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DOE/Sandia National Labs Energy Storage Program

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Sandia National Laboratories

NAATBatt

Member Update

February, 2015

Sandia National Laboratories

Exceptional service in the national interest

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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Energy Storage (ES) Demonstration & Analysis

Presentation Outline

- **Project Overview**
  - Mission Statement
  - Approach
- **Current Projects**
  - Geographical Location of Projects
  - Summary Chart of Projects
- **Path Forward - Next Steps**
  - Demonstration and Analysis
  - Commissioning
  - Safety & Reliability

SNL ES Program Overview

Mission Statement:

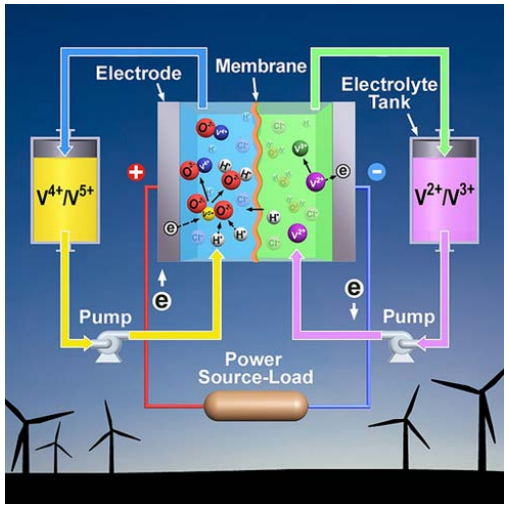
Encourage investment in Energy Storage (ES) by:

- Developing new ES technologies
- Developing new materials for ES devices
- Power electronics research and development
- Evaluation, analysis, and optimization of ESSS
- Conducting field demonstrations of new and existing technologies in various applications
- Commissioning support and operational evaluation
- Developing codes, standards and regulation
- Outreach

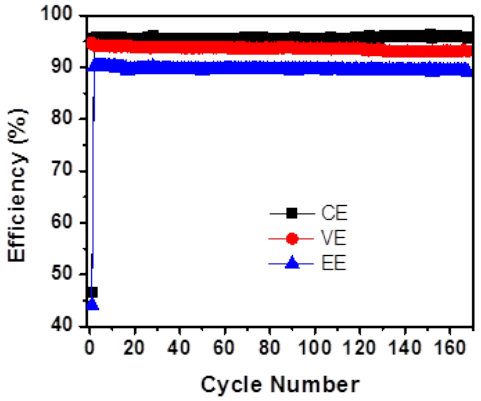
Advanced Membranes for VRFB

- VRFB are being explored by DOE and industry for large scale energy storage
- Several companies looking to commercialize the technology

UniEnergy Technologies WattJoule IMERGY POWER SYSTEMS



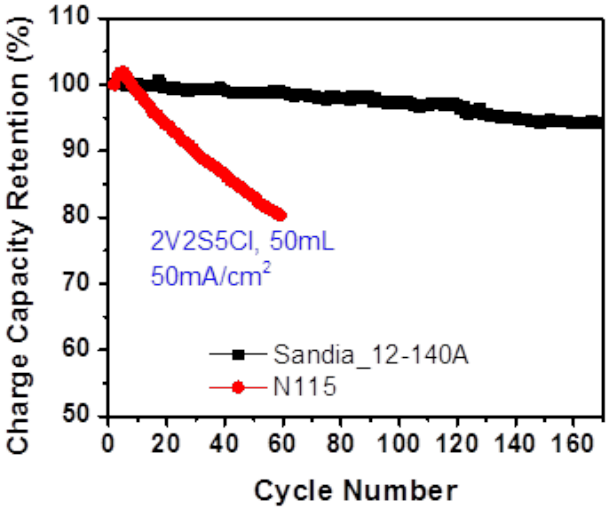
- Sandia is developing a low cost membrane separator that has been shown to have high efficiencies and able to maintain high charge capacity over 160 cycles (4 months of testing) while Nafion loses 80% of capacity after 60 cycles



Columbic efficiency 95%

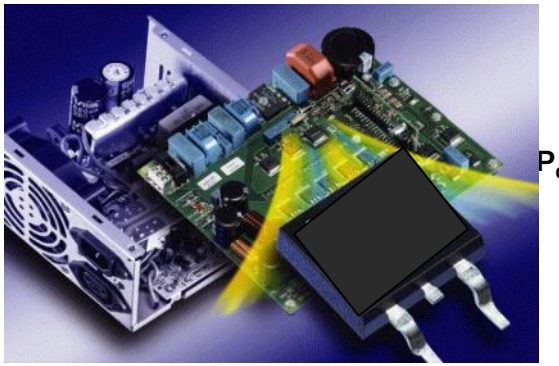
Voltage efficiency 94%

Energy efficiency 90%



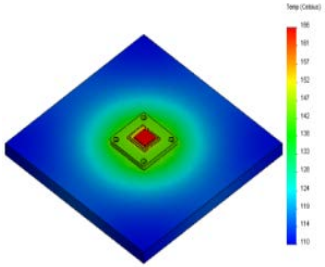
Energy Storage Power Electronics Program, SNL

Using wide bandgap semiconductor devices, advanced topologies, and controls to reduce installed cost and footprint, improve control capability, and increase reliability



Arkansas Power Electronics International 15kV Discrete SiC Package

P_{dis} = 200 W, Max Temperature = 166 ˚ C



Recognition

- Four R&D100 Awards
- Three U.S. Patents, three pending
- Over 40 technical publications
- Stan Atcitty received Presidential Early Career Award for Scientists and Engineers
- Power Electronics for Renewable & Distributed Energy Systems book

FY15 Accomplishments

- Developed World's first high voltage (15kV at 100 amps, 200C) SiC multichip module
- Developed world's first normally-off 6.5 kV SiC Junction Field Effect Transistor (JFET) high voltage module
- Developed route for direct fabrication of advanced transformer cores for > 20 kHz high frequency converters

FY15-16 Plans

- Transition the SiC high voltage module into a manufactured product and commercialize
- Demonstrate continuous operation of the 6.5kV JFET module at 20 kHz, 60A, 200C for next generation ESS
- Optimize synthesis and fabrication of advanced transformer cores to maximize performance of high frequency DC-link converters

The Energy Storage Systems Analysis Laboratory (ESSAL)

U.S. DEPARTMENT OF ENERGY

Sandia National Laboratories

Providing reliable, independent, third party analysis and verification of advanced energy technologies for cell to MW systems

Cells and Modules

72V 1000A Bitrode (2 Channels)

Cell, Battery and Module Analysis

- **14 channels from 36 V, 25 A to 72 V, 1000 A for battery to module performance analysis**
- **Over 125 channels; 0 V to 10 V, 3 A to 100+ A for cell performance analysis**
- **Potentiostat/galvanostats for spectral impedance**
- **Multimeters, shunts and power supply for high precision testing**
- **Temperature chambers**

Fully Integrated Systems

Lab Analysis

Energy Storage Test Pad (ESTP)

- **Scalable from 5 KW to 1 MW, 480 VAC, 3 phase**
- **1 MW/1 MVAR load bank for either parallel microgrid, or series UPS operations**
- **Subcycle metering in feeder breakers for system identification and transient analysis**
- **Thermal imaging**
- **System Safety Analysis (new)**

Field Analysis (new)

Remote Data Acquisition System (RDAS)

- **Portable, Modular, Remotely Reconfigurable, and outdoor-ready**
- **Subcycle metering**
- **Tractable calibration**
- **Command Signal Ready for Grid Operator Simulation**
- **No control over grid conditions**

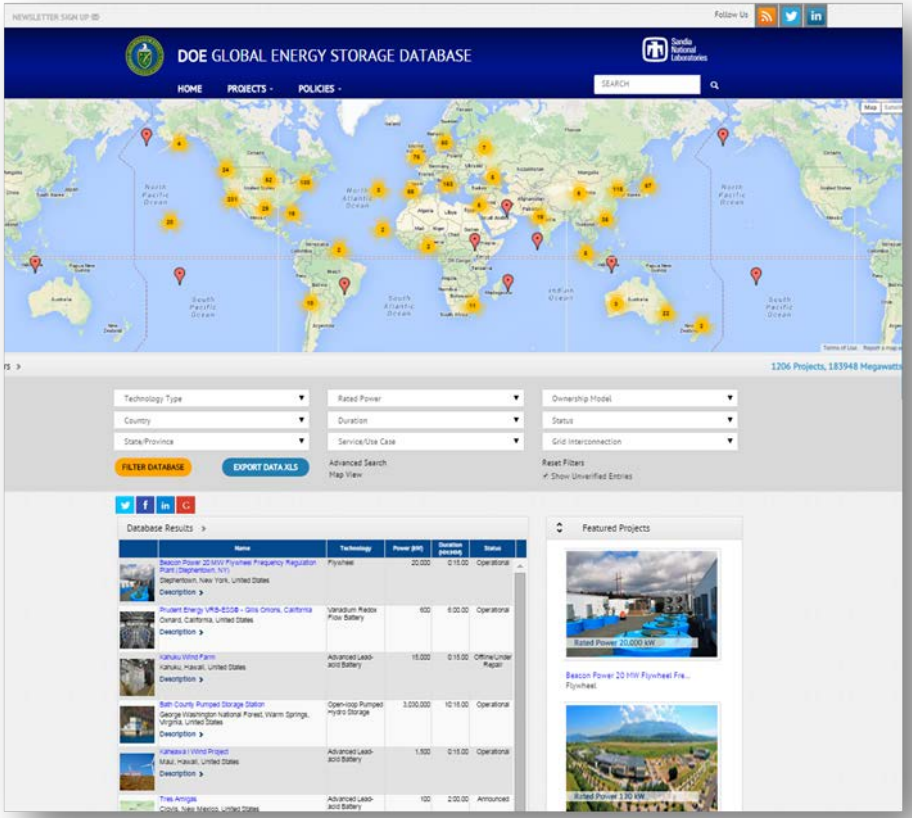
ES Demonstration & Analysis Project Overview

Approach

- Work with National and International entities including DOD, State Energy offices, Utilities, ES Industry, Universities and Consumers to:
  - Provide **third party independent analysis and evaluation** for cells and systems
  - Support **grid-tied field demonstration** projects to monitor and analyze new and existing ES technologies in differing applications
  - Support State renewable/resiliency/ES initiatives
  - Develop public information programs

DOE Global Energy Storage Database

www.energystorageexchange.org



Live Since June 2012

- 1,206 Projects
- 21 Policies
- Users in 189 countries
- 60+ data fields
- 50+ energy storage technologies
- Data Visualization

Help grow ES industry - providing data allowing analysis by a variety of users

Safety & Reliability Resource In Development:

Battery Evaluation Website

For more information, visit the website at:
www.sandia.gov/batterytesting

The 2015 Winter Call:

The call will be issued in February 2015

To receive notification when announced:
Sign up for RSS feed on the ESS Program website
http://www.sandia.gov/ess/events_news.html

The database is always open for *FAST-Track* Proposals.

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Thank You

Questions?

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Power Electronics

- Advanced Magnetics for high frequency power conversion system for energy storage - focus high density power electronic designs
- Advanced power semiconductor device development to significantly increase performance (efficiency and reliability) of PCS for energy storage
- Advanced capacitor development in increase power density of PCS for energy storage applications.
- Wide bad gap device reliability characterization and optimization.