

Grid Energy Storage

DOE Perspective

IMRE GYUK, PROGRAM MANAGER
ENERGY STORAGE RESEARCH, DOE

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Li-ion: Convenient solution offered by Pacific Rim
Tied to EV, Safety issues, no recycling

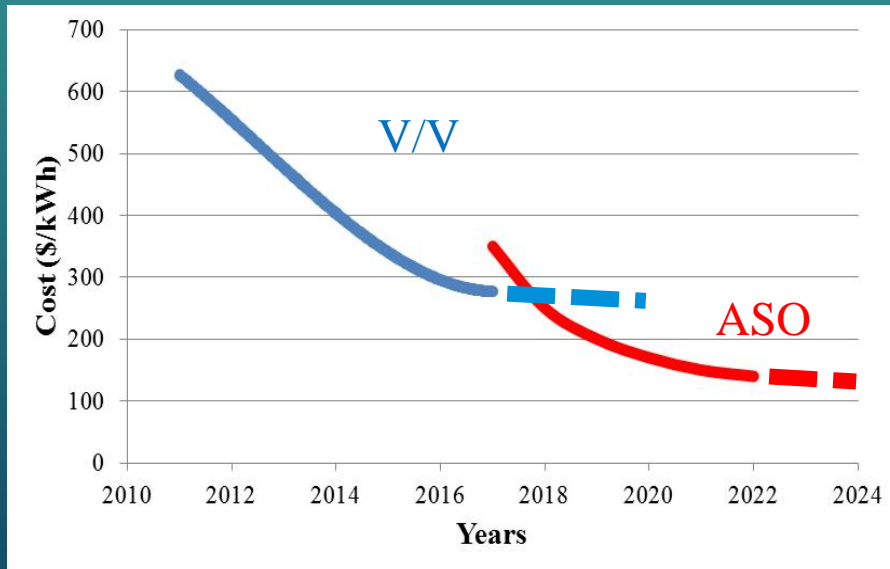
L/A, Lead Carbon: The Sleeping Giant!
Good safety record, 98% recycled

Flow batteries: True energy storage
V/V Cost reduced by $\frac{1}{2}$, 10MW/4hr deployed,
still tied to commodities market

The frontier: Na-batteries, molten metals
-> aqueous soluble organics

V / V Redox System with Mixed Acid Electrolyte

- Temperature stability + 80%
- Energy density + 70%
- Projected system **cost** of \$300kWh for 4 hour system
- 5 Licenses



Following consistent Performance Enhancement, and Reduction in System Costs, Redox Material and Membrane Costs now predominate.

New Technology:
Aqueous Soluble Organics



Frequency regulation business case established
Courtesy 20MW Beacon plant and FERC

California 1.3 GW Mandate – the Duck curve
Lots of activity, effectiveness ?

Solar PV industry becoming increasingly friendly

Storage as peaker? Yes please!!!

Behind the meter market active but effectiveness ?

Resilient micro-grids, military bases being explored

Smaller states becoming involved

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.



-> HI

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



->OR

Ribbon Cutting
Avista, April 2015

