Developing Value Propositions: U.S. Dept. of Energy Storage Projects

IMRE GYUK, PROGRAM MANAGER ENERGY STORAGE RESEARCH, DOE

Storage Economics:

The **Cost** of a Storage System depends on the Storage Device, the Power Electronics, and the Balance of Plant

The Value of a Storage System depends on Multiple Benefit Streams, both monetized and unmonetized



LCOE depends on Application! Policy is important!

A Portfolio of Technologies:

Pumped Hydro Compressed Air (CAES) Aquifer CAES Advanced Isothermal Batteries NaS **Flow batteries** ZnBr Vanadium Redox Lead Acid Lead carbon Aqueous hybrid ion Lithium Ion

Flywheels – Energy – Power Electrochemical Capacitors



Power Short Duration Market Conditioning, Developing Business Cases



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

These projects showed that Frequency Regulation using Energy Storage has twice the Value than using Fossil Fuel Plants with equal nameplate power.



ARRA Project – Beacon Hazleton, PA. 20MW Frequency Regulation for PJM. Commissioning of full 20MW Aug. 2014 2013: FERC's Order 755 Mandated "Pay for Performance"

Frequency Regulation using Energy Storage is now a Commercially viable Business in FERC compliant Regions!

ARRA - Southern California Edison / LG Chem – Li-Ion:8 MW / 4 hr battery plant for wind integration at Tehachapi, CA.



Tehachapi: 4,500MW Wind by 2015!



Commissioned: Sept. 2014 Integrator: ABB

8MW / 32MWh Storage Plant

Energy Storage Systems for Peakshaving, Loadshifting, Ramping



October 2013: California PUC sets target of 1.3GW of Storage by 2020

Working with the States (CESA is a big Help!)

Energy Storage for Resilience

Every \$1 on protection measurements Can prevent \$4 in repairs after a storm!







Trends indicate the situation will get worse not better!!

Vermont Public Service Dept. – DOE - Green Mountain Power

Resilient microgrid in Rutland, VT 4MW / 3.4MWh of storage Integrated with 2MW PV Integrator: Dynapower

Groundbreaking: Aug. 12, 2014 Commissioning: Sep. 15, 2015





Storage: Reduces demand charges by high load peak shaving PV: Green power for the grid. Situated on Brown Field area.

System can be islanded to provide emergency power for a resilient microgrid serving a highschool / emergency center.

Referenced as model in VT Energy Strategic Plan. New projects underway!

Washington State Clean Energy Fund:

Solicitation for \$15M for Utility Energy Storage Projects

Selected projects with UET vanadium flow battery:

- Avista (1MW / 4MWh) -- PNNL -- WA State U
- Snohomish (2MW / 8MWh) PNNL -- 1Energy -- U of WA

Under a DOE / WA MOU, PNNL will participate in both projects, providing use case assessment and performance analysis.

Vanadium technology with 1.7x Energy density developed at PNNL for DOE



Ribbon Cutting Avista, April 2015



2nd Solicitation: DOE Teaming with Avista on Transactive Microgrid

Eugene Water and Electric Board (EWEB) Grid Edge Demonstration Project – Eugene, OR

- Significant engagements with OR prior to project.
 - 03-14 Storage Workshop with OR-DOE and OR-PUC
 - 05-15 Storage Bill passed; 5MW or 1% by 2020
 - 07-15 NW PUC storage workshop organized by OE / PNNL
 - 09-15 Joint Solicitation issued with \$250,000 grant from OE/Sandia
 - 11-15 Project selected:

Eugene Water & Energy Board Microgrid

- 500kW + 125kW PV + diesel gen sets at 3 aggregated sites
- Resiliency for critical infrastructure
- Aggregation of energy storage to provide grid services (e.g.)
 - Peak shifting, AGC control, Volt-VAR control, Transmission congestion relief, Capacity / resource adequacy.
- EWEB working with Sandia and PNNL:
 - Define and monetize value of use cases
 - Evaluate design of planned microgrids.



Massachusetts Energy Storage Report Commissioned by MA-DOER and MA-EC. Recommendations:

> 600 MW of storage by 2025 would save \$800 million in system costs! And 350K tons of GHG reduction.

5 % of MA peak load! vs. 1% for OR, 2% for CA

MA DOER Resilient Power Initiative

\$40 M state solicitation - 18 muni projects funded - 11 include energy storage

Sterling MA MA-DOER: Microgrid/Storage Project

Sterling Municipal Light Department

\$1.5M Grant from Community Clean Energy Resiliency Initiative.

1MW/2hr storage to provide resiliency for Police HQ and Dispatch Center

In conjunction with existing 3.4 MW PV

DOE-OE providing funds and technical support towards expansion to 2MW/3MWh

- Backup for police station / dispatch center
- Cost savings through capacity reduction
- Revenues from demand charges and arbitrage
- Integration of intermittent PV





Northampton, MA MA-DOER: Microgrid / Storage Project

- Brings multiple assets together to improve resiliency
 - Biomass, PV, Diesel
 - Energy Storage
- Islands 3 abutting campuses during outage.
 - Northampton Dept. of Public Works
 - Smith Vocational & Agricultural High School.
 - Cooley Dickinson Hospital

Energy storage benefits:

- Demand charges
- Black start capability for biomass facility during extended outages
- Reduce diesel during an outage and improve resiliency.

With DOE support, PNNL will model microgrid operations in order to evaluate financial benefits and optimally scale all energy assets during design phase.



ARRA – Vionx: Two Grid-scale Flow Batteries in MA

500 kW / 6 hrs Worcester Project Wind Integration (600kW)



- Site preparation completed
- Devices installed
- Electrolyte filled
- Finalizing interconnection

500 kW / 6 hrs Shirley Project Solar PV Integration (1MW)



- Permits being finalized
- Containers will ship Jan. 2017
- Commissioning scheduled 17/Q1



Soon to follow:

Hawaii and Solar PV Alaska and Hydro

The Big Picture

Energy Storage Procurement, Guidance Document for Municipalities

This document was a response to requests from Massachusetts municipalities engaged in energy storage procurements, for assistance in drafting RFPs for equipment and services. It is now available for use by any entity procuring storage.

- Developed by Sandia National Laboratories
- Funded by DOE-OE
- Produced in partnership with CESA
- Contains two sample RFPs developed with Sterling, MA, plus a matrix of elements to include in an energy storage RFP

Massachusetts Energy Storage Initiative Study commissioned by MA-DOER and MA-CEC Recommends: 600 MW of storage by 2025, which would save \$800 million in system costs! And 350K tons of GHG reduction over 10 years.





Energy Storage Procurement

Guidance Documents for Municipalities

Prepared by Sandia National Laboratories With assistance from Clean Energy States Alliance Funded by U.S. Department of Energy – Office of Electricity Delivery and Energy Reliability

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Energy Storage – Equitable Regulatory Environment

Reducing institutional and regulatory hurdles for energy storage to provide an environment where the opportunities for deployment and the services provided by energy storage are recognized, implemented and appropriately valued requires coordination across federal, state and municipal entities

- Hosted regional Pacific Northwest utility regulatory commission workshop on energy storage with commissioners and staff from WA, OR, ID, and MT.
- Hosted Southwest regional utility regulatory commission workshop (May 4th, 2016) with NM, UT, AZ, CO, NV PUC's. With support from NARUC,
- Provided information to WA, OR, CA, and MA commissions on valuation of energy storage assets.
- Supporting plenary dockets on energy storage initiated by the Washington UTC and the Oregon PUC.
- Supported CA-ISO in review of storage market rules.
- DOE OE-VT efforts lauded as model for federal-state engagements in VT Strategic Energy Plan.





Energy Storage Technology Advancement Partnership ESTAP

Regular Webinars

http://cesa.org/projects/energy-storage-technology-advancementpartnership/energy-storage-events/ With new Technologies Cost will go down, Safety and Reliability will increase

With every successful Project the Value Propositions will continue to increase!