Smart Grid Energy Storage Demonstrations Overview

Ron Staubly – National Energy Technology Laboratory

DOE Smart Grid Demonstration Program
The Program At a Glance

### AREA OF INTEREST 2.1 - Battery Storage for Utility Load Shifting

<table>
<thead>
<tr>
<th>Recipient</th>
<th>Demo/Pilot Test Location</th>
<th>Storage Capacity</th>
<th>Storage Technology Provider</th>
<th>Storage Technology</th>
<th>Utility</th>
<th>Federal Funding</th>
<th>Total Project Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern California Edison</td>
<td>Kern County, CA</td>
<td>8MW</td>
<td>A123</td>
<td>Lithium-ion</td>
<td>Southern California Edison</td>
<td>$24.9M</td>
<td>$54.8M</td>
</tr>
<tr>
<td>Primus Power</td>
<td>Modesto, CA</td>
<td>25MW</td>
<td>Primus Power</td>
<td>Zinc-Halogen</td>
<td>Modesto Irrigation District</td>
<td>$14.0M</td>
<td>$46.7M</td>
</tr>
<tr>
<td>Duke Energy</td>
<td>Notrees Windfarm, TX</td>
<td>24MW</td>
<td>TBD</td>
<td>TBD</td>
<td>Duke Energy</td>
<td>$21.8M</td>
<td>$43.6M</td>
</tr>
<tr>
<td>Hazle Spindle, LLC</td>
<td>Hazle Township, PA</td>
<td>20MW</td>
<td>Beacon Power</td>
<td>Flywheel</td>
<td>PJM/PPL</td>
<td>$24.0M</td>
<td>$48.1M</td>
</tr>
<tr>
<td>East Penn Manufacturing Co.</td>
<td>Lyon Station, PA</td>
<td>3MW</td>
<td>East Penn/Ecoult</td>
<td>advanced lead-acid / ultracapacitor</td>
<td>PJM/PPL</td>
<td>$2.5M</td>
<td>$5.0M</td>
</tr>
<tr>
<td>Public Service of New Mexico</td>
<td>Albuquerque, NM</td>
<td>2.8MWh</td>
<td>East Penn/Ecoult</td>
<td>advanced lead-acid / ultracapacitor</td>
<td>Public Service of New Mexico</td>
<td>$2.5M</td>
<td>$6.3M</td>
</tr>
<tr>
<td>The Detroit Edison Company</td>
<td>MI</td>
<td>1.5MW</td>
<td>Dow KoKam</td>
<td>Lithium-ion</td>
<td>Detroit Edison</td>
<td>$4.9M</td>
<td>$10.8M</td>
</tr>
<tr>
<td>City of Painesville</td>
<td>Painesville, OH</td>
<td>1MW</td>
<td>Ashlawn Energy</td>
<td>Vanadium redox</td>
<td>Painesville Municipal Power</td>
<td>$4.2M</td>
<td>$9.6M</td>
</tr>
<tr>
<td>Premium Power Corporation</td>
<td>Sacramento, CA, Everett, MA Wochester, MA</td>
<td>2.5MW</td>
<td>Premium Power</td>
<td>Zinc-Bromide</td>
<td>Sacramento Municipal Utility District &amp; National Grid</td>
<td>$6.0M</td>
<td>$12.5M</td>
</tr>
</tbody>
</table>

### AREA OF INTEREST 2.2 - Frequency Regulation Ancillary Services

<table>
<thead>
<tr>
<th>Recipient</th>
<th>Demo/Pilot Test Location</th>
<th>Storage Capacity</th>
<th>Storage Technology Provider</th>
<th>Storage Technology</th>
<th>Utility</th>
<th>Federal Funding</th>
<th>Total Project Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York State Electric &amp; Gas</td>
<td>Reading, NY</td>
<td>150MW</td>
<td>TBD</td>
<td>CAES</td>
<td>NYSEG</td>
<td>$29.5M</td>
<td>$125.0M</td>
</tr>
<tr>
<td>Pacific Gas &amp; Electric</td>
<td>TBD, CA</td>
<td>300MW</td>
<td>TBD</td>
<td>CAES</td>
<td>PG&amp;E</td>
<td>$25.0M</td>
<td>$355.9M</td>
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</tbody>
</table>

### AREA OF INTEREST 2.3 - Distributed Energy Storage for Grid Support

### AREA OF INTEREST 2.4 - Compressed Air Energy Storage (CAES)

### AREA OF INTEREST 2.5 - Demonstration of Promising Energy Storage Technologies
## Breakdown by Storage Technology

<table>
<thead>
<tr>
<th>Lithium Ion Batteries</th>
<th>Flow Batteries</th>
<th>Advanced LABs</th>
<th>Other</th>
<th>CAES</th>
<th>Flywheels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detroit Edison (Kokam)</td>
<td>Ktech (Enervault)</td>
<td>East Penn</td>
<td>Aquion (Sodium-Ion)</td>
<td>NYSEG</td>
<td>Amber Kinetics</td>
</tr>
<tr>
<td>So Cal Edison/A123</td>
<td>Painesville (Ashlawn)</td>
<td>Public Service of NM (East Penn/Ecoult)</td>
<td>PG&amp;E</td>
<td>Beacon Power</td>
<td></td>
</tr>
<tr>
<td>Seeo</td>
<td>Premium Power</td>
<td>Duke (Xtreme*)</td>
<td></td>
<td>SustainX</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Primus Power</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DOE Smart Grid Demonstration Program**
## Breakdown by Primary Storage Application to be Demonstrated

<table>
<thead>
<tr>
<th>Capacity/Arbitrage</th>
<th>Renewable Firming/Shifting</th>
<th>Grid Support/Distributed Storage</th>
<th>Frequency Regulation</th>
<th>NA/TBD</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYSEG</td>
<td>Duke</td>
<td>Detroit Edison</td>
<td>Amber Kinetics</td>
<td>Aquion</td>
</tr>
<tr>
<td>PG&amp;E</td>
<td>Ktech</td>
<td>Painesville</td>
<td>Beacon Power</td>
<td>Seeo</td>
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<td>Public Service of NM</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>So Cal Edison</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

DOE Smart Grid Demonstration Program
Duke Energy Business Systems
Notrees Wind Storage Demonstration Project

DOE Smart Grid Demonstration Program
Wind Firming EnergyFarm™
Primus Power

2012: EnergyCell
- 20 kW
- 80 kWh

2013: EnergyPod™
- 250 kW
- 1,000 kWh

2014: shipments start

MegaWatt Deployments

DOE Smart Grid Demonstration Program
Tehachapi Wind Energy Storage Project

8 MW x 4 Hr Battery Energy Storage System (BESS)

DOE Smart Grid Demonstration Program
Hazle Spindle - 20 MW Flywheel Plant

DOE Smart Grid Demonstration Program
Ancillary Services Using the UltraBattery Technology

Project in operations as of July 25, 2012

Providing up to 3MW of Ancillary Services to PJM

Data collection, monitoring and evaluation for next 30 months

DOE Smart Grid Demonstration Program
Detroit Edison’s Advanced Implementation of Community Energy Storage Systems for Grid Support
Painesville Municipal Electric Power Vanadium Redox Battery Demonstration Project

DOE Smart Grid Demonstration Program
Public Service Co. of New Mexico
Prosperity Energy Storage Project

DOE Smart Grid Demonstration Program

Firmed PV – 2 to 6pm
Firmed PV – 2 to 6pm with Simultaneous Smoothing

Red=Primary Meter   Blue=PV Meter   Yellow = Battery Meter
New York State Electric and Gas (NYSEG)
Seneca Compressed Air Energy Storage Project

Off Peak Electricity In

On Peak Electricity Out
Low & High Pressure Expanders
Fuel
Heat Exhaust

Motor/Compressors
Motor/Generator
Turbines
Recuperator

Air In/Out

338 MMcf Limestone Cavern

CUSTOMIZED ENERGY SOLUTIONS

DOE Smart Grid Demonstration Program
Compressed Air Energy Storage (CAES) In California

DOE Smart Grid Demonstration Program
Flywheel Energy Storage Demonstration

amber_kinetics

DOE Smart Grid Demonstration Program
Demonstration of Sodium Ion Battery for Grid Level Application

Supporters

AQUION ENERGY

KPCB

Foundation CAPITAL

ATV

DoE high voltage demonstration at Aquion

DOE Smart Grid Demonstration Program
Solid-State Batteries for Grid-Scale Energy Storage – Seeo, Inc.

DOE Smart Grid Demonstration Program
DOE Smart Grid Demonstration Program

MW-Scale Isothermal CAES System
For Further Information

• Visit SmartGrid.Gov for more information on the SGDP energy storage demonstration projects
  ▪ Build Metrics for installed equipment are posted as they are deployed
  ▪ Technology Performance Reports (TPRs) will be published on the site as they become available. NYSEG and PNM TPRs will be posted soon.

• Other information is available on the ARRA FederalReporting.Gov website