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from American Electric Power

# Dynamic Islanding: Improving Electric Service Reliability with Energy Storage

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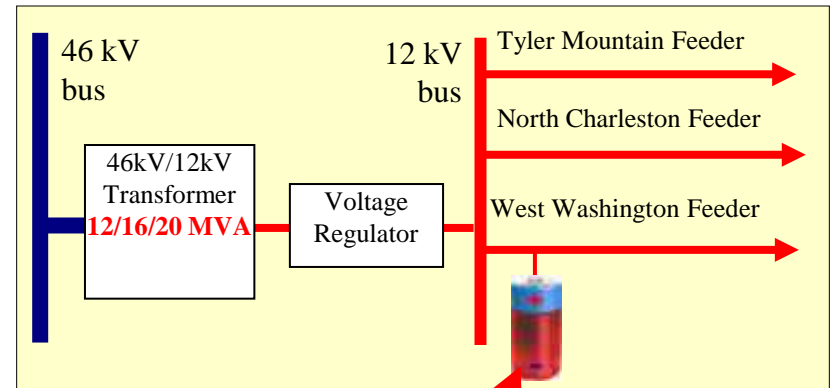
# Project Description

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- Outages on distribution system can last several hours.
- Energy Storage Systems can be leveraged to reduce impact of outages.
- Project demonstrates ability of Energy Storage to mitigate outage impact.
- Three 2-MW systems commissioned in 2009.
- Demonstrated ability to provide backup power.

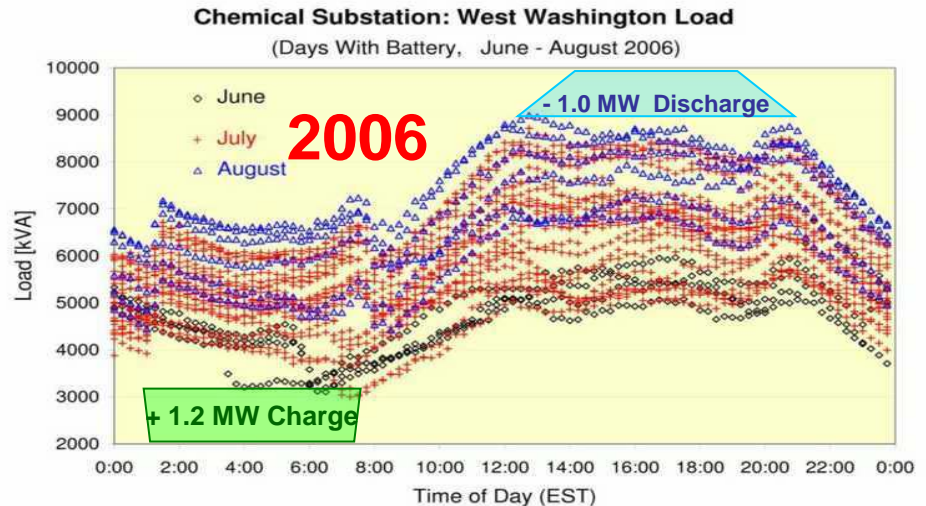
# 2006 - Battery in a Substation for Capital Deferral

- Installed **1MW, 7.2 MWh of NAS** battery on a feeder to defer building a new substation
- Daily Peak Shaving

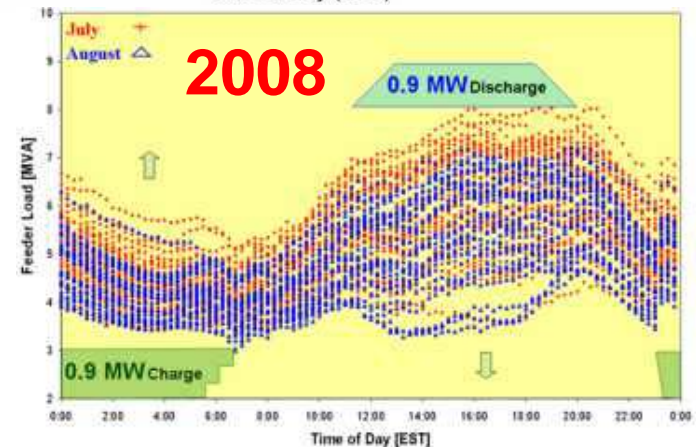
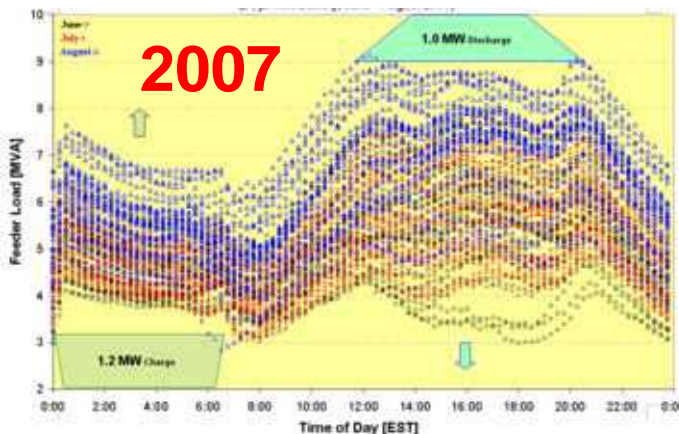


# AEP 2006 Project – Performance Data

- Scheduled trapezoidal Charge & Discharge profiles
- Improved the feeder load factor by 5% (from 75% to 80%)
- AC Efficiency 80% - **Effectively 90%** due to reduced T&D losses  
*( IEEE Transactions on Power Delivery, Vol23, NO.4, Oct 2008, pp2168-73)*

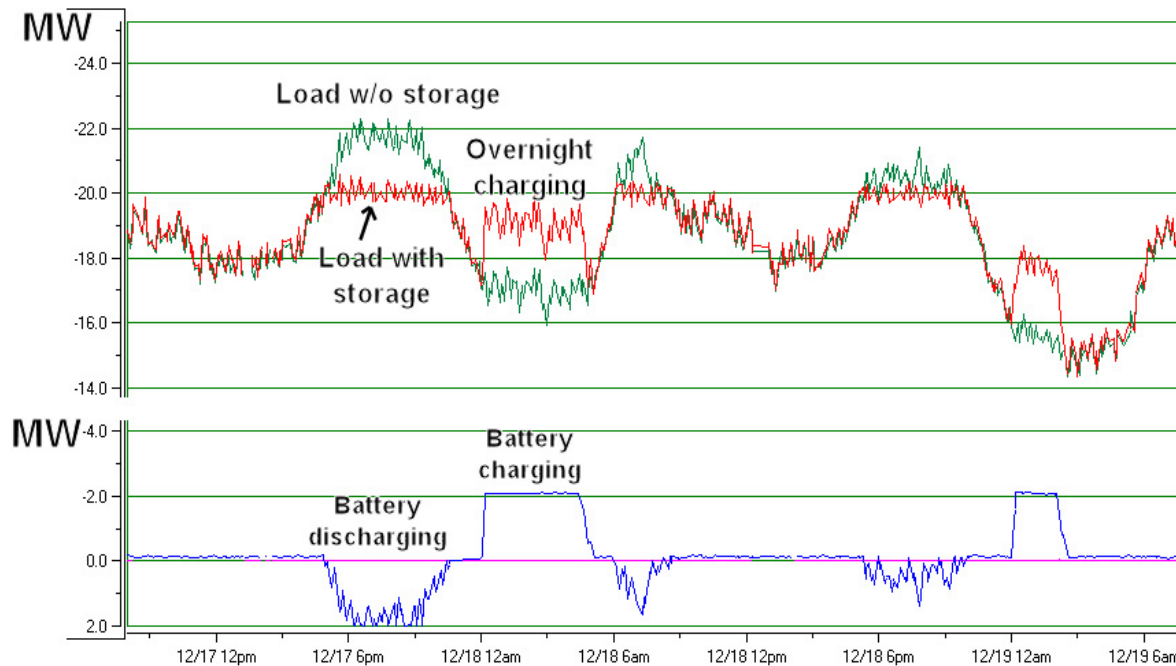


Three  
 Successful  
 Years of  
 Peak  
 Shaving



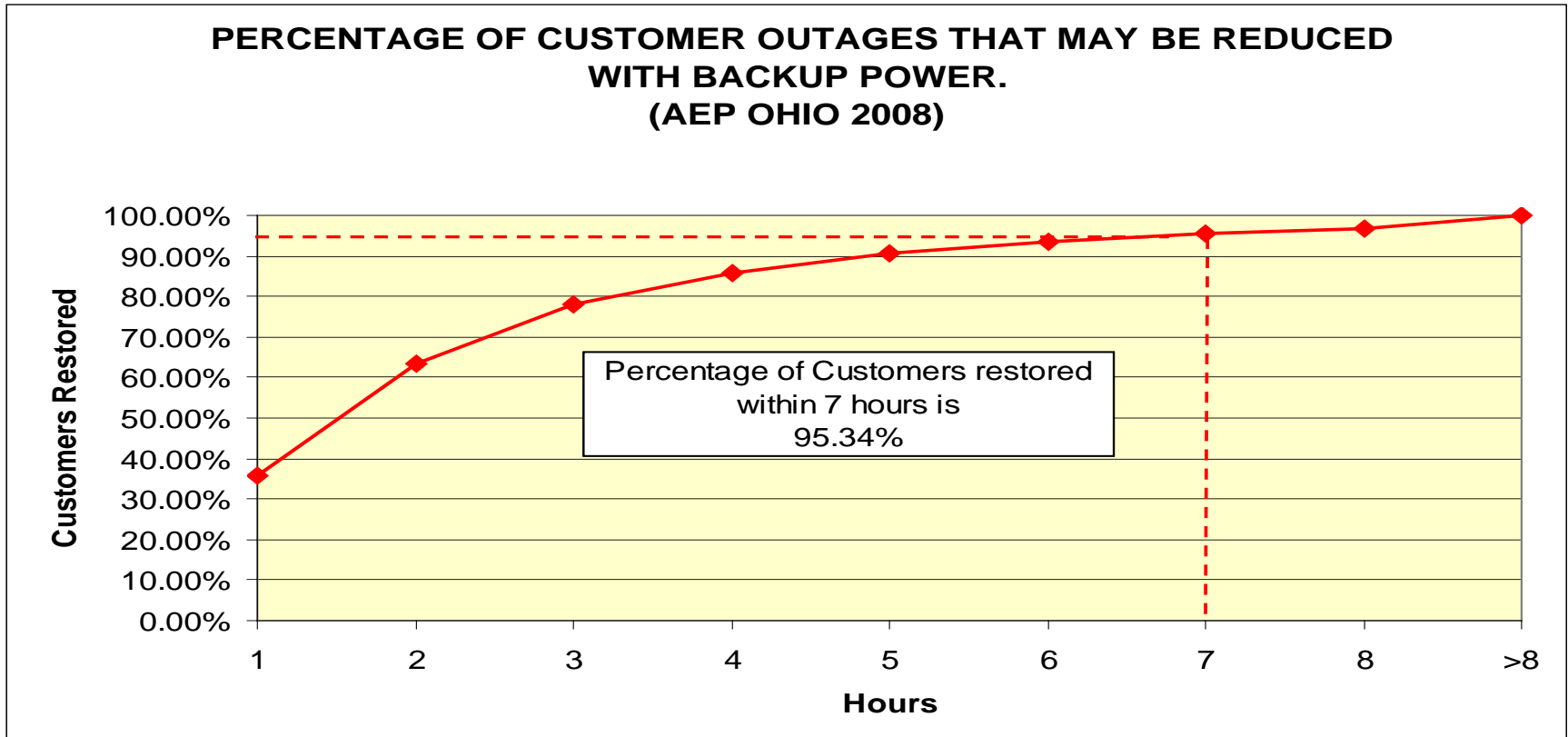
# New Features in the 2009 Storage Devices: Load Following

- Increase battery life with fewer shallow discharges
- Increase availability for backup power and other valuable services



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

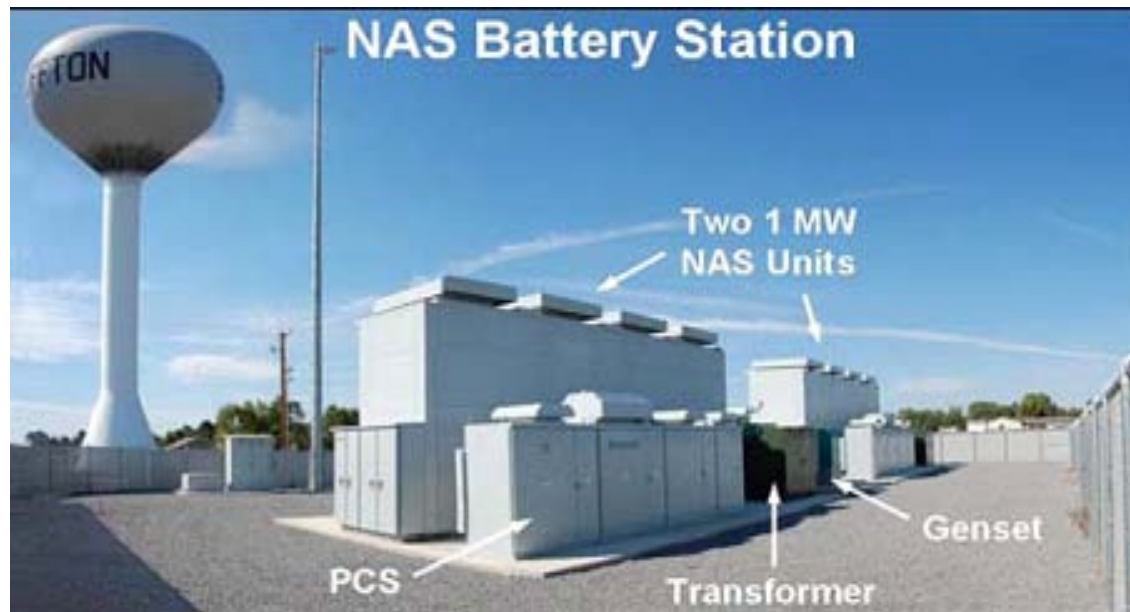
# New Features in the 2009 Storage Devices: Backup Power



**Assumption: excludes traditional major events and momentary outages.**

# 2008 Projects – To Improve Service Reliability

- 2MW, 14.4 MWh in Bluffton, Ohio
- Two other identical sites in West Virginia and Indiana (2008)
- All with dynamic islanding



# 2008 Projects – To Improve Service Reliability

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2MW, 14.4 MWh in Churubusco, IN

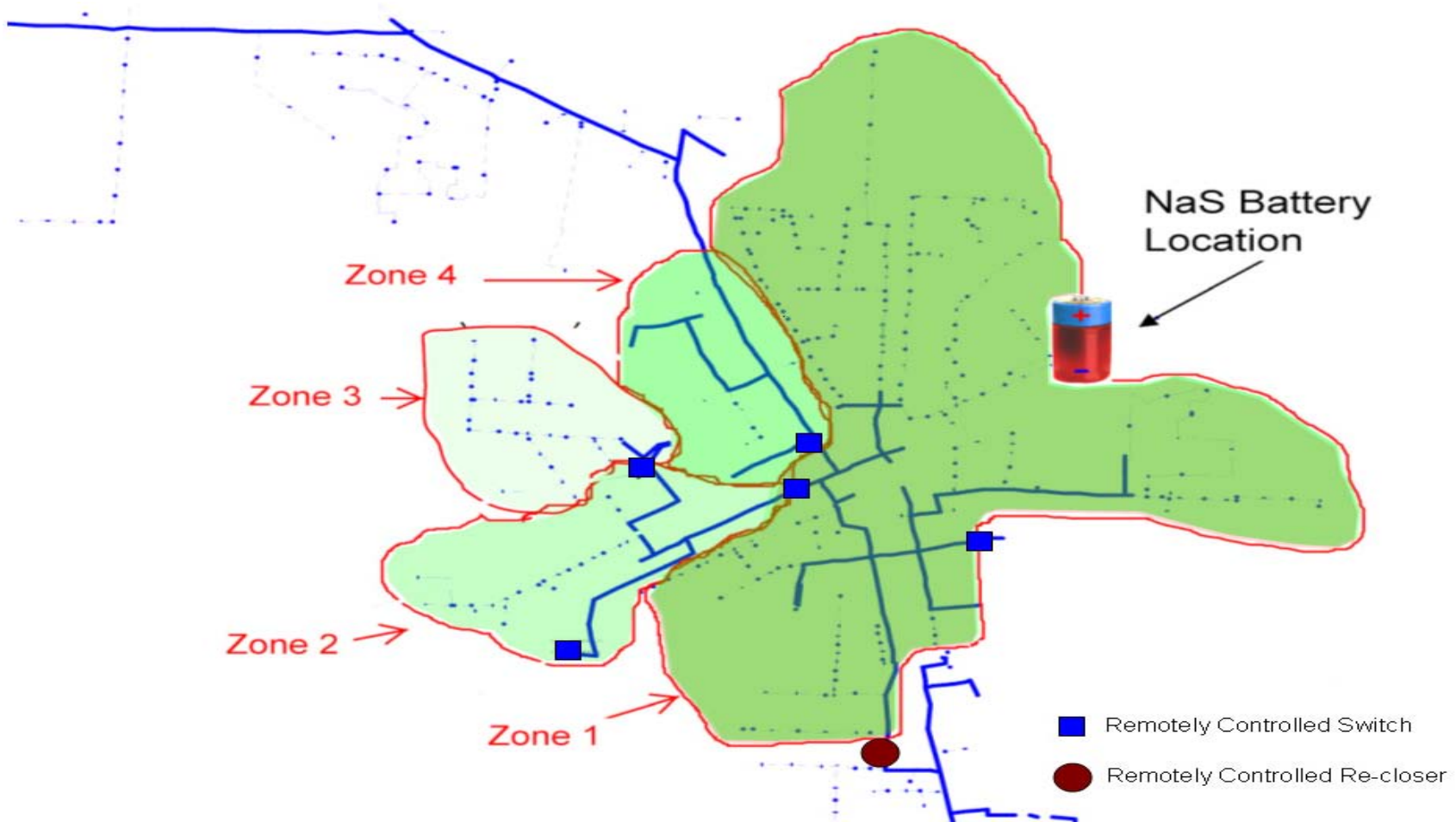


2MW, 14.4 MWh in Milton, WV

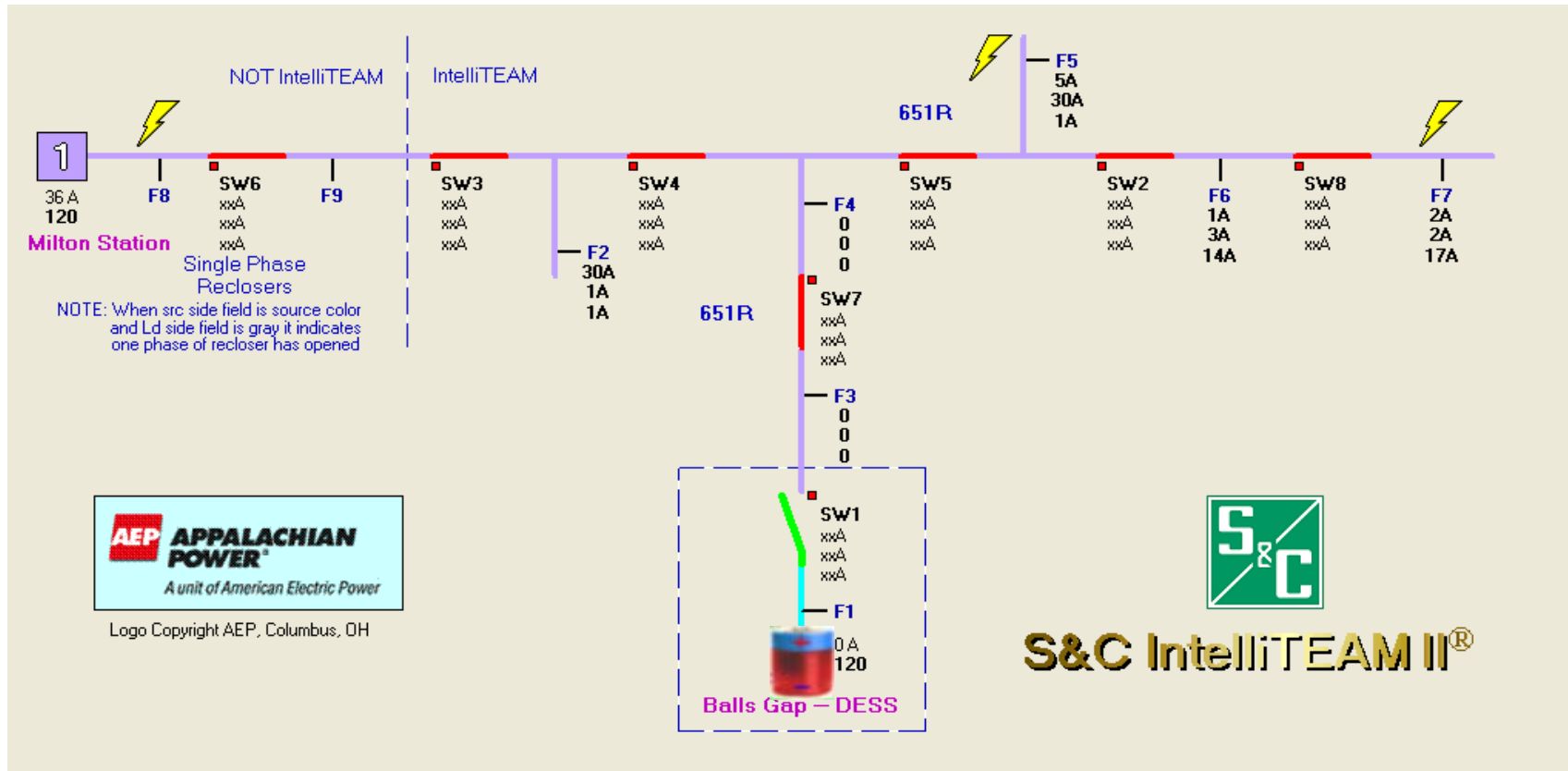




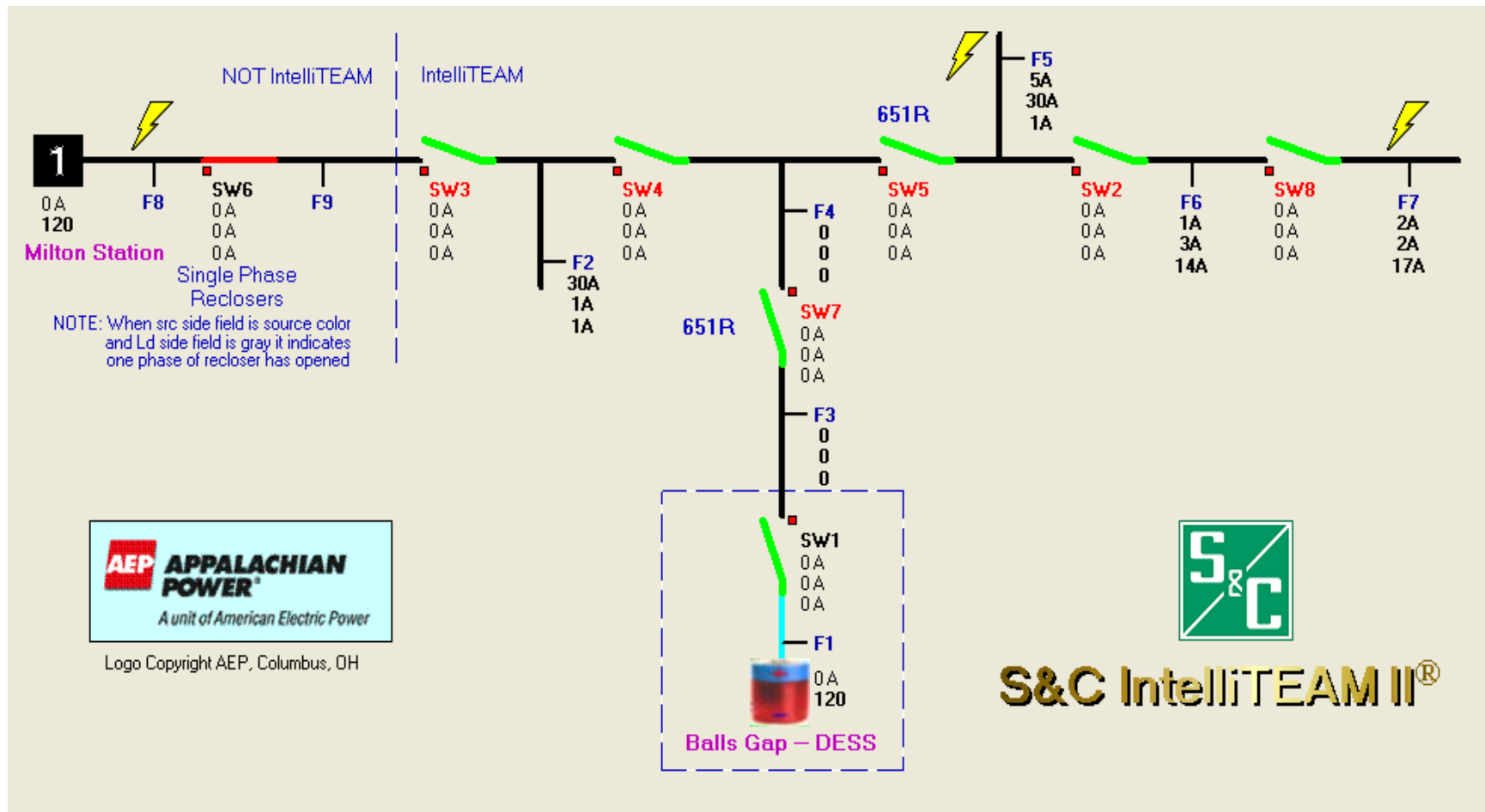
# Churubusco, IN: Battery Islanding Zones.



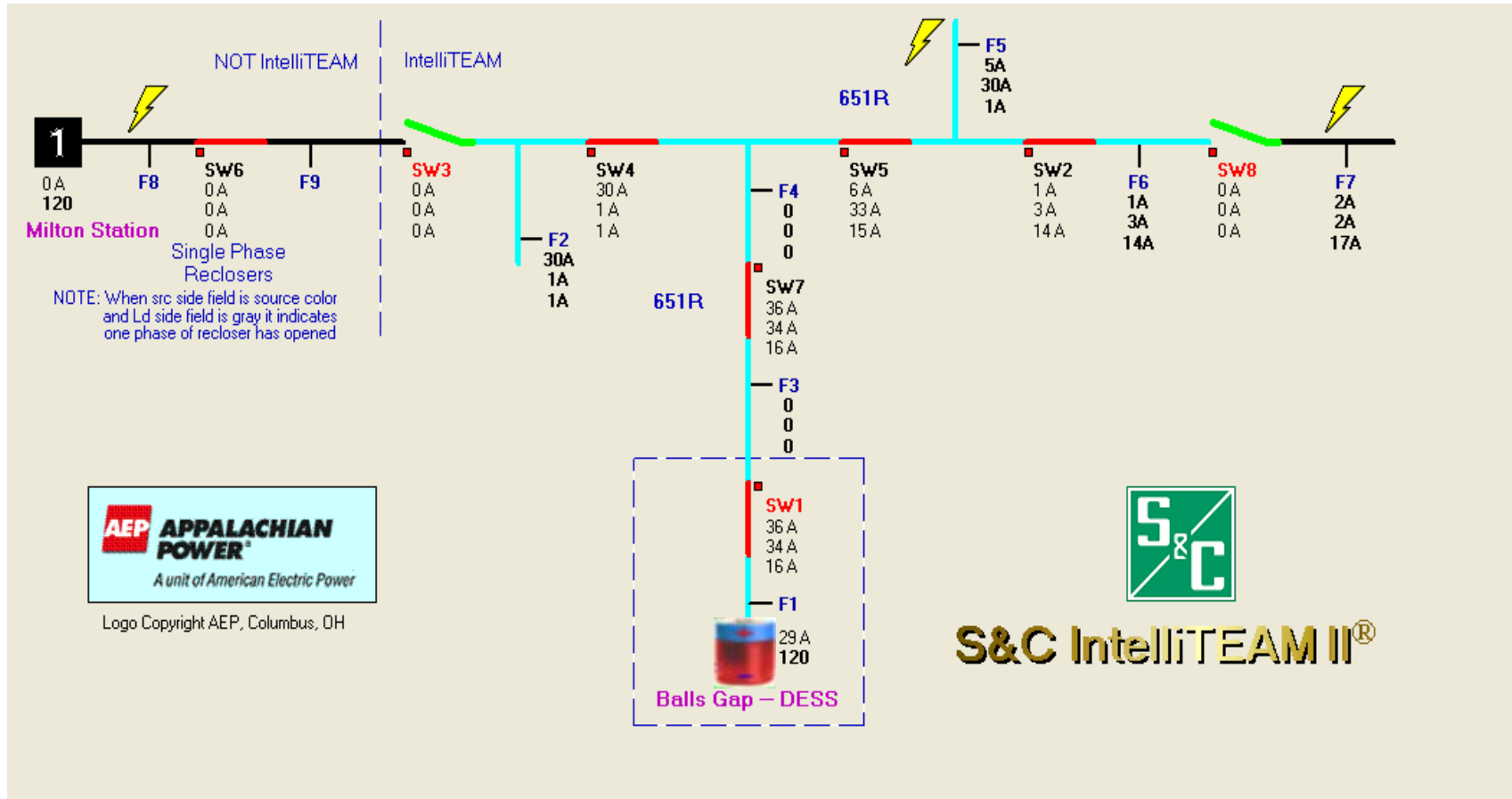
# System Normal : Grid connected. Battery disconnected.



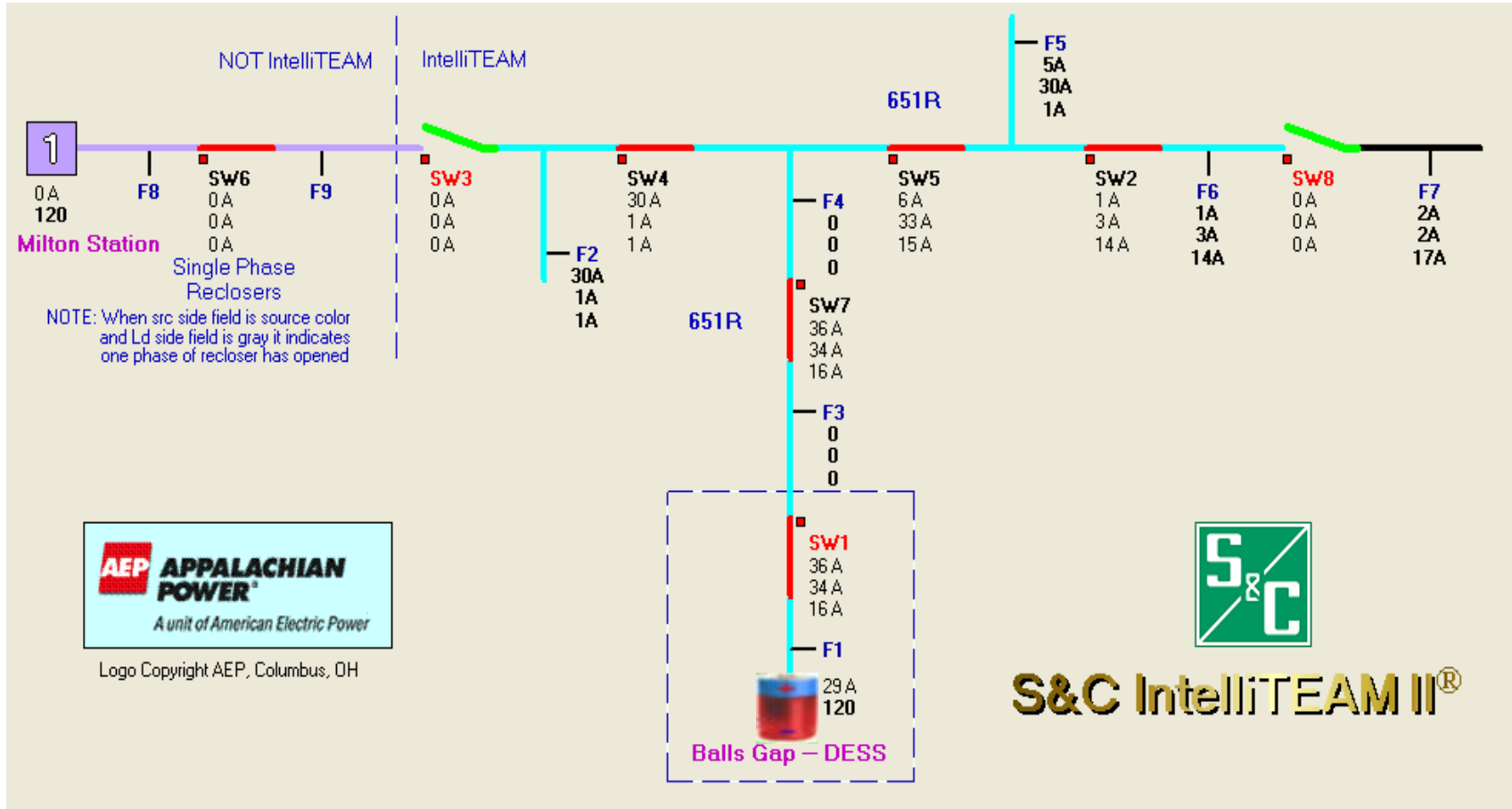
# Fault at F8; loss of grid power. All reclosers and switches in the island open.



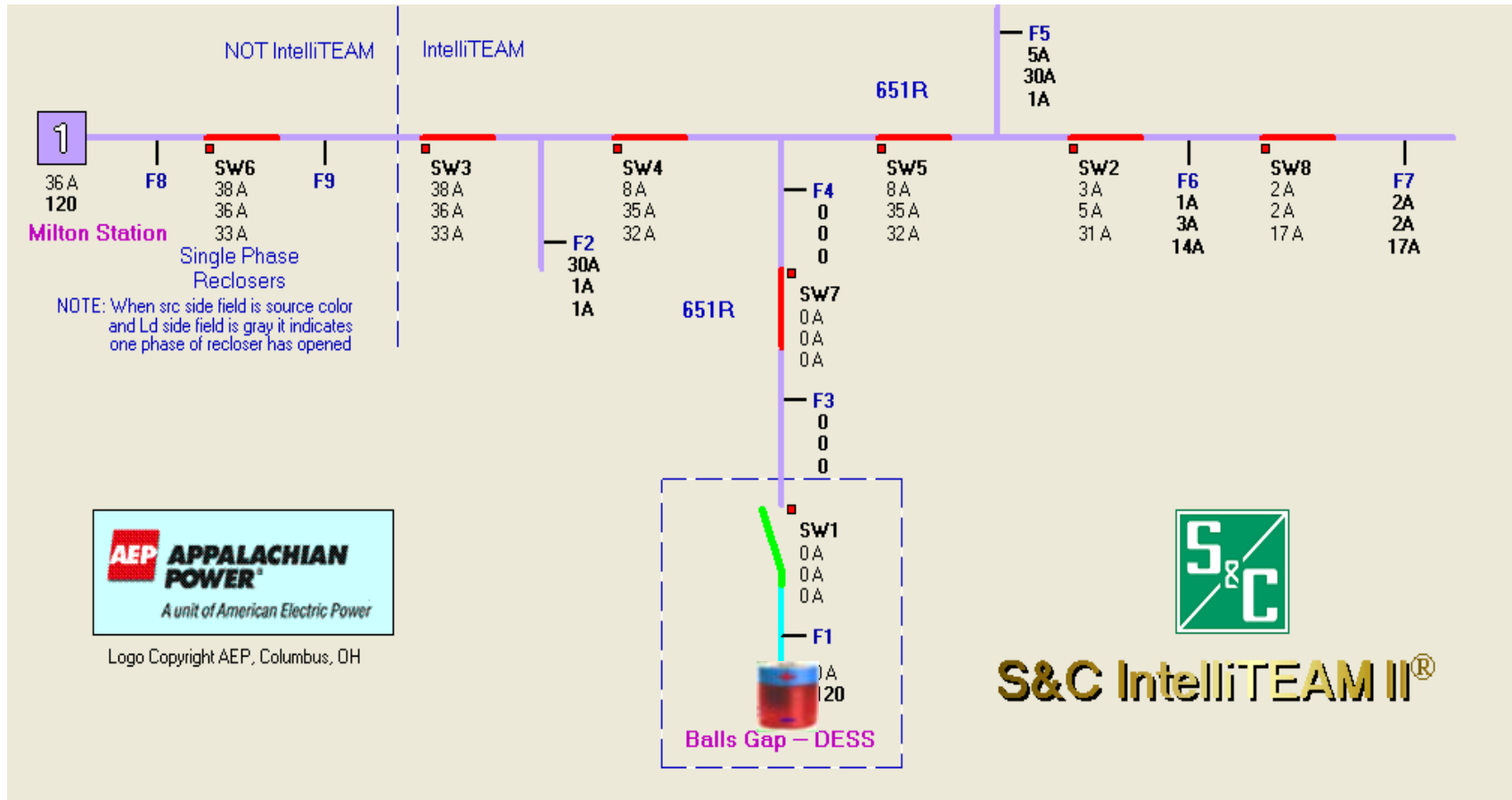
# Battery picks up island based on last load information.



# Grid power restored.



# Battery disconnected. Load connected back to the grid.



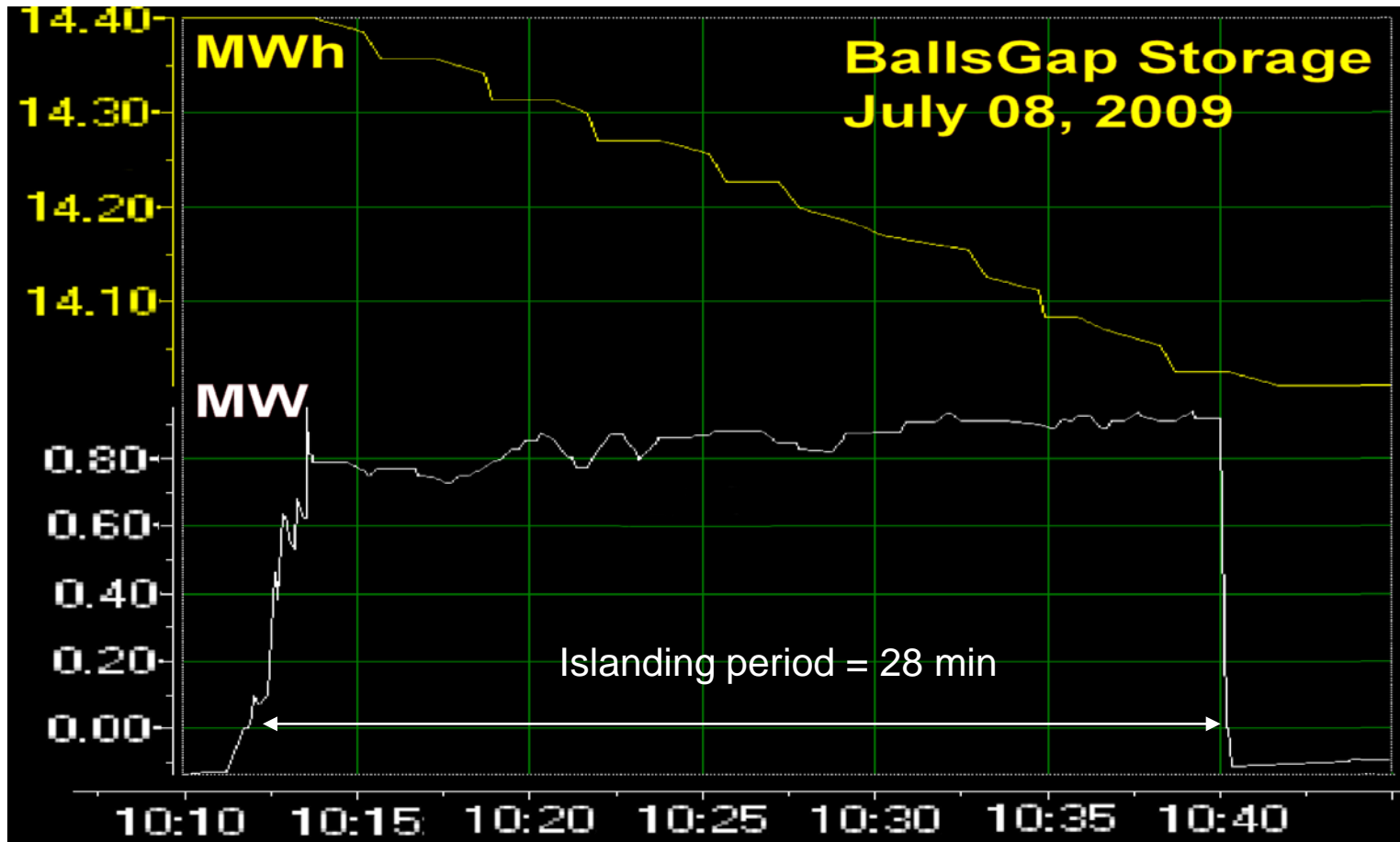
# Live Islanding Test Information

- **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:** 28 min.
- **Time to Exit Island:** 6 sec. (not Synchronized)
- **Average Island Load: 0.8 MW**



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

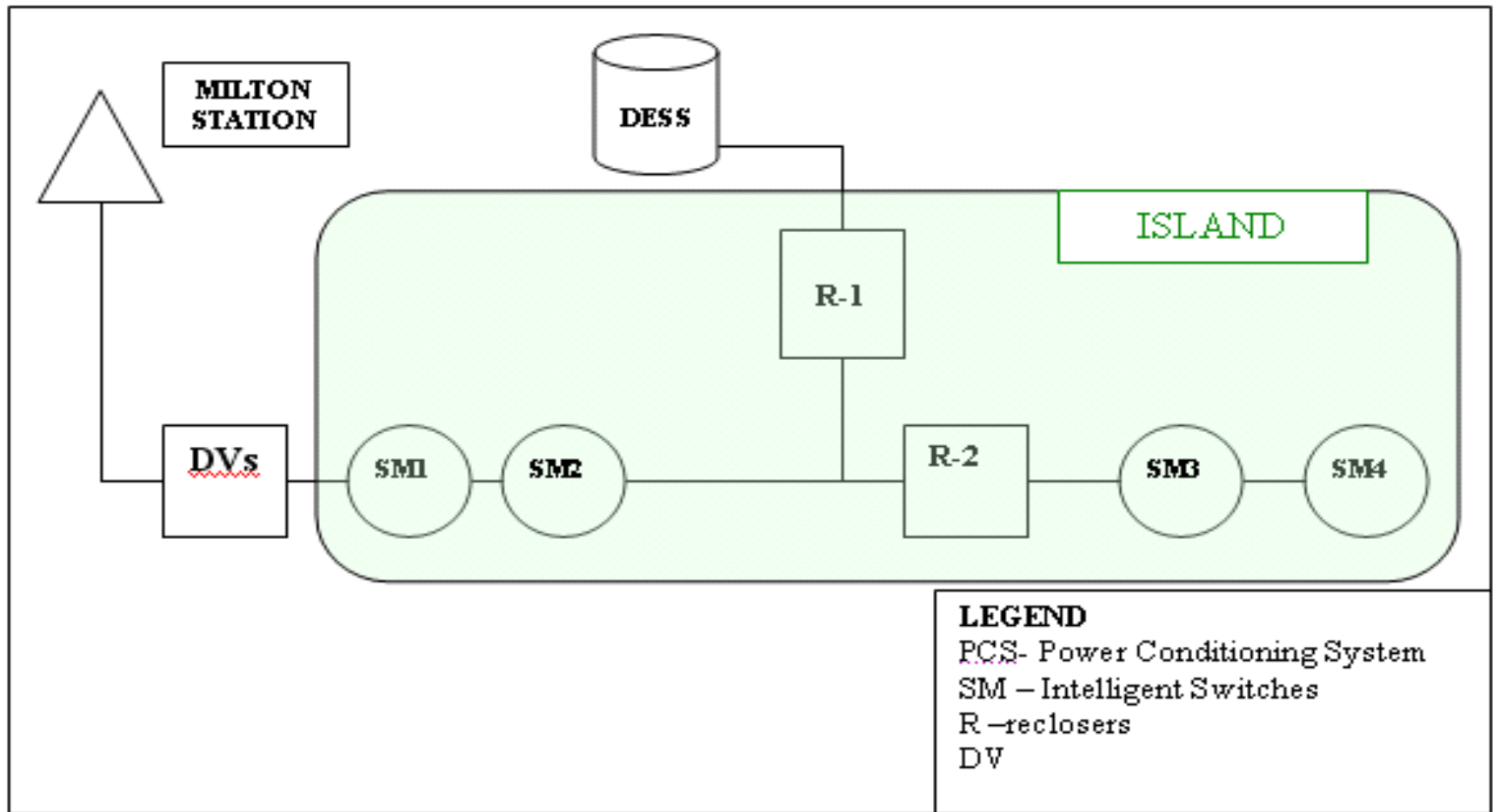
# Islanding Data – Battery Load & Energy



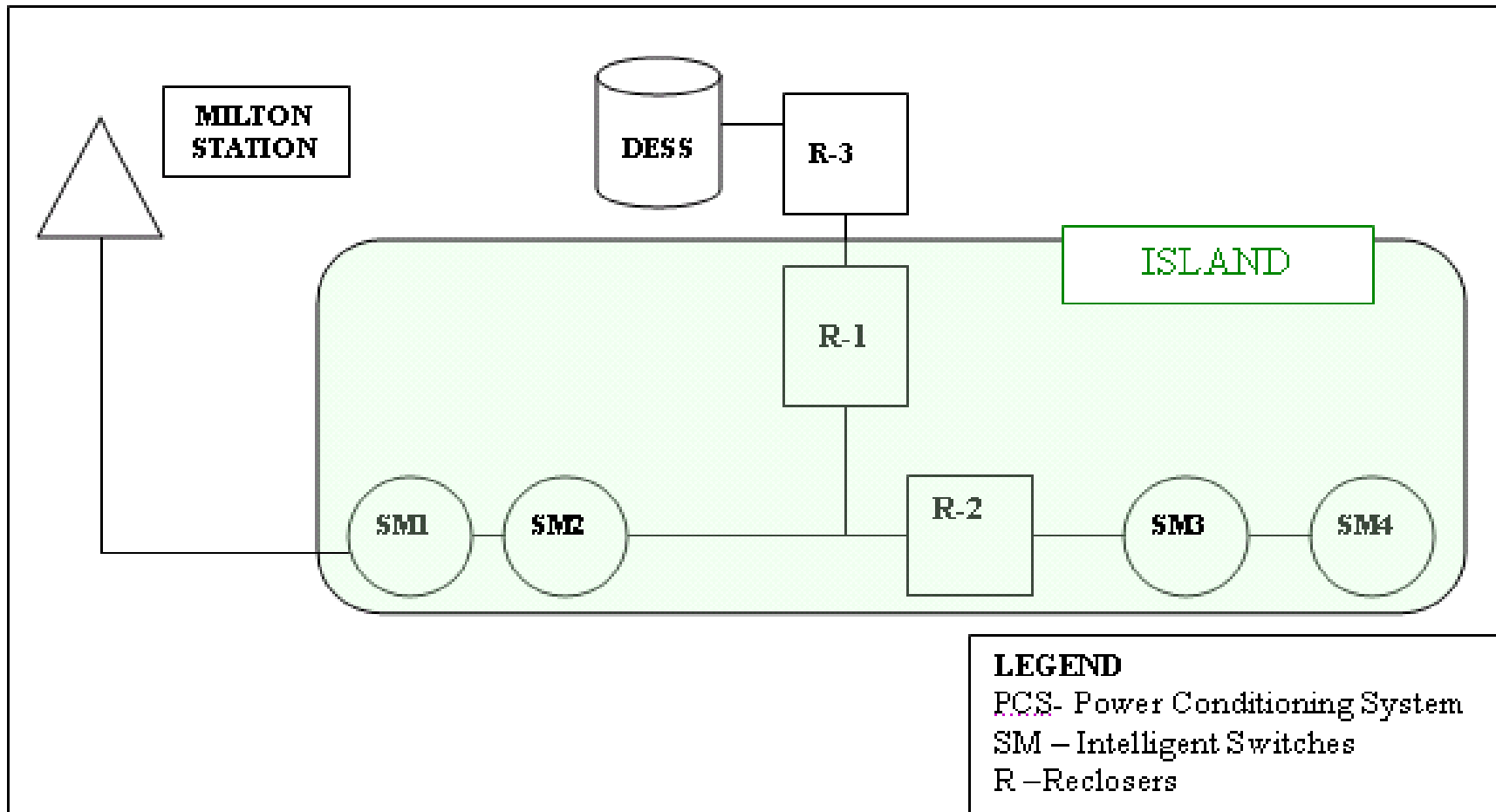
This First Community-Scale Backup Power with NAS Battery is Partially Funded by DOE/Sandia



# Old Islanding Scheme at Milton



# New Islanding Scheme at Milton



# Live Islanding Experience

- **NaS Storage Site :** Balls Gap, Milton, WV
- **Outage Date:** Dec 18, 2009
- **Outage Cause:** Heavy snow
- **Island Size:** 25 Customers (small area)
- **Time to island customers:** 2 min.
- **Power Outage Duration:** 2 Days
- **Time to Exit Island:** 6 sec. (not Synchronized)
- **Average Island Load:** 167 kW

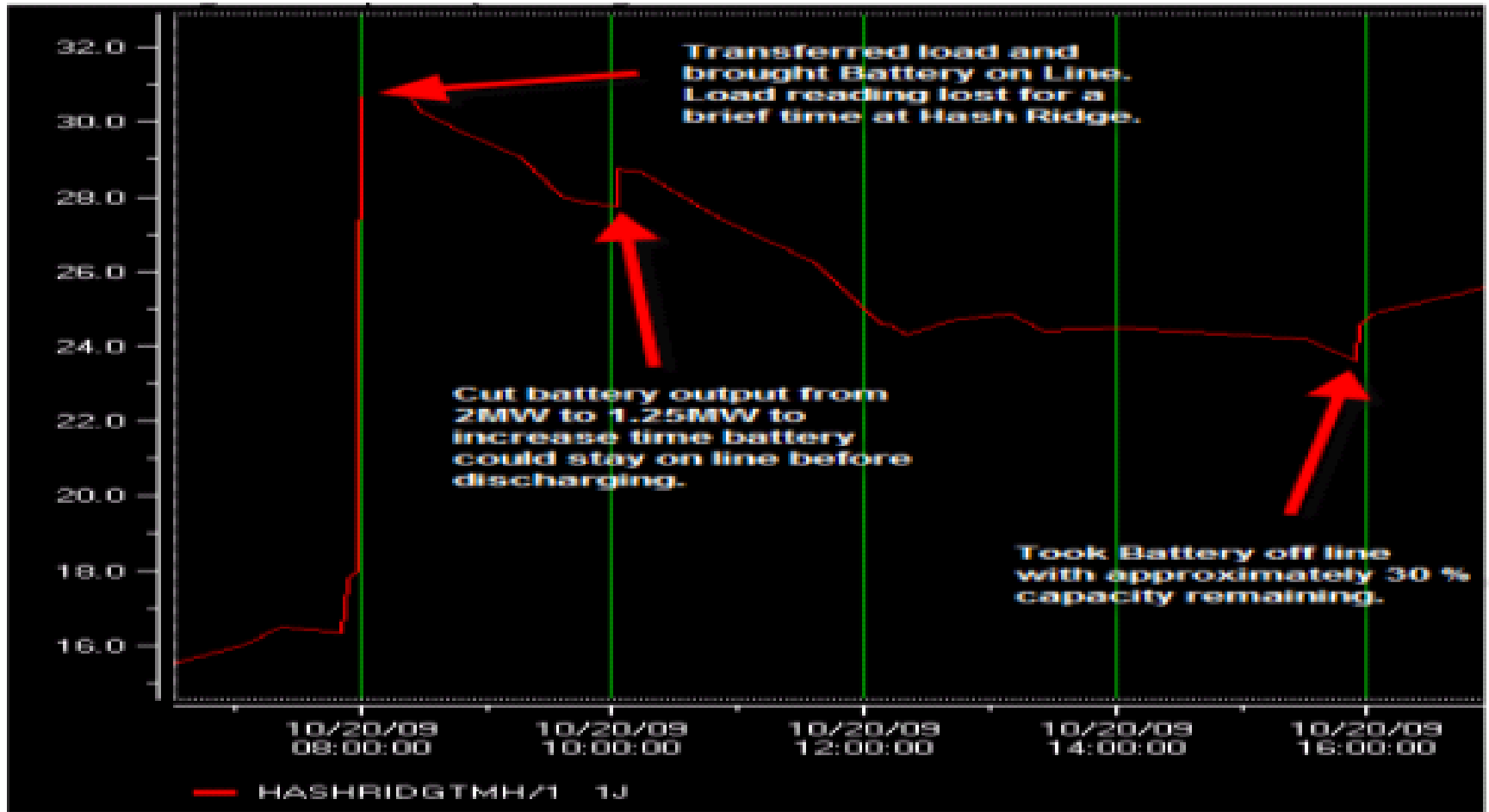


# Lessons Learned

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- Islanding automation improvement.
- Design Improvement : Scheme should work with loss of 1-MW string.
- No opportunity at other sites.

# Battery used for voltage support



# Conclusion

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- Successful deployment of energy storage systems.
- Demonstrated “Islanding”.
- Automation and Design improvement.
- Demonstrated load-following and voltage support.