Energy Storage:
Peer Review 2014, Sep. 17-19

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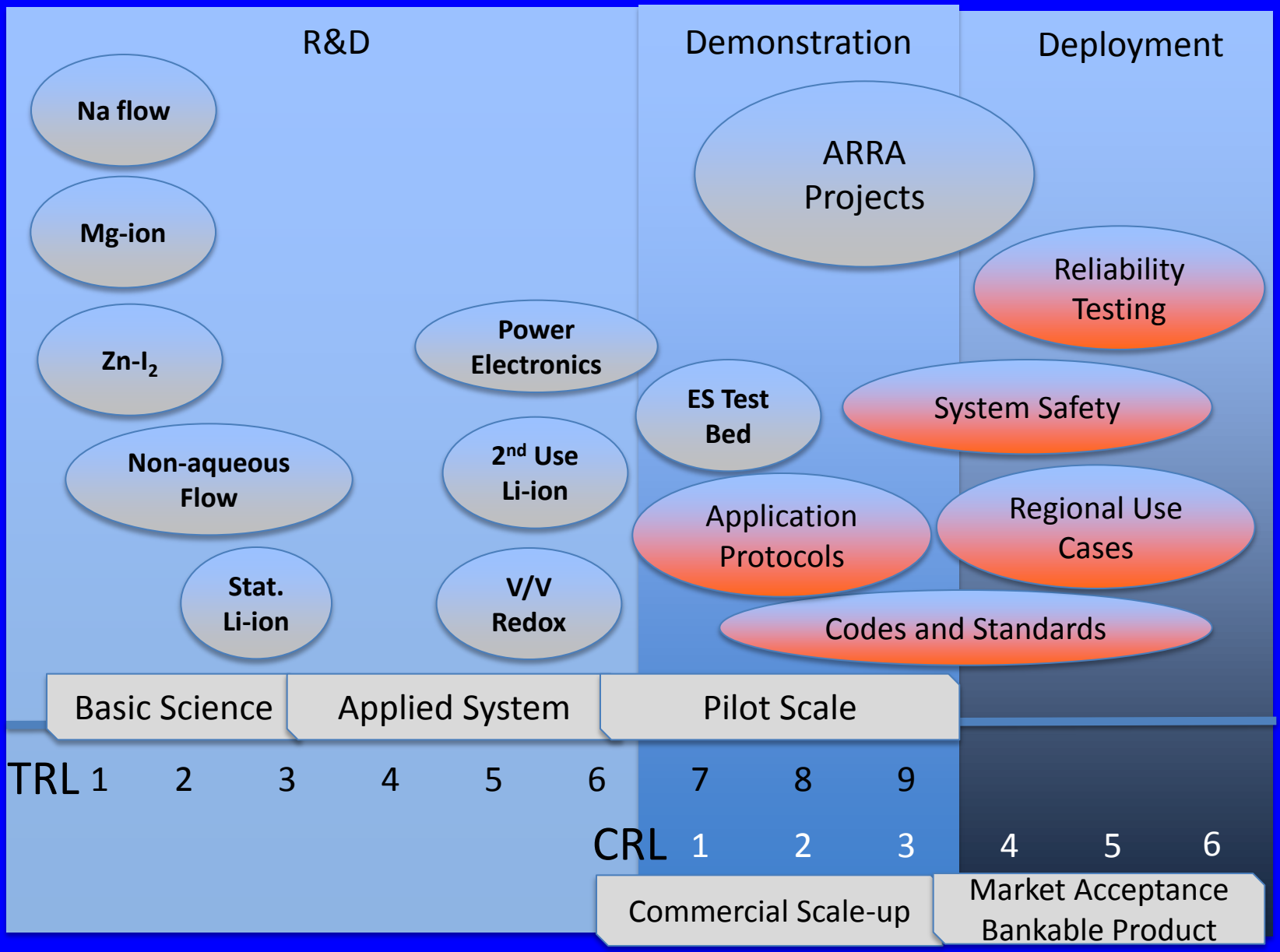
DOE-OE Project Mapping



Technology Development Activities

Stakeholder Acceptance Efforts

Emerging Storage Technologies, (PNNL, SNL, ORNL)

Non-Aqueous Flow Batteries (e.g. ferrocene, alkylamines)

- Higher operating voltage than aqueous (no H_2O electrolysis) enables higher energy density flow systems
- Low electrolyte conductivity diminishes power capability

Na-ion

- Both aqueous and organic (Li-ion analog) electrolytes offer potential for lower cost materials systems.
- Limited by suitable high capacity, low degradation anode materials.

Mg-Ion

- Divalent ion increases theoretical energy density; Mg metal anode with low potential for dendrite formation.
- Low capacity cathode materials and electrolyte/cathode materials.

Li-S

- High energy density (2X Li-ion)
- Safety and long term operation of Li metal anode, long term stability of cathode.

Solid State Li-ion

- Replacement of flammable Li-ion electrolyte improves safety.
- Poor electrolyte conductivity limits power, additional manufacturing step for electrolyte.

DOE-ARRA Storage Installations:

2011, NM: 500kW, 2.5MWh with PV

2013, TX: 36MW with Wind

2014, CA: 250kW for Peak Shaving

2014, PA: 20MW for Frequ. Reg.

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!

Construction of Facility and
Commissioned: Sept. 2014
Integrator: ABB

8MW / 32MWh Storage Plant

States are beginning to provide Incentives for Storage

California: 1.3GW Mandate
Hawaii: 200MW Storage Solicitation
New York: 2100$/kW at Peak

The DOE State Initiative for Storage will partner with the States to develop effective local Projects for Grid Energy Storage

Vermont Public Service Dept. – DOE
Green Mountain Power

Solicitation issued by VPS. Joint funding by VPS, DOE-OE, GMP

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

Groundbreaking: Aug. 12, 2014

Situated on Brown Field Area

Ancillary grid services, peak shaving during high load periods

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

Washington State Clean Energy Fund:

Solicitation for $15M for Utility Energy Storage Projects

Selected Projects with UET V/V technology:

- Snohomish PUD (2MW / 6.4MWh) – PNNL -- U of WA
- Avista (1MW / 3.2MWh) – PNNL -- 1 Energy -- WA State

UET V/V technology was developed at PNNL with DOE-OE funding

PNNL will participate in these Projects with benefit optimization studies.

Oregon State Initiative:

Energy Storage Workshop, March 22, 2014, Portland
Organized by DOE-OR, OR-PUC, and DOE-OE

Energy Storage Pilot Projects Request for Comments, July 2014 by DOE-OR in collaboration with DOE-OE

RFP by DOE-OR in preparation

Grid Energy Storage Safety Initiative

DOE identified *Validated Safety* as a critical need for the success of grid energy storage.

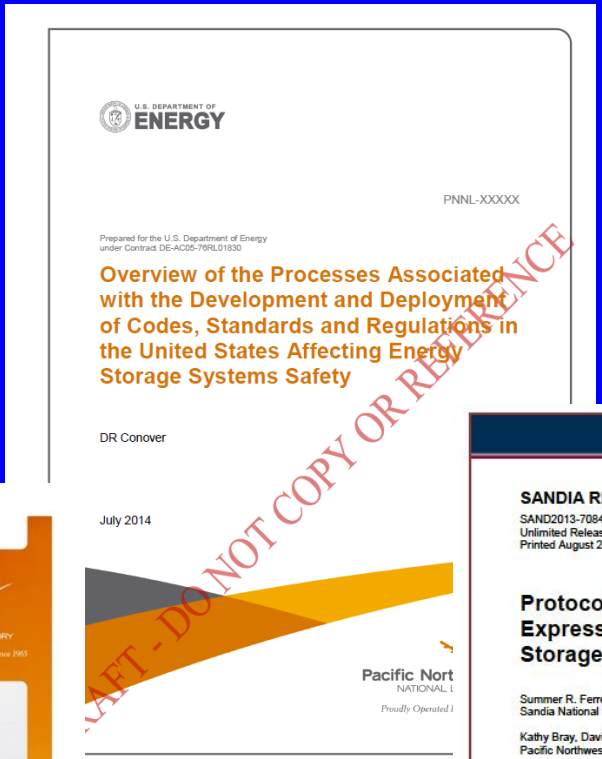
The ability to validate the safety of energy storage systems will:

- Decrease human and financial risk,
- Minimize installations costs,
- Accelerate acceptance of new storage technologies.

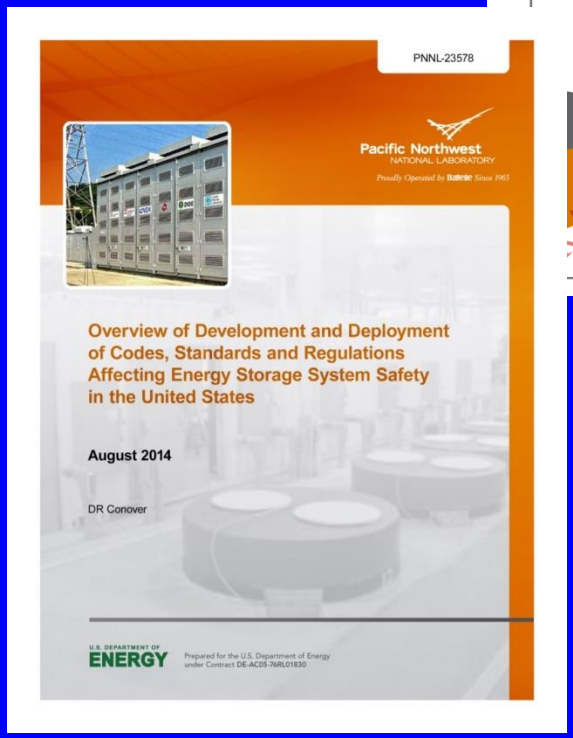
To address this need DOE is engaging key energy storage stakeholders:

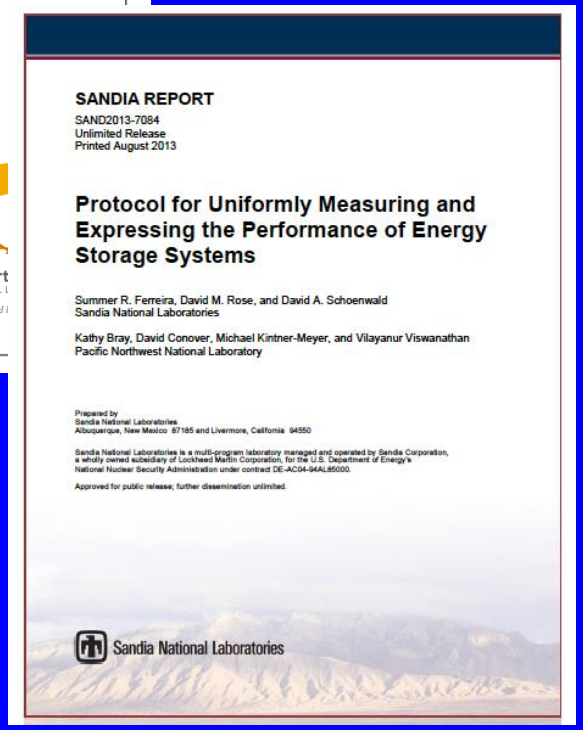
- DOE OE Energy Storage Safety Workshop, February 2014
- DOE OE Webinar on Energy Storage Safety, April 2014
- DOE OE Safety Panel – ESA annual meeting and conference, June 2014
- DOE OE *Strategic Plan on Energy Storage Safety* – Sept/Oct 2014

Safety Web site: Documents



Storage Safety 101





Storage Performance Protocol

Directory of Applicable Codes

The OE Energy Storage Program aims
at a wide Portfolio of Technologies and
a broad Spectrum of Applications.
Storage will contribute
to a safer, greener, and more resilient Grid