Application of Large-Scale Energy Storage Systems in AEP

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Distributed Energy Resources
American Electric Power

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A Possible Future of Distribution

Energy Storage is key to a controlled energy flow on the grid.

Transmission & Distribution

Bulk Generation

Transmission Substation

Distribution Substation

Residential

Gensets, Solar, Fuel Cells (FC), Load Management (LM)

Commercial

Industrial

Gensets, Solar, FC, LM

Gensets, FC, LM
Storage Options for Utility Applications

- 1-10 MW, 4-8 hour storage systems
- After reviewing all feasible technologies, AEP selected Sodium Sulfur (NaS) battery for distributed energy storage
- NaS strengths:
  - **Cost**
  - **Favorable field experience**
  - **Compactness**
  - **Commercial record over 1MW**
  - **Modularity**
  - **Ability to be relocated**
Some Selection Criteria for Energy Storage
Partners

American Electric Power
- Owner & Operator of DESS
- Project Management
- Site Work
- Permits

NGK Insulators
- Manufacturer of NAS Battery System

S&C Electric Company
- PCS
- System Integration

DOE/Sandia
- Partial Sponsor

DOE/Sandia's *timely* support pushed AEP over the tipping point on its 1MW NAS project that is now grown into a commitment to deploy 1000 MW more energy storage over the next decade.
AEP’s First Commercial Energy Storage System

- Charleston, WV
- 1.2 MW, 7.2 MWh
- Operational since June 26th 2006
# Distributed Energy Storage System (DESS) Project

<table>
<thead>
<tr>
<th>Main Function</th>
<th>1.2 MW Peak Shaving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Justifications</td>
<td></td>
</tr>
<tr>
<td>1) Corporate Strategy</td>
<td>(long-term economics)</td>
</tr>
<tr>
<td>2) Distribution Capital Deferral</td>
<td></td>
</tr>
<tr>
<td>3) A Relatively Quick Solution</td>
<td></td>
</tr>
<tr>
<td>4) Relocate-able to other Sites</td>
<td></td>
</tr>
<tr>
<td>5) Market values (RTO)</td>
<td></td>
</tr>
<tr>
<td>DOE Support</td>
<td>Covered Non-Repeat Expenses</td>
</tr>
</tbody>
</table>
LONG-TERM Economics of Energy Storage

1. **Strategic Values** - *high*

2. **Political Merits** - *high*

3. **Short-term Cost/Benefit Analysis** - *Marginal*
Storage Cost and DOE/Sandia’s Role

Cost Components

- NAS Battery: 45%
- Factory-to-site costs: 6%
- Battery Enclosures: 4%
- PCS & System Integration: 21%
- Site Work: 7%
- Non-Repeat Engineering Support: 17%
DESS Reduced the Peak Load Down to the Transformer Rating

Sample of Peak Shaving – Highest Peaks of each Year

Chemical Substation Transformer Load


Transformer Load [MVA]

Battery Output [MW]

Charge
1.2 MW peak – 7 hrs

Discharge
1.0 MW peak – 8.5 hrs

Time of Day [h]

2006

2007

Tyler Mountain Feeder
12 kV bus

North Charleston Feeder
46 kV/12 kV
Transformer
12/16/20 MVA

West Washington Feeder
Voltage Regulator

46 kV bus
Load Leveling - 2006

Load Factor Improved from an average of 0.75 to 0.80
Load Leveling - 2007

Chemical Substation: West Washington Load
(Days with Battery, June - August 2007)

Feeder Load [MVA]

1.2 MW Charge

1.0 MW Discharge

Time of Day [EST]
Transformer temperature was dropped by several degrees C
Savings on the Energy Market (PJM)

Estimated Monthly Savings from AEP’s 1 MW Energy Storage in Charleston, WV

Approximately $5,500 per month

- 1MW NAS Battery Storage was installed and operational in just 9 months
- The battery helps shave transformer peak loads for 8.5 hours a day
- Keeps transformer temperature down by several degrees C
- Improves the feeder’s Load Factor from 0.75 to 0.80, on average
- Provided a PJM Market Energy Value of $5,500 per month (average)
- Helped AEP build more confidence on this Energy Storage initiative
Installation of the First Distributed Energy Storage System (DESS) at American Electric Power (AEP)

A Study for the DOE Energy Storage Systems Program

All Natural

Prepared by
Sandia National Laboratories
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Free copies of the report are available from the Sandia website
Going Forward

• Energy Storage has many utility benefits that, when combined, MAY pay for the equipment cost.

• But all storage benefits may NOT apply to a given application.

• Need to choose the right application with the right business model.
Storage Benefits

NPV $/kW

Storage Cost
(installed)

AC Energy Storage
Re-locatable “BLACK BOX”
(7-hour discharge)

Automatic
(aggregation)

Storage Benefits (NPV)

Traditional Business Model
Improved Reliability & Capital Deferral

Alternative Business Model
Profiting from RTO Markets

Dist. Capital Deferral
(site dependent)

Improved Service Reliability
Based on the cost of conventional solutions to reduce Customer Minute Interrupted
(site dependent)

Energy Arbitrage
Generation Capacity

Frequency Regulation
(large variability)
Combining Storage Benefits

Service Reliability
(backup)

Load Leveling
(Capital Deferral)

RTO Market
(Energy Arbitrage, Frequency Regulation, Capacity)

Renewable Sources

AEP #1

AEP #2

AEP #3
• Energy Storage is a key to the initiative for modernizing our grid

• 6 MW more NAS operational in 2008 (purchased)

• 25 MW more by the end of this decade

• 1000 MW more by the end of next decade