AEP System Overview

- 5.3 Million customers
- 11 States
- 39,000 MW Generation

AEP Service Territory
- 38,953 miles Transmission
- 212,781 miles Distribution
- 6006 Distribution Circuits
- 3240 D Transformer Windings
Distribution System Operational Strategy

Transforming from single source distribution circuits to an interconnected grid with multiple sources, real time visualization, resiliency, automation, and control.

- Equipment sensors that provide real time condition/status
- Two way communication amongst devices with central control center visibility and automated outage recovery
- Two way power flow support – easy integration of distributed generation
- Digital meters with remote service switch
- Dynamic voltage and customer load control
- Integrated back office systems to provide remote and automated data collection, analysis, visualization and action
Energy Storage At AEP

- The Next Step -

AEP Ohio
AEP’s (NaS) Battery Application

1 MW, 7.2 MWh installed in Chemical Station (Charleston, WV - 2006)
- Deferred substation upgrades

Three installations in 2008 (2 MW Each)
- Peak Shaving
- Demonstrate “Islanding”
- Storage of intermittent renewables
- Sub-transmission support

AEP selected Sodium Sulfur (NaS) technology
- Proven technology in Japan (TEPCO)
- 1-10 MW, 4-8 hour storage systems
- NaS strengths:
  - Commercial record over 1MW (over 100 installations)
  - Cost
  - Compactness
  - Modularity & Ability to be relocated
Bluffton, OH – 2 MW with Islanding

NAS Battery Station

Two 1 MW NAS Units

PCS  Transformer  Genset
Churubusco, IN with Islanding

NaS Battery
The Concept of Community Energy Storage

- **CES** uses distributed resources to offer >> flexibility @ << cost than *bulk* storage as battery volumes increase
- CES fits with the Grid’s emerging need for **Distributed Intelligence AND Speed**
- Storage at the load offers unique benefits that bulk storage can’t match
  - Direct integration with PHEV batteries to act as a buffer for load mgmt (PHEV charging)
  - Direct integration with customer owned renewable resources
  - Demand Control thru contractual integration with HAN
Community Energy Storage (CES)

CES is a distributed fleet of small energy storage units connected to the secondary of transformers serving a few houses or small commercial loads.
### CES Specifications

<table>
<thead>
<tr>
<th>Key Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (active and reactive)</td>
<td>25 kVA / 25 kW</td>
</tr>
<tr>
<td>Energy</td>
<td>25 kWh future 75 kWh</td>
</tr>
<tr>
<td>Voltage</td>
<td>240 / 120V AC</td>
</tr>
<tr>
<td>Battery – Similar to PHEV</td>
<td>Li-Ion</td>
</tr>
<tr>
<td>Round trip efficiency</td>
<td>&gt; 85%</td>
</tr>
</tbody>
</table>

AEP Specifications for CES are “OPEN SOURCE” for Public Use and Feedback. During 2009 EPRI hosted free, open webcasts to solicit industry wide input.

www.aeptechcenter.com/ces
Local Benefits:

1) Backup power
2) Flicker Mitigation
3) Renewable Integration
**CES – Virtual Station Scale Storage**

**Local Benefits:**
1) Backup power
2) Flicker Mitigation
3) Renewable Integration

**Grid Benefits:**
4) Load Leveling at substation
5) Power Factor Correction
6) Ancillary services
CES Layout

Transformer

Primary Voltage
240/120 V

Optional Pedestal

Communication to CES Hub
Communication to local loads

DC Links

DC/DC Input Module

AC/DC Converter
Pullout Module

Control & Data Acquisition
Pullout Module

DC Bus

DC/DC Input Module

PHEV Battery
Pullout Module

PHEV Battery
Pullout Module

gridSMART
From AEP AMERICAN ELECTRIC POWER

Bolted Termination
Control Measurements
Revenue Meter

13
Load Leveling Example

Performance of Balls Gap’s 2MW Battery from 12/17 to 12/19/2008
AEP Ohio GridSMART Demonstration

- **CES**: 2MW/2MWh; Fleet of 80 25-kW Units
- **Circuit**: Morse Rd 5801; 13 kV, 6.3 MVA Peak Load, 1742 customers
- **Coverage**: Approximately 20% of customers
- **Schedule**:  
  - Aug 2011  Begin installations
  - Dec 2011  Complete installations
- **Customer Contacts**:  
  - 53 letters resulted in 17 signed agreements
  - Total of 140 targeted xfmrs < 22 KVA load
Mock Installation
Drivers for Energy Storage

- Peak Load Shaving / Leveling
  - T&D infrastructure project deferrals
  - Increased utilization of existing Generation
- Islanding of Load Area
- Smoothing Variability of Solar / Wind Generation
- Energy Arbitrage
  - Charge at lower cost / Discharge at higher value
- Ancillary Services
  - Frequency regulation
  - Spinning reserve
Cost Parity – Peaking Plant vs. Storage

Cost per Equivalent Unit of Demand @3KWh/KW ($000’s/KW)

Technology pricing
- Based on industry estimates
- Leverages automotive volumes
- Has not always been reliable

Actual cost (stationary applications)
- Packaging differences – stationary vs. automotive
- Control system differences
- Manufacturing volumes less predictable than automotive

Year

Costs shown are representative for high level discussion only
Balancing Cost and Benefits

- Energy Storage Cost is still high
- Energy density needs to improve
- Utilities need to find full value of energy storage
  - T&D deferral is easiest to calculate but varies greatly
  - Other values such as energy arbitrage, frequency, enhancement of variable energy sources, etc. do not have identified $$ values
DOE Project Enhancements

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Questions?

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