EPRI 4th International Conference on Integration of Renewable and Distributed Energy Resources

American Electric Power's

Community Energy Storage

Paul R. Thomas

Grid Management Deployment

AEP AMERICAN® ELECTRIC POWER

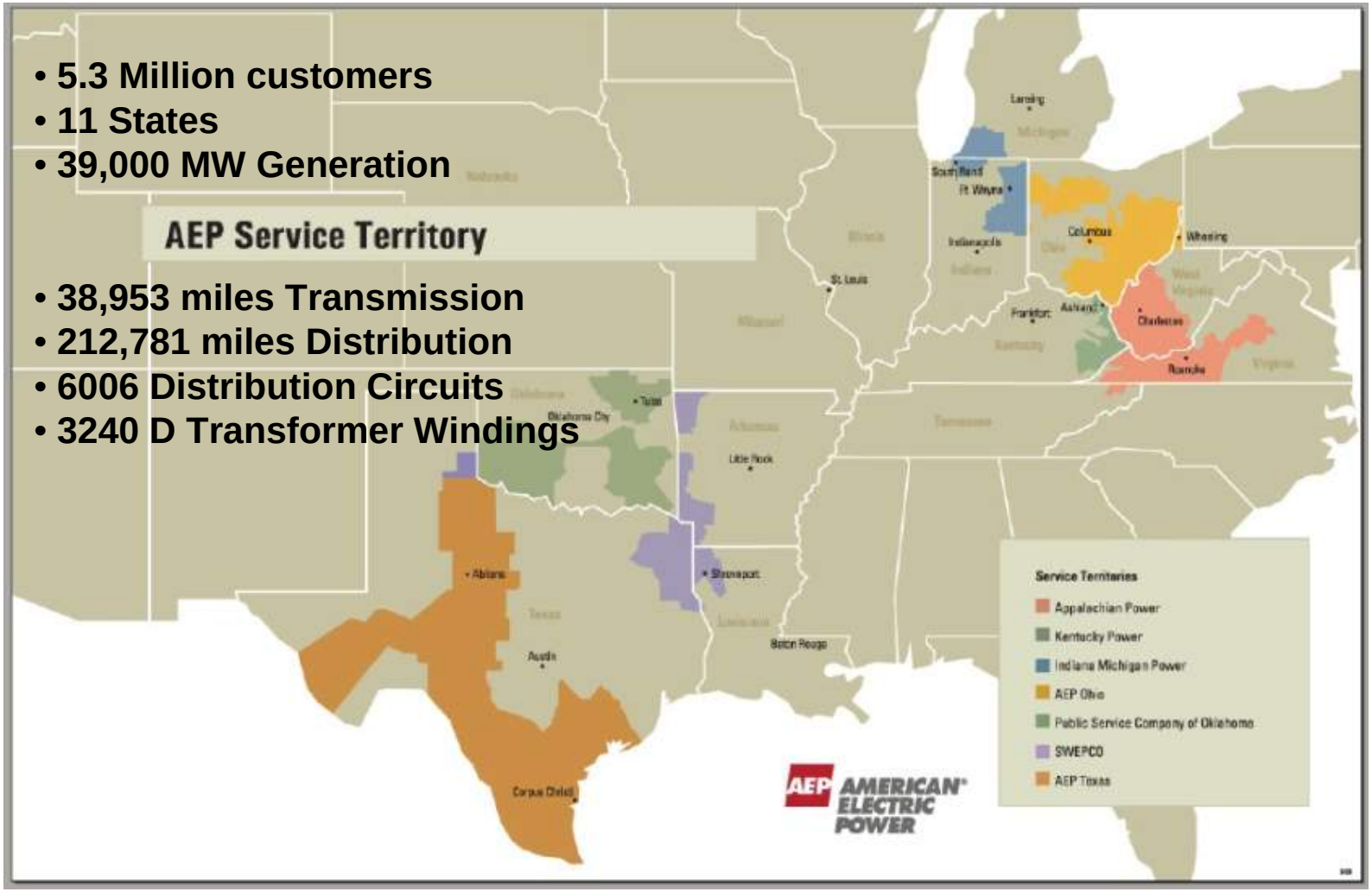
gridSMART℠ from American Electric Power

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



gridSMART from American Electric Power

Community Energy Storage At AEP

- The Next Step -

AEP Ohio

Community Storage

Storage Deployment at AEP

Community Energy Storage (CES) – the next step

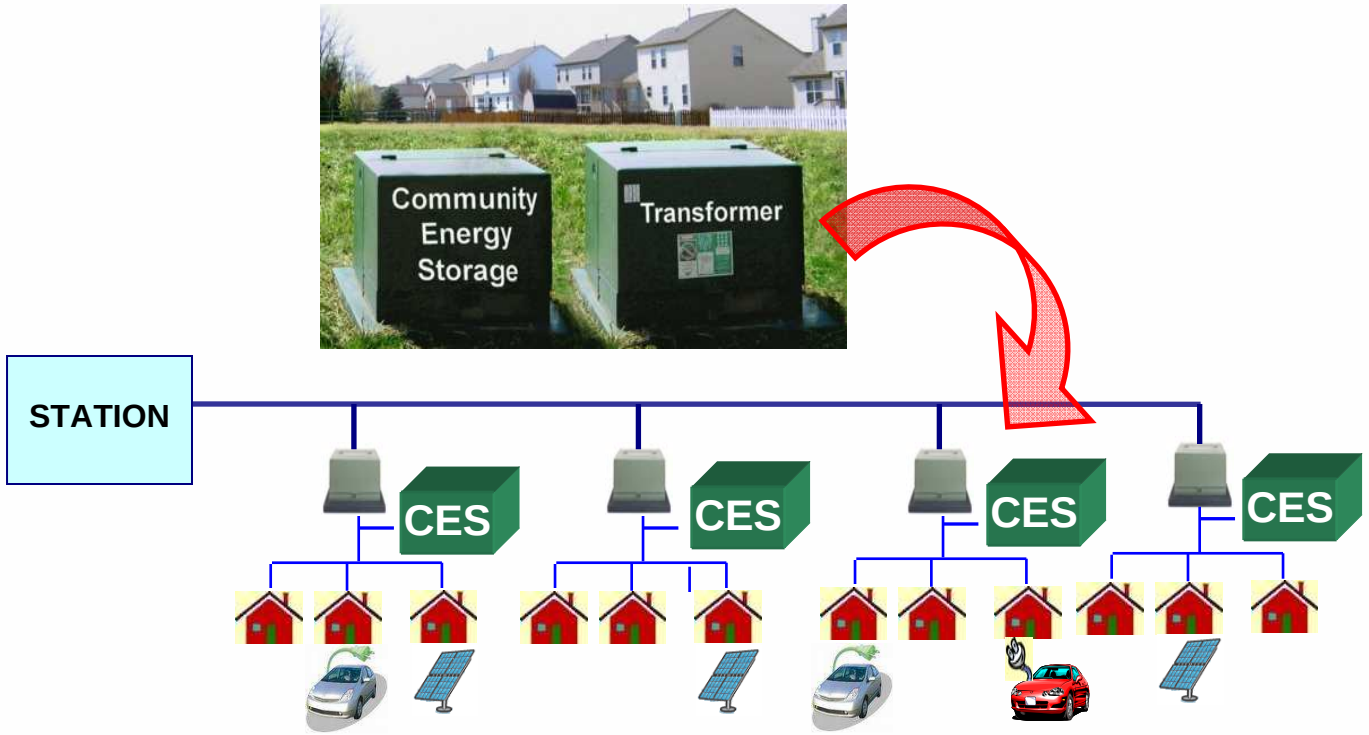
Load Leveling using a CES fleet

Energy allocation during backup

CES Deployment Challenges

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

Key Parameters	Value
Power (active and reactive)	25 kVA / 25 kW
Energy	25 kWH future 75 kWh
Voltage	240 / 120V AC
Battery – Similar to PHEV	Li-Ion
Round trip efficiency	> 85%

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

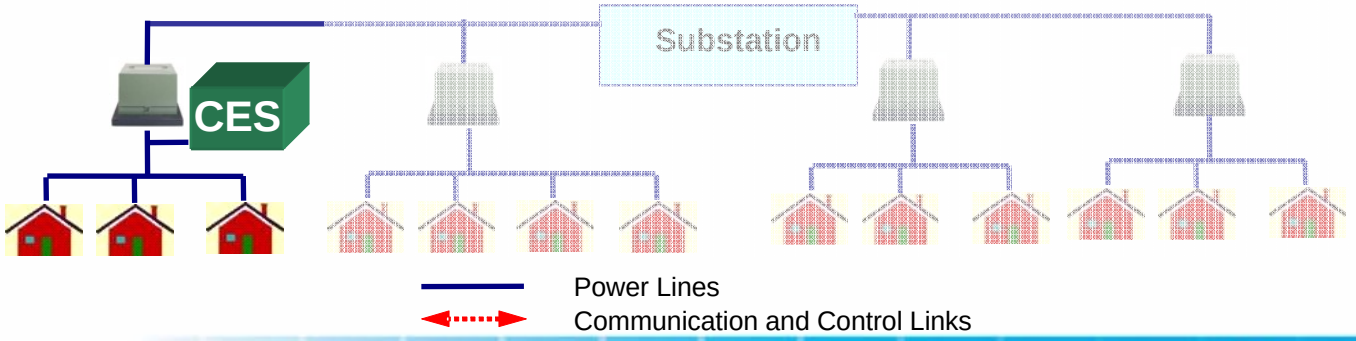
www.aeptechcenter.com/ces

CES – Virtual Station Scale Storage

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

Local Benefits:

1) **Backup power**
2) **Flicker Mitigation**
3) **Renewable Integration**



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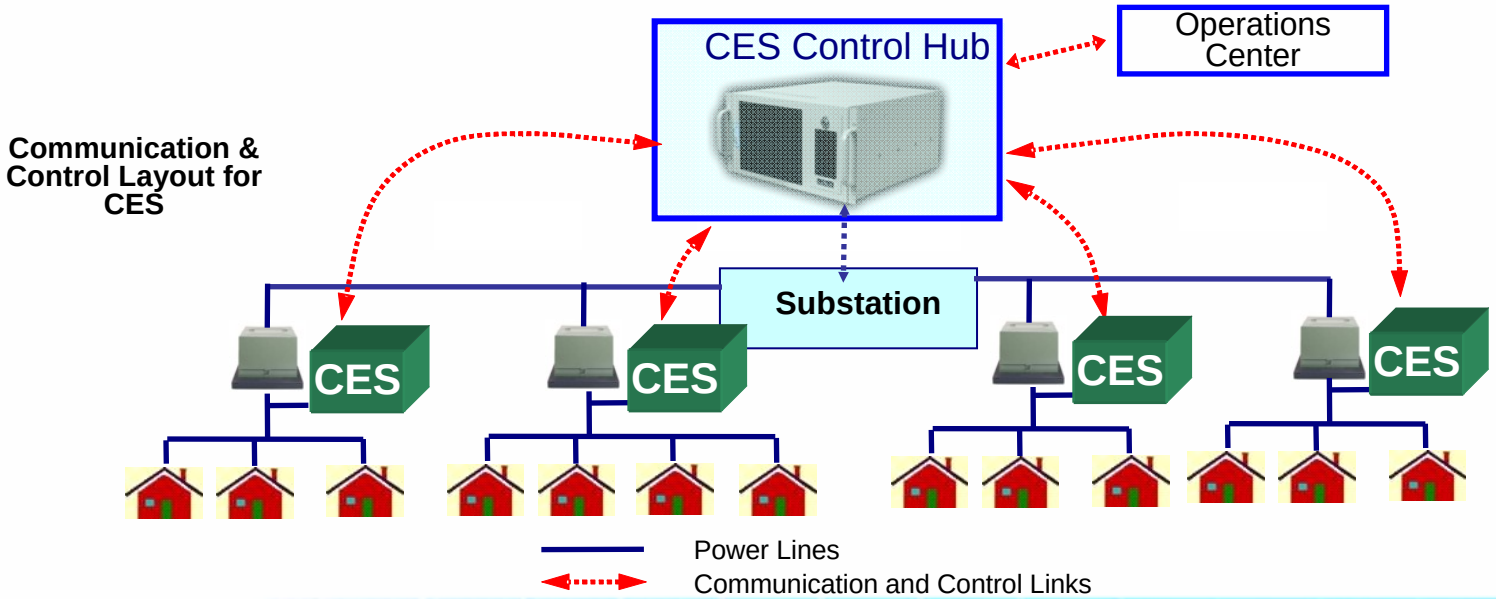
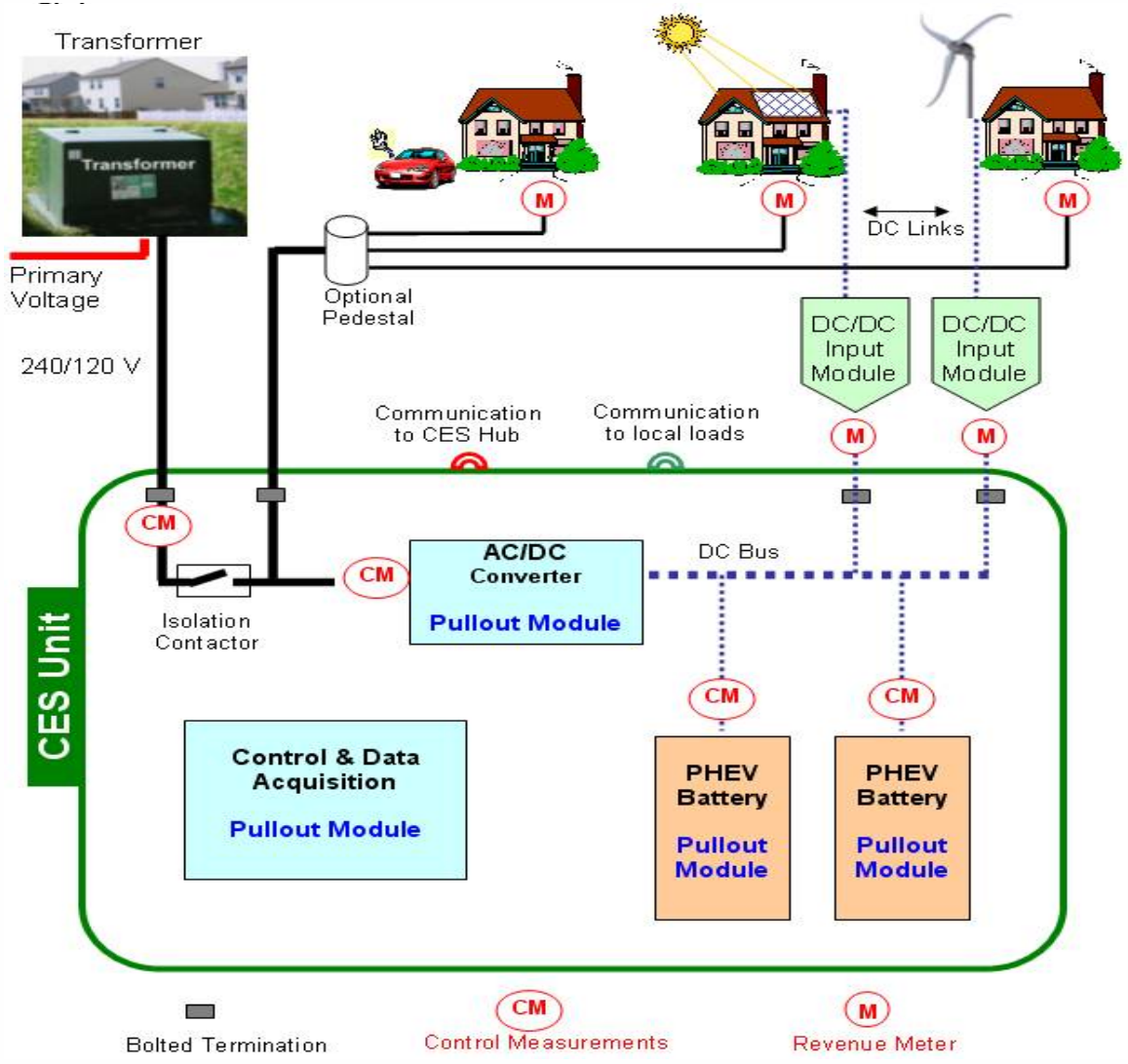
Grid Benefits:

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



CES Layout


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

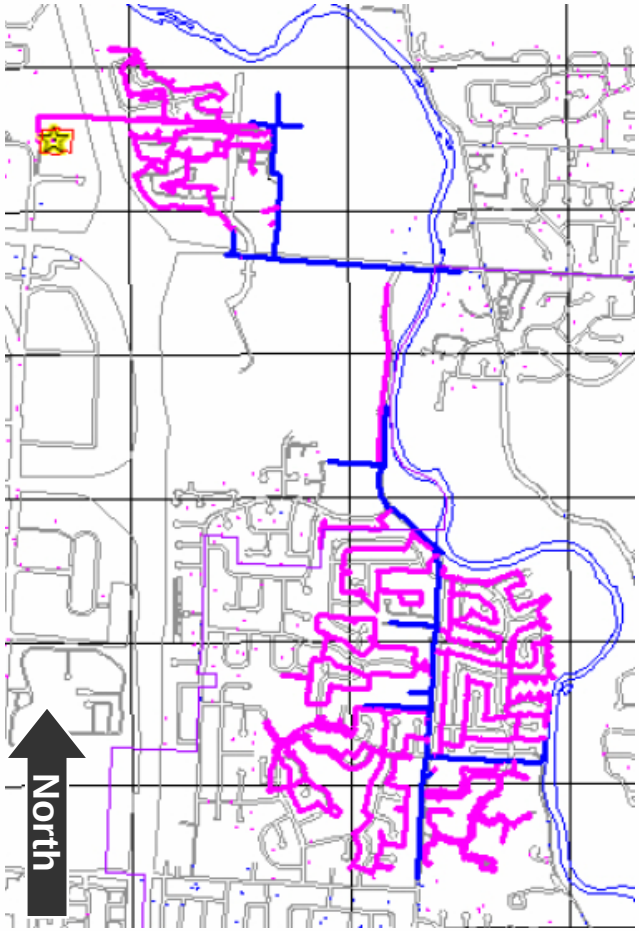
AEP Ohio GridSMART Demonstration - CES

AEP OHIO®
A unit of American Electric Power

- **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:**

  Jun 2010 Deliver Prototype 1
  May 2011 First 0.5MW
  Oct 2011 Remaining 1.5MW

- **Status:** Oct 2010 – Finalized testing of 1st prototype, awaiting 2nd prototype by end of Nov '10



Morse Rd 5801

CES – NE Columbus Project Benefits.

Community Energy Storage

gridSMART℠ From AEP OHIO

80 units, 25kW (2 MW/2 MWh)

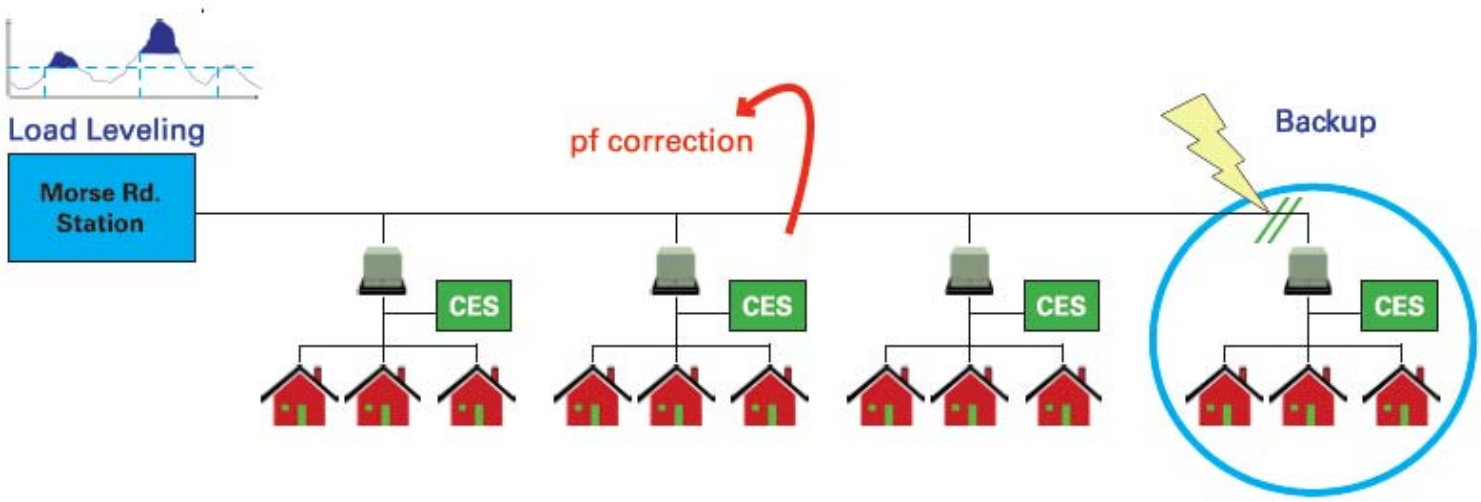
Control hub at Morse Rd Station (northern Columbus)

Circuit F5801

13kV, 6.3 MV peak load

1,742 customers

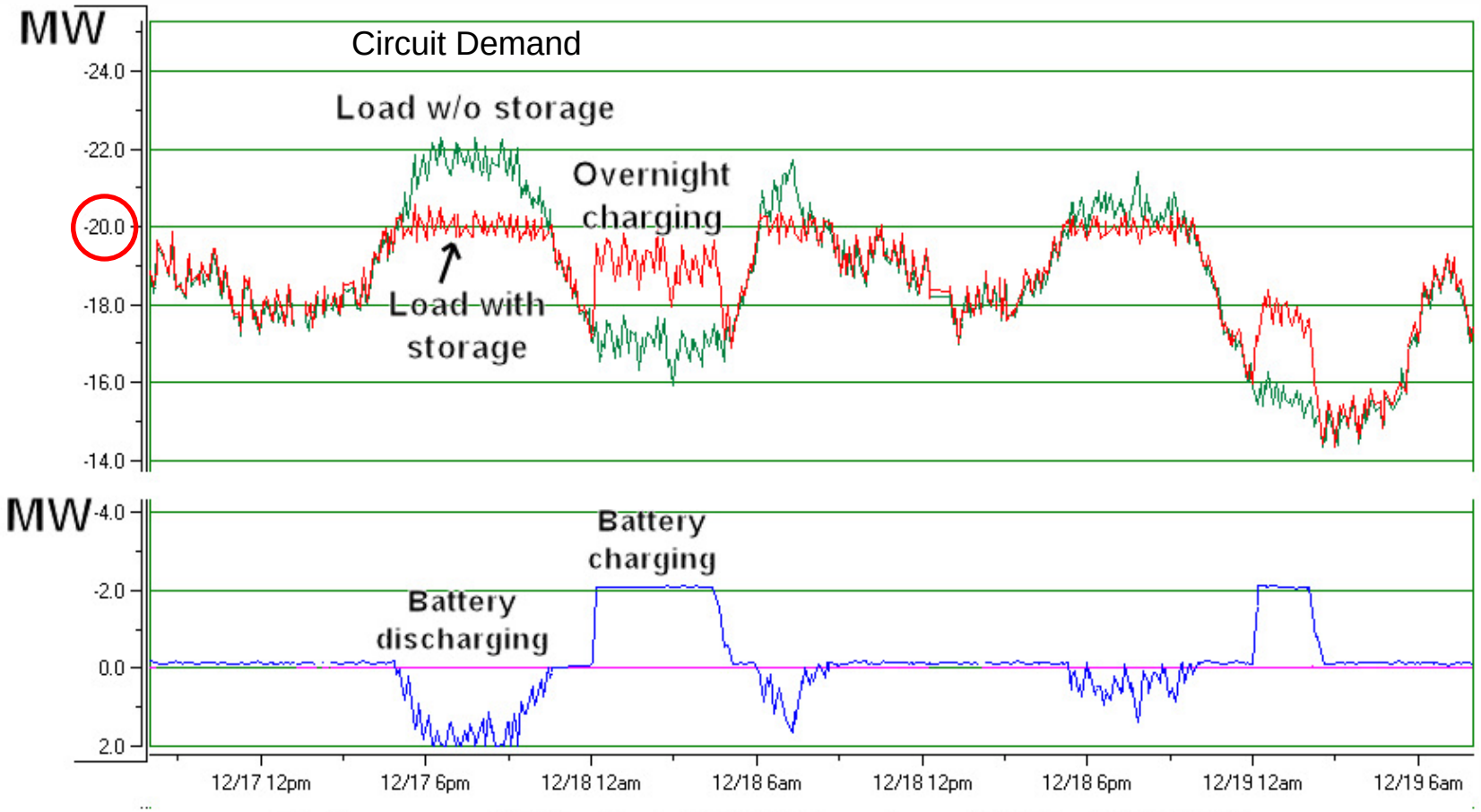
System will cover approximately 20% of customers



Prototype testing at Dolan Technology Center

Dolan Technology Center Installation

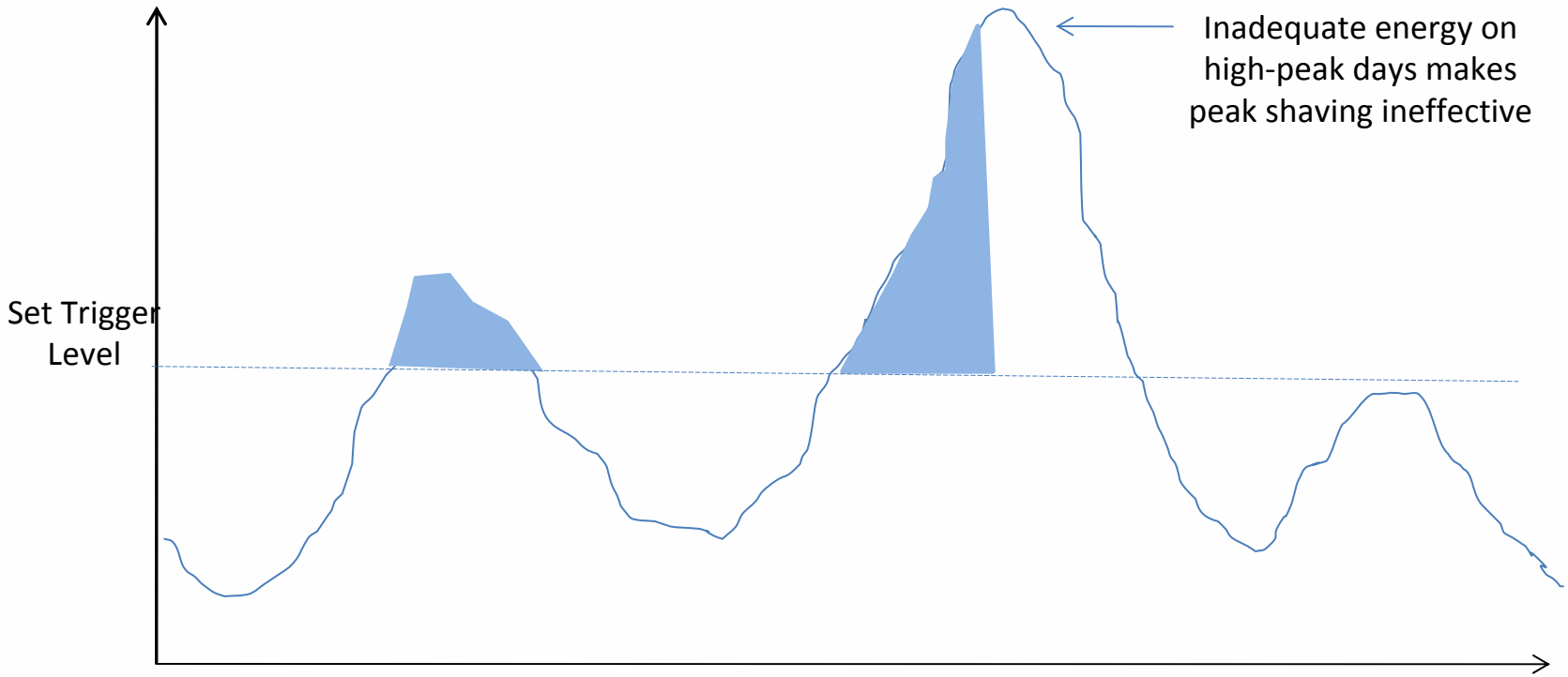
Circuit Load Leveling Example



Performance of Balls Gap's 2MW Battery from 12/17 to 12/19/2008

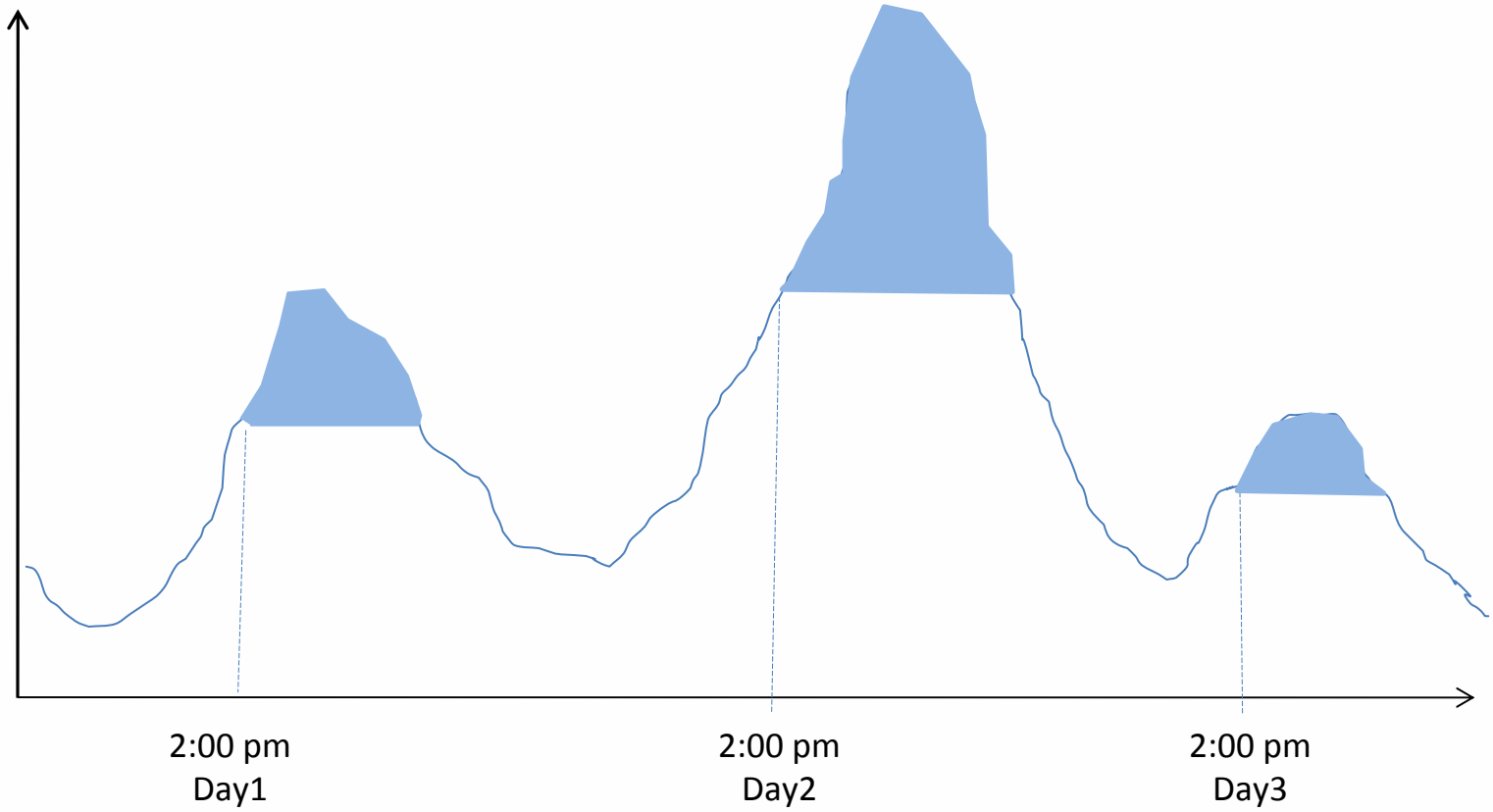
Demand Triggered Load Following

Ideal and simple if stored energy is sufficient. However, there is no assurance that stored energy would be adequate and , therefore, peak shaving could be completely ineffective.



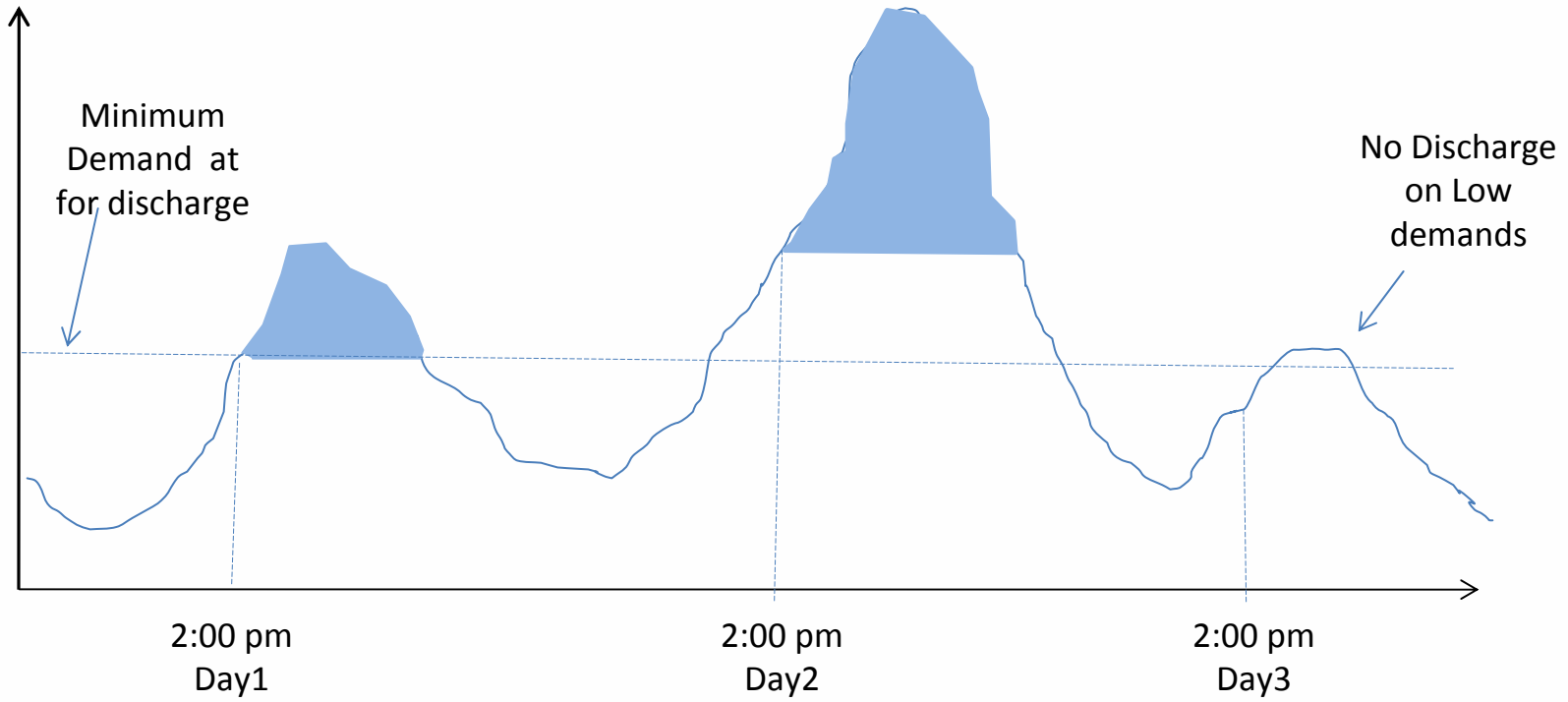
Time Triggered Load Following

Simple and the amount of energy is somewhat proportional to the peak load but there is no assurance that stored energy would be adequate



Time & Min Demand Triggered Load Following

- Set Points:
  - Start Time (same for all days)
  - Minimum Demand below which no energy should be discharged



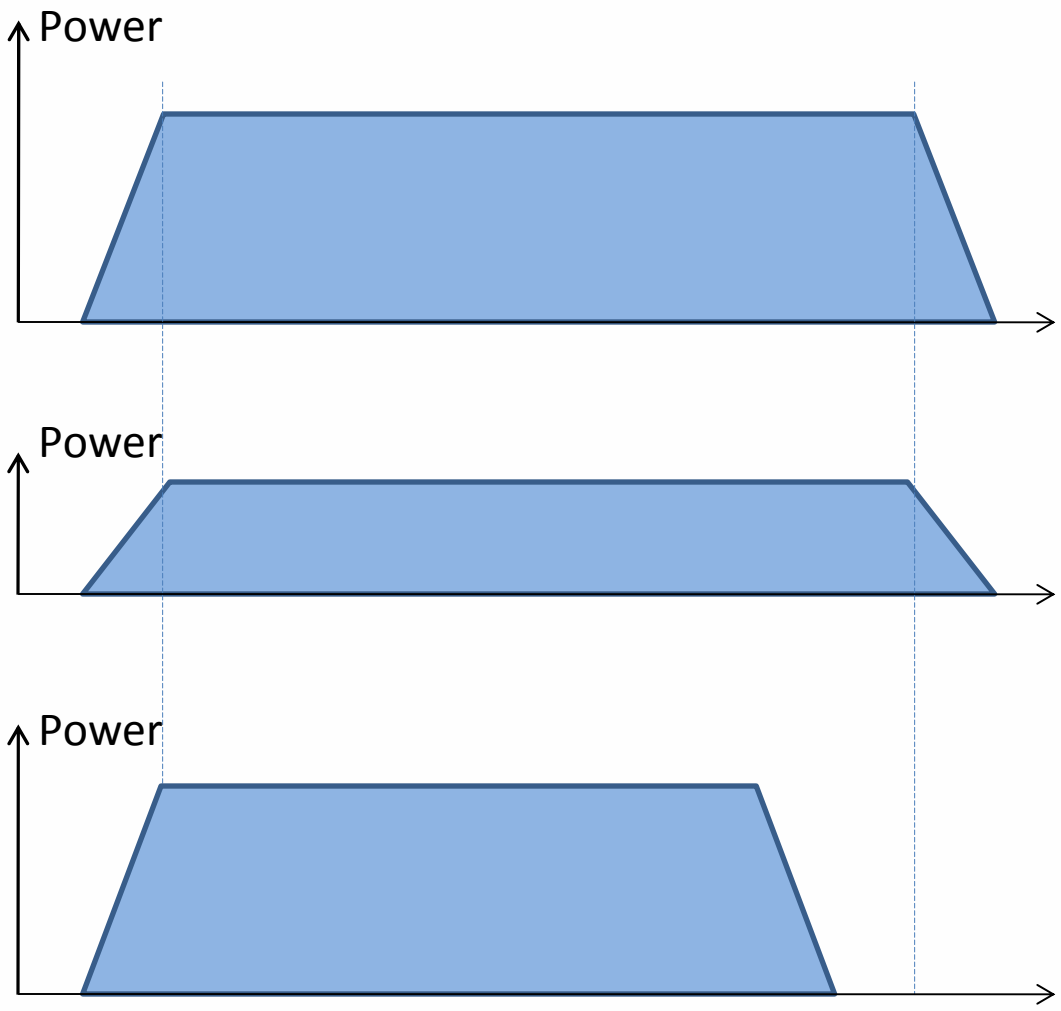
CES Unit Power & Energy

Case 1 – Reported Available energy is sufficient

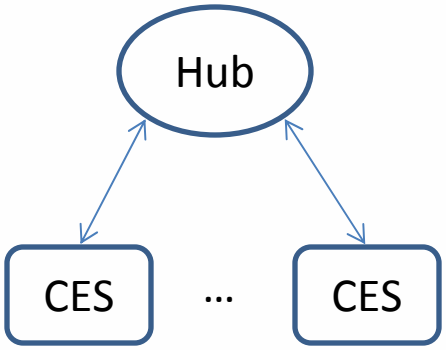
Case 2 – Available energy is not sufficient

1.Planner Option (Keep Duration, reduce Power)

2.Dispatcher Option (Keep Power, reduce duration)

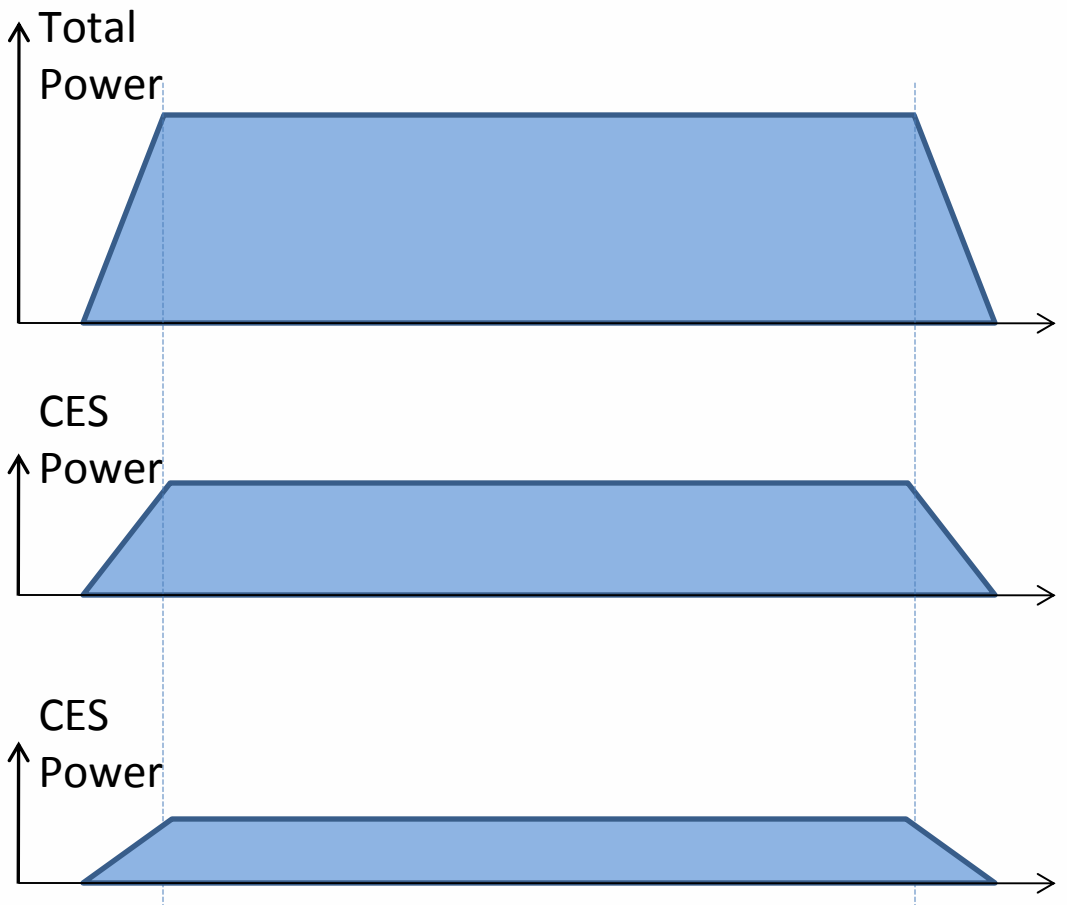


Hub Power & Energy – *Duration Priority*

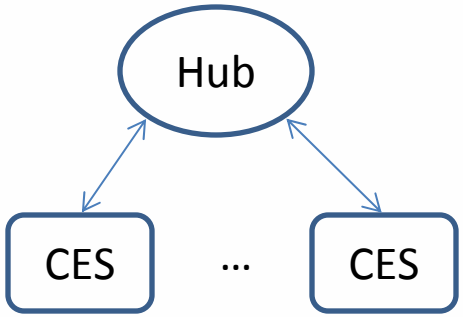


CES Power =Proportional to its available energy to equalize energy in all CES

If the available energy in any CES unit is NOT sufficient, its Power level will be reduced to keep the set duration

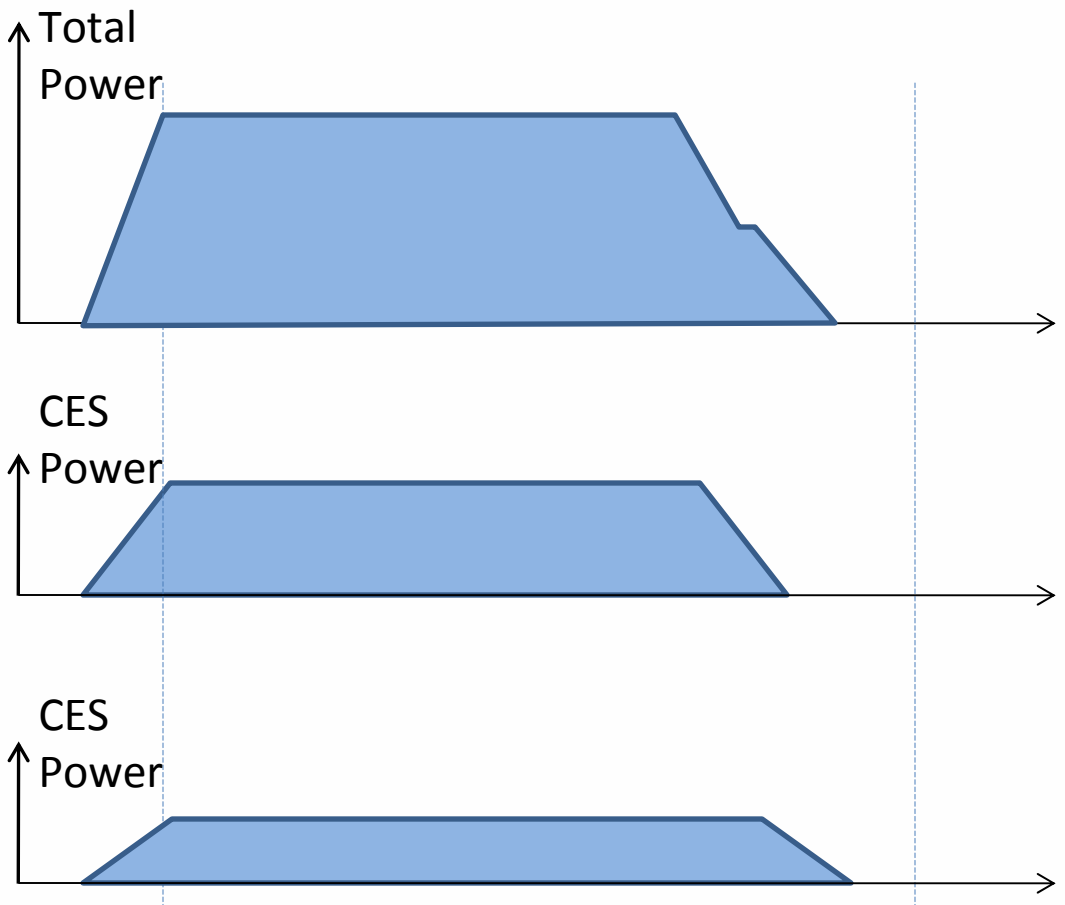


Hub Power & Energy – *Power Priority*

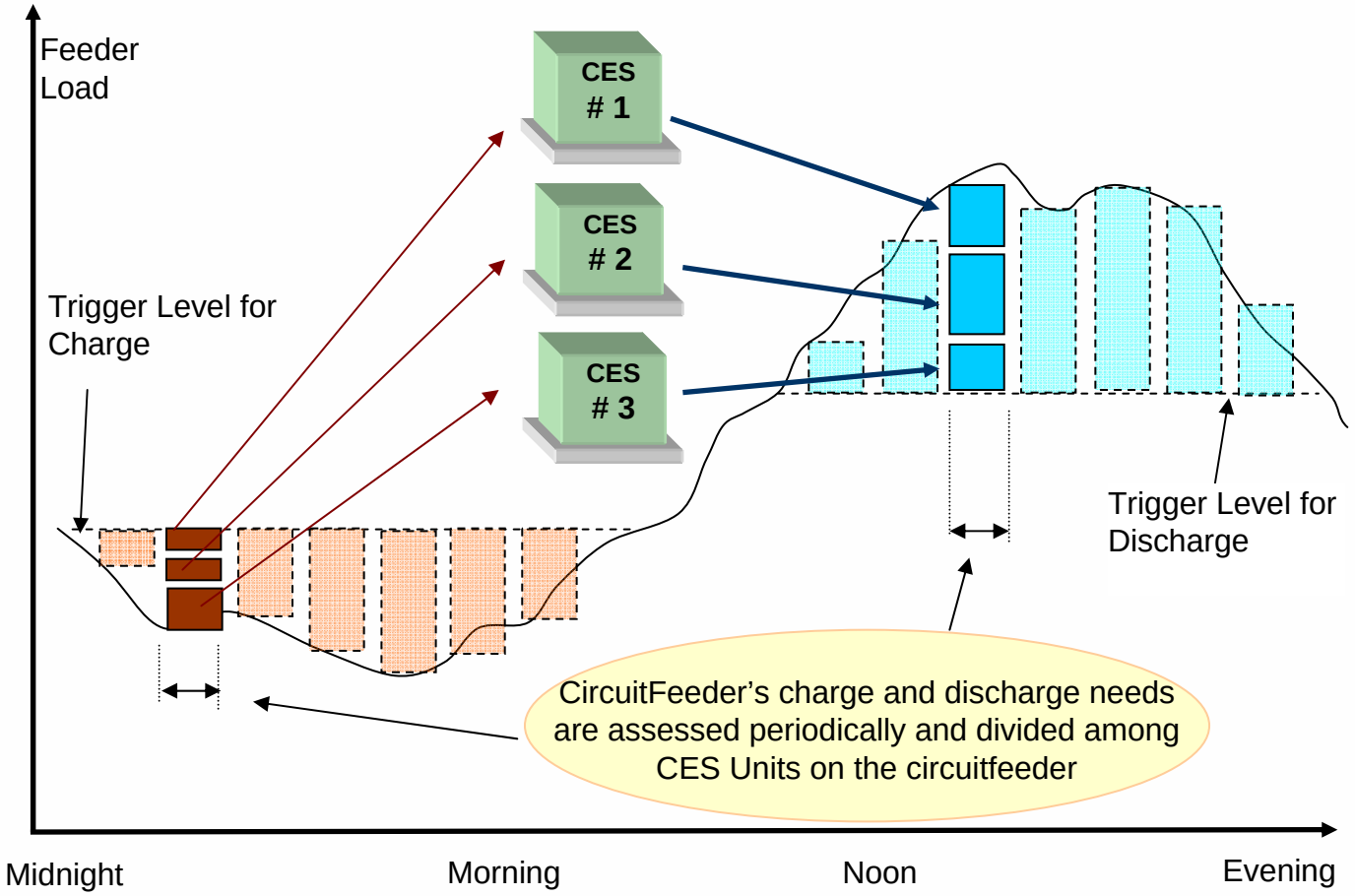


CES Power =Proportional to its available energy to make all CES units last almost the same duration

If the available energy in any CES unit is NOT sufficient, Duration will be reduced to keep the set power as long as possible

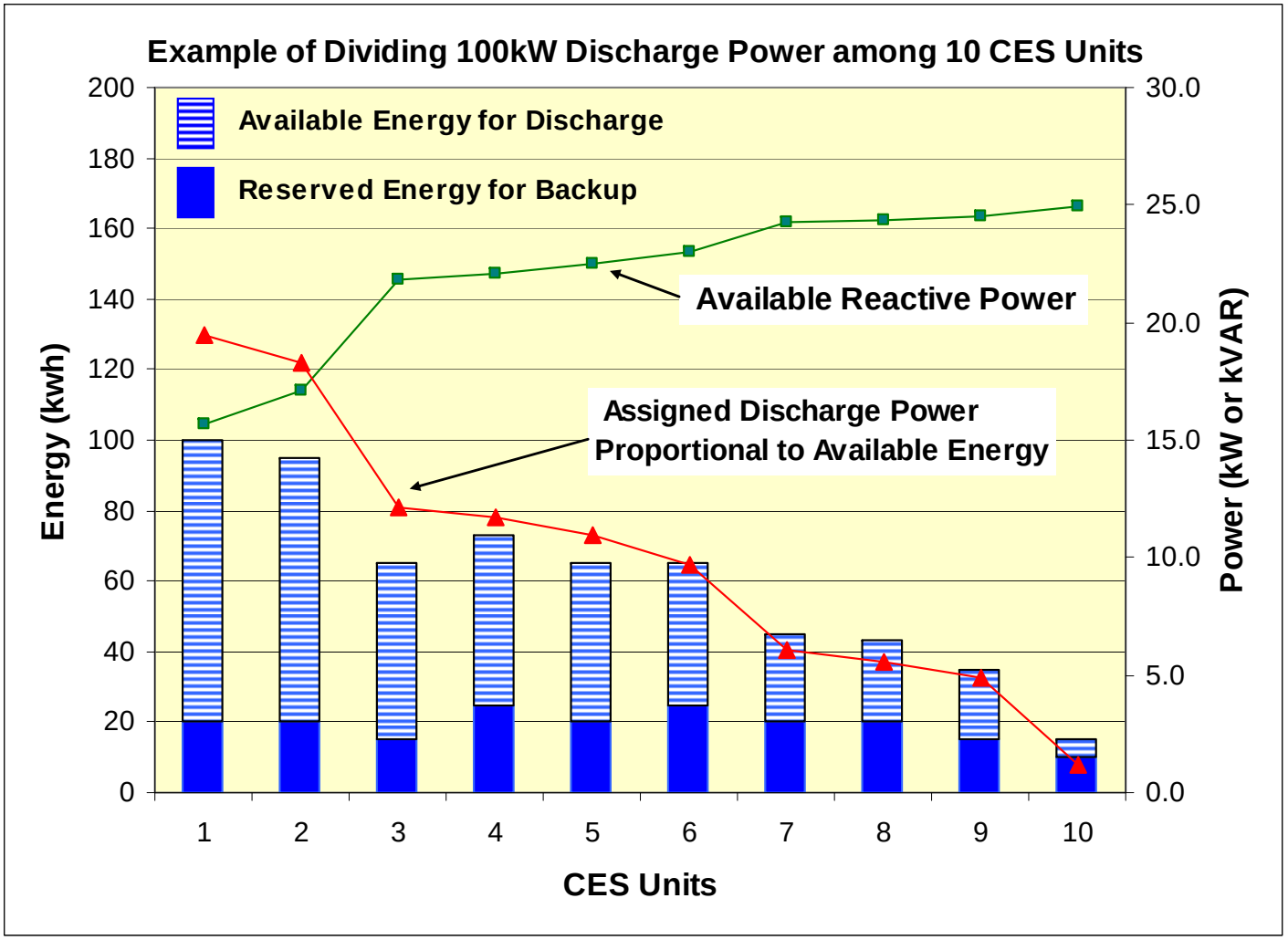


Load Leveling – Spread Across the CES Fleet



Feeder level demand profile showing CES Unit charge and discharge

Load Leveling – Spread Across the CES Fleet



CES Energy Allocation during backup

Each customer connected to the CES Unit gets a fair share of available stored energy at the time an outage occurs.

CES goes into backup (island) mode

1. Establish the island, calculate available energy per locally connected customer; x kWh
2. Instruct each locally connected collar to initiate energy limiting; allow x kWh
3. If a customer reaches energy allocation, x kWh, the collar opens its disconnect switch

CES Energy Allocation - Return

CES returns from backup (island) mode when the circuit returns to normal (system is stable for 5 minutes)

1. CES synchronizes and reconnects to circuit, closed transition
2. CES cancels energy allocation instruction to each locally connected collar
3. Each open collar closes the disconnect switch {unless there was another active command to open}

CES Customer In Home Display

CES Presentation to customer; System Normal

- *Backup is Available (Date/time of status)*

Backup Notification

- *Backup Started (Date/Time)*
- *Remaining Energy (kWh for this customer)*
- *Time Remaining at current usage (Hr:Min)*
- *Current Usage (kW)*

CES Customer Interface Challenges

- Another box in the yard, installation
- Equipment access for maintenance
- Transformer has 4 customers, 2 are interested
- Reliability is not really a problem
- My neighbor will use all the energy

Conclusions

- **Multiple Benefits** can be recognized; G, T, & D
- **Technology** is advancing and costs are dropping
- **Multiple Storage Formats** are needed to meet all storage objectives
- **Smart Grid** Enables smart storage
- **Community Energy Storage (CES)** is the logical next step

AMERICAN® ELECTRIC POWER

Questions?

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