

Distributed Energy Storage Projects

Vanadium Redox: City of Painsville, OH

Load leveling for 32MW coal plant; 1MW, 6-8MWh

Lithium Ion, Edison Electric, A123

Community Energy Storage; 20units @ 25kW, 50kWh

Lead/Carbon, EastPenn

Frequency regulation, Peak shifting; 3MW, 1-4MWh

Lead/Carbon, Public Service New Mexico

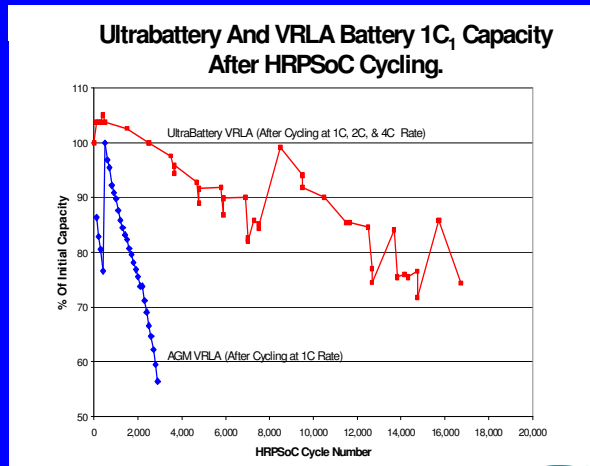
Smoothing of 500MW PV installation; 500kW, 2.5MWh

ZnBr, Premium Power

Peak shaving; 5 systems @ 500kW, 2.5MWh

ARRA - East Penn:

3MW Frequency Regulation + 1MW / 1hr Demand Management
Using new Lead-Carbon Technology



Testing at Sandia



Battery Stacks

New >200MW East Penn
Battery Manufacturing
Plant at Lyon Station, PA

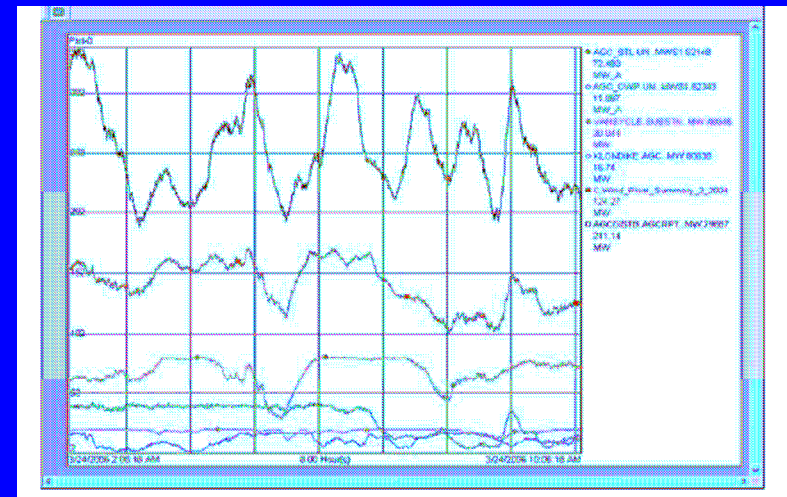
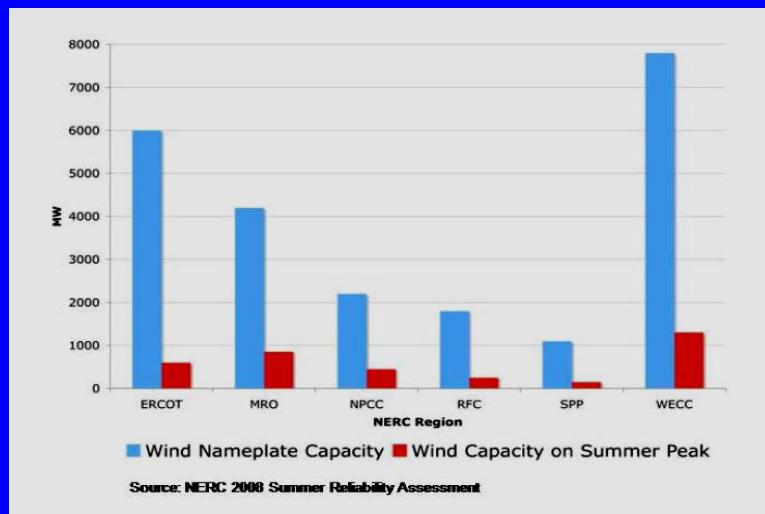


5 Distributed Projects = 9MW in Stimulus Package

RENEWABLES DISPATCH SMOOTHING, RAMPING, and PEAK SHIFTING

increasingly considered

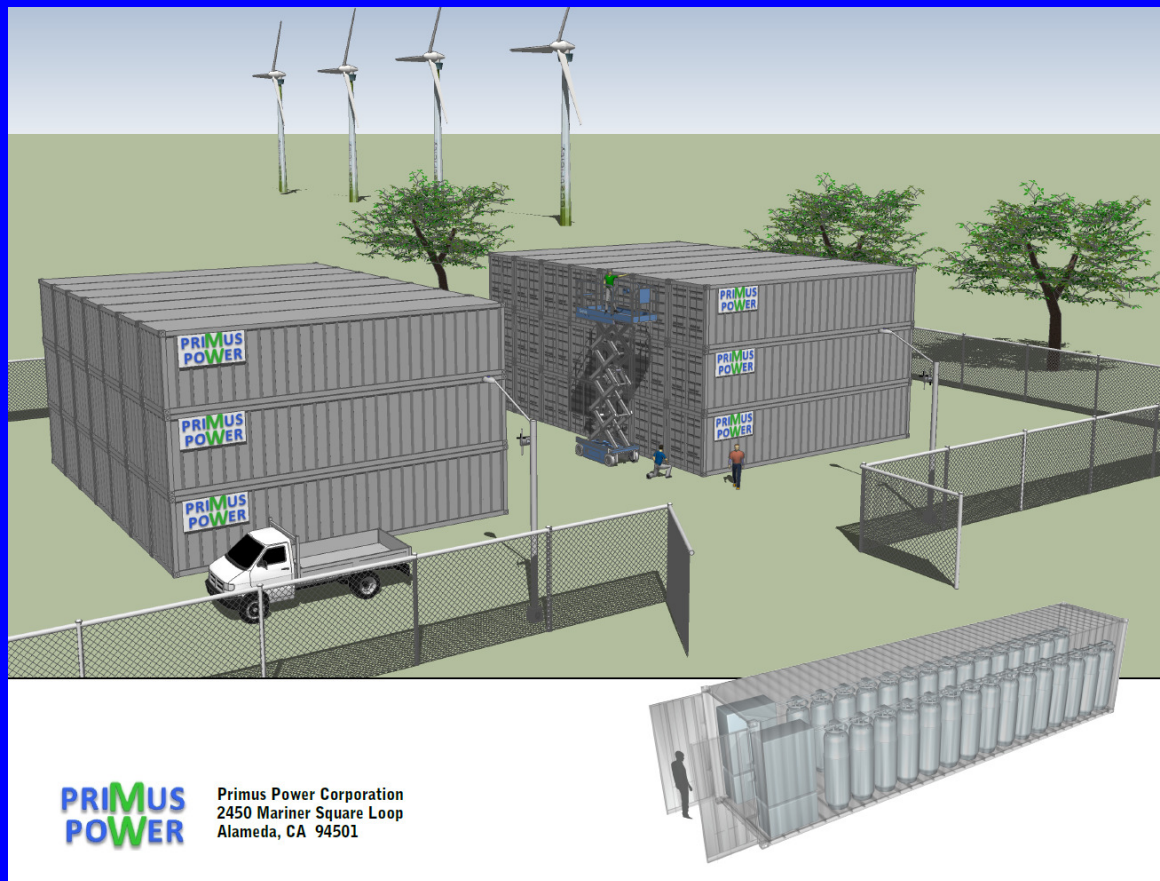
Large Batteries for Wind Integration



3 Large Battery + Wind Projects =
53MW in Stimulus Package!

ARRA- Primus Power:

25MW / 3hr battery plant for the Modesto, CA Irrigation District, firming 50MW of Wind, replacing \$75M of Gas fired Generation.



ARRA - Southern California Edison / A123 – Li-Ion:
8 MW / 4 hr battery plant for wind integration at Tehachapi, CA.



Compressed Air Energy Storage CAES

Inexpensive Off-Peak Power to Compress Air for Storage in Aquifers, Salt Domes or Caverns. On-Peak, Compressed Air is used as Input for Gas Turbine Compressor, increasing Efficiency

McIntosh, Alabama, 110 MW



Huntorf, Germany, 290 MW



ARRA - NYSEG:

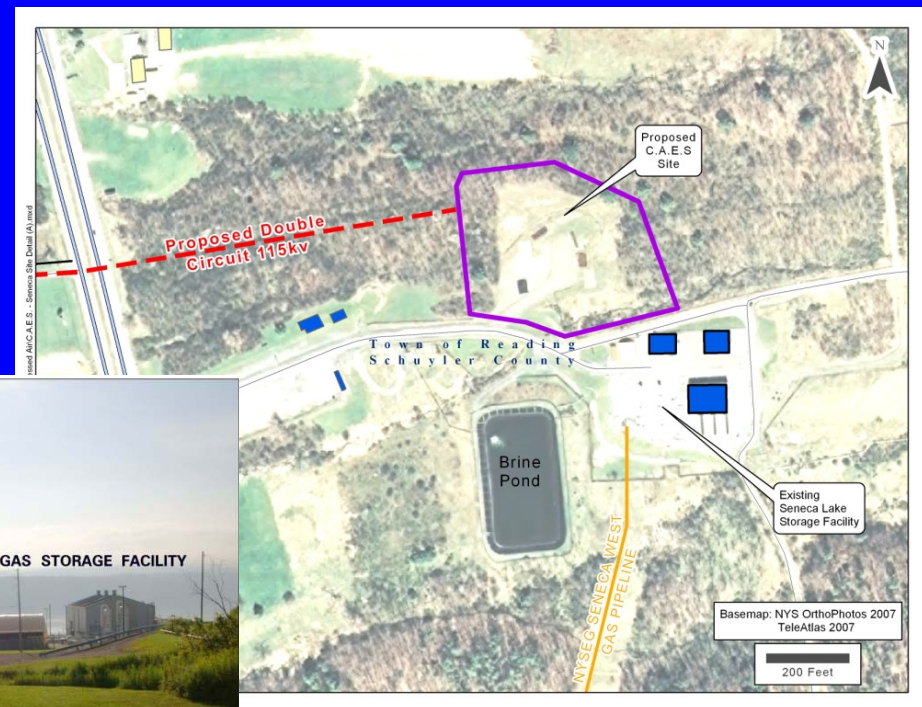
180 MW / 10hr Compressed Air Energy Storage Facility in
Watkins Glen, NY

Layered Salt formation

Gas Pipe Line

Transmission Line

Installed Wind Generation



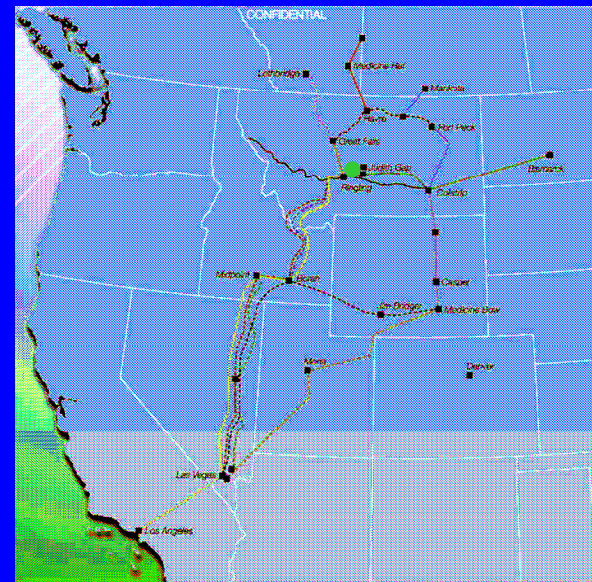
2 CAES Projects = 450MW in Stimulus Package!

Pumped Storage Hydro-Electric Power



Ameren: Taum Sauk, Missouri,
440MW re-commissioned May, 2010

US – 20 GW
EU – 32 GW
US Proposed:
15-30 GW



Grasslands Plan:
3000 MW aggregated wind
300 MW pumped hydro
→ Green Baseload Energy

Community Energy Storage



25 kW / 2 hrs
15 year life time

Backup, Platform for Solar,
Utility Dispatchable

ARRA Project puts 20 Li-Ion CES Units on Detroit Edison Grid

Widespread Adoption of EV may reduce the cost of Li-Ion Batteries
Or else, used EV Batteries could be used for Grid Applications

News Flash!

Consortium Initiated
to explore Re-use of EV Batteries for Grid
Storage Applications

DOE – OE, Storage Program

DOE – EERE, EV Program

EPA – Vehicle and Fuel Emissions Lab

ORNL – Sustainable Electricity Program

Nissan, General Motors

5 New Storage Technologies

Sodium Ion Battery: Aquion

Low cost, long life, aqueous sodium ion electrolyte

Flywheels: Amber Kinetics

Low cost bulk energy storage; 50kW, 50kWhr

Iron Chromium Redox: Enervault

PV Smoothing and peakshifting; 250kW, 1 MWhr

Low cost Li-Ion: Seeo

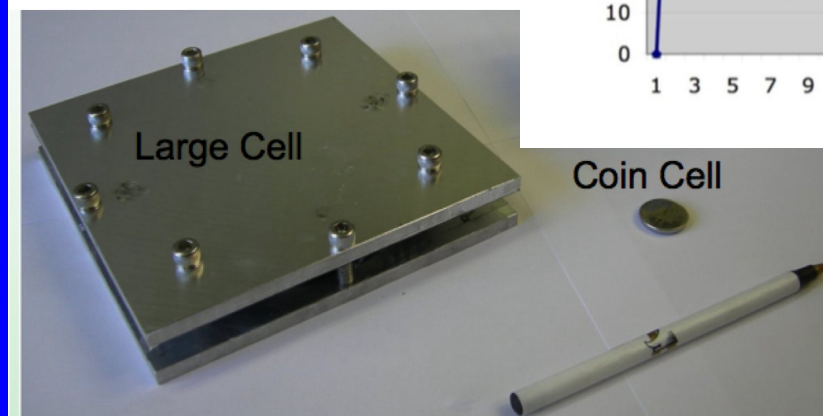
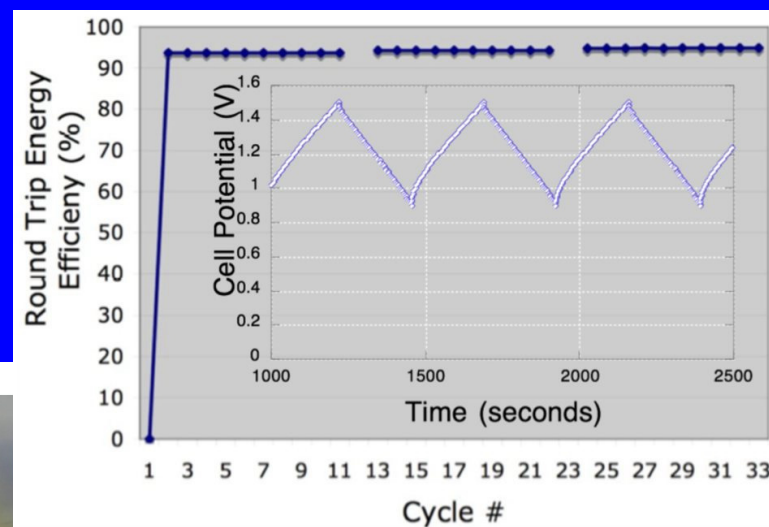
Nanostructured polymer electrolyte

Compressed Air Energy Storage

Hydraulic pump and motor; 1MW

ARRA - Aquion Energy: Aqueous Sodium Ion Battery

- Cost Goal: <\$200/kWh
- Lifetime cost: <\$0.10/kWh
- Ubiquitous, low cost precursors
- Inexpensive manufacture
- Roundtrip Efficiency >85%
- 5000 cycles demonstrated



ARRA - Enervault: 250kW/4hr Fe-Cr Flow Battery for PV

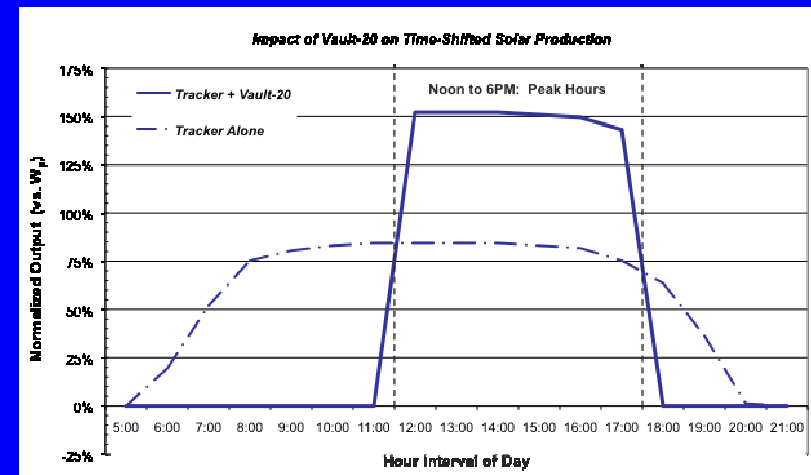
PV: 300 kW
Storage: 250 KW
Peak output: 450kW
Storage Cost: +16%
Storage Value: +84%



Tracking PV in Almond Grove



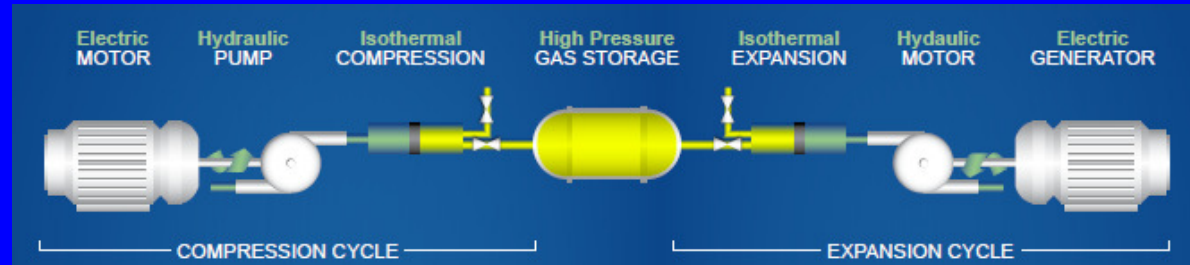
Flow Battery Prototype



Leveraging PV with Storage

ARRA - SustainX:

Development of Isothermal Compressed Air Energy Storage Using Hydraulics



Experimental isothermal efficiency of 94.9% is achieved with the use of SustainX's technology as compared with 54% for an adiabatic technique.

Our Goal is to make

Energy Storage

Ubiquitous

on the Electric Grid!!

RESOURCES:

www.sandia.gov/ess

www.electricitystorage.org

EPRI/DOE Energy Storage Handbook

DOE Program Review, Nov. 2-4, DC

