of Energy,
Office of Electricity Delivery and
Energy Reliability

Dan Borneo
Sandia National Laboratories
Energy Storage Technology Advancement Partnership (ESTAP)

- A project of Clean Energy States Alliance (CESA), a non-profit organization providing a forum for states to work together to implement effective clean energy policies & programs
- Conducted under contract with Sandia National Laboratories, with funding from US DOE-OE

**ESTAP Key Activities:**

1. Disseminate information to stakeholders
   - ESTAP listserv >3,000 members
   - Webinars, conferences, information updates, surveys.

2. Facilitate public/private partnerships to support joint federal/state energy storage demonstration project deployment

3. Support state energy storage efforts with technical, policy and program assistance

**ESTAP Project Locations**
Resilient Power Project

- Increase public/private investment in clean, resilient power systems
- Engage city officials to develop resilient power policies/programs
- Protect low-income and vulnerable communities
- Focus on affordable housing and critical public facilities
- Advocate for state and federal supportive policies and programs
- Technical assistance for pre-development costs to help agencies/project developers get deals done
- See www.resilient-power.org for reports, newsletters, webinar recordings

www.cleanegroup.org
www.resilient-power.org
The Landscape for Storage: a patchwork quilt of markets, regulations, utility programs and state incentives

California
- ES capacity mandate – 1.3 GW by 2020
- SGIP incentive
- AB-693 $1B multifamily affordable housing solar roofs program

Northeastern Resilient Power Programs
MA, NJ, NY, CT

PJM wholesale frequency regulation market
- Premium for fast response resources
- Lowered barriers to entry for distributed resources

• Demand charge management
• State incentives
• High electricity prices/net metering caps
## Frequency Regulation in PJM

### Key Statistics

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member companies</td>
<td>960+</td>
</tr>
<tr>
<td>Millions of people served</td>
<td>61</td>
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<tr>
<td>Peak load in megawatts</td>
<td>165,492</td>
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<tr>
<td>MW of generating capacity</td>
<td>171,648</td>
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<tr>
<td>Miles of transmission lines</td>
<td>72,075</td>
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<tr>
<td>2014 GWh of annual energy</td>
<td>792,580</td>
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<tr>
<td>Generation sources</td>
<td>1,304</td>
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<tr>
<td>Square miles of territory</td>
<td>243,417</td>
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<tr>
<td>States served</td>
<td>13 + DC</td>
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</table>

*21% of U.S. GDP produced in PJM*
PAY FOR PERFORMANCE IMPLEMENTED

SEPTEMBER 2012
PJM introduces a second, fast moving regulation signal (RegD)

$13.75 MWh
$38.75 MWh

MARKET CLEARING PRICES

OCTOBER 2012
Regulation requirements reduced

DYNAMIC FAST RESPONDING RESOURCES (REGD)

OCTOBER 2012
6

OCTOBER 2013
19

450 MW
OF DYNAMIC FAST, RESPONDING RESOURCES

REGULATION REQUIREMENTS (MW)

PJM coordinates frequency regulation through two different control signals: RegD - fast moving dynamic regulation (e.g. batteries, flywheels) RegA - traditional regulation resources (e.g. simple cycle gas turbines)
Invenergy’s Beech Ridge 32 MW energy storage project paired with 100 MW wind energy in West Virginia.

Source: PJM
<table>
<thead>
<tr>
<th>Regulation</th>
<th>Zone</th>
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<tr>
<td>Locations</td>
<td>RTO</td>
<td>293</td>
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<tr>
<td>MW</td>
<td>RTO</td>
<td>22</td>
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</table>

**DR Market Participation: Regulation Market**

- Water_Heaters: 42%
- Batteries: 23%
- HVAC: 18%
- Generator: 12%
- Refrigeration: 1%
- Manufacturing: 4%

*Note: Percent of CSP Reported Load Reduction MWs*
FY2015 Renewable Electric Storage Incentive Solicitation Results

October 22, 2014 - Board Approved Solicitation & Evaluation Process
December 08, 2014 - Applications Due; 22 Received => Evaluated
March 18, 2015 – Board Approved 13 Applications for Incentive Award

- 22 Applications Received
  - $4,694,642 Requested
  - $70,000 to $468,708 per
  - $323,585 to $1.86 million
  - 13,430 kW total capacity
  - 250 kW to 1,500 kW
  - 19 Li-ion & 3 Lead Carbon
  - 18 public & critical, 4 not

- 13 Applications Approved
  - $2,908,804 Awarded
  - $70,000 to $468,708 per
  - $330,766 to $1.855 million
  - 8,750 kW total capacity
  - 250 kW to 1,500 kW
  - 13 Li-ion projects
  - 13 public and critical

NJCleanEnergy.com
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  - 13 public and critical

NJCleanEnergy.com
With federal and foundation support, CESA is providing free technical assistance to the DOER awardees whose resiliency projects include an energy storage component

- Sandia National Laboratories
- Pacific Northwest National Laboratories
- Contractors
Municipal Utility Analysis - Massachusetts

- Analysis conducted by Sandia National Laboratories
- Based on 1 MW/1MWh lithium ion battery installed on distribution grid, with 3 MW solar PV
- System to be owned and operated by a MA municipal utility
- Potential value streams:
  - **Energy arbitrage** revenues (buy low, sell high)
  - **Reduction in transmission obligation** to ISO-NE (cost savings based on monthly peak hour)
  - **Reduction in capacity obligation** to ISO-NE (cost savings based on annual peak hour)
  - **Resilient power provision** to critical emergency facilities (non-monetizable benefit)
### Arbitrage basis

#### Final Real-Time Locational Marginal Prices ($/MWh)

**9/2/2014**

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<td>AVG</td>
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<td>On Peak AVG</td>
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<td>Off Peak AVG</td>
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</table>
Energy Arbitrage

- Analyzed 33 months of data (January 2013-September 2015)
- Optimization using perfect foresight
- Cycling limitations were not included
Reduction in Transmission Obligation (Regional Network Service (RNS) payments) to ISO-NE

- Monthly payment based on maximum load
- Payment for using transmission facilities to move electricity into or within New England
- Current pool rate, effective June 1, 2015: $98.70147/kW-yr
- Need to “hit the hour” to reduce load, or else no benefit
- Having a multi-hour battery (more capacity) provides no increase in benefit, but increases the odds of “hitting the hour”

### RNS Savings for 1 Hour Energy Storage System

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<tr>
<th>Power (MW)</th>
<th>Annual Savings ($)</th>
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<td>1</td>
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<td>$296,104</td>
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<td>$394,806</td>
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Impact of Energy Storage Capacity on Transmission Savings

Increased energy storage capacity increases the likelihood of hitting monthly peaks.
Reduction in Capacity Obligation to ISO-NE

- Each load serving entity is responsible for a fraction of the Forward Capacity Market obligations
- Based on one annual peak hour
- Rates due to triple in three years
- Increasing capacity does not increase revenue, just increases the odds of “hitting the hour”

### Capacity Clearing Price, ISO-NE

<table>
<thead>
<tr>
<th>Year</th>
<th>Price ($/kW-Month)</th>
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<th>2 MW</th>
<th>3 MW</th>
<th>4 MW</th>
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Impact of Storage Capacity on Capacity Savings

Increased energy storage capacity of limited benefit, due to distribution of annual peaks

Percentage of Annual Peaks as a Function of Capacity
Historical Data (2000-2015)

Distribution of ISO-NE Annual Peak Hours, 2000-2015
Grid Resilience

• Municipality has identified 10kW as the critical load at community critical emergency facilities
• Resilience is not monetizable but is valued highly by the community and the state
Summary of Monetizable Benefits

• Total potential revenue, 1MW, 1MWh system

<table>
<thead>
<tr>
<th>Description</th>
<th>Total</th>
<th>Percent</th>
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<tr>
<td>Arbitrage</td>
<td>$40,738</td>
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<td>RNS payment</td>
<td>$98,707</td>
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<td>FCM obligation*</td>
<td>$115,572</td>
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<tr>
<td><strong>Total</strong></td>
<td>$255,017</td>
<td>100%</td>
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• For a capital cost of ~1.7M, the simple payback is 6.67 years

*2017-2018 data. Rates will be higher in 2018-2019, resulting in additional savings.
Take-Aways

• Energy storage is installed and operational in many states
  • Utility scale
  • Behind the meter

• Energy storage can provide many valuable benefits
  • Demand charge management
  • Demand response
  • Frequency regulation
  • Renewables integration
  • Resilience
  • T&D investment displacement/deferral

• It is possible to provide resilience to critical facilities AND generate revenues/cost savings, so that storage systems will pay for themselves

• Energy storage can compete today in open markets under pay-for-performance conditions

• As prices continue to fall, energy storage will find new markets and applications
ESTAP

Project Director: Todd Olinsky-Paul
Contact: Todd Olinsky-Paul, Todd@cleangen.org

The Energy Storage Technology Advancement Partnership (ESTAP) is a federal-state funding and information sharing project, managed by CESA, that aims to accelerate the deployment of electrical energy storage technologies in the U.S.

The project’s objective is to accelerate the pace of deployment of energy storage technologies in the United States through the creation of technical assistance and co-funding partnerships between states and the U.S. Department of Energy.

ESTAP conducts two key activities:

1) Disseminate information to stakeholders through:
   - The ESTAP listserv (>2,000 members)
   - Webinars, conferences, information updates
Thank You

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Project Director
CEG/CESA
Todd@cleanegroup.org
ESTAP Website: http://bit.ly/CESA-ESTAP