

Jason Hoffman
Ecoult

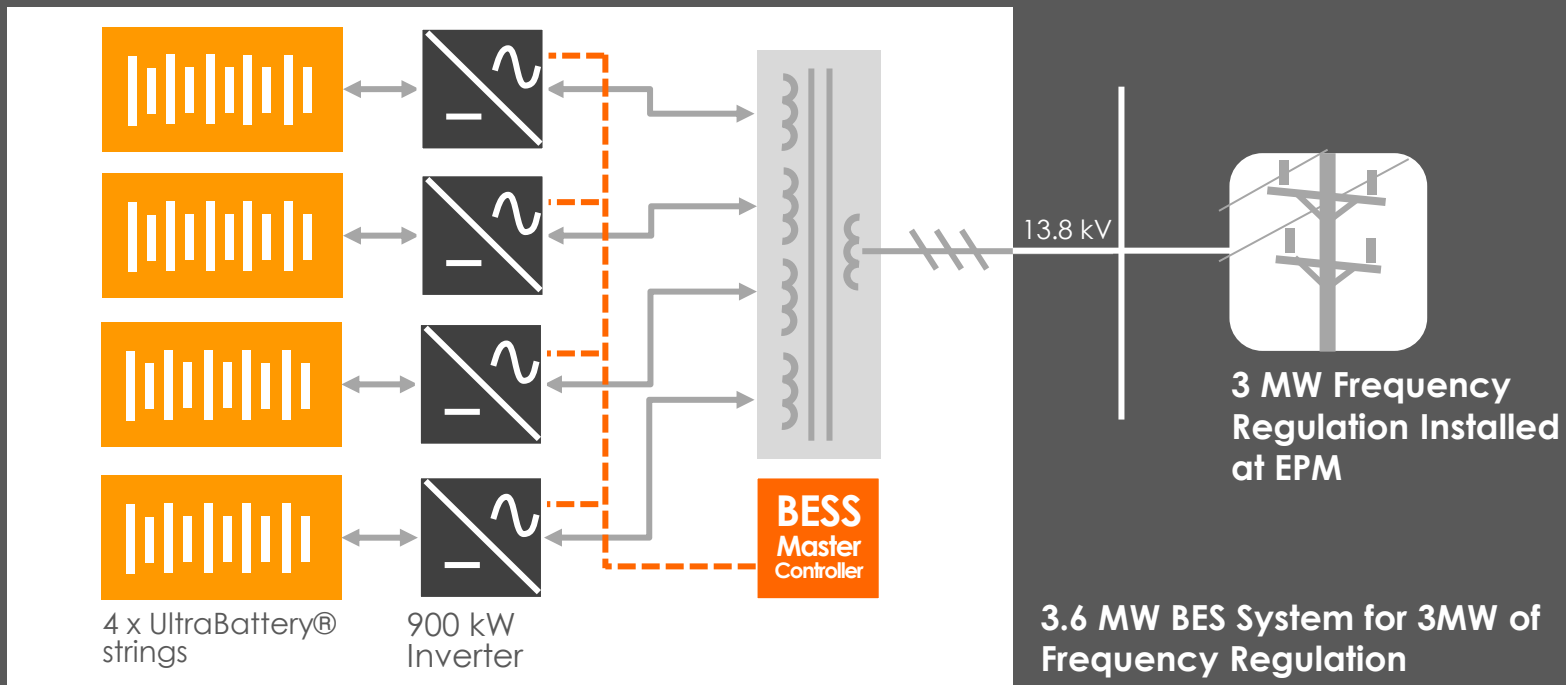
Grid-Scale Energy Storage Demonstration for Ancillary Services Using UltraBattery®

PJM Frequency Regulation



Electrical Single Line Diagram

PJM Frequency Regulation Project



Communications Framework



Secure Communications Framework



BESS

System Control Processor

Master and Subsystem
Controllers

UltraBattery®
Storage Blocks



Battery Management
and Monitoring System

*Via Modbus
over TCP/IP*

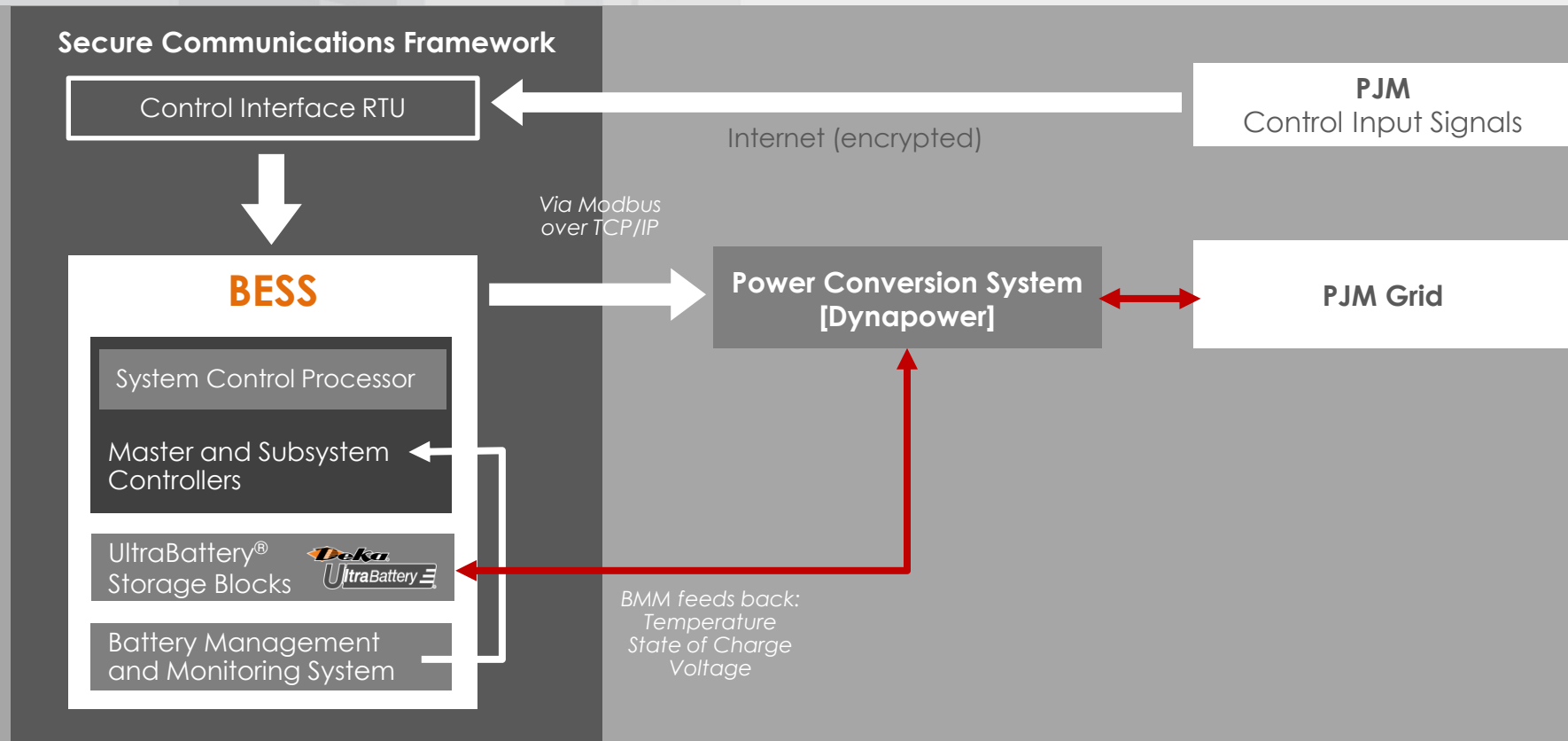
**Power Conversion System
[Dynapower]**

PJM
Control Input Signals

Internet (encrypted)

PJM Grid

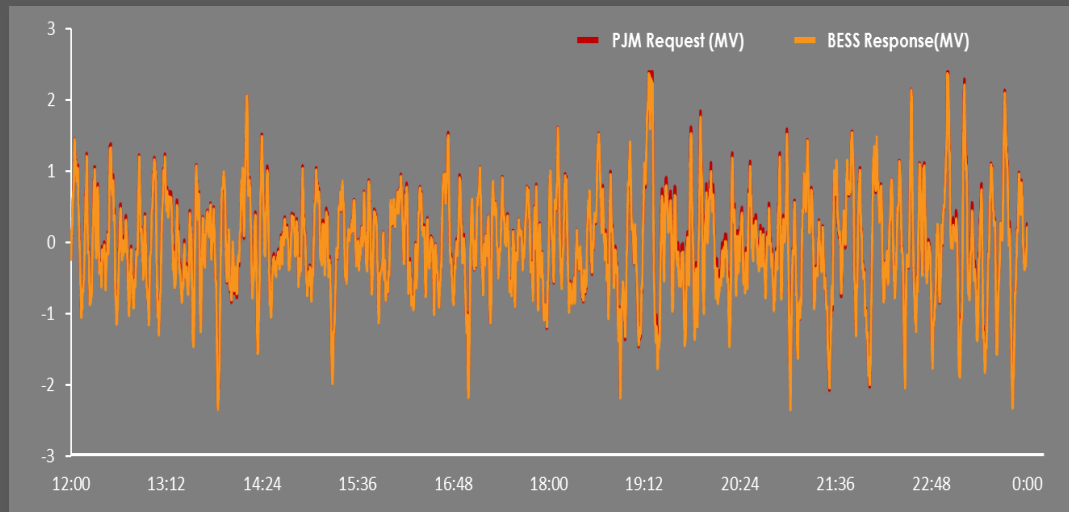
*BMM feeds back:
Temperature
State of Charge
Voltage*



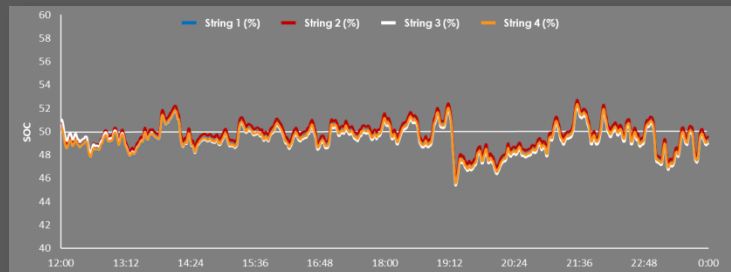
PJM System Performance



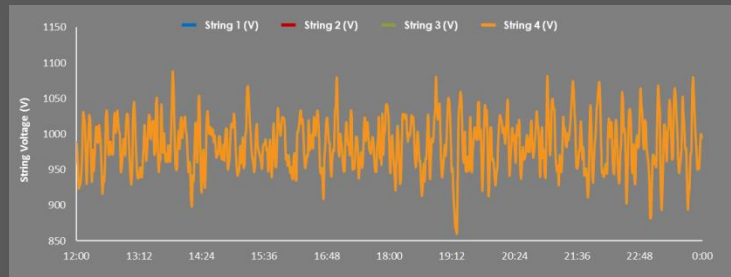
PJM Request and BESS Response for Aug 5, 2013



String SOC – Aug 5, 2013



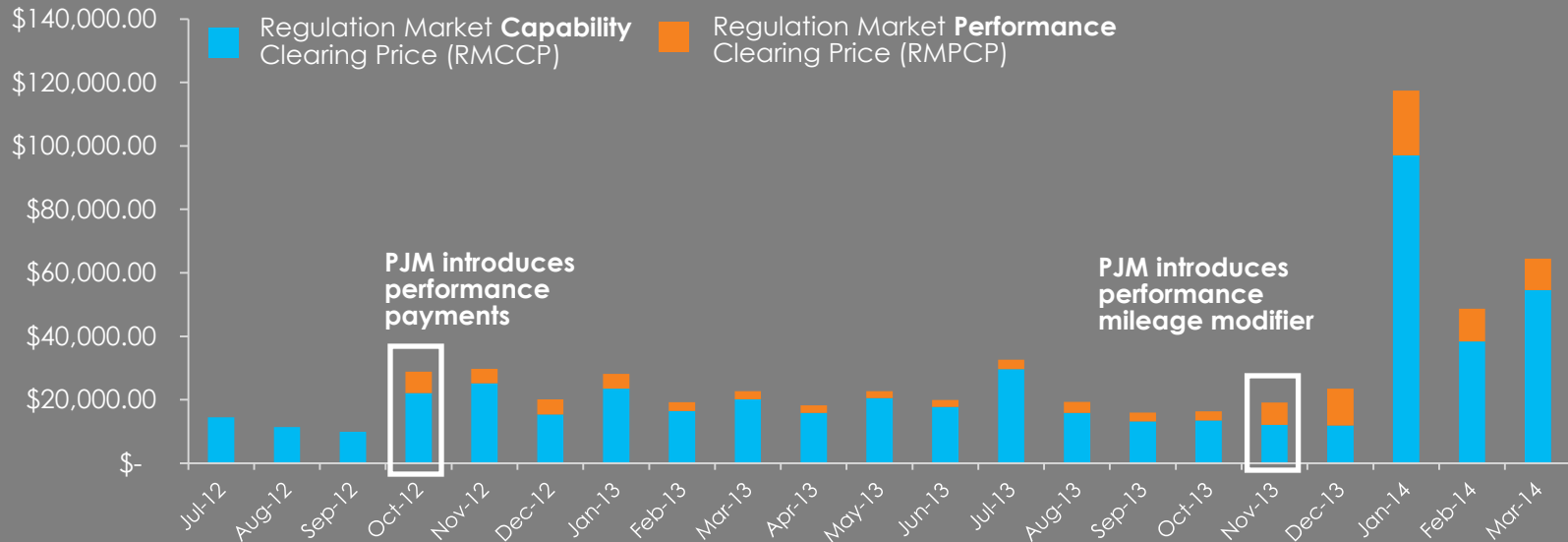
String Voltages – Aug 5, 2013



Regulation Services on PJM



Revenue of 1MW Regulation Plant Operated Continuously With 100% PJM Performance Score



Regulation Services on PJM



Traditional Regulation

Daily
Mileage
141.7
MW



Mileage
Ratio
1.0



Dynamic Regulation

Daily
Mileage
434.3
MW



Mileage
Ratio
3.1



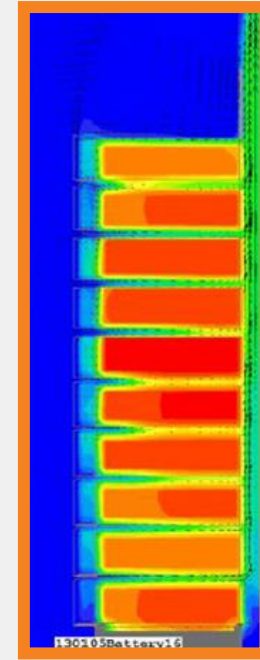
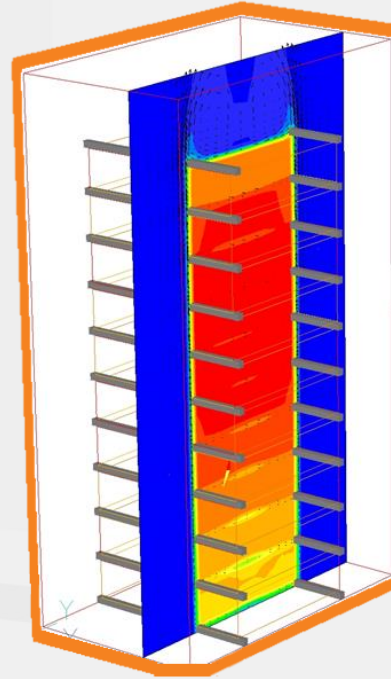
PJM System Performance



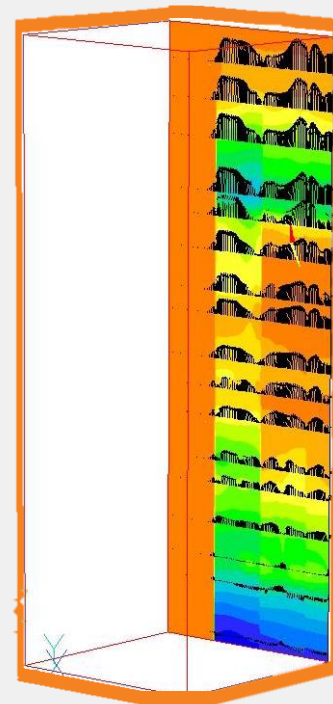
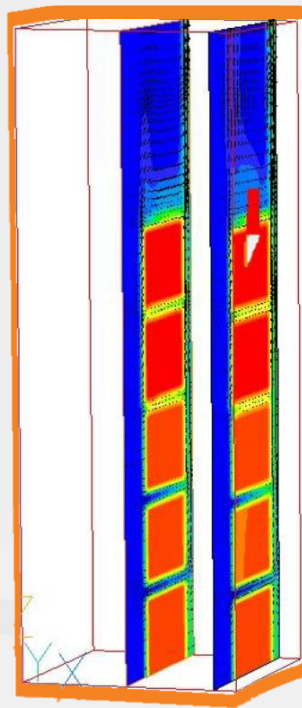
Energy (Capacity at Rated Power - 100% Capacity)	2.2 MWh
Used Partial State of Charge Energy Band	0.5 MWh
Daily MWh Throughput (Charge + Discharge) per MW	≈ 6.5
Total MWh Throughput(Charge + Discharge) to Date	≈ 5.5 GWh
Total Number of Hours of 1MW Reg. Service Supplied to PJM	≈ 20,000
Average Hourly Price Since October 2012	≈ \$48/MW
DC-DC Efficiency (Rate Dependent)	≈ 92%
AC-AC Efficiency (13.2kV Revenue Meter)	≈ 82%
Parasitic Losses	≈ 8.5%
Current Average Operational Availability	≈ 90%



PJM System Performance



PJM System Performance



UltraBattery Technology: Understanding & Breakthrough



Original batteries
[UB 95-33]
0.7 – 0.9 C 1



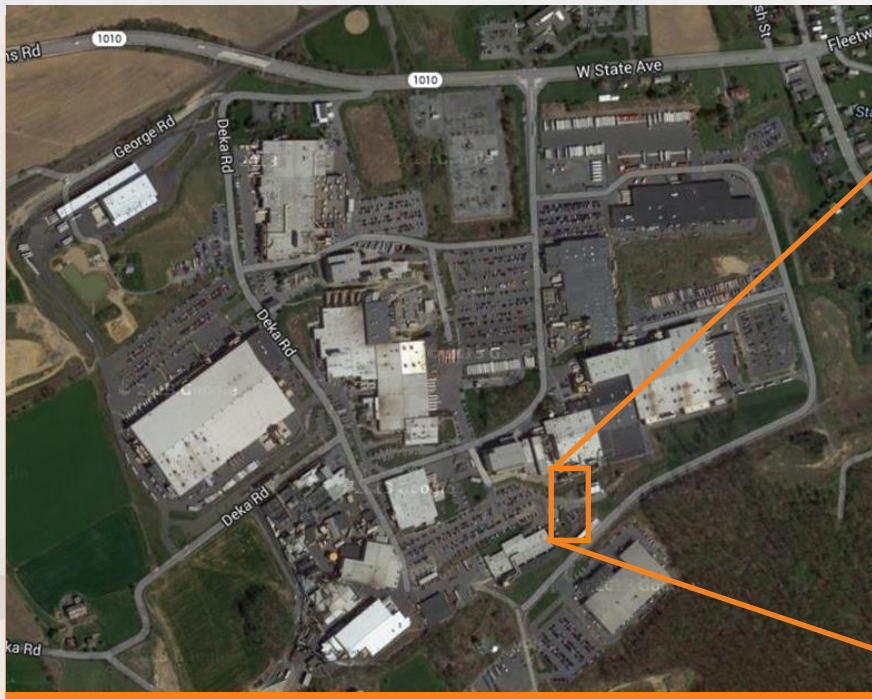
New UltraRax & UltraFlex
batteries [UB 145 ET]
1.4 C 1

2x Power
Higher Efficiency
Even temperature

PJM System Performance



EPM funding additional projects to demonstrate UltraBattery performance



Storage Facility #1:

3MW Frequency
Regulation

2x Power



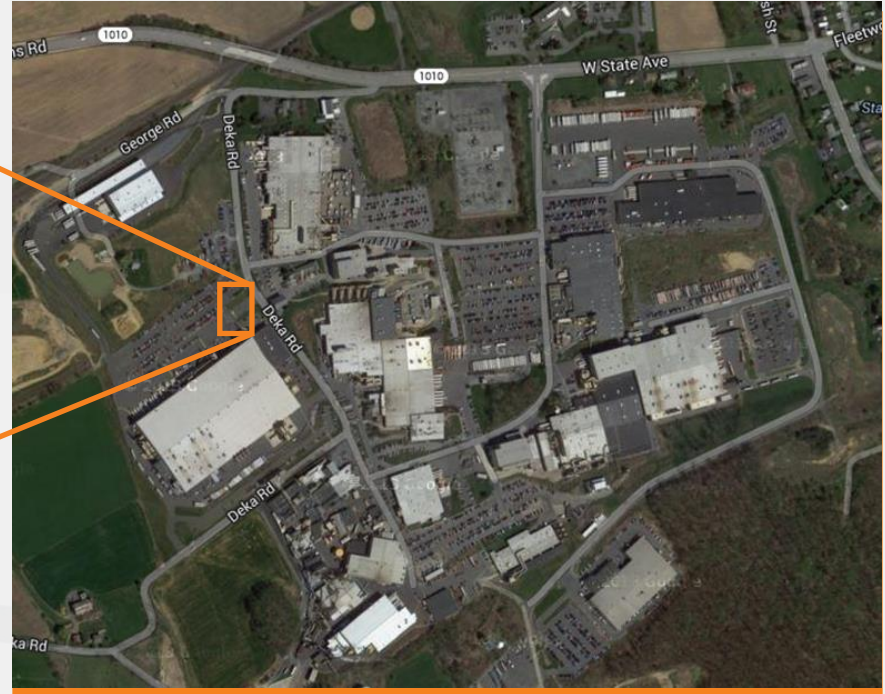
Multi-Purpose Storage System



Storage Facility #2:

100 kW Frequency
Regulation

250kW UPS/Back-up



Multi-Purpose Storage System

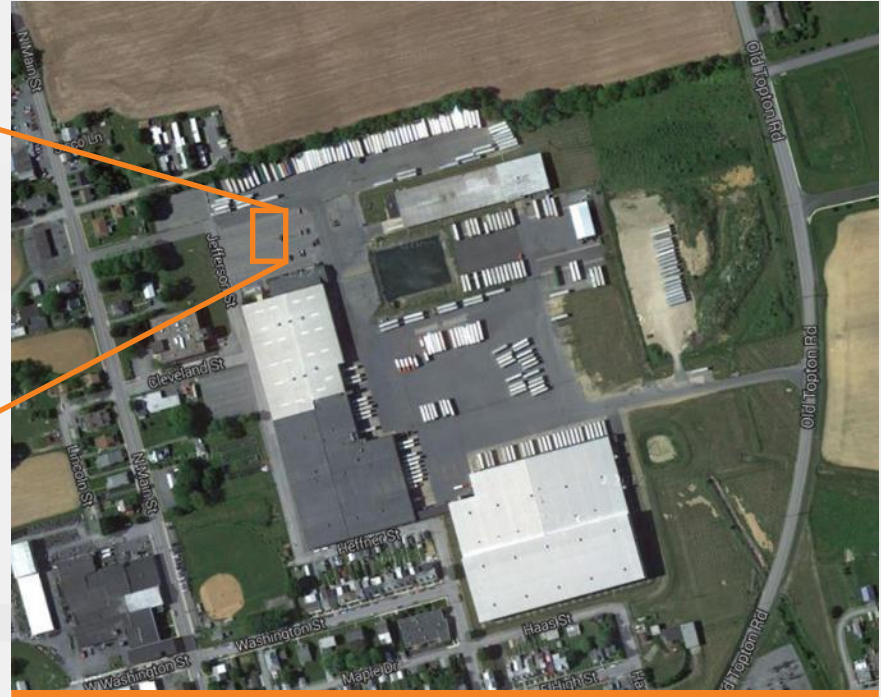


Storage Facility #3:

200 kW Frequency
Regulation

200 kWh Demand
Management

200 kW UPS/Back-up



Ecoulth and UltraBattery®

The Energy Storage Solution of Choice



THANK YOU

Jason Hoffman

Electrical Engineer Ecoulth
jason.hoffman@ecoulth.com



Jason Hoffman
Ecoult

Grid-Scale Energy Storage Demonstration for Ancillary Services Using UltraBattery®

PJM Frequency Regulation

