Energy Storage Projects in AEP

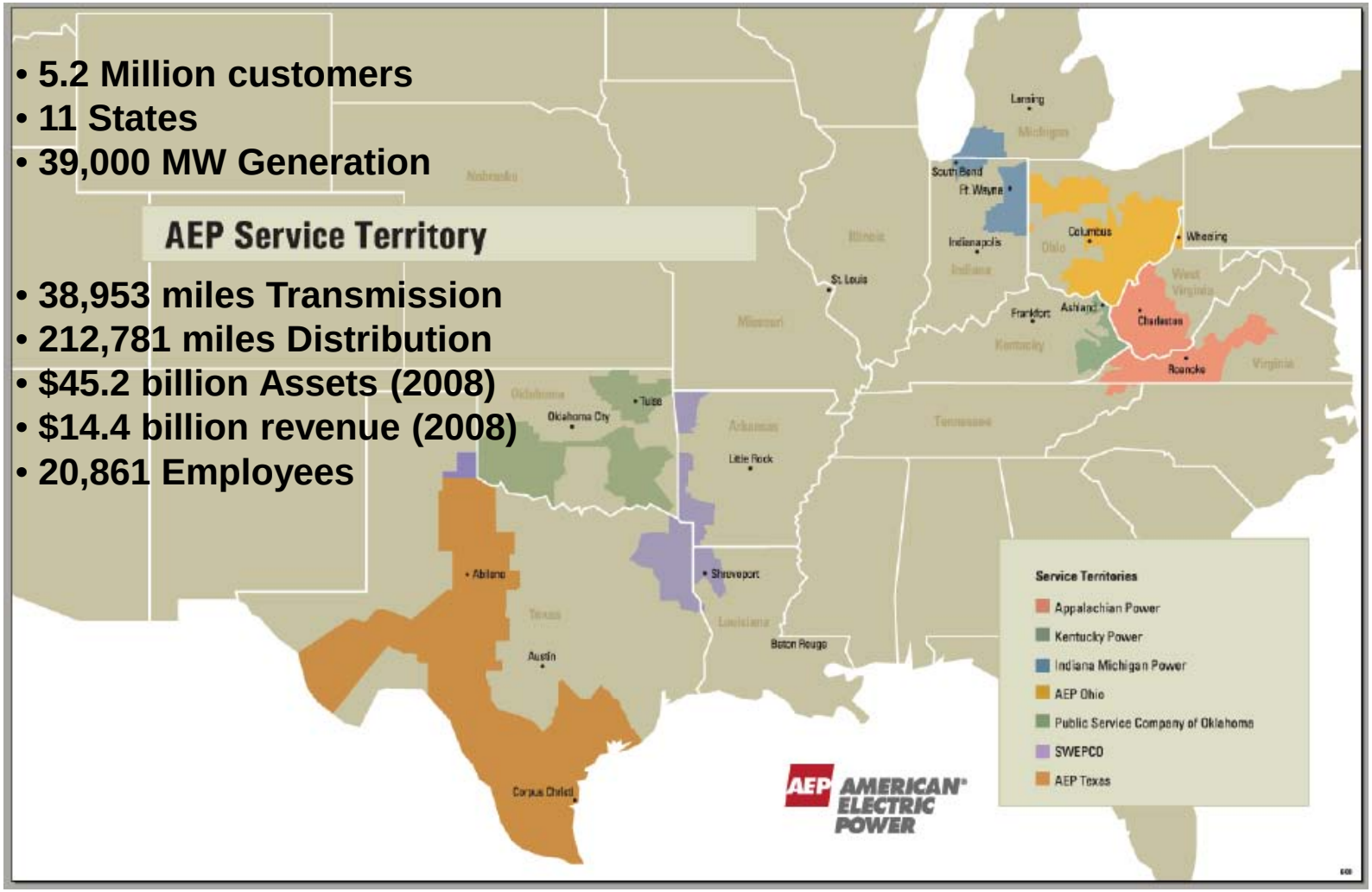
- A Migratory Trend -

EESAT 2009
October 4-7
Seattle

Ali Nourai
American Electric Power
Chairman, Electricity Storage Association

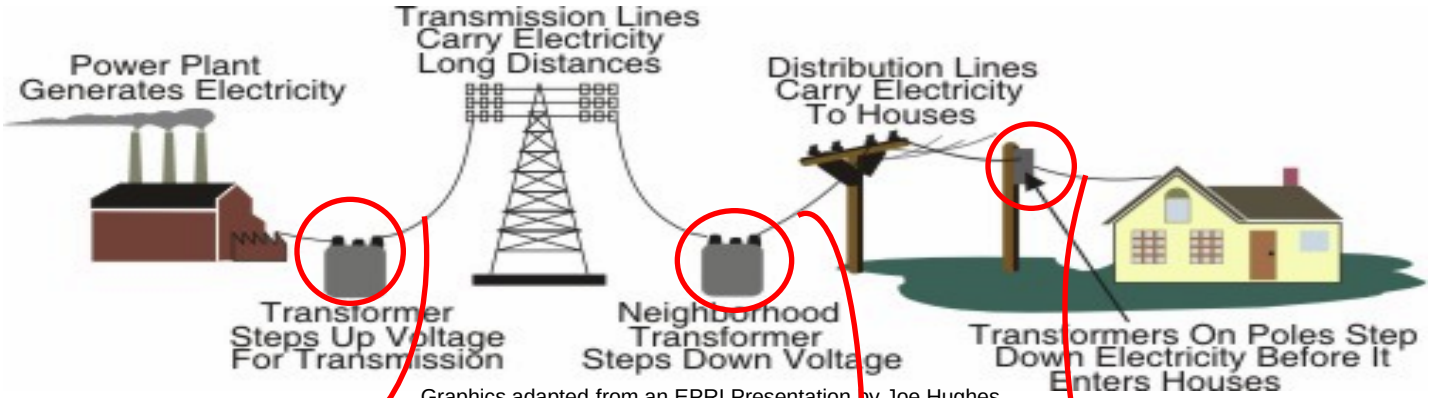
AEP Overview

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



- 38,953 miles Transmission
- 212,781 miles Distribution
- $45.2 billion Assets (2008)
- $14.4 billion revenue (2008)
- 20,861 Employees

Migratory Path of Utility Energy Storage – in AEP



Graphics adapted from an EPRI Presentation by Joe Hughes

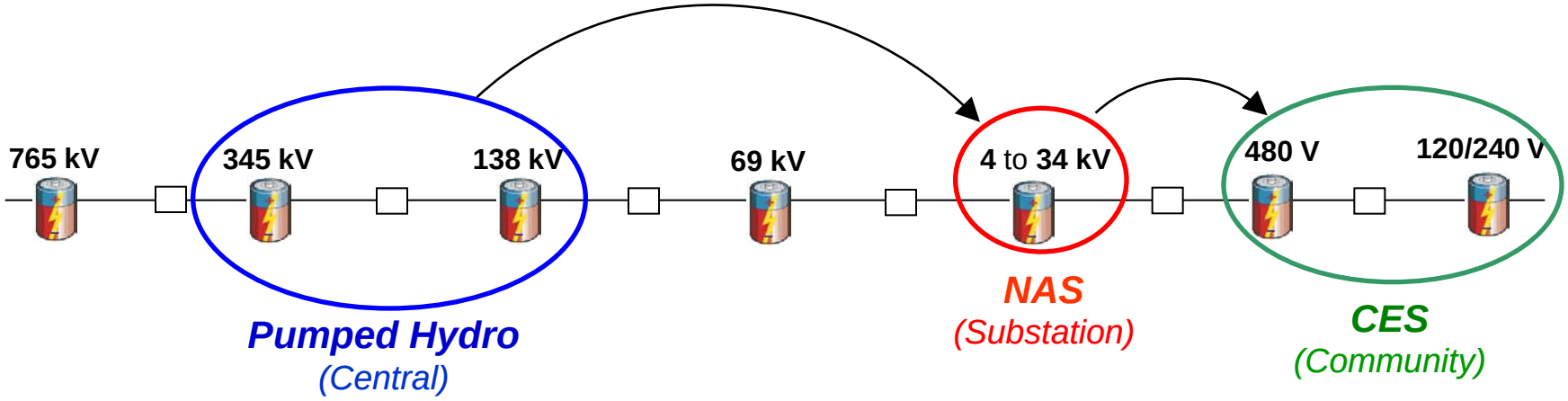
Large Central Units

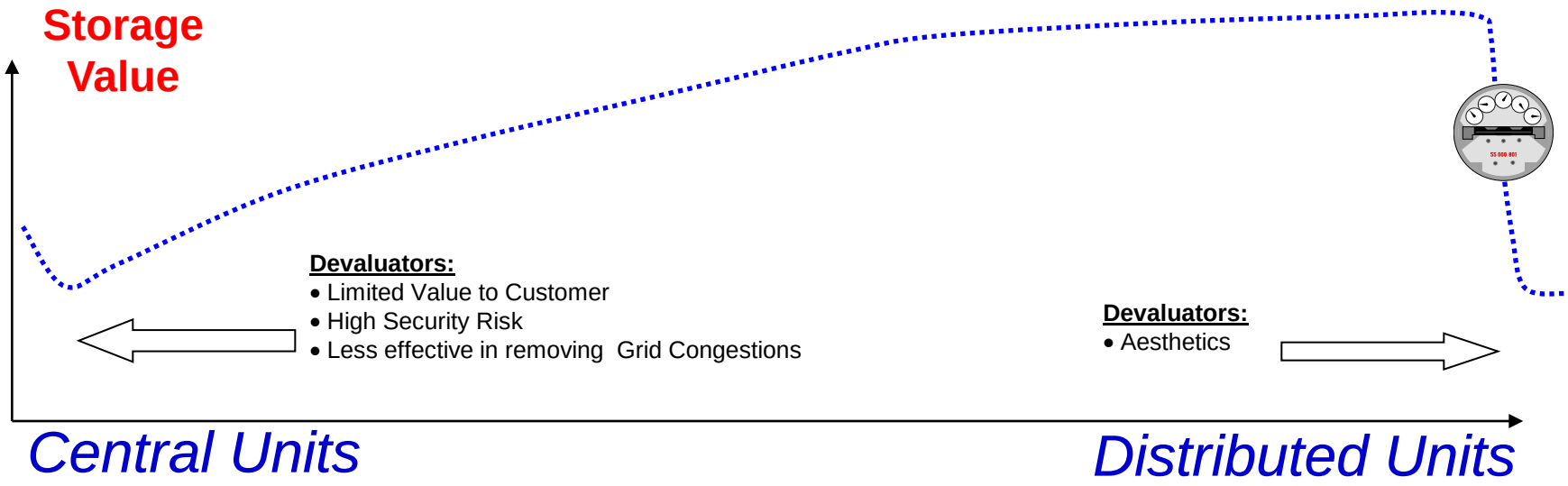
Substation Batteries

Storage at Grid Edge

This Migration Trend is Driven by
Popularity of Customer-Owned Distributed Generation
and Customers' demand for higher service quality

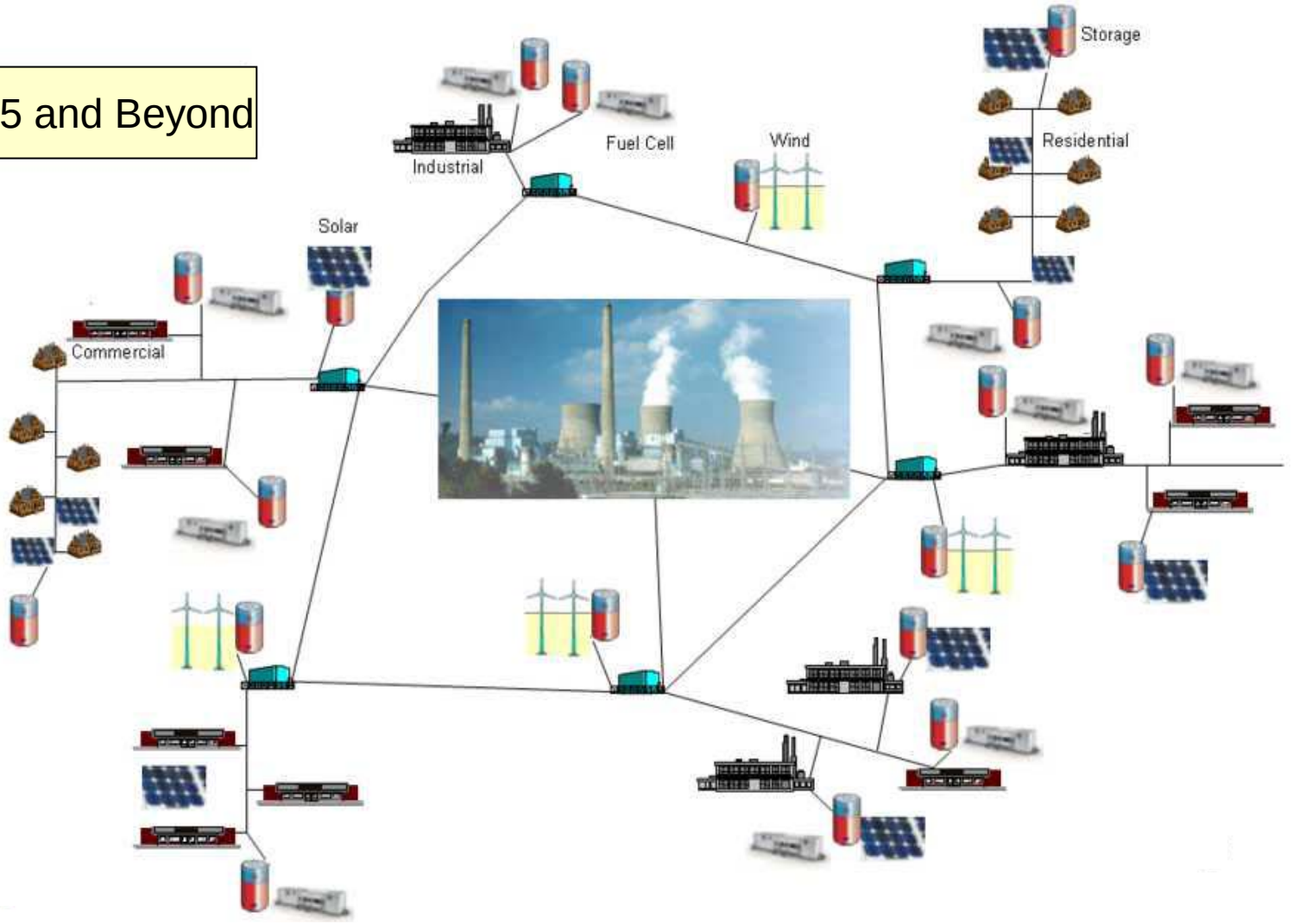
AEP's View of Energy Storage Value





Massive Electricity Storage – AEP's Vision

2015 and Beyond



The Three Categories of Storage Benefits

1- Strategic Benefits

- Serve Net-Zero Customers
- Prepare for New Revenue Models

Electric Utilities Need to Focus On All 3 Benefits to Justify the Storage Cost and Survive the Coming Changes

!

2- Service Benefits

- T&D Capital Deferral
- Buffering Renewables
- Service Reliability
- Voltage Support

3- Market Benefits

- Energy Arbitrage
- Frequency Regulation
- Generation Capacity

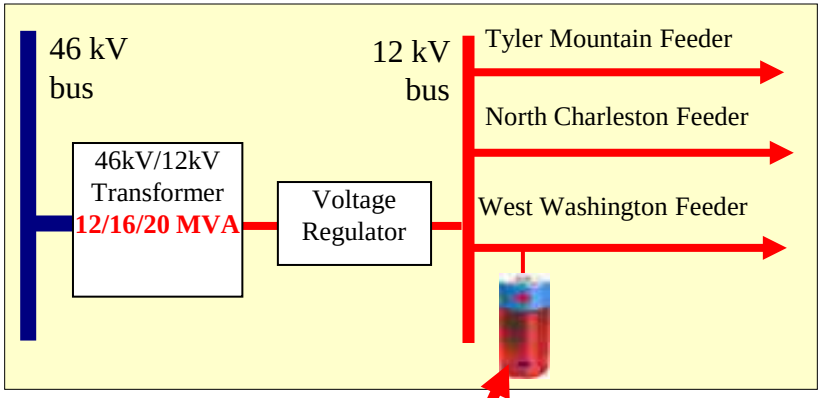
AEP AMERICAN ELECTRIC POWER

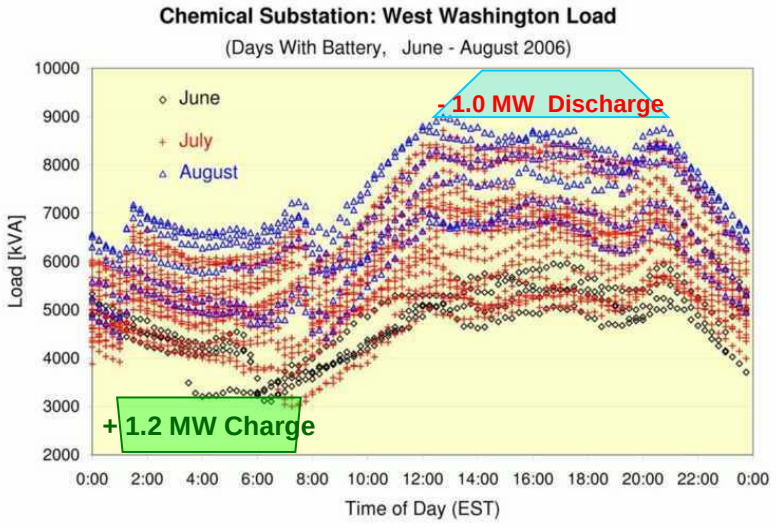
ESA ELECTRICITY STORAGE ASSOCIATION

AEP's First Substation Battery for Capital Deferral

This First Utility-Scale NAS Project was Partially Funded by DOE/Sandia

- 2006
- **1MW, 7.2 MWh** of NaS battery
- Deferring New Substation





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AEP Substation-Scale Storages – 11MW, 75MWh

1 MW, 7.2 MWh installed in 2006

- Deferred substation upgrades

3 x2MW,14.4 MWH installed in 2008

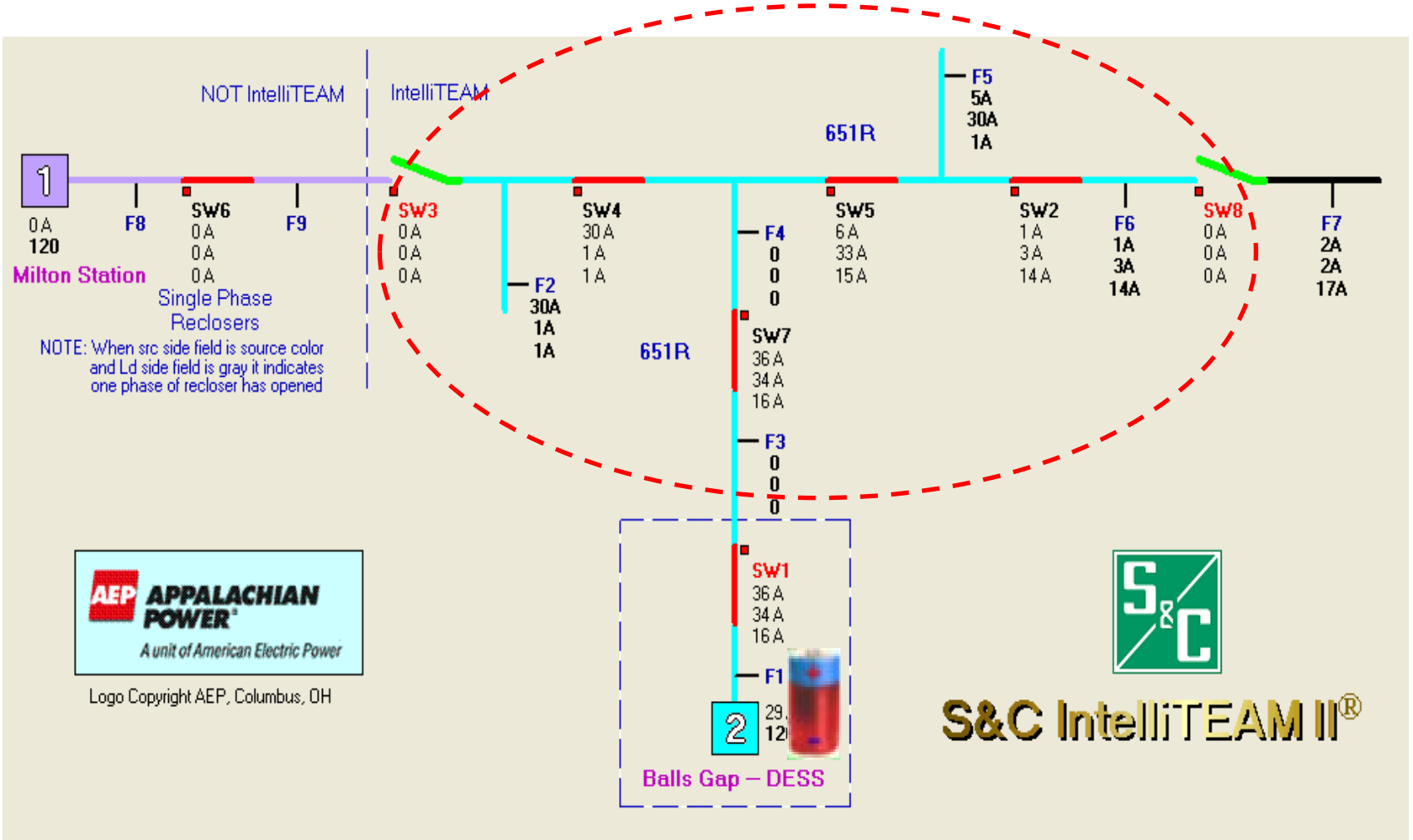
- Demonstrated **"Islanding"**

4MW, 25MWh substation will be on-line in January 2010

The New "Islanding" feature was Partially Funded by DOE/Sandia

Dynamic Islanding – Backup Power

This First Community-Scale Backup Power with NAS Battery was Partially Funded by DOE/Sandia



Live Islanding Test Information

- Test Site : Balls Gap, Milton, WV
- Test Date: July 8, 2009
- Island Size: 700 customers
- Time to island customers: 0.5 to 2 min.
- Power Outage Duration: 29 min.
- Time to Exit Island: 6 sec. (not Synchronized)
- Average Island Load: 0.8 MW

This First Community-Scale Backup Power with NAS Battery was Partially Funded by DOE/Sandia

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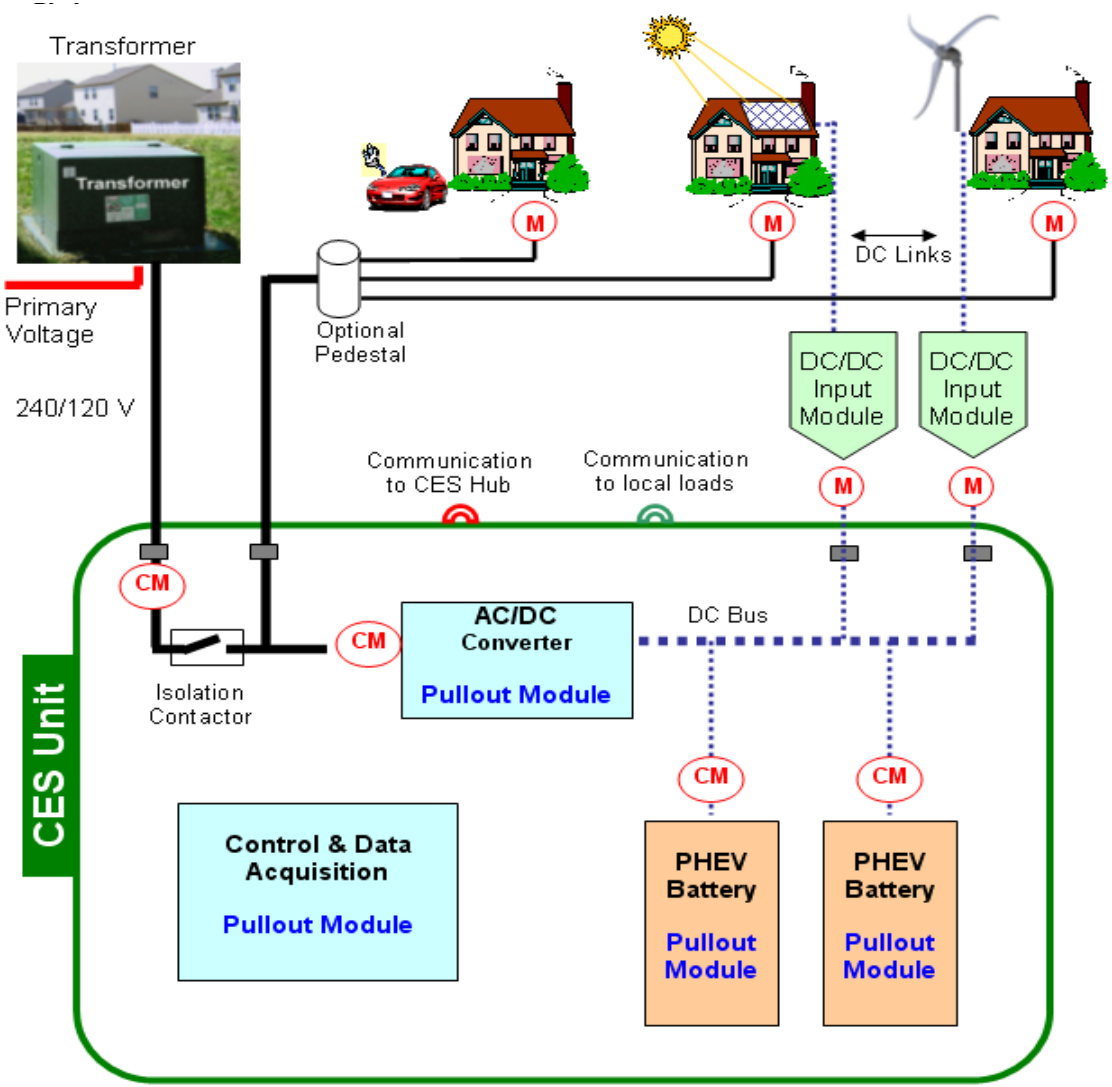
Community Energy Storage (CES)

CES is a small distributed energy storage unit connected to the secondary of transformers serving a few houses or small commercial loads

- ***Uses New or Used PHEV- EV batteries***

- Offers All Values of Substation Batteries when ***aggregated,***
- Offers Backup Power to customers
- Buffers Customer Renewable Generation
- Makes PHEV Charging Time a less critical issue

CES Layout


Transformer
Transformer
Primary Voltage
240/120 V
Optional Pedestal
M
M
M
DC Links
DC/DC Input Module
DC/DC Input Module
Communication to CES Hub
Communication to local loads
M
M
CM
CM
Isolation Contactor
AC/DC Converter
Pullout Module
DC Bus
CES Unit
CM
CM
Control & Data Acquisition
Pullout Module
PHEV Battery
Pullout Module
PHEV Battery
Pullout Module
Bolted Termination
CM
Control Measurements
M
Revenue Meter

CES – A Virtual Substation Battery

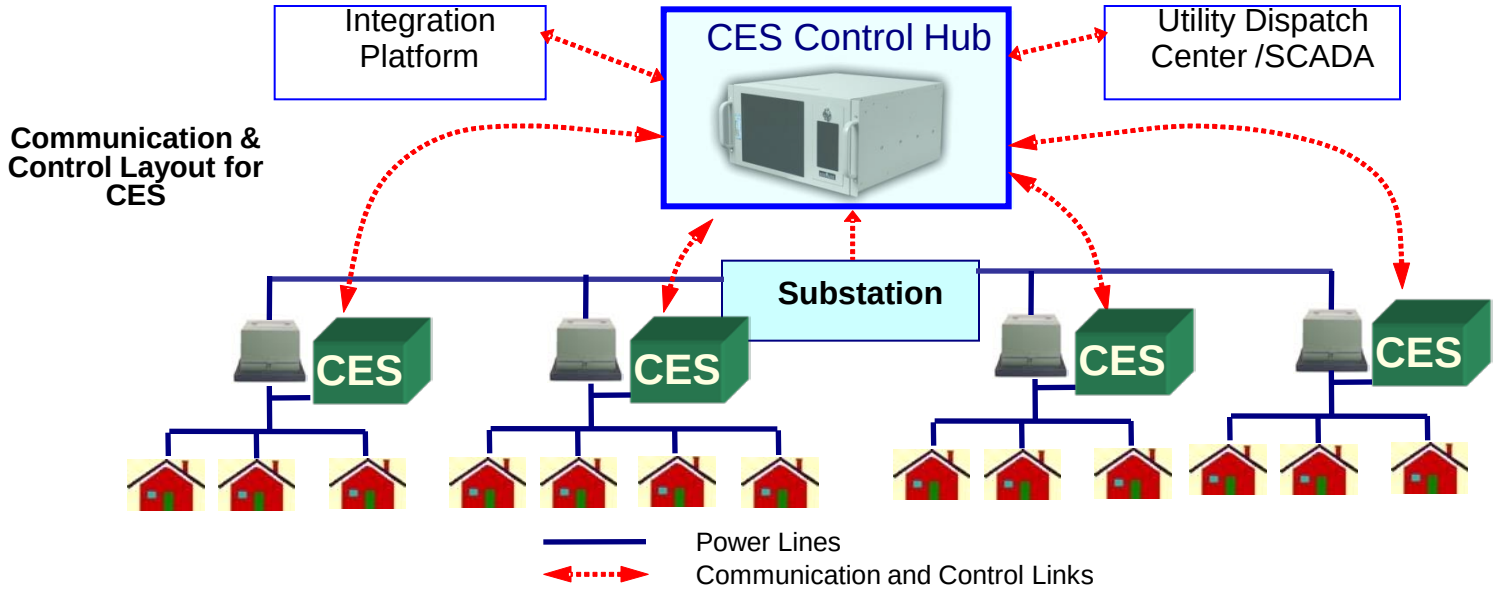
CES is Operated as a Fleet offering a Multi-MW, Multi-hour Storage

Local Benefits:

1) **Backup power**
2) **Voltage correction**
3) **Renewable Integration**

Grid Benefits:

4) **Load Leveling** at substation level
5) **Power Factor** Correction
6) **Ancillary** services



Advantages of CES to Substation Batteries

While CES is, Functionally, a Multi-MW, Multi-hour Substation Battery, It has some Inherent Advantages:

1. More reliable Backup Power to customers (closer)
2. More Effective in providing Voltage Support (distributed)
3. More likely to be a standardized commodity (low cost)
4. More Efficient in buffering customer renewable sources
5. More synergy with Electric Vehicle batteries (competition)
6. Easier installation and maintenance (240 V)
7. Unit outage is less critical to the grid (smaller)
8. Lower resistive loss in wires (closer to customer)
9. A better fit into the Smart Grids & MicroGrids

CES Functional Specifications – Open to Public

AEP Specifications for CES is
"OPEN SOURCE"
for Public Use and Feedback.

Latest Version available from

www.aeptechcenter.com/ces

EPRI is Facilitating Industry-Wide Collaboration with Utilities and Vendors

Key Parameters	Value
Power (active and reactive)	25 kVA
Energy	50 kWh
Voltage	120V / 240V
Round Trip AC Energy Efficiency	> 85%

CES Cost Forecast

PHEV, and its battery development, is a **US National Priority** as well as having an extensive global competition

Pending the successful market penetration of PHEV, CES cost forecast (for a 2-hour system) over the next five years is:

- **$1,000 /kW** Commodity Pricing will keep this number low

or

- **$500 /kWh** PHEV Penetration will push this number down

Conclusion

We See Higher Value in

Utility Owned & Operated

Grid-Connected Energy Storage

Located

Closer to Our Customers