Energy Storage
Project Financing
Mustang Prairie Energy

Bridging the Financial and Technical Sides of the Energy Storage Industry

**Advisory**
- Support Investors, Project Developers, & OEMs
- 17 Years in the industry
- Board of Director, ESA
- Energy Storage: A Nontechnical Guide (PennWell)

**System Cost**
- **Lazard Levelized Cost of Storage (LCOS)**
  - Advisor, Enovation Partners

**Project Financing**
- DOE Funded Study Series
- Outreach to Financial Industry
- Reduce Barriers to Entry
- Reduce Transaction Costs
- Wider Access to low Cost Capital

Energy Storage Pricing Survey
- DOE funded, in planning stage
- All major technologies
- Wider range of Use Cases
- More Application Impact on Design / Cost

Energy Storage: A Nontechnical Guide

Lazard Levelized Cost of Storage (LCOS)

Energet Storage Pricing Survey

Energy Storage Financing: A Nontechnical Guide

Energy Storage Financing: SAND2016-8109
Report Series: Energy Storage Financing

Energy Storage Financing: A Roadmap for Accelerating Market Growth  
SAND2016-8109

Energy Storage Financing: Performance Impacts on Project Financing  
SAND2017-xxxx

Energy Storage Financing: Advancing Energy Storage Contracting  
SAND2018-xxxx

Reduce Barriers of Entry
• New Lenders
• Managing Risk
• Mapping Storage Financing to Traditional Financing

Promote Access to Capital
• De-Risk Project Development
• Financeable Performance Metrics
• Performance Insurance

Improve Documentation
• Supporting Documents
• Project Models
• Contract Language
Manage Risk for Successful Project Financing

**Technical Risk**
- Technology
- Project
- Operation

**Economics**
- Cost
- Revenue
- Value

**Contracts**
- Supporting Material
- Contract Language
Technical Risk

Design
• Bankability
• IE Reports

Equipment
• System Integration
• EPC
• Commissioning

Operation
• Operation & Maintenance
• Warranty
• 3rd Party Monitoring

Lessons Learned
Technical Risk: Design

Bankability Study
- Energy Storage Technology Evaluation
- Original Equipment Manufacturer (OEM) Review
- Manufacturing Process
- Supply Chain
- Competition

Independent Engineering Report (IER)
- Energy Storage Project Evaluation
- Regulatory & Revenue Evaluation
- Contract Review - PPA, ESPC, etc.
- Technology Performance Testing & Valuation
- Plant Design and Performance
- Construction and O&M Review
- Safety, Permitting, & Local Ordinances
- Warranty & Insurance Evaluation
- Review of Risk Management Plan
- Project Evaluation & Financial Modeling
Technical Risk: Equipment

**System Integration**
- Engineering Design
- Component Capability
- Control Systems
- System Assembly

**Engineering Procurement & Construction (EPC)**
- Engineering Design
- Component vs. System Capability
- Non-Recurring Engineering (NRE)
- Procurement – Vendor Evaluation
- Shipping / Transportation
- Local Ordinances / Regulation
- Site Engineering
- Construction

**Commissioning**
- Review of Installed System
- Initial Test Procedure
- Operator/Maintenance Training
Technical Risk: Operation

Operation & Maintenance (O&M)
- Safety
- Remote Monitoring
- Onsite Testing
- Operating Performance Verification (3rd Party)

Equipment Warranty
- Warranties vs. Contract Requirements
- Component Warranties
- System Wrap
- Degradation Management

Operating Performance Verification
- Remote Monitoring
- Field Evaluation & Testing

Range of Coverage
- Item #1
- Item #2
- Item #3
Technical Risk: Lessons Learned

**NGK Insulators**

Joso City, Ibaraki Prefecture
Mitsubishi Materials
2011

- 4 MW Facility
- NAS Sodium Sulfur
- Module Short Circuit

Company Covers Replacement

**Beacon Power**

Beacon Power Facility
Stephentown, NY
2011

- 20 MW Facility – 100kW unit
- Flywheel
- Composite Rotor Failure

Facility Remains in Operation

**Xtreme Power**

Oahu, HI
Kahuka Wind Farm
2012

- 11 MW Facility
- Advanced Lead Acid
- Transformer / Battery Stacks

Business Interruption
## Economics

### Costs

<table>
<thead>
<tr>
<th>Project Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Project Development</td>
</tr>
<tr>
<td>• Legal</td>
</tr>
<tr>
<td>• Cost of Capital</td>
</tr>
<tr>
<td>• Bankability Study</td>
</tr>
<tr>
<td>• Independent Engineering Report</td>
</tr>
<tr>
<td>• EPC</td>
</tr>
<tr>
<td>• End of Life</td>
</tr>
</tbody>
</table>

**Equipment Costs**

**Augmentation Cost**

**Operating Cost**

### Revenue

<table>
<thead>
<tr>
<th>Value Streams</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Discrete</td>
</tr>
<tr>
<td>• Definable</td>
</tr>
<tr>
<td>• Not Easily Priced</td>
</tr>
</tbody>
</table>

**Variability**

**Additional Drivers**

**Design Implications**

### Levelized Cost of Storage

- Usage dependent
- Metric ($/MWh or $/kW-yr.)

### System Value

- Value Stacking
- Market Rules
- Incentives
# Economic: Equipment Cost

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Racking Frame / Cabinet</td>
<td>Container</td>
<td>Bi-directional Inverter</td>
<td>Application Library</td>
<td>Project Management</td>
</tr>
<tr>
<td>Local Protection (Breakers)</td>
<td>Electrical Distribution &amp; Control</td>
<td>Electrical Protection</td>
<td>Economic Optimization</td>
<td>Engineering Studies / Permitting</td>
</tr>
<tr>
<td>Rack Management System</td>
<td>Communication</td>
<td>Connection to Transformer</td>
<td>Distributed Asset Integration</td>
<td>Site Preparation / Construction</td>
</tr>
<tr>
<td>Battery Management System</td>
<td>HVAC / Thermal Management</td>
<td></td>
<td>Data Logging</td>
<td>Foundation / Mounting</td>
</tr>
<tr>
<td>Battery Module</td>
<td>Fire Suppression</td>
<td></td>
<td></td>
<td>Commissioning</td>
</tr>
</tbody>
</table>
**Economics: Augmentation Cost**

**Augmentation**
- Oversizing system to sustain rated energy capability
- Periodic additions
- Driven by environmental and usage factors
- Timing of additions impacted by declining equipment costs

**System Degradation Drivers**

<table>
<thead>
<tr>
<th>Environment</th>
<th>Cycle Life</th>
<th>Depth of Discharge</th>
<th>Calendar Life</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="The Effect of Temperature on Battery Capacity" /></td>
<td><img src="image2" alt="Capacity vs. Cycles, Time" /></td>
<td><img src="image3" alt="Number of Cycles vs. Depth of Discharge" /></td>
<td><img src="image4" alt="Calendar Life" /></td>
</tr>
</tbody>
</table>
Economics: Operating Cost

Round Trip Efficiency (RTE)
- Cell/Modules
- Power Electronics
- HVAC

Operation & Maintenance
- Remote Monitoring
- Onsite Inspection & Replacement

Extended Warranty
- Cell/Modules
- Power Electronics

Software License
- Cell/Modules
- Power Electronics

Insurance
- Cell/Modules
- Power Electronics

Performance Insurance
Economics: Insurance / Risk Management

Traditional Insurance
• Liability
• Property Insurance
• Business Interruption

Enhance Project Risk Management
• Bridging Gaps in Coverage
• Cover Gaps in/Extend Warranty Coverage
• Wrap Technology Risk
• Credit Enhancements
• Customer Creditworthiness

Project Continuity (Lockbox)
• Process IP
• Operation & Maintenance Plan
• Replacement Parts
• Warranty

Performance Insurance
• Technical Performance (Availability, etc.)
• Cover Loss of Revenue from Disruption
• Not Cover Loss from Merchant Activity
Economic: Revenue

Value Streams
• Discrete
• Definable
• Not Easily Priced

Variability
• Regional
• Formal Market
• Independent
• Customer Rank

Additional Drivers
• Mandates
• State Incentives
• Solar ITC

Design Implications
• Energy Capacity
• Interconnection
• Augmentation Schedule
Economics: Revenue Streams

ISO/RTO Services
- Arbitrage
- Frequency regulation
- Spin/Non-Spin Reserves
- Voltage Support
- Blackstart

Utility Services
- Resource Adequacy
- Distribution Deferral
- Transmission Congestion Relief
- Transmission Deferral

Customer Services
- TOU Bill Management
- PV Self Consumption
- Demand Charge Reduction
- Back-up Power

Applications Not Widely Priced
- Ramping
- Reliability / Resiliency
- Power Quality
Contracts

Supporting Documents
- Legal
- Lending
- Insurance
- Technical

Contract Language
- Front of Meter
- Renewable
- Utility
- Behind the Meter
# Contracts: Supporting Documents

<table>
<thead>
<tr>
<th>Typical</th>
<th>Additional Concerns</th>
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<tbody>
<tr>
<td><strong>Legal</strong></td>
<td><strong>Data Transfer</strong></td>
</tr>
<tr>
<td>• Merchant</td>
<td>• Solar: Orange Button</td>
</tr>
<tr>
<td>• Lease</td>
<td>• Storage: ??</td>
</tr>
<tr>
<td>• BOT</td>
<td></td>
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<tr>
<td><strong>Lending</strong></td>
<td><strong>3rd Party Monitoring</strong></td>
</tr>
<tr>
<td>• Debt</td>
<td>• O&amp;M</td>
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<tr>
<td>• Equity</td>
<td>• Warranties</td>
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<tr>
<td><strong>Insurance</strong></td>
<td><strong>Project Models</strong></td>
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<tr>
<td>• Property</td>
<td><strong>Financeable Performance Metrics</strong></td>
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<tr>
<td>• Business Interruption</td>
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<td>• Performance</td>
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<td>• Independent Engineering Report</td>
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<td>• Safety</td>
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Contracts: Financeable Performance Metrics

Why We Need Financeable Performance Metrics
• Basis for Contracts – Stable Revenue, Reduce Loss Exposure
• Existing – Unit Technical Based: Availability, RTE, etc.
• Possible – Application Specific Metric
• Able to be Monitored by a 3rd Party (Non-Proprietary data)

Front of the Meter
• PJM – Frequently Regulation, RegD
• Performance Score (Accuracy, Delay, & Precision)
• 2015 - RES Americas, “Jake” & “Elwood” FR plants
• Performance Score & Hedge → Revenue Guarantee
• Financing through Prudential & Lincoln National Life Ins. Co.

Utility
• Feeder Level Distributed Unit
• Reliability / Resiliency
• 3rd Party Provider, Service Agreement
• Possible Metric: Maintain X% Capacity

Behind the Meter
• Residential (Consumer Market)
• Peak Shave
• “GridStar” – Based on EPA EnergyStar
• Possible Metric: EnergyGuide Inspired Standard Savings Range
Contracts: “standardized” Contract Language

**Benefits of Contracts**
- Single Point of Responsibility
- Better Contracts – Stable Revenue, Reduce Loss Exposure
- Multiple Applications, Some Are Currently Monetized, Some Non-Monetized
- Able to be Monitored by a 3\textsuperscript{rd} Party

**Front of the Meter**
- Contract Type: Power Purchase Agreement (PPA)
- Ownership: Owner Operator, 3\textsuperscript{rd} Party (Tolling)
- Markets Roles
  - Merchant
  - Hybrid Storage
  - Utility
- Price indicator: ISO Markets

**Behind the Meter**
- Contract Type: Energy Savings Performance Contracts
- Ownership: Owner Operator, Lease
- Market Roles
  - Commercial & Industrial
  - Residential
- Price Indicator: Utility Cost of Service. ISO Markets
Thank You

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Background: Richard Baxter

Mustang Prairie Energy, President
Bridging the Financial and Technical Needs of the Storage industry
• Advise Investors, Manufacturers, and Project Developers
• 15+ Years in the Energy Storage Industry

Current Activity
• Advisor, Enovation Partners
  o Lazard Levelized Cost of Energy Storage (LCOS) – Cost Survey & Analysis

Recent Activity
• NECA-NEIS 416-2016: Recommended Practice for Installing Energy Storage Systems – Reviewer

Former Roles
• Board of Directors: Energy Storage Association (ESA)
• Board of Directors: Charitable Foundation of the Energy Bar Association (CFEBA)
• Director of Product Strategy: Premium Power (Flow Battery)
• Principal: Charles River Associates
• Investment Banker & Equity Analyst, Ardour Capital
Additional Resources

  • http://www.sandia.gov/ess/publication/

Protocol for Uniformly Measuring and Expressing the Performance of Energy Storage Systems

Energy Storage Safety
  • http://www.sandia.gov/ess/resources/energy-storage-safety/

DOE/EPRI Electricity Storage Handbook with NRECA

Global U.S. DOE Energy Storage Database
  • https://www.energystorageexchange.org/

Energy Storage Financing
  • Energy Storage Financing: A Roadmap for Accelerating Market Growth (SAND2016-8109.pdf)
Additional Resources (Cont.)

Energy Storage Technology Advancement Partnership
• http://cesa.org/projects/energy-storage-technology-advancement-partnership/

Energy Storage Procurement Guidance Documents for Municipalities

Commissioning Energy Storage

Lazard Levelized Cost of Storage (LCOS) Survey
• LCOS 1.0: https://www.lazard.com/perspective/levelized-cost-of-storage-analysis-10/
• LCOS 2.0: https://www.lazard.com/perspective/levelized-cost-of-storage-analysis-20/
• LCOS 3.0: https://www.lazard.com/perspective/levelized-cost-of-storage-analysis-30/  (Nov 2017)

DNV GL: Safety, operation and performance of grid-connected energy storage systems

NECA 416 – 2016, Recommended Practice for Installing Energy Storage Systems
• https://www.necanet.org/store/product/neca-416-2016-recommended-practice-for-installing-energy-storage-systems-416-16
International Electrotechnical Commission TC120 – Electrical Energy Storage Systems

NEC 2017 – Article 706: Energy Storage Systems

NECA – Energy Storage Systems & Microgrids