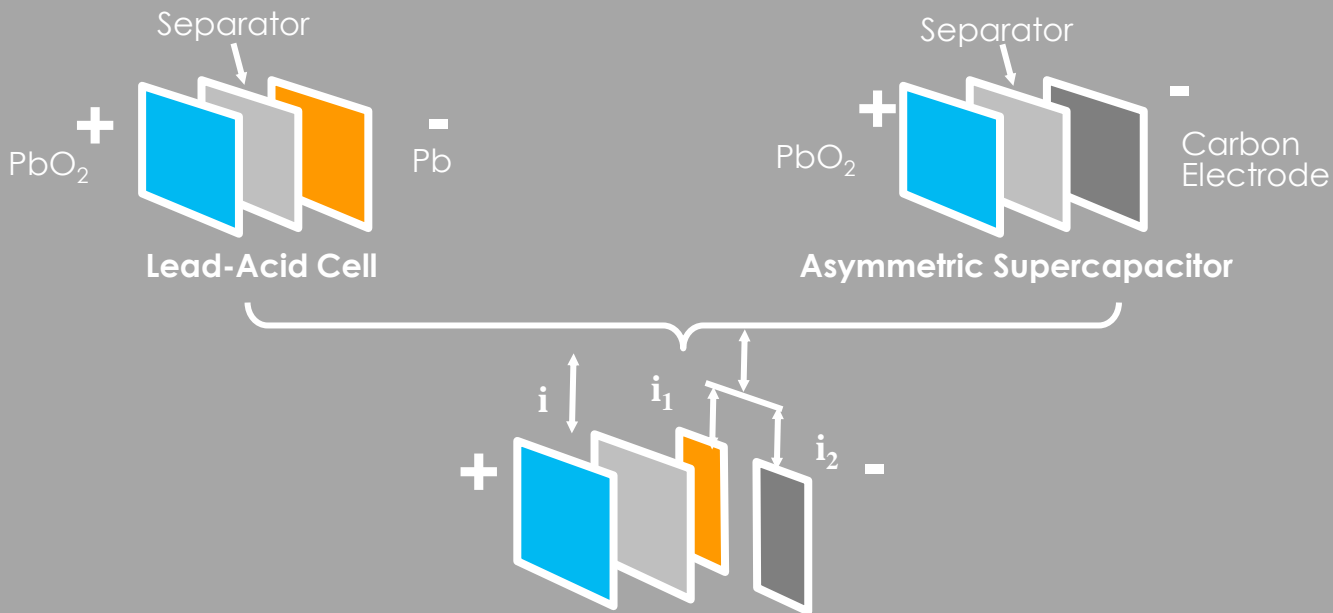


# Grid-Scale Energy Storage for Regulation Services

PJM Frequency Regulation



## UltraBattery® Technology



# UltraBattery®



The New Dimension in a Lead Acid World

**Starter  
Battery**

Market Size:  
**\$15B**

**Motive  
Battery**

Market Size:  
**\$3.5B**

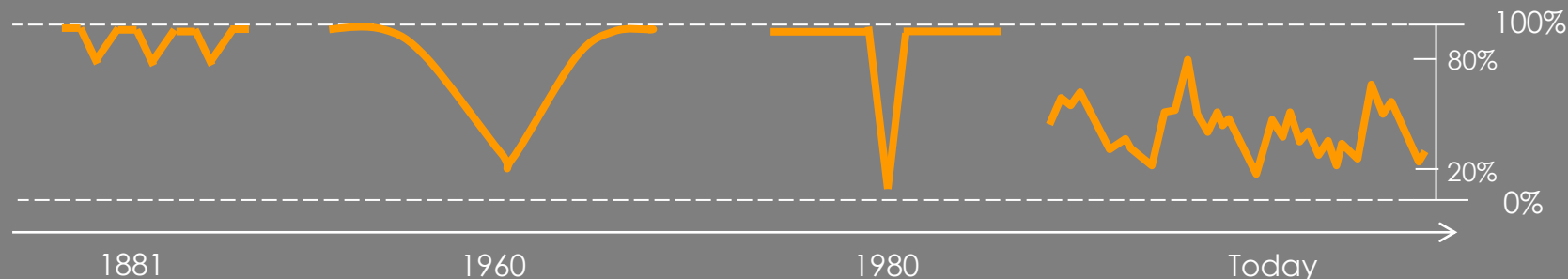
**Standby  
Battery**

Market Size:  
**\$6B**

**PSOC  
UltraBattery**

New Lead-Acid  
Market

State of Charge



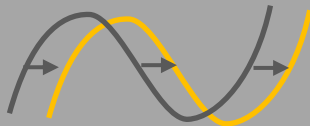
**EAST PENN manufacturing co., inc.**



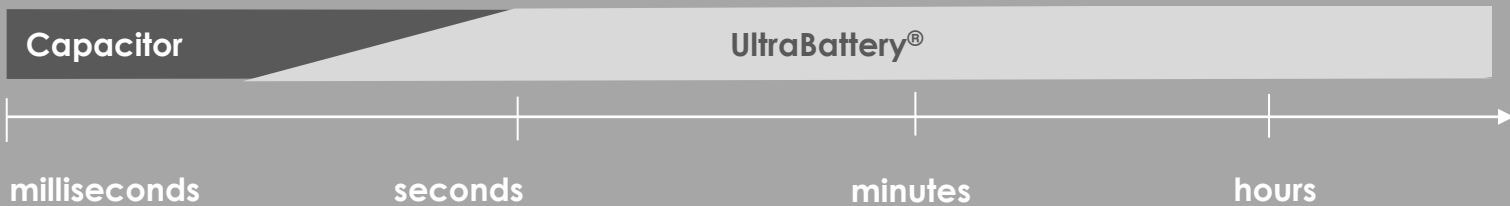
# Variability Management



Intracycle



Regulation and Variability Management



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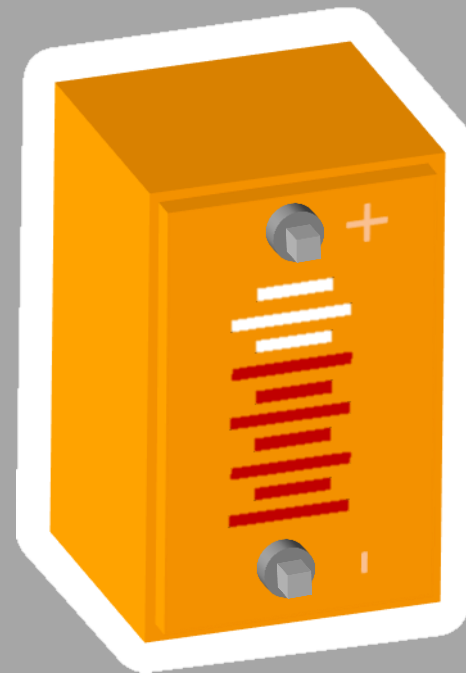
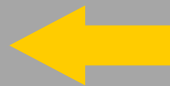
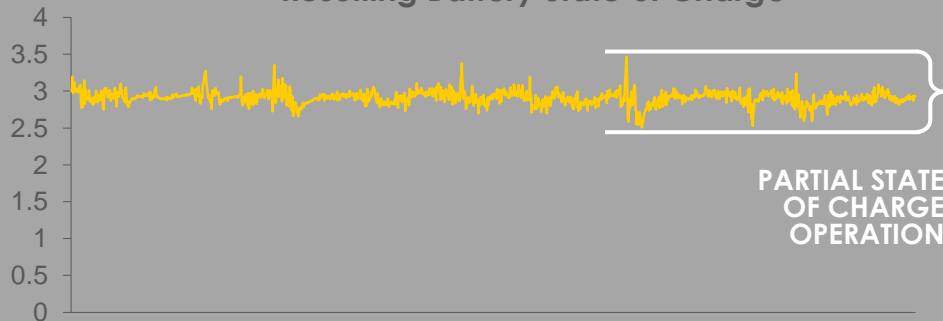
# Partial State of Charge



Regulation Signal



Resulting Battery State of Charge

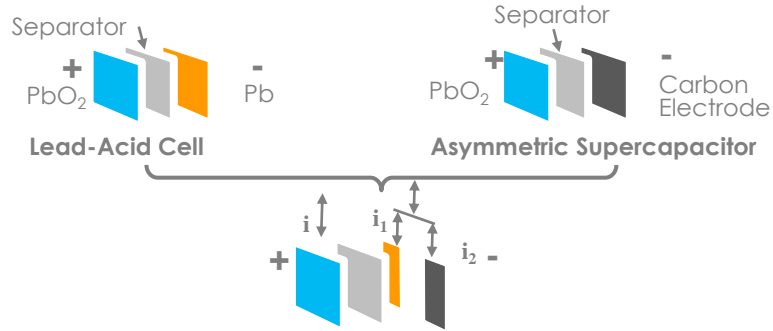


# UltraBattery®

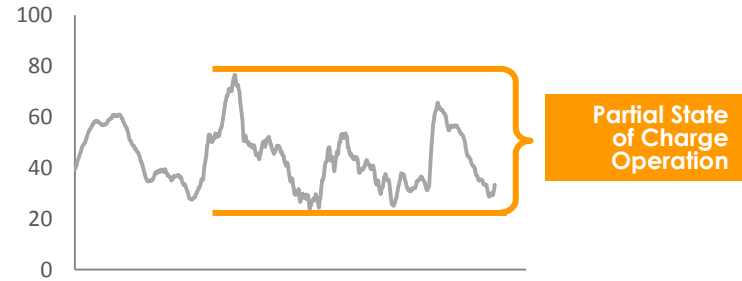


## Partial State of Energy Storage

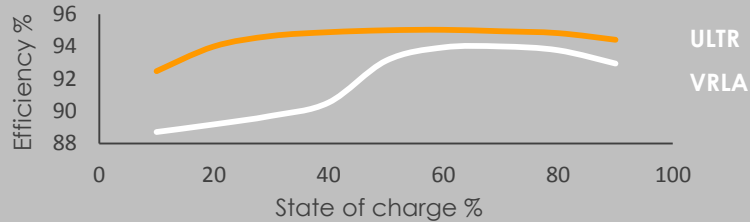
UltraBattery®



## Partial State of Charge Operation

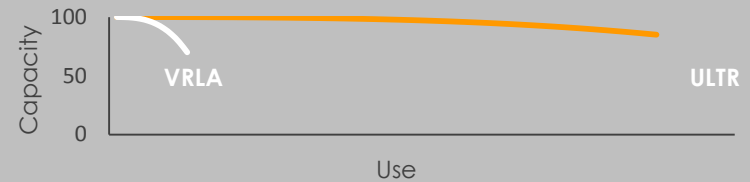


## Comparison of Efficiency vs State of Charge



UltraBattery® is more efficient across range of SOC

## Capacity over time with PSoC use



UltraBattery® can turn over much more energy during its life

# PJM Frequency Regulation

Regulation Services



***EAST PENN manufacturing co., inc.***



# Regulation Services on PJM

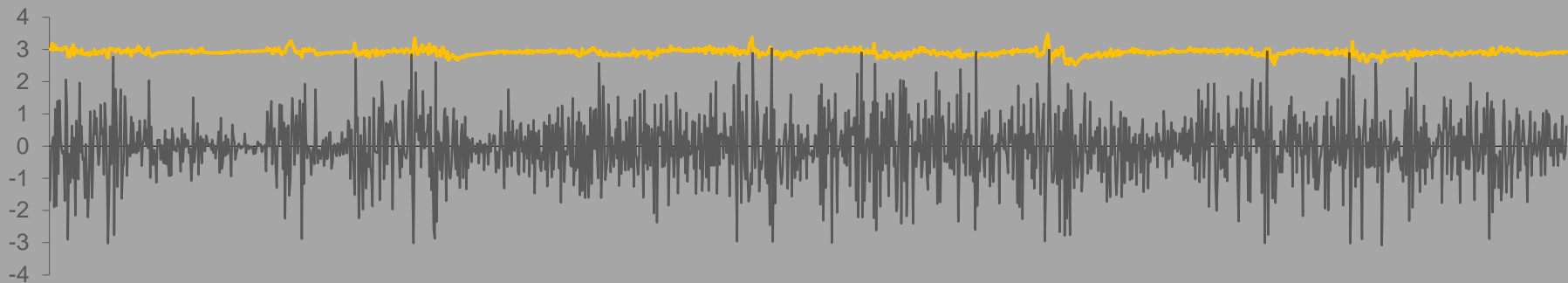


Fast Response Regulation Signal

Energy Store - PJM Regulation (5 Days) – Ordinary Regulation Signal



Energy Store - PJM Regulation (5 Days) – Fast Response Regulation Signal

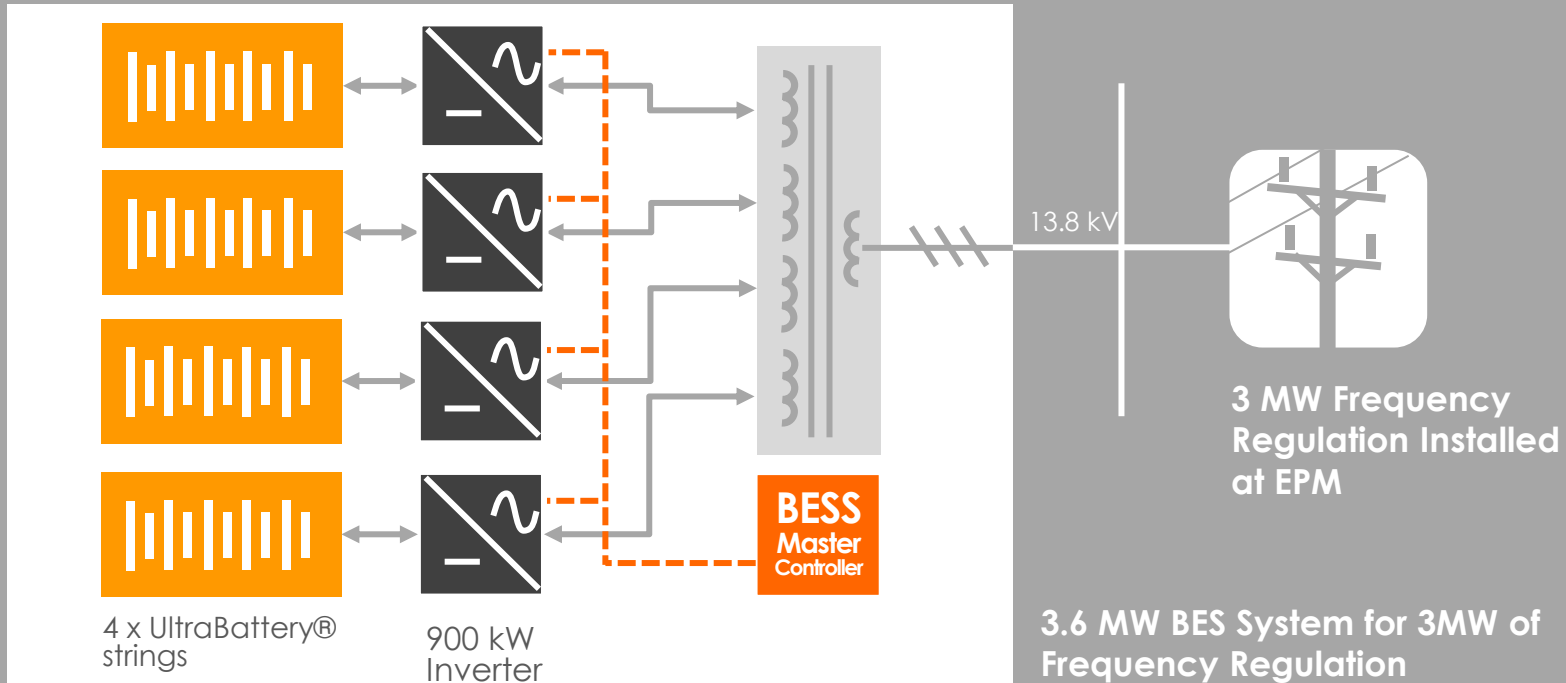




# Electrical Single Line Diagram

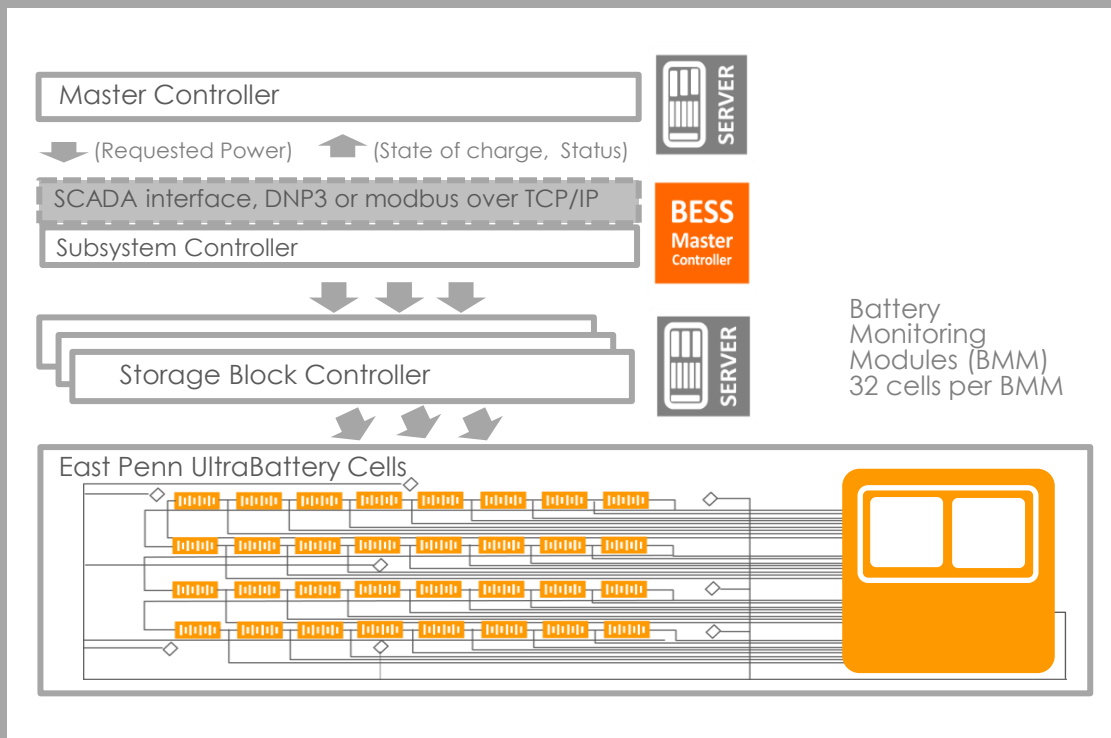


PJM Frequency Regulation Project



# Battery Management

and Monitoring System – PJM Frequency Regulation Project

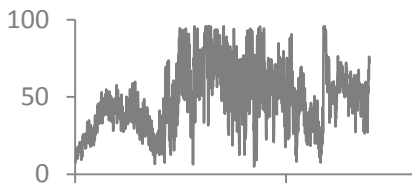
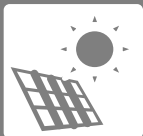


# Smoothing Renewables

Using UltraBattery® Technology



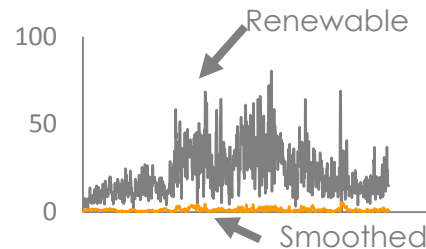
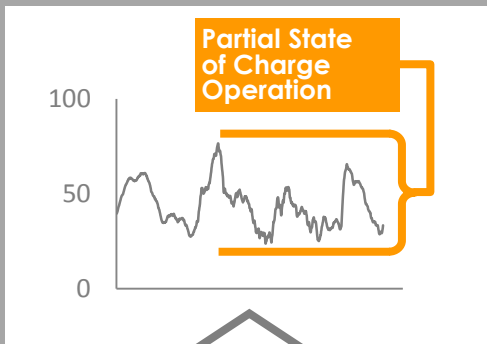
Variable  
Renewable  
Power



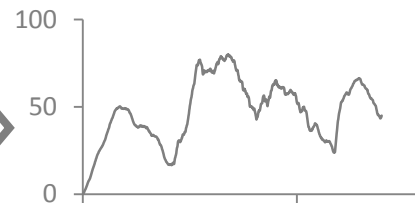
Renewable Output



Energy Store



5 Minute Power Variability



Smoothed Output

# PNM Prosperity Project

Solar Smoothing and Shifting (New Mexico, USA)



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# Hampton Wind Farm

Wind Smoothing (New South Wales, Australia)



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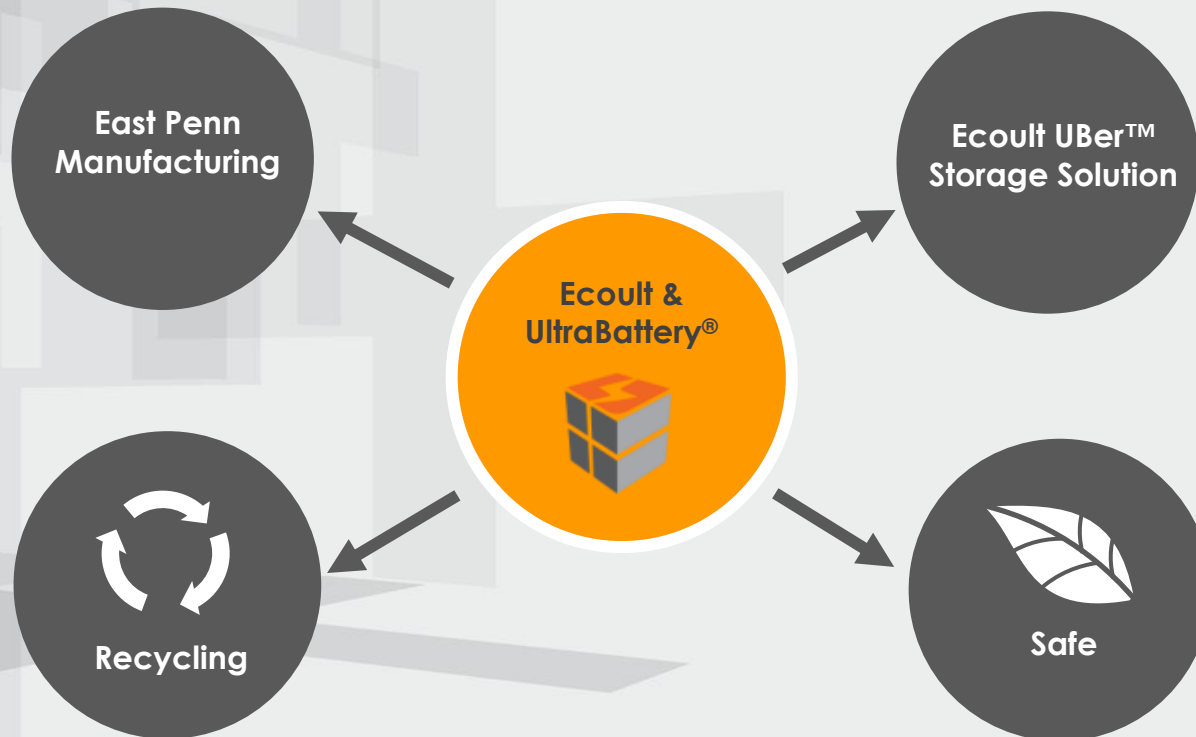




# Ecoults and UltraBattery®



The Energy Storage Solution of Choice



**EAST PENN** manufacturing co., inc.

