Energy Storage Technologies & Deployment Opportunities

Richard Baxter
President, Mustang Prairie Energy
Richard Baxter
President, Mustang Prairie Energy
- Advise Investors and Developers on Energy Storage Opportunities
- 14 Years in the Energy Storage market

Current Activity
- Board of Directors, Energy Storage Association (ESA)
- Partner, Ardour Capital Investments
- Advisor, Enovation Partners

Storage Industry Development
- Chairman, ESA Membership Committee
- Conference Chairman
  - 2014 Energy Storage Association Annual Conference
  - 2013 Dufresne World Energy Storage Forum
The Energy Storage Opportunity

<table>
<thead>
<tr>
<th>Wholesale / Utility</th>
<th>Commercial/Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Utility Mandate</strong></td>
<td><strong>Commercial &amp; Industrial (US)</strong></td>
</tr>
<tr>
<td>• Mandated Storage Procurements</td>
<td>• Demand Charge &amp; Solar</td>
</tr>
<tr>
<td>• 2,000+ MW through 2020</td>
<td>• 720 MW Cumulative by 2020 (GTM)</td>
</tr>
<tr>
<td><strong>Merchant</strong></td>
<td><strong>Solar/Storage (US Commercial)</strong></td>
</tr>
<tr>
<td>• Peaker Replacement (SCE 260MW)</td>
<td>• 100MW annual by 2018 (GTM)</td>
</tr>
<tr>
<td>• 26,700 MW through 2025 (EIA)</td>
<td>• 318 MW Cumulative</td>
</tr>
<tr>
<td><strong>Utility T&amp;D</strong></td>
<td><strong>Microgrid (Global)</strong></td>
</tr>
<tr>
<td>• Substation (ex. Oncor—5,000 MW)</td>
<td>• C&amp;I, Military, Campus: Grid -&gt; Island</td>
</tr>
<tr>
<td>• Reliability / Resiliency</td>
<td>• $600M (2014) $4BN (2024,Navigant)</td>
</tr>
</tbody>
</table>

![Graph showing energy storage cost range](image)

Source: EPRI
### Energy Storage Procurement Target (MW)

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>2014</th>
<th>2016</th>
<th>2018</th>
<th>2020</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern California Edison</td>
<td>90</td>
<td>120</td>
<td>160</td>
<td>210</td>
<td>580</td>
</tr>
<tr>
<td>Pacific Gas &amp; Electric</td>
<td>90</td>
<td>120</td>
<td>160</td>
<td>210</td>
<td>580</td>
</tr>
<tr>
<td>San Diego Gas &amp; Electric</td>
<td>20</td>
<td>30</td>
<td>45</td>
<td>70</td>
<td>165</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>200</td>
<td>270</td>
<td>365</td>
<td>490</td>
<td>1,325</td>
</tr>
</tbody>
</table>

### Southern California Edison
- **2013 Local Capacity RFO**
  - 50 MW Minimum
  - Awarded 260 MW
  - San Onofre Closure
  - AES 100 MW (Li-Ion)
  - STEM (85 MW)
  - Ice Energy (25.6 MW)
  - Advanced Microgrid Solutions (50 MW)
- **2014 Procurement Target**
  - 16 MW
  - RFO – Dec 1, 2014
  - Final Selection – Sept 2015

### Pacific Gas & Electric
- **2014 Procurement Target**
  - 78 MW Total
  - RFO – Dec 1, 2014
  - Service or Utility Owned
- **Deferred**
  - 150 MW
  - Rice Solar Energy CSP
- **CAES**
  - ARRA Project
  - 300 MW - Aquifer

### San Diego Gas & Electric
- **2014 All Source RFO**
  - San Onofre Closure
  - 25 MW Storage minimum
- **2014 Procurement Target**
  - 16 MW
  - RFO – Dec 1, 2014
The Program and How it Fits

Goal:
Prepare the Electrical Construction Industry to take advantage of the emerging Energy Storage market opportunity through Education & Engagement

ESI Efforts
- Technology
- Standards
- Regulatory
- Finance
- Deployment

ECI Efforts
- Standards
- Education
- Outreach
- Experience

ES Program
- Industry Insights
- Conference Events
- Report
- Presentation
- Webinar

Outcome: Immediate and Long Term Benefits & Impacts
Industry Insights

Goal:
Learn What to Expect When Looking for Partners in the Energy Storage Industry

Survey
- Energy Storage Community
- Energy Storage Association (ESA)
- ESA Technical Working Group

What You Want in a Partner

Interviews
- Energy Storage Industry
- Electrical Construction Industry

Installation & Commissioning Challenges

ES Project Developer
- Good Relationship with Local Inspectors
- Flexible/Multiple Shifts to Get Project Completed Quickly
- Other Connections:
  - Crane
  - Cement
  - Interconnect

One Stop-Shopping
Goal:
How to Find Potential Partners in the Energy Storage Industry

NY-BEST
March, 2015
Troy, NY
Workshop

ESA
May, 2015
Dallas, TX
Workshop

ESNA
October, 2015
San Diego, CA
Coordinate / CalCharge

Storage Industry
Project Developers
System Integrators
Storage OEMs

Questions
What Do You Want
What Do You Need
Dialogue
Technology Descriptions
• 15 Technology Families
• 40 Specific Technology Types

System Overview
• 5 Components

Applications
• 21 Market Applications

Regulatory Status
• Federal / State

Survey / Interviews
• What to Expect

Conference Events
• What’s in a Partner

Job Potential
• Specific to Scale/Type

Standards
• Current Status
# Energy Storage Technologies

<table>
<thead>
<tr>
<th>Category</th>
<th>Type</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical</td>
<td>Cell</td>
<td>Li, Pb, Na, Metal-Air, AHI</td>
</tr>
<tr>
<td></td>
<td>Flow</td>
<td>V, ZnBr, ZnCl, FeCr, ZnCr</td>
</tr>
<tr>
<td>Thermal</td>
<td>Cold</td>
<td>Chilled Water, Ice</td>
</tr>
<tr>
<td></td>
<td>Hot</td>
<td>Molten Salt, Brick</td>
</tr>
<tr>
<td>Mechanical</td>
<td>Rotation</td>
<td>Flywheel</td>
</tr>
<tr>
<td></td>
<td>Gravity</td>
<td>Pumped Hydro</td>
</tr>
<tr>
<td></td>
<td>Pressure</td>
<td>CAES, Hydraulic</td>
</tr>
<tr>
<td>Electrical</td>
<td>Electrostatic</td>
<td>UltraCap, Pseude-Cap</td>
</tr>
<tr>
<td></td>
<td>EM Field</td>
<td>SMES</td>
</tr>
</tbody>
</table>
Energy Storage Systems

Energy Storage Module
- Storage Medium
- Battery Management System
- Safety

Controls & Communication
- Monitoring & Recording
- Analytics & Controls
- Communication

Power Conversion System
- Bi-Directional Inverter
- Switchgear
- Transformer

Balance of Plant
- Thermal Management
- Fire Suppression
- Enclosure

Deployment & Operation
- Shipping & Installation
- Commissioning
- Operation & Maintenance
Energy Storage Applications

**Wholesale**
- Arbitrage
- Capacity
- Freq. Regulation
- Load Following
- Spinning Reserves
- Voltage Support
- Black Start

**Renewable**
- Ramping Support
- Capacity Firming
- Time Shift

**T&D**
- Transmission Support
- Congestion Relief
- Upgrade Deferral
- Permanent Load Shift
- Distribution Losses
- Service Reliability
- Substation Power

**Retail**
- Energy Management
- Power Management
- PQ/Reserve Power
- Regenerative Energy
Contract & Design Issues

- **Power**
  - Rate of Charge / Discharging
  - Response Time

- **Energy**
  - Duration of Operation
  - Temperature Impact
  - Usage Impact

- **Efficiency**
  - Roundtrip - DC:DC, AC:AC
  - Charging / Discharging rates
  - Hotel Loads

- **Life**
  - Cycle Life
  - Shelf Life
  - Capacity Decay

- **Safety**
  - Storage Module
  - Operation
  - Containment

- **Cost**
  - Capital
  - Operating
  - Financing

Friction Points in Contracts
Storage is a Multi-Variant Question

Risk => Cost
Standards Development

International Electrotechnical Commission (IEC) – Technical Committee (TC) 120: EES (Electrical Energy Storage) Systems
- Overseeing the development of International Standards that address all different EES technologies in a systems approach

IEEE P2030.2

NECA-NEIS
- Energy Storage Installation Standard (In Development)

Underwriter’s Laboratory (UL)

NEC® (NFPA 70)
- 2017 NEC® update – Energy storage system integration

Modular Energy Storage Architecture (MESA) Standards Alliance
- Standardized communication / software interface between subsystems

EPRI – Energy Storage Integration Council (ESIC)
- **WG1 - Applications**: Functional and technical requirements in distribution-connected use cases
- **WG2 - Performance**: Common metrics of performance, test protocols, and reference duty cycles
- **WG3 - System Development**: Common approaches to component and system standardization, technical specification, safety, and communications and control
- **WG4 - Grid Deployment**: Installation and commissioning, controls, dispatch, and protection
Budget & Timeline

Budget

• $40,000

Timeline

• March  Networking Event, NY-BEST (Troy, NY)
  ➢ Need: Electrical Construction Industry Panelists
• April+  Interviews
• May  Networking Event, ESA Annual Conference (Dallas, TX)
  ➢ Need: Electrical Construction Industry Panelists
• July  Project Task Force Meeting
• September  Survey – Energy Storage industry
• October  Electri International Presentation
• October  Networking Event, ESNA Conference (San Diego, CA)
  ➢ Need: Electrical Construction Industry Panelists
• November  Final Report
• November+  Webinar
Benefits & Impacts

**Goal:**
Prepare the Electrical Construction Industry to take advantage of the emerging Energy Storage market opportunity through Education & Engagement

**Benefits:**
- Industry Insights: What the Storage Industry Wants
- Partnership Development: Who is the Best Partner – Multiple Choices
- Education: Technology, Uses, Design, and Direction

**Impact:**
Put the Electrical Construction Industry in a better position as the energy storage market growth accelerates
Thank You

Richard Baxter
President
Mustang Prairie Energy

(M) 1.617.320.0598
rbaxter@mustangprairie.com