Flow Battery Testing & Demonstration Project

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The Project

• Partnership with two corporations
• 3-year program (started back in 2015)
• Focused on a variety of technologies
• Multi-application and multi-sector
• Aligned with their corporate mission and technology goals
• Provide opportunities for students, faculty and staff
• Develop IP and build capacity
• Raise the visibility of the San Antonio area
The Project – 1st Year

• Establish Partnership
• Identify technologies of interest
• Market survey
• Identify key companies
• Questionnaires and Phone Interviews
• Site visits
• Selection
• Procurement
The Project – 2nd Year

• Commissioning

• Testing
  • Performance
  • Functional

• Analysis of ISO data (ancillary services and pricing)

• Understanding technology, benefits, limitations, capacity, sizing, scheduling, integration

• Evaluation of costs and potential applications
Project Overview

**ECONOMIC MODELING**

**SIMULATION**
- Market Regulation Research
- Statistical modeling to forecast price and signal data for frequency regulation
- Revenue and Scheduling Optimization
- Return on Investment Calculations

**VALIDATION**
- Charge/Discharge time at various SOCs
- Energy Consumption and Output
- Accuracy of BMS
- Performance over charge/discharge cycles

**FLOW BATTERIES**

**TESTING**
- Response time to FR signals
- Testing profiles using historical signal data

**PERFORMANCE TESTING**

**FUNCTIONAL TESTING**
Analysis of ISO Data

- Integration of renewables
- Deployment and demonstration
- Rules and regulations
- Historical data
- Revenue potential vs grid reliability
- Understand the market and its players
- Integration with traditional resources
- Benefits at Transmission, distribution, customer levels
Energy Storage Applications

ISO/RTO SERVICES
- Frequency Regulation
- Energy Arbitrage
- Spin / Non Spin Reserve
- Voltage Support

UTILITY SERVICES
- Resource Adequacy
- Distribution Investment Deferral
- Transmission Congestion Relief
- Transmission Investment Deferral

CUSTOMER SERVICES
- Time-of-use Bill Management
- Increase PV Self Consumption
- Demand Charge Reduction
- Backup Power
Redflow ZBM2

Zinc Bromide Flow Battery
- DC Voltage Operating Range: 40-58 V (48 V nominal)
- Absolute Range: 30-72 V
- Power Rating: 0-3kW (5kW Peak, discharge)
- Net Energy Range: 0 to 10kWh
- Net Energy Eff.: 80% DC-DC Max
- Operating Temperature: 50-122 °F
- Integrated BMS
- Modular, Flexible, Scalable
Redflow ZBM2

Laboratory Setup
Performance Testing Plan

Characterization

- Static Capacity Test
- Full Cycle at variable power discharge
- Partial Cycle Test at Variable SOCs

Cycle Life and Calendar Life

- 5-day continuous cycle within 0-100% SOC
- 5-day continuous cycle with 30% SOC reserve
- Variable SOCs self-discharge test (100% and 50%)

Safety Test

- Overcharge test and high power discharge test
- Minimum charge test or trickle charge test
Redflow ZBM2 - Testing

- Constant Current
- Constant Voltage
- Constant Power
- Constant Resistance
- Auxiliary Loads during Charge and Discharge
- Full Cycle
- Partial Cycle
- 5-day Continuous Cycle
- Minimum Charge (trickle)
TEST 1: Rate Capability of Variable Charge Currents

<table>
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<th>TEST</th>
<th>Charge Rate (A)</th>
<th>Capacity (Ah)</th>
<th>Avg Current (A)</th>
<th>Avg Voltage (V)</th>
<th>Avg Power (W)</th>
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## TEST 1: Rate Capability of Variable Charge Currents

**CONSTANT POWER (1.0 kW) DISCHARGE TESTS**

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<th>Capacity (Ah)</th>
<th>Avg Current (A)</th>
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</table>

The University of Texas at San Antonio, One UTSA Circle, San Antonio, TX 78249
Cellstrom CellCube FB20

Vanadium Redox Flow Battery
- Power Rating: 20kW
- Capacity: 100 kWh
- DC Voltage Output: 48 V
- Net Energy Efficiency: Up to 80%
- Operating Temperature: -40 to 122 °F
- No degradation
- Integrated FBC, EMS and Climate Control
- Modular, Flexible, Scalable
Future Work

• Functional testing for the ZBM2
• Commissioning and testing of CellCube FB20 battery
• Economic evaluation of energy storage services
• Scheduling and sizing of the storage system
• Demonstration project
THANK YOU

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