Energy Storage Test Pad

Date 09/28/2012

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OFFICE OF ELECTRICITY DELIVERY & ENERGY RELIABILITY

The author gratefully acknowledges the support of Dr. Imre Gyuk and the Department of Energy's Office of Electricity Delivery & Energy Reliability.

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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Energy Storage Test Pad (ESTP)

- **Challenge**: Unbiased, third party evaluation is a necessary step to bring new technologies to market
  - The equipment and expertise necessary to perform testing of energy storage systems can be cost prohibitive, especially at the MW level
- **Approach**: Offer third party testing that provides a real picture of how energy storage systems operate
  - This in turn provides confidence to developers, users and adopters of energy storage
- **Goal**: Utilize infrastructure and expertise at Sandia to perform high value testing of energy storage systems
  - Generate reliable data by performing validation testing
  - Research new and advanced testing methodologies
  - Organize and participate in standards activities

Energy Storage Systems Testing

Sandia National Laboratories

ALTAIR NANO

Deka EAST PENN manufacturing co., inc.

redflow advanced energy storage

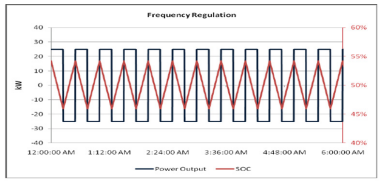
BOEING

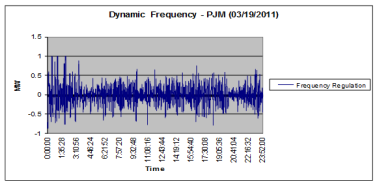
Testing Validation

Altairnano
East Penn
RedFlow DC
RedFlow AC
Boeing Flywheel

Testing Methods

Service Modeling
Stacked Profiles





Testing Standards

DOE
IEEE
IEC

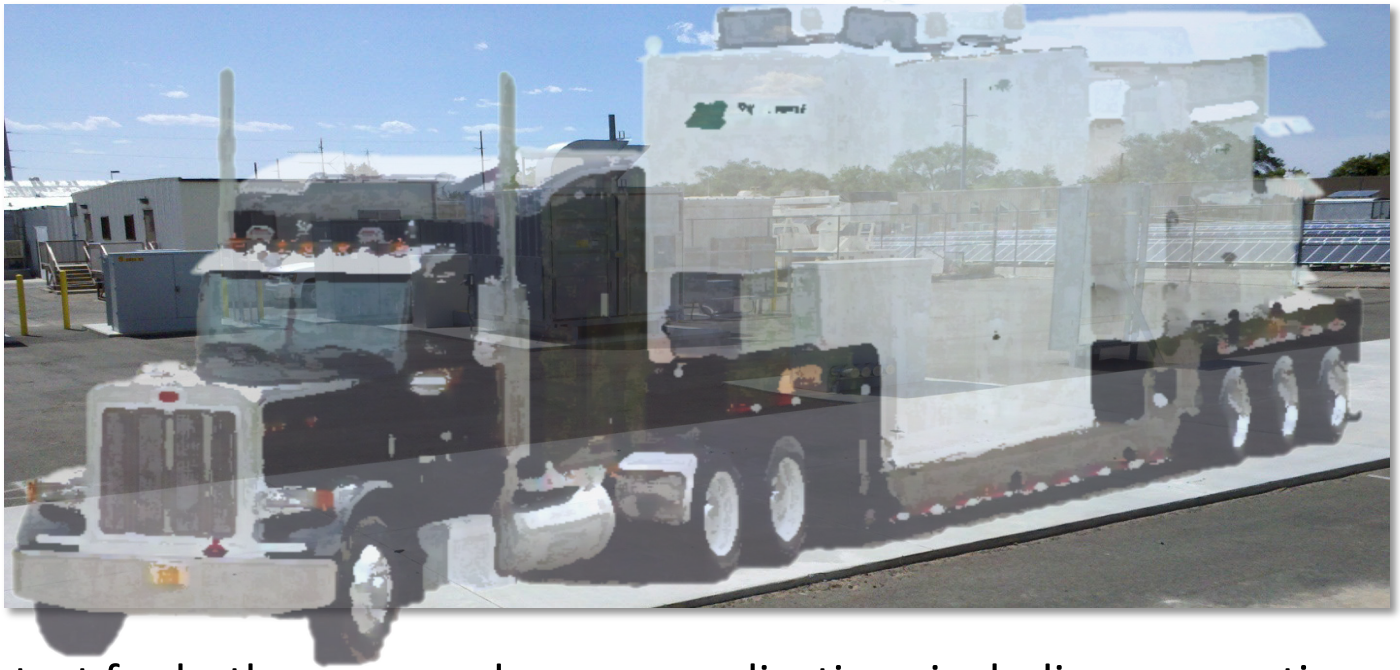
IEC

IEEE

Testing Validation (systems)

- Energy Storage Test Pad (ESTP)
  - Capabilities (MW and beyond)
- RedFlow System Development Kit (SDK)
  - DC System, preliminary report released in February
  - Temperature testing performed since then
  - Full report pending on completion of R510US testing
- RedFlow R510US
  - AC System, preliminary commissioning and cycling data
- Boeing 3kW 5kWh Flywheel with superconductive bearings
  - Low speed testing complete at Boeing

Energy Storage Test Pad (ESTP)

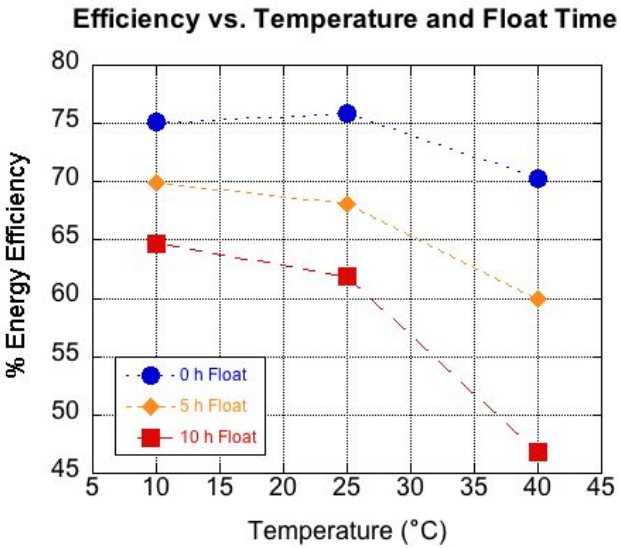


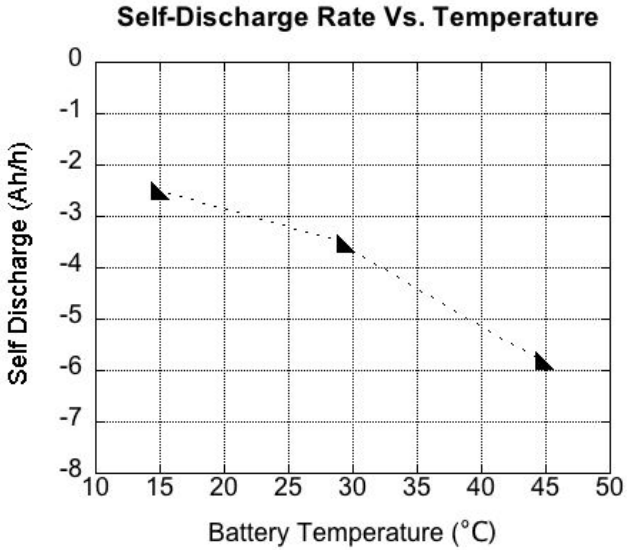
- Can test for both power and energy applications including energy time shift, capacity, load following, area regulation, voltage support, T&D deferral, demand charge management, and power quality and reliability.
- Programmatically integrated with Distributed Energy Technologies Lab (DETL)
- Test duration can range from one day to multiple months.
- Scalable from 1 KW to 1 MW, 480 VAC, 3 phase.

Testing Validation RedFlow SDK

- Released Initial Test Results Report in February
  - Covered initial characterization
- Progress:
  - Completed temperature testing
  - Will begin telecom service cycling soon

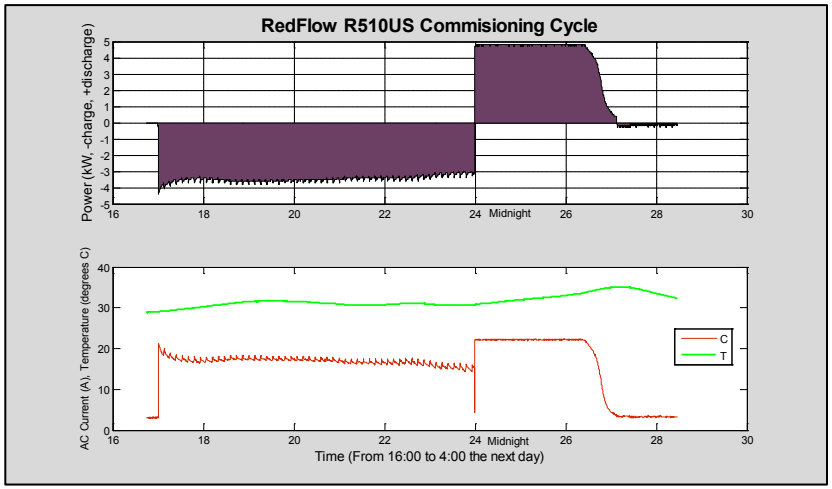
RedFlow SDK Undergoing Temperature Testing





Testing Validation RedFlow R510US

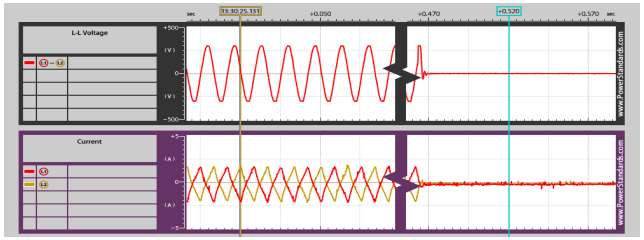
- Cycling



- Islanding data from real power outage

V (t)

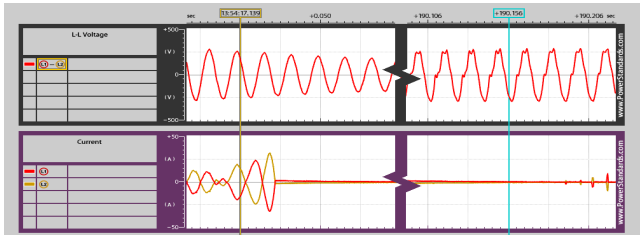
I (t)



Breaker Trip Island Test

V (t)

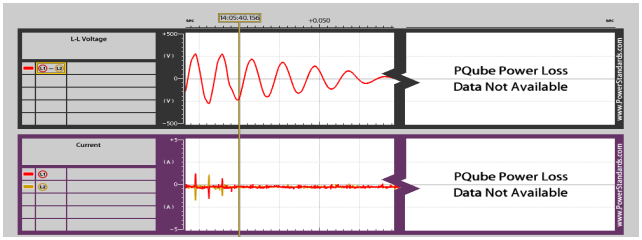
I (t)



Voltage Sag 1

V (t)

I (t)



Voltage Sag 2

Testing Validation Flywheel

Initial Test Plan

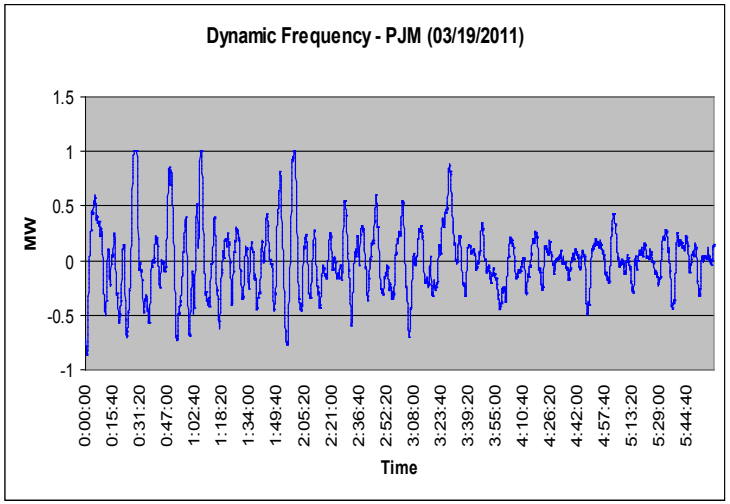
- Capacity
- Efficiency
- Self Discharge
- Response Rate

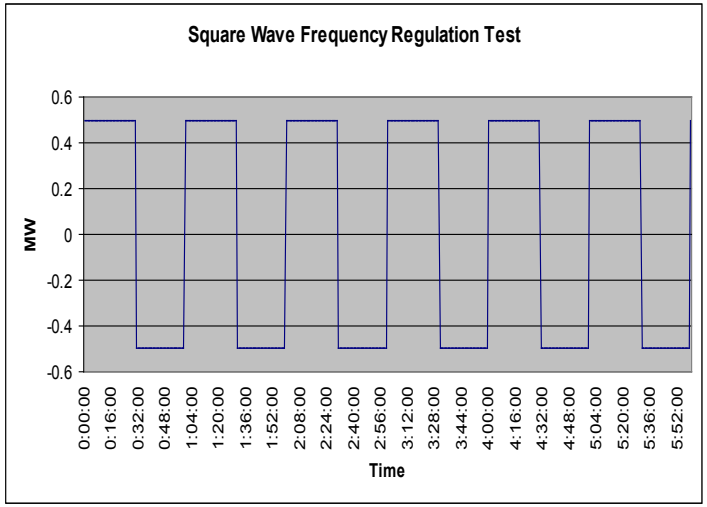
Long term plan

- Utilize as a research and development asset to test new control schemes and hardware

Testing Methods

- Application Characterization and Modeling
  - Statistical analysis of day-to-day variations in application requirements.
  - Autoregressive Modeling to Generate Statistically Representative Profiles

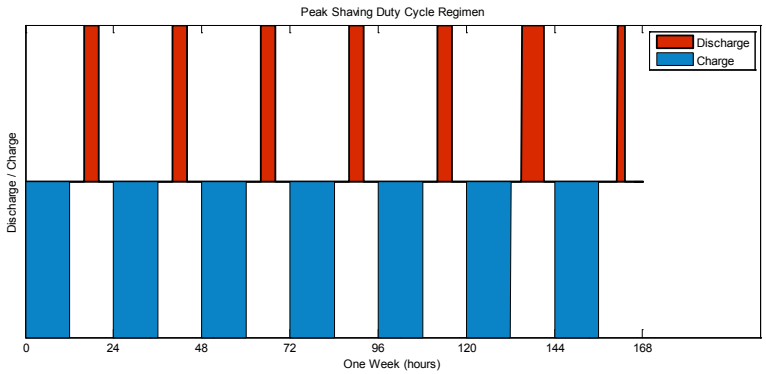


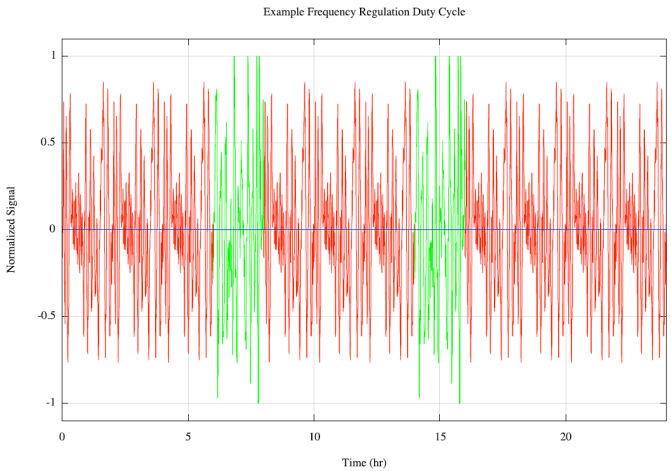


- Effect on Cell Life of Stacked Profiles
  - Frequency Regulation & Peak Shaving

Testing Standards

- DOE Performance Protocol
  - Application Specific Performance





- IEEE P2030.2 Interoperability of Energy Storage
  - Continuing Contributors

Outreach

- Released a Call for Collaboration
  - Generated interest from many industry partners including: Samsung SDI, Primus Power, Altairnano
- Energy Storage at Forward Operating Bases (Fort Devens)
  - RFI requires validation at ESTP before demonstration
- Collaboration with the Electric Power Research Institute (EPRI)
  - Demonstration project in 2013 to be validated at ESTP
- Ongoing pursuit of collaborators

Summary/Conclusions

- Validation
  - Report released in February 2012 on the initial test results of the RedFlow DC system
  - RedFlow AC system
  - Boeing System being prepared for shipment to Sandia
- Methodology
  - Frequency regulation model data has been statistically validated
  - Life cycle cell testing with stacked applications has begun at KEMA
- Standards
  - DOE Performance protocol published
  - IEEE activity is ongoing

Future Tasks

- Continue testing systems
  - RedFlow
  - Boeing
- Continue to refine our testing methodology
  - Completion and publication of stacked waveform and stochastic application testing
- Continue to contribute to energy storage standards
  - IEEE
  - IEC
- Find new collaboration opportunities for testing
  - End Users
  - Manufacturers
  - You!

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The author gratefully acknowledges the support of Dr. Imre Gyuk and the Department of Energy's Office of Electricity Delivery & Energy Reliability.