Progress With Manufacturing and Deploying Zn-MnO_2 Batteries

Sanjoy Banerjee

Founder & Executive Chairman
Urban Electric Power Inc., NY
sanjoy@urbanelectricpower.com

Distinguished Professor of Chemical Engineering,
Director, the CUNY Energy Institute
The City College of New York
banerjee@ccny.cuny.edu

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URBAN ELECTRIC POWER

Objective

Discuss progress with manufacturing and deploying of Zn-MnO_2 batteries for a range of energy storage applications

Background

01 Rechargeable zinc-based batteries are a low-cost, multiple timescale storage option for transitioning the grid to renewables. Zinc-manganese dioxide batteries are versatile and also apply for long duration storage

02 Zinc-manganese dioxide battery chemistry: Proton Insertion (Gen 1 battery) and Conversion Reactions (Gen 2 battery)

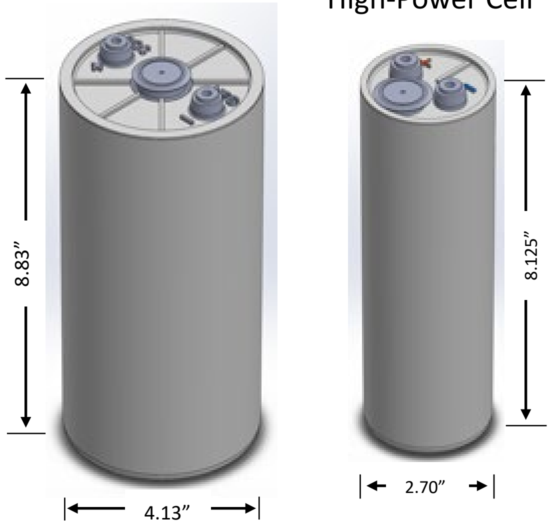
03 From concept to product: Manufacturing progressed to semi-automated pilot facility producing 100MWh/shift of Gen 1 batteries

04 Progress in zinc-manganese battery deployments to preserve resilience and assure capacity in a largely renewables – based decarbonized grid

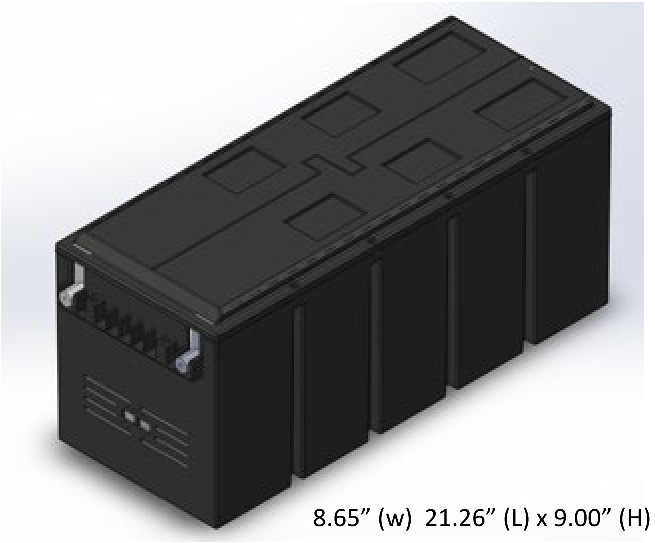
UEP's Rechargeable Zn-MnO_2 Products

High-Energy Cell

High-Power Cell

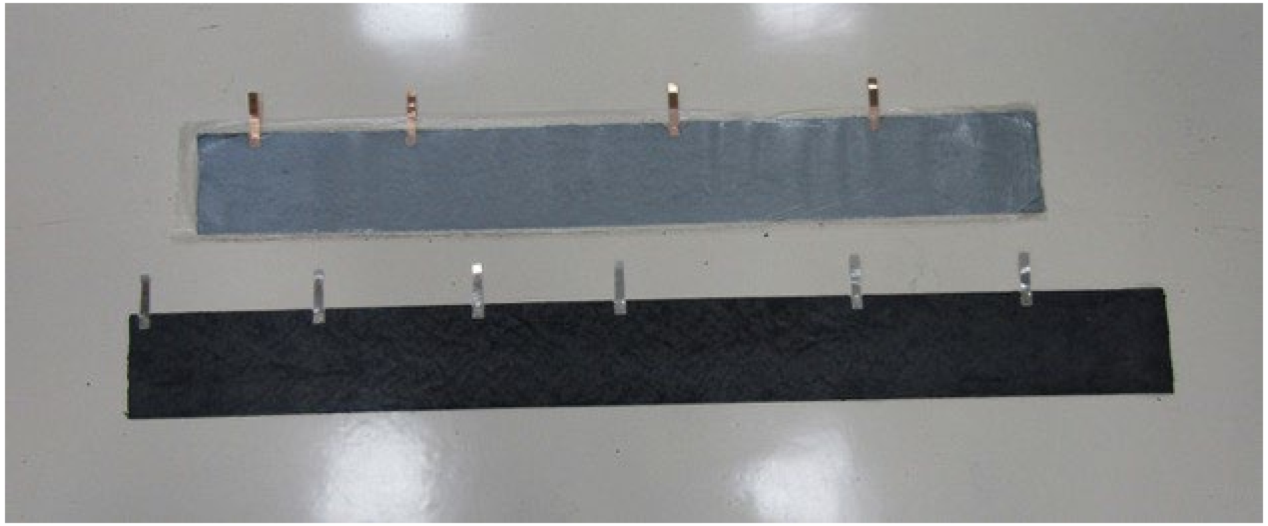


4D Module



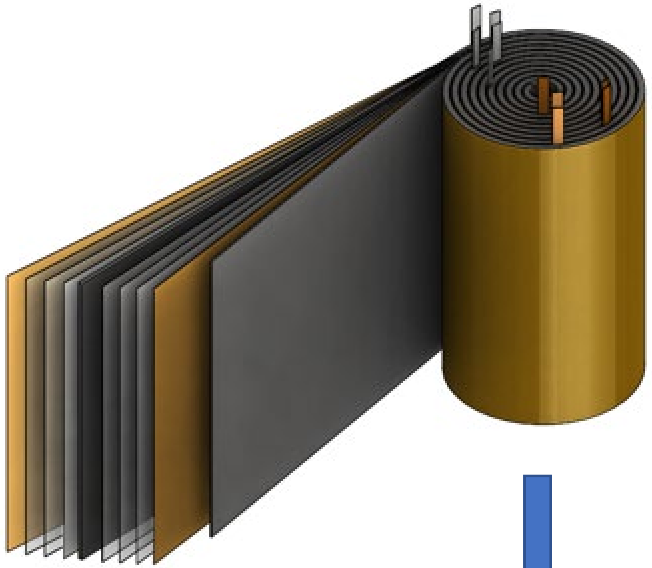
- UEP manufactures battery cells in two distinct configurations, a high-energy cell and a high-power cell.
- Both cells are integrated into a standard 4D size module offering easy installation and scalability to meet varying power and energy demands.

Cell and Battery Product



Positive and Negative Electrodes

Jellyroll

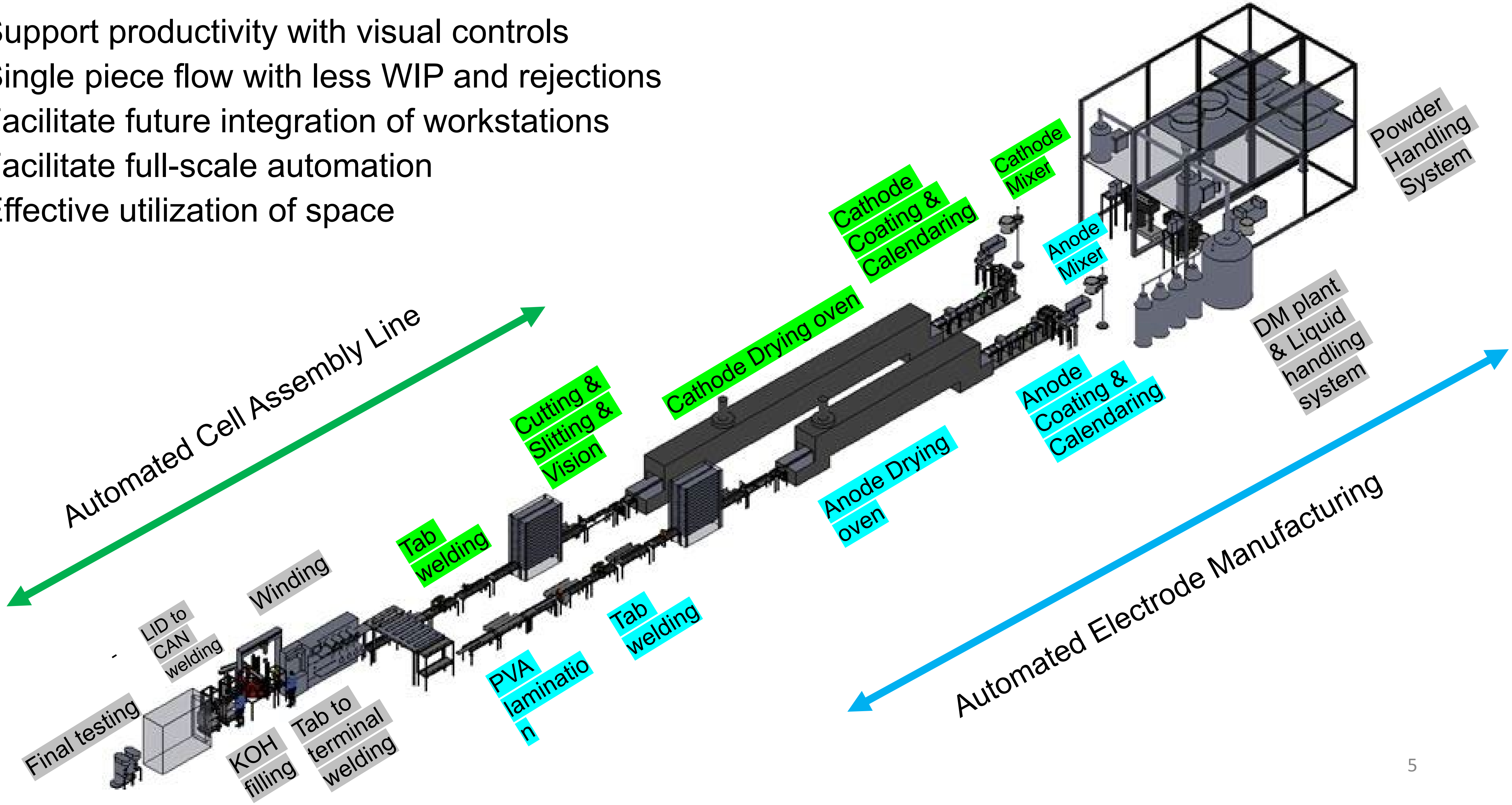


Cell

Battery

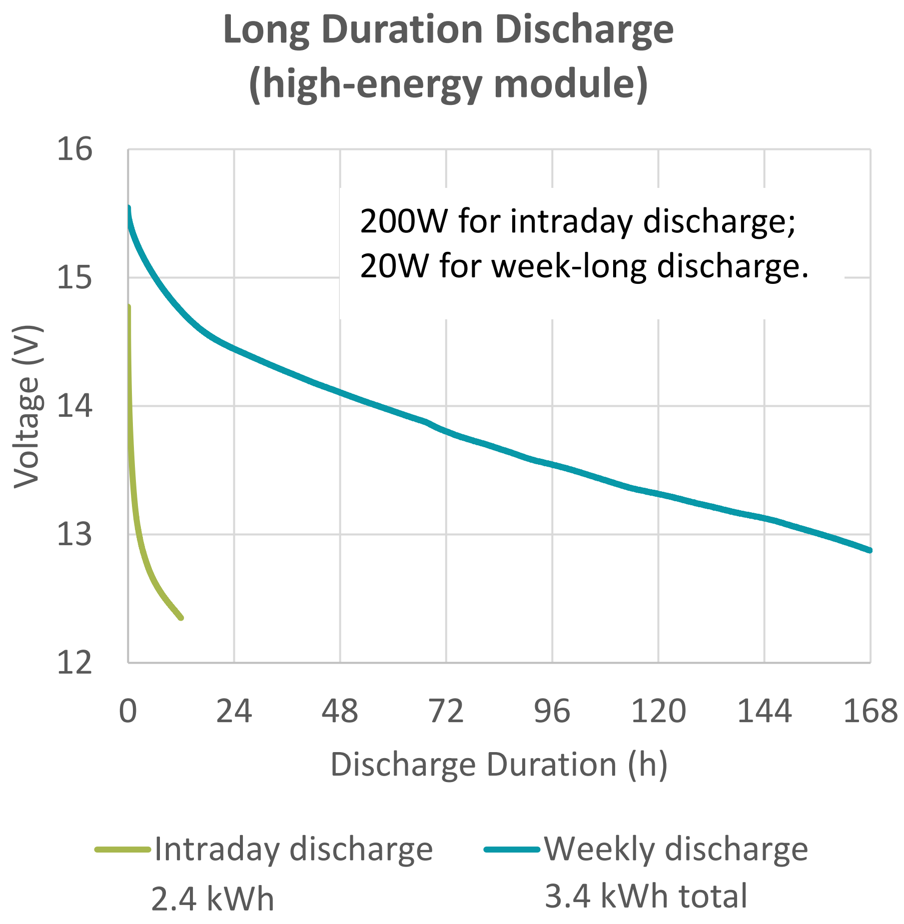
Battery Manufacturing Process (Automated Plant)

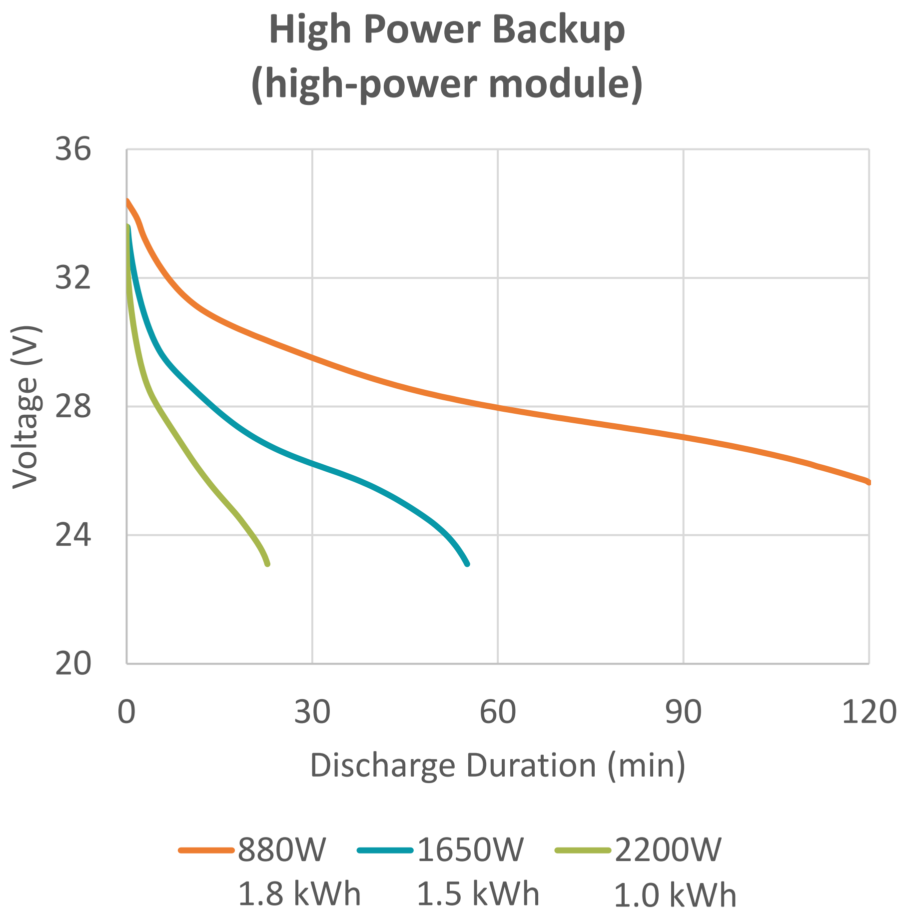
- ✓ Support productivity with visual controls
- ✓ Single piece flow with less WIP and rejections
- ✓ Facilitate future integration of workstations
- ✓ Facilitate full-scale automation
- ✓ Effective utilization of space



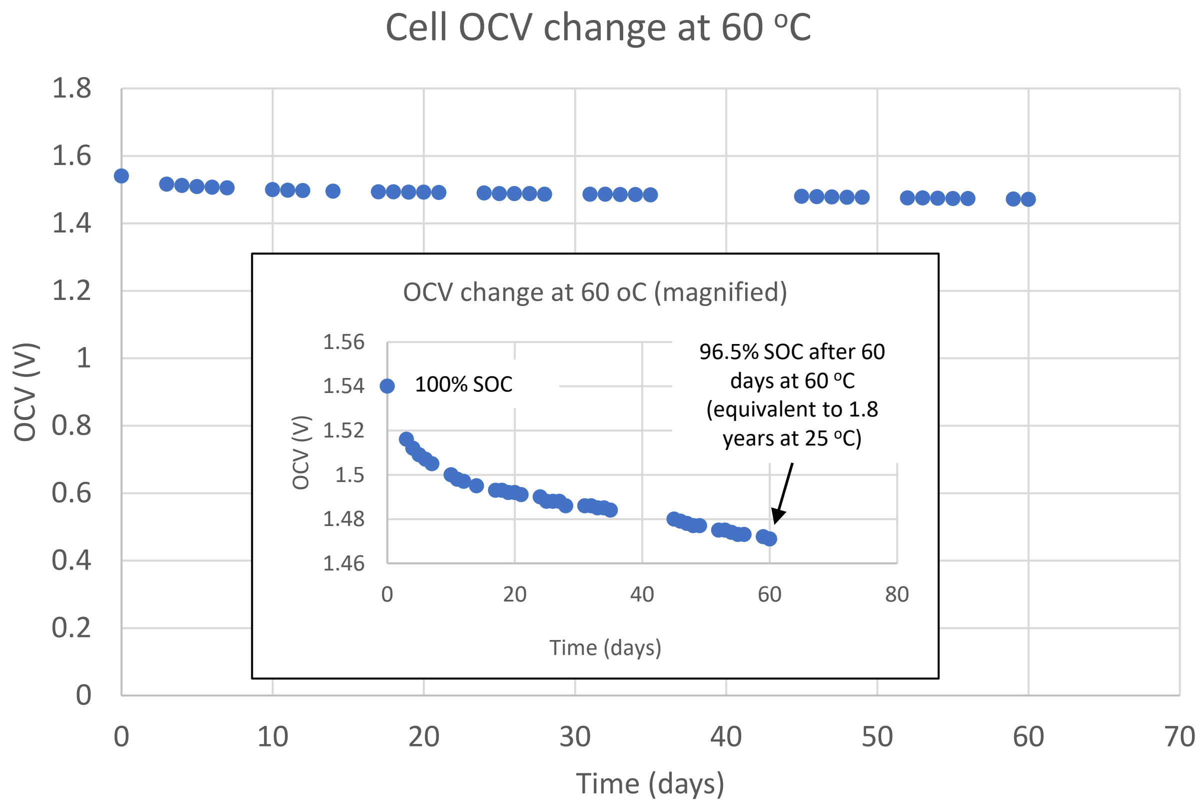
Zn-MnO_2 Cell Manufacturing Plant

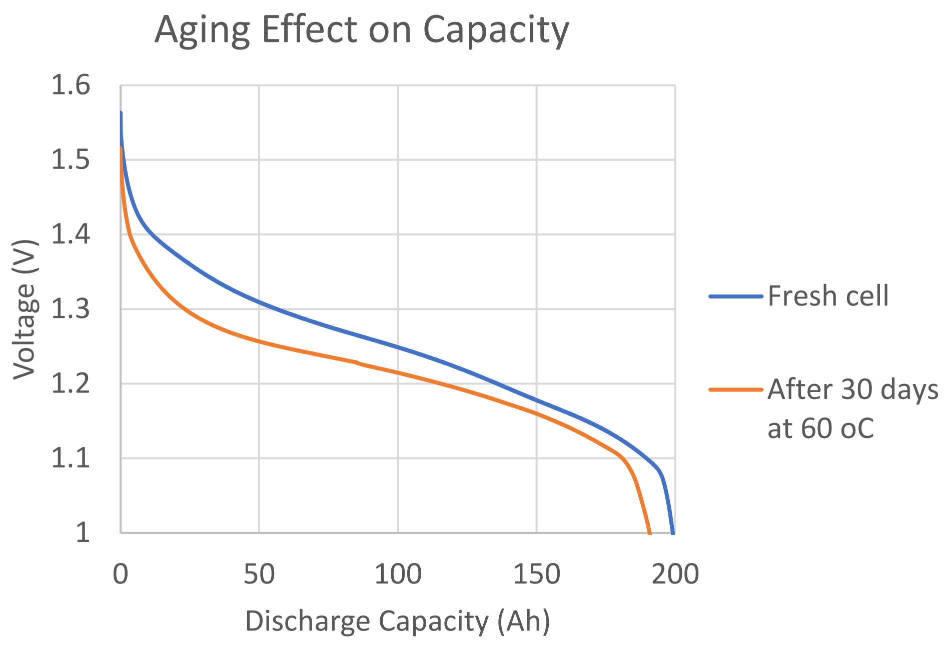
UEP Zn-MnO_2 Batteries for Varying Power and Energy Demands





UEP Zn-MnO_2 Batteries with an Extremely Low Self-Discharge Rate

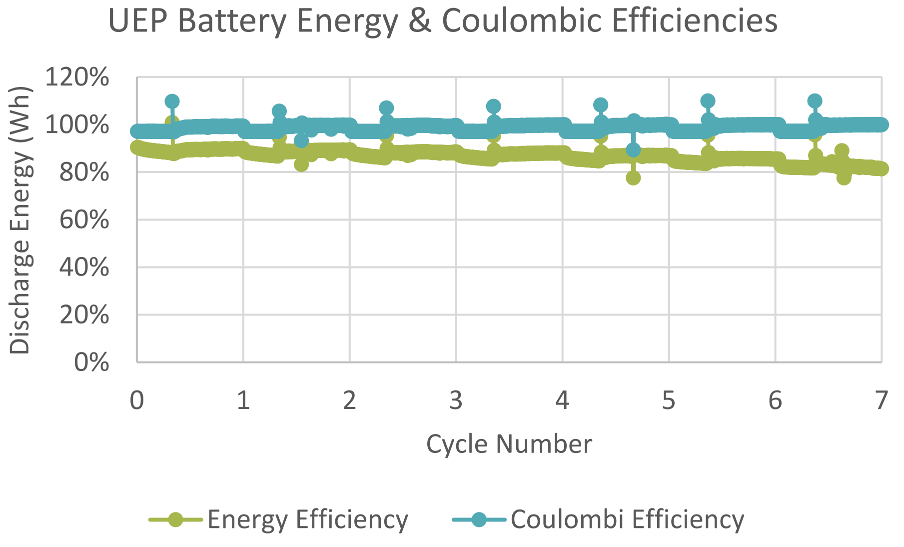


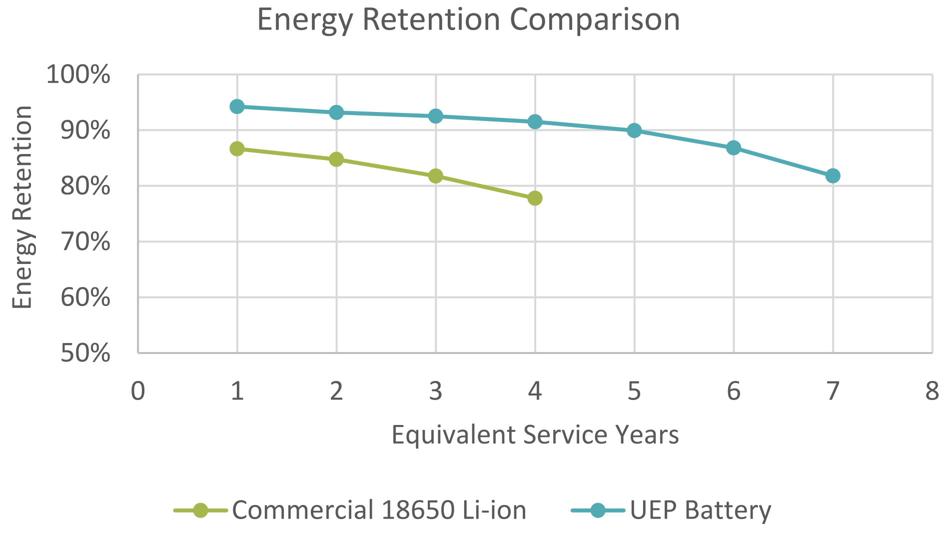


UEP's battery has a self-discharge rate of approximately **2% per year (0.2% per month)** at room temperature. Self-discharge rates of lead-acid batteries are typically 4-6% **per month** while lithium-ion battery self-discharge rates are 2-3% **per month**[1].

UEP Zn-MnO_2 Battery under IEC standard Protocol for Solar Microgrid

UEP Battery completed 7 years and still running under IEC 61427-1 testing protocol, defined below, for solar microgrid use case.





Phase A: 3h C/10 charge and 3h C/10 discharge cycling at low state of charge for 50 cycles.
Phase B: 6h charge and 2h C/8 discharge cycling at high state of charge for 100 cycles.
A 9-hour C/10 discharge is done between phases B and A at the end of each year.

Under the same IEC 61427-1 solar protocol:

- The commercial 18650 Li-ion battery lost 20% of its nameplate energy after 4 years.
- UEP Battery shows an energy retention above 80% of its nameplate after 7 years of service life.

Targeting Markets

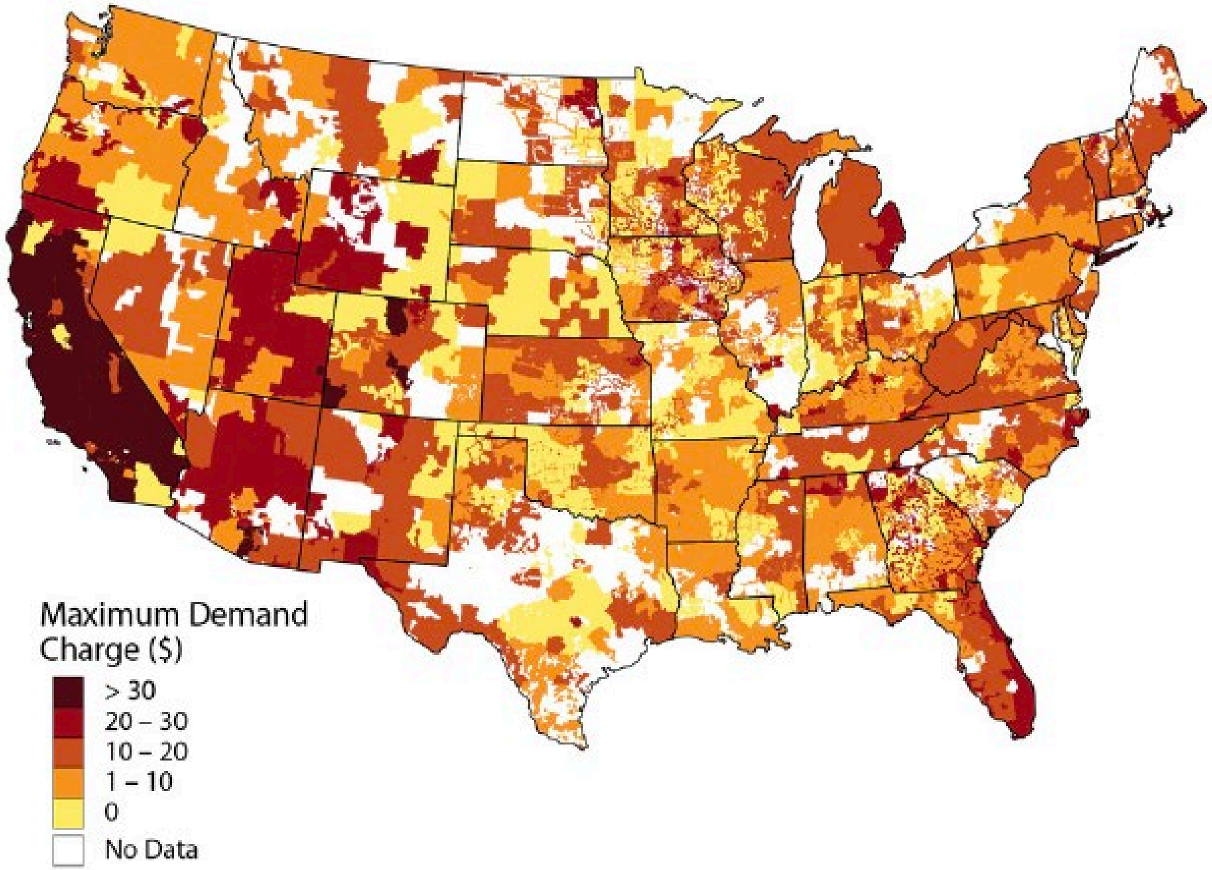
Solar Microgrid

Demand Charge Reduction

Power Backup

E-mobility / SLI

Demand Charge Heat Map ($/kW/month)



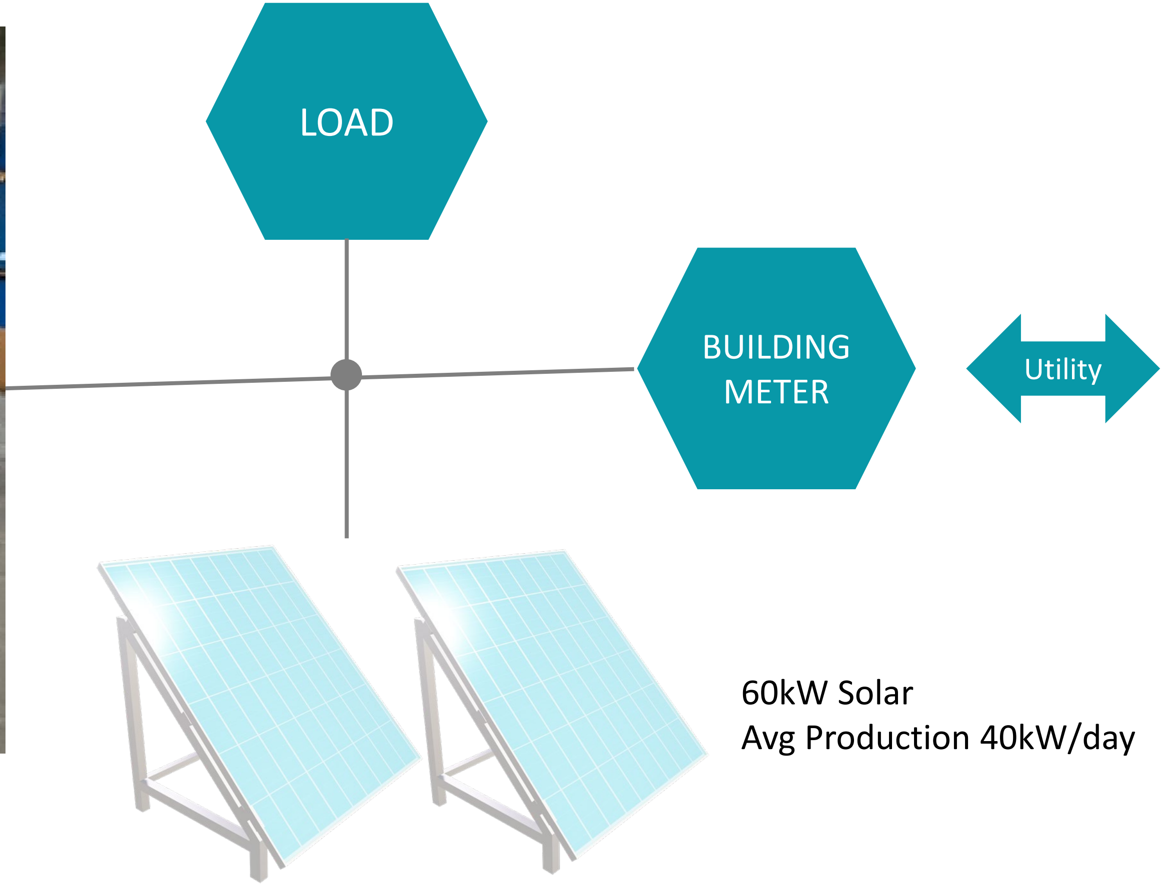
Application: Demand Charge Reduction

Examples: Two installations in Utah

Two UEP systems installed: 20kW/80kWh each

A 20kW/80kWh system
In Salt Lake City, Utah

A 20kW/80kWh system
In Ogden, Utah



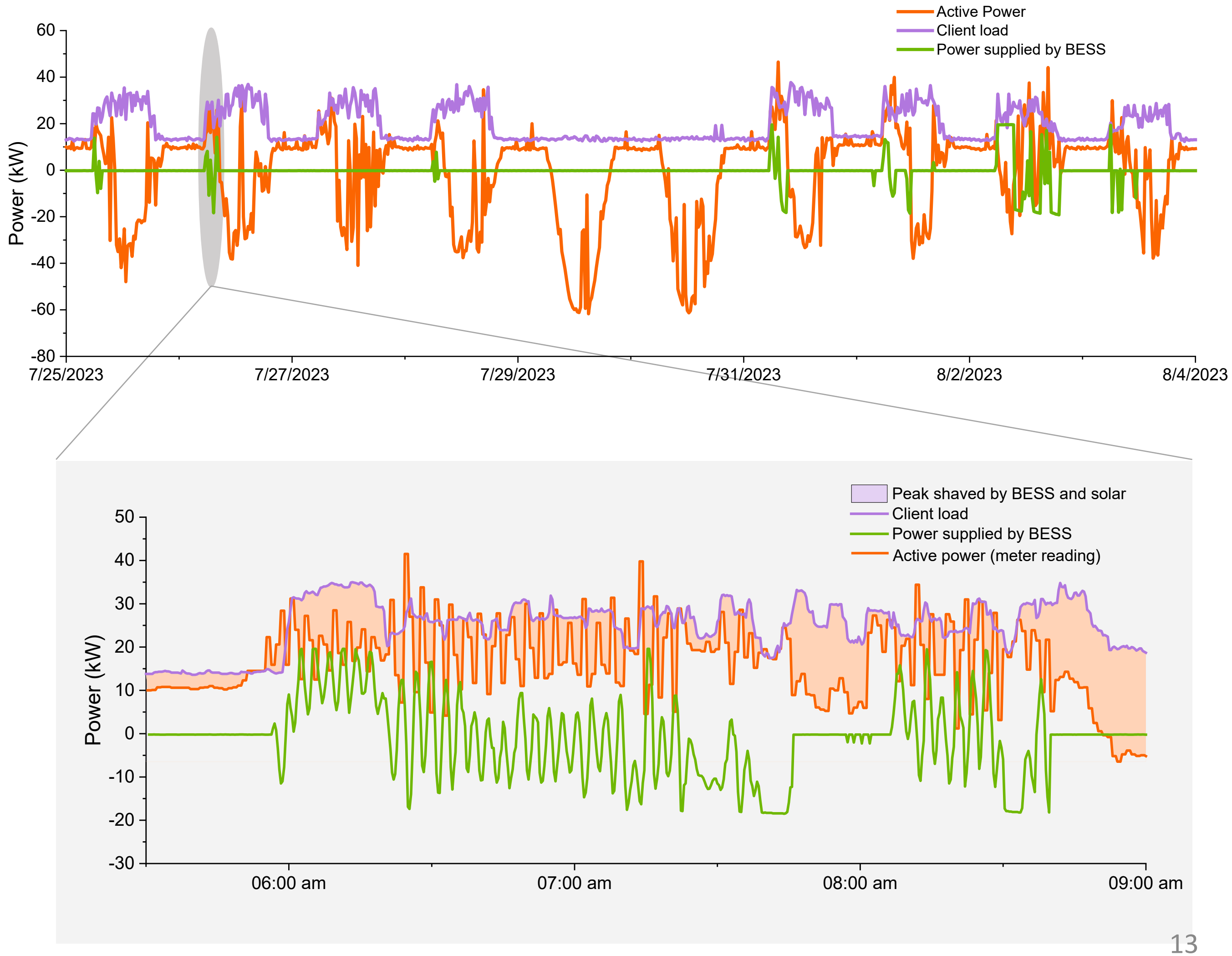
Application: Demand Charge Reduction

Example: Installation in an Oil Warehouse in Salt Lake City, Utah

- Battery energy storage systems (BESS) can significantly reduce demand charge by charging during low demand hours and discharging during peak periods to reduce peak demand.

- In the example shown here, when there is no solar in the early mornings, the UEP BESS is utilized for demand charge management.

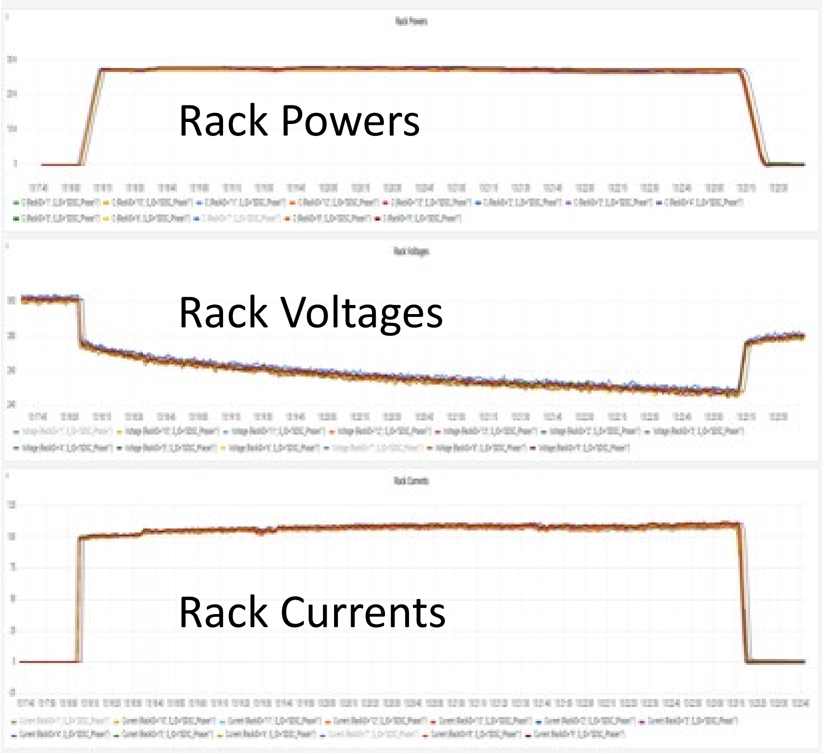
- In average, the peak mitigated by UEP BESS for this one event is ~9 kW, about 12% depth of discharge.



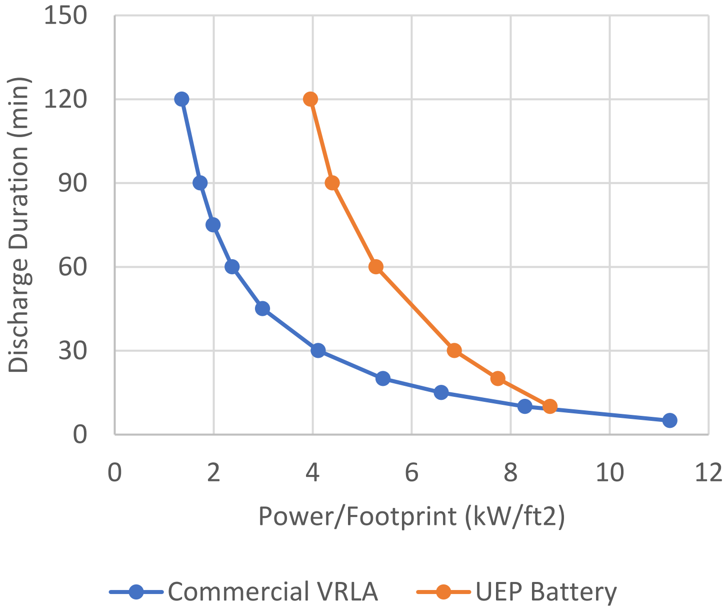
Application: Power Backup / UPS

Example: San Diego Supercomputer Center (SDSC)

Acceptance test at SDSC at 350kW



Comparison of a UEP UPS system with a commercial VRLA system



- Testing of a constituent rack for the SDSC UPS/backup system.
- 26 such racks in parallel will provide 2 hours of power backup.
- At the same rack power, the UEP system provides longer backup than a VRLA system, especially for hour-long durations.

COLLABORATING TEAM: UEP, CCNY, SNL, BNL, DOE OE

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