Progress with Manufacturing and Deploying $Zn|MnO_2$ Batteries for Grid-Scale Applications

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CTO

Urban Electric Power

Talk Flow

1. The Electrochemistry of a Zn|MnO_2 Cell
    1. Introduction
    2. Materials Chemistry & Characteristic Voltage Curves
    3. Limitations in Reversibility
2. Rechargeable Zn|MnO_2 Cell
    1. Manufacturing in New York
    2. 1st Generation Cell
    3. Safety Testing
    4. Applications
        1. Solar Microgrid
        2. Data Center Backup
        3. Off-Grid Solar
    5. Automated Manufacturing
    6. Performance of Cells from Automated Plant
3. Next Generation Rechargeable Zn|MnO_2 Cell
    1. 2nd Generation
    2. Materials Improvement and LDES Application
4. Current and Future UEP Projects

Talk Duration: Short to Medium Duration

The Electrochemistry of a Zn|MnO_2 Cell

1.Introduction

Citation: Gautam G. Yadav, in peer review (2024)

The Electrochemistry of a Zn|MnO_2 Cell

2. Materials Chemistry & Characteristic Voltage Curves

Citation: Gautam G. Yadav, in peer review (2024)

The Electrochemistry of a Zn|MnO_2 Cell

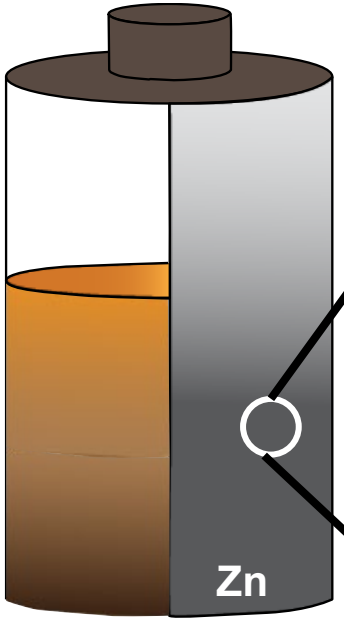
3.Limitations in Reversibility

Citation: Gautam G. Yadav, in peer review (2024)

The Electrochemistry of a Zn|MnO_2 Cell

3. Limitations in Reversibility

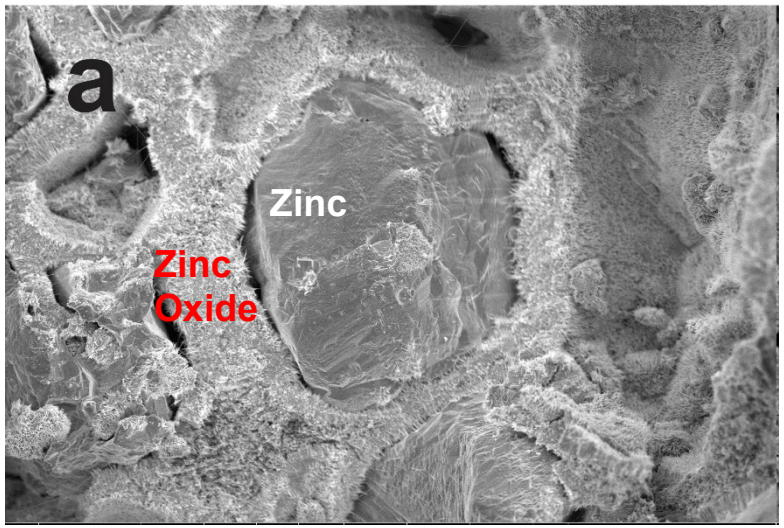
Challenge to Access High Zn utilization
& Area Capacity without experiencing
The problems mentioned in the box



Zinc Passivation Redistribution

Zinc Shape Change

Zinc Shape Change & Passivation

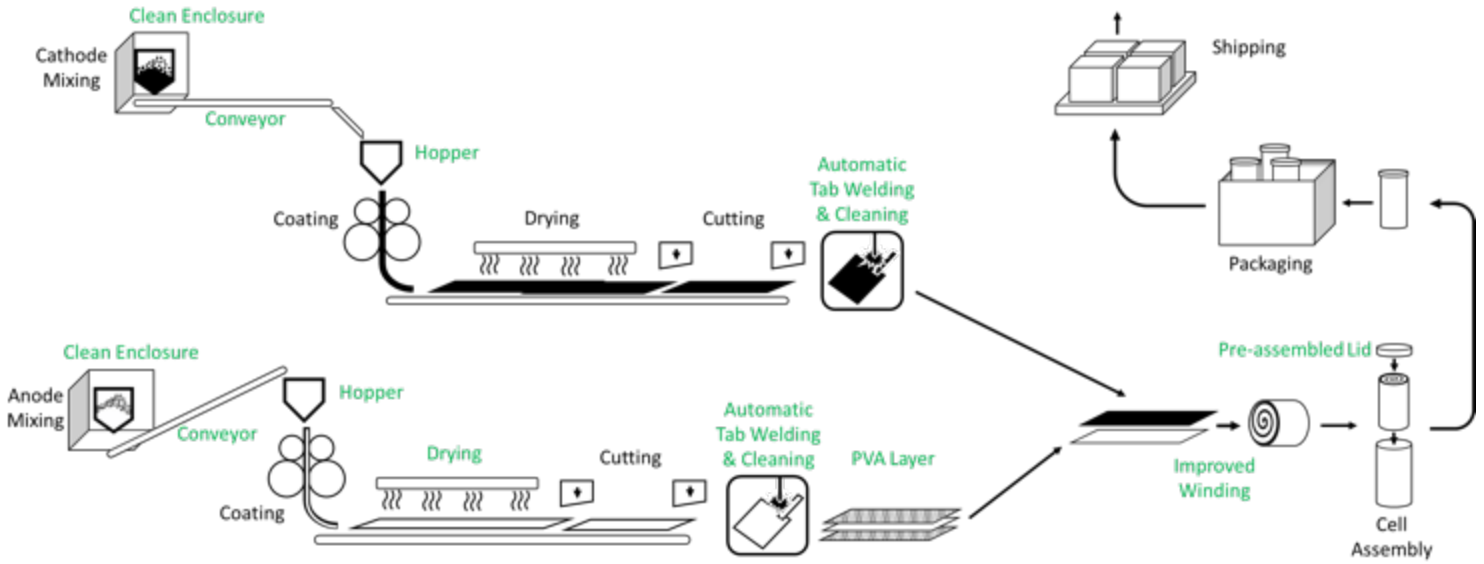


Citation: Gautam G. Yadav, in peer review (2024)

Rechargeable Zn|MnO_2 Cell

1. Manufacturing

Pearl River, New York
Plant Capacity ~ 10MWh




Control


Coating

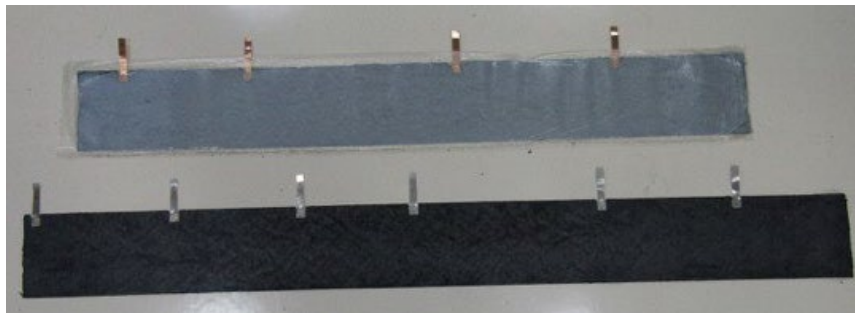

Calendaring


Slitting

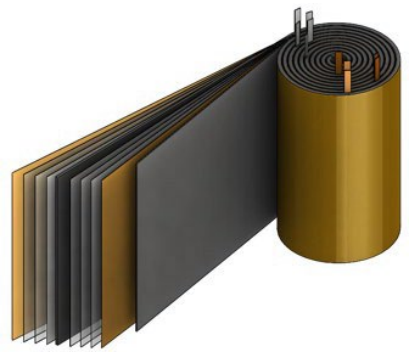
Citation: Gautam G. Yadav, in peer review (2024)

Rechargeable Zn|MnO_2 Cell

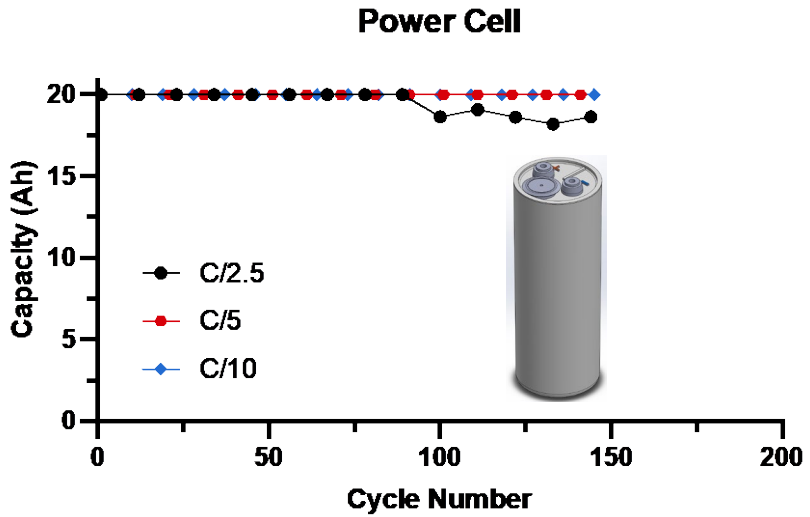
2. *1st Generation Cell*

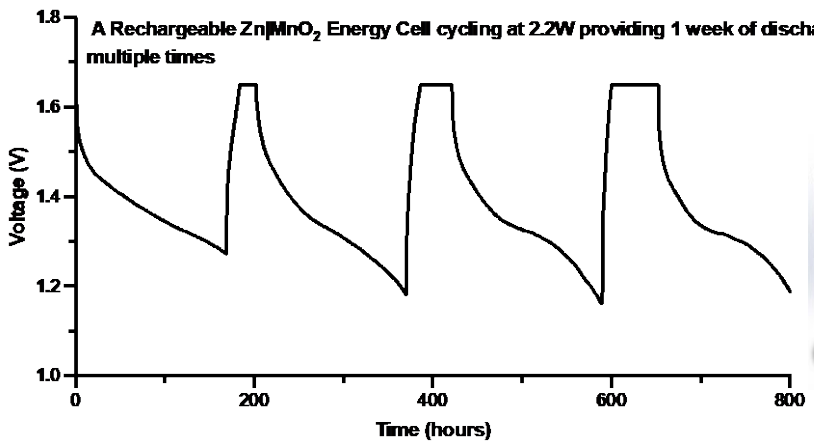


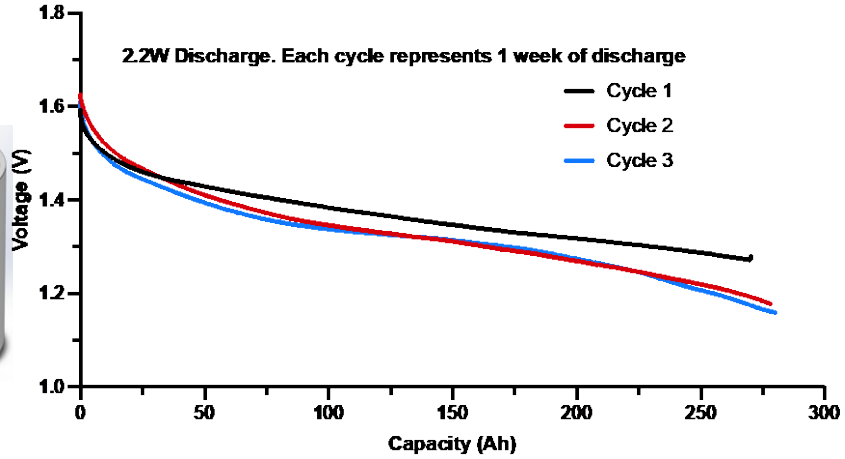
Top – Zinc Anode
Bottom – Manganese Dioxide Cathode

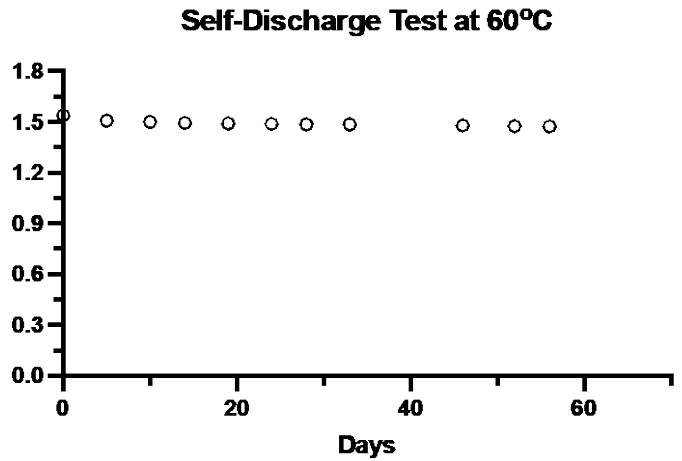


Cylindrical Jelly Roll









Energy Cell

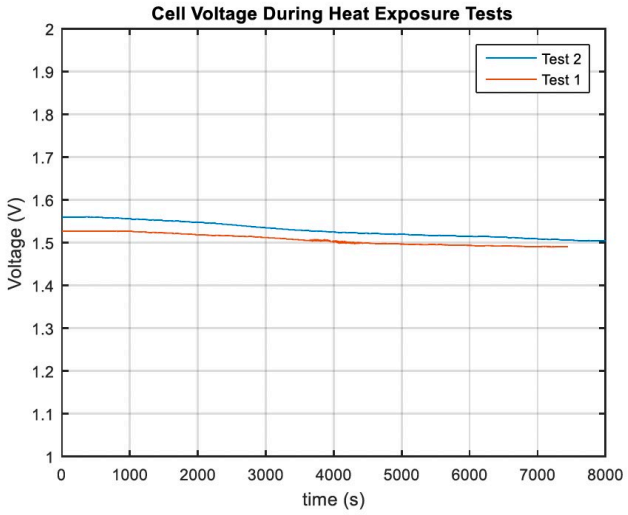
Rechargeable Zn|MnO_2 Cell

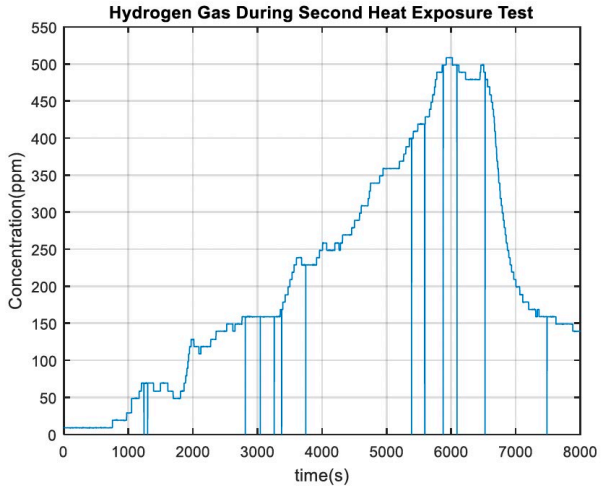
3. Safety Testing

Test	Test Method	Thermal Runaway
1.	Film Heater	Not Observed
2.	Pipe Heater	Not Observed
3.	Nail Penetration	Not Observed
4.	Overcharge	Not Observed
5.	Overdischarge	Not Observed

Heat Exposure Tests:

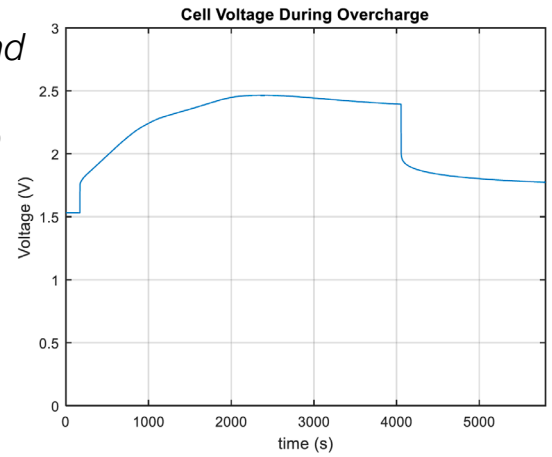
"~1.2% of H_2 gas generated which is very manageable in line with Pb-acid"





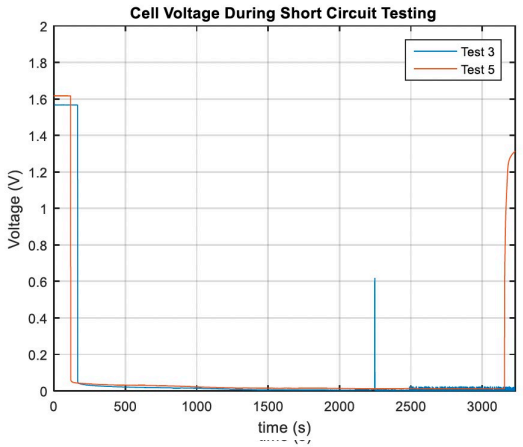
Overcharge Tests:

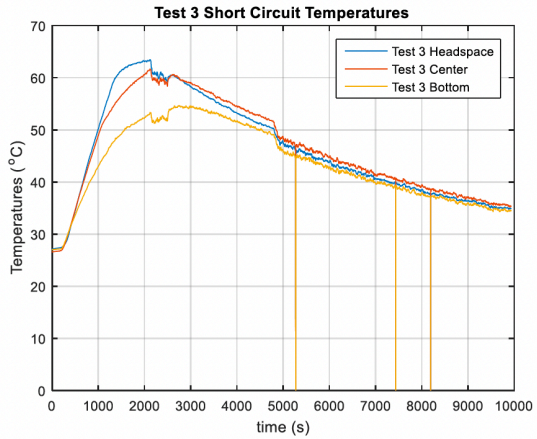
"Water Vapor and low-levels of O2 detected, but no signs of ignition sources"

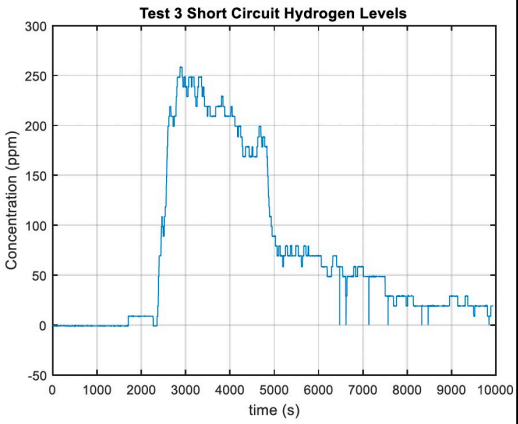


Short-Circuit Tests:

"Cells drop to 0V and bounce-back with expected temperature increase"







"DNV-GL believes Zn|MnO_2 batteries are similar to Pb-acid batteries in terms of risks posed and substantially different than Li-ion batteries"

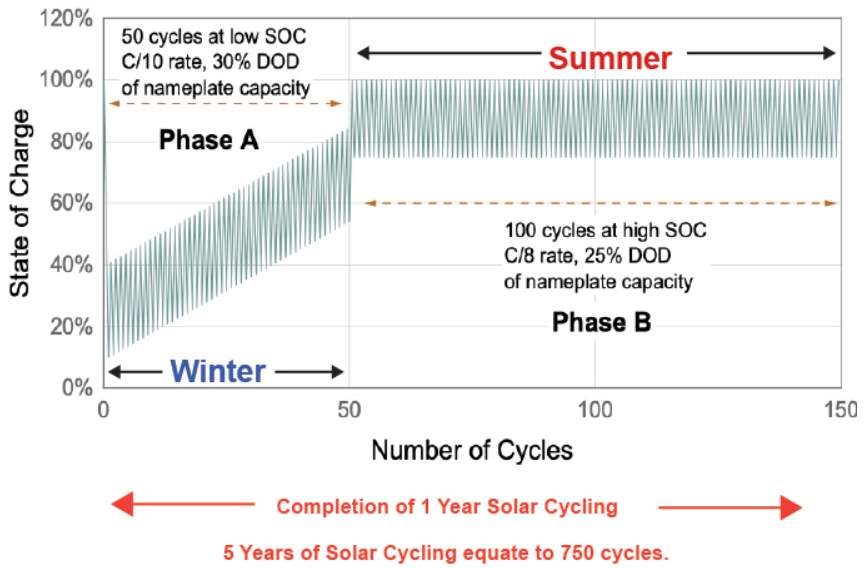
UL 1973/9540A safety certification confirms no fire risk.

Citation: UEP Data (2024)

Rechargeable Zn|MnO_2 Cell

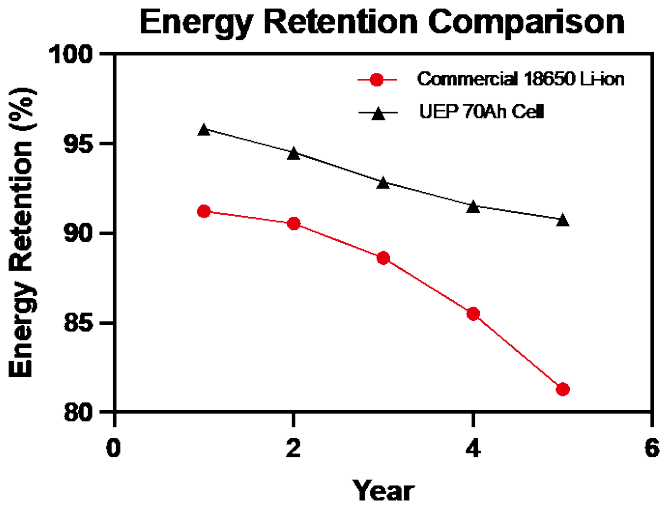
3. Applications – Solar Microgrid

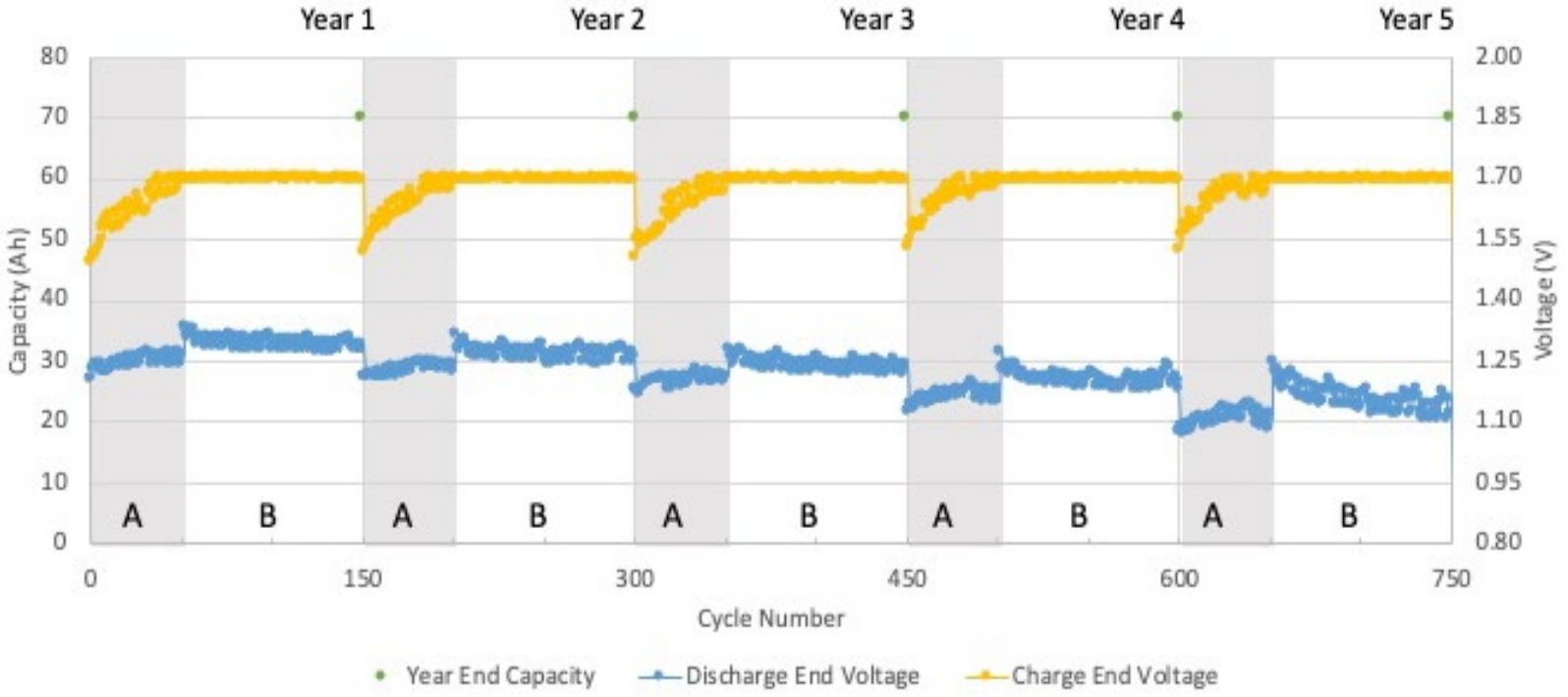
IEC-61427



Completion of 1 Year Solar Cycling

5 Years of Solar Cycling equate to 750 cycles.





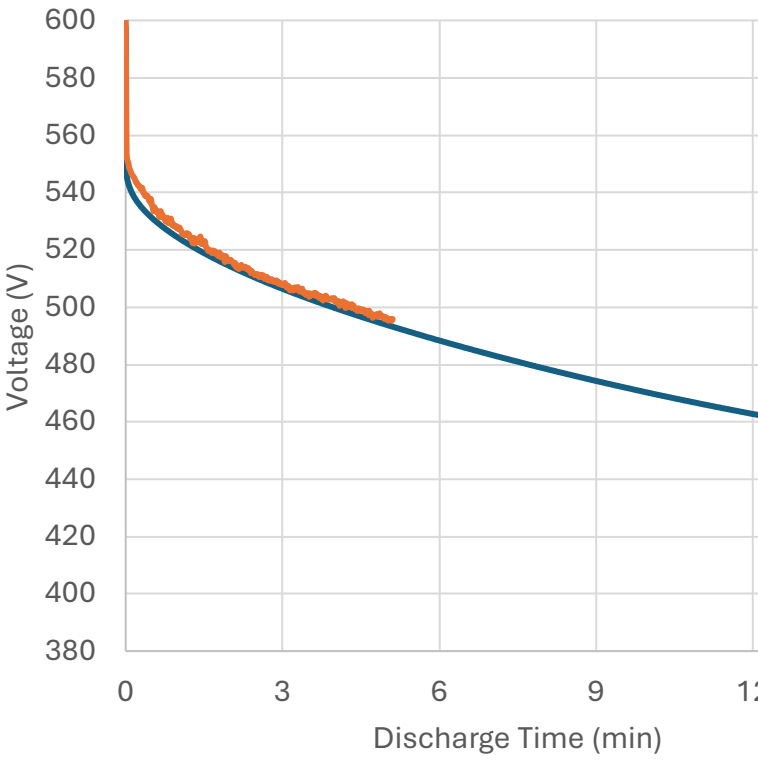
Phase A: 3h C/10 charge and 3h C/10 discharge cycling at low state of charge for 50 cycles.
Phase B: 6h charge and 2h C/8 discharge cycling at high state of charge for 100 cycles.
A 9-hour C/10 discharge is done between phases B and A at the end of each year.

Citation: Gautam G. Yadav, et al, Polymers (2022)

Rechargeable Zn|MnO_2 Cell

3. *Applications – Data Center Backup*

San Diego Supercomputer Center



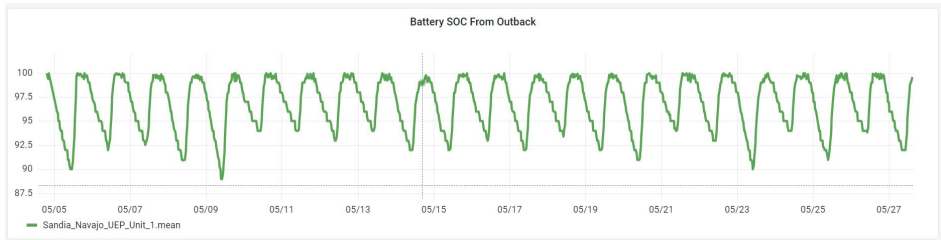
- The orange curve is the average discharge voltage curve of 13 racks during the commissioning test. The commissioning test ran for 5 minutes at 350 kW (equivalent to 75W per cell) as requested by the customer.
- The blue curve is the discharge voltage curve of a single cell tested in UEP at 75W. The single cell voltage is multiplied by 360 to be compared to the rack voltage.
- The average voltage of the racks falls on top of the single cell discharge curve under equivalent discharging conditions.
- At the 15-min cutoff, which is the max backup time that the lead acid batteries can provide, the voltage of the UEP system is about 453 V, way above the 380 V inverter limit.

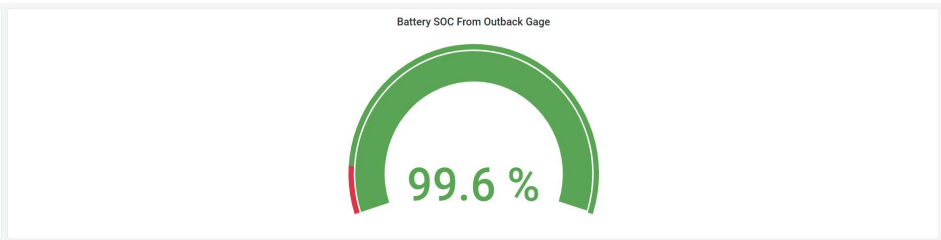
Citation: UEP Data (2024)

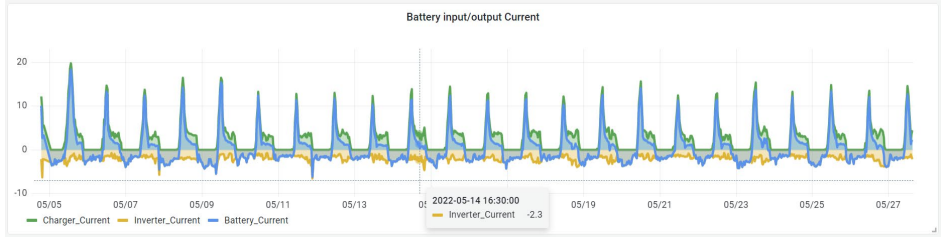
Rechargeable Zn|MnO_2 Cell

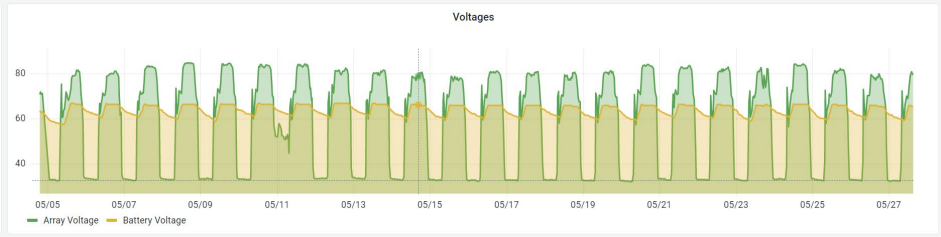
3. Applications – Off-Grid

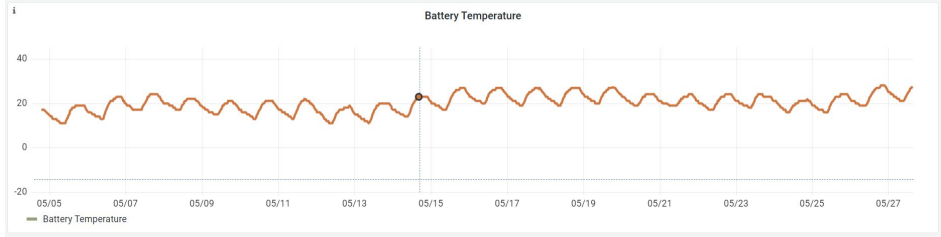
- 13 kWh solar microgrid system to be deployed in October 2021
- System uses a standard Outback inverter and seats on a self-contained pod

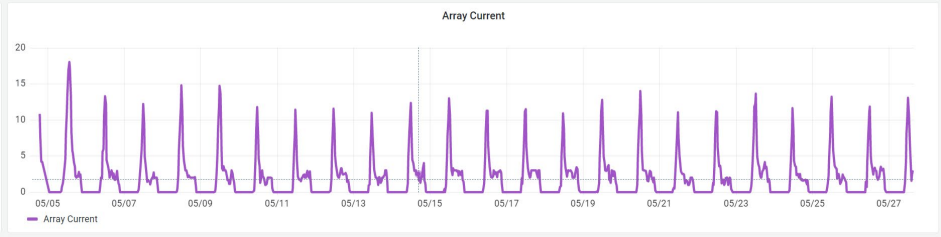


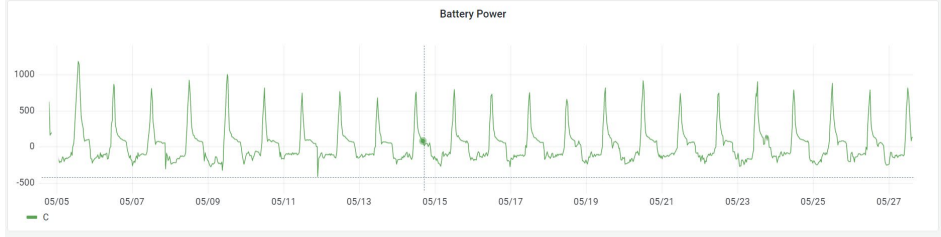












Citation: UEP Data (2024)

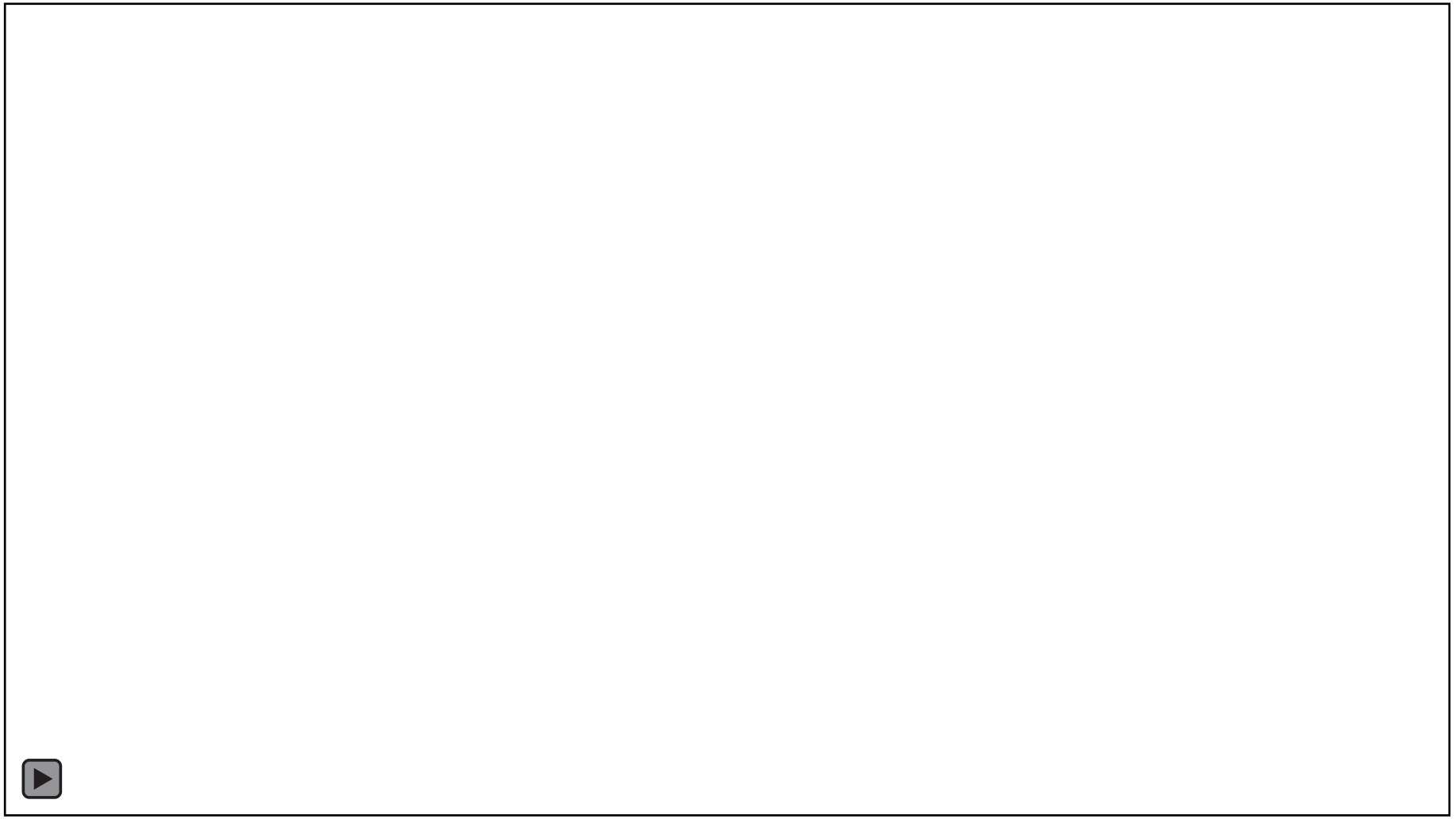
Rechargeable Zn|MnO_2 Cell

4. Automated Manufacturing

Citation: Godrej & Boyce (2024)

Rechargeable Zn|MnO_2 Cell

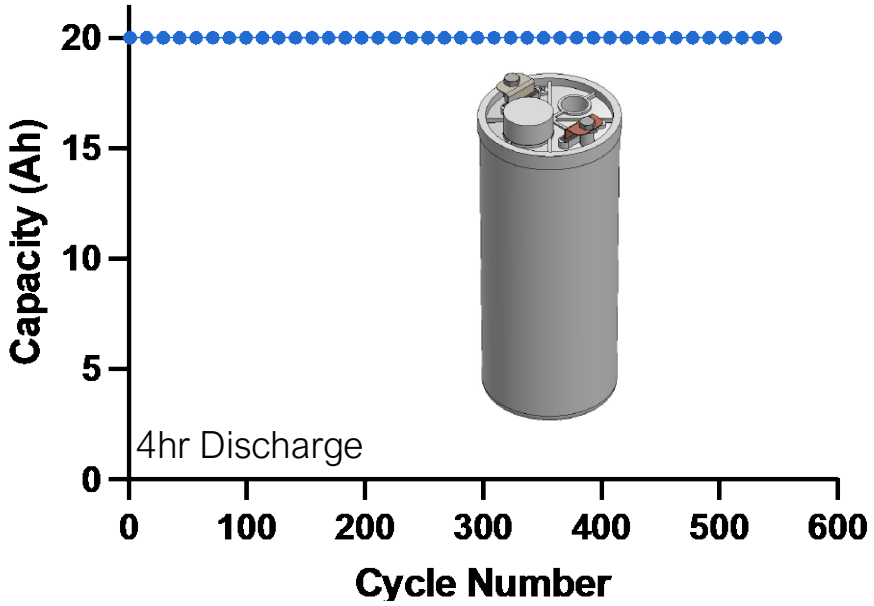
4. Automated Manufacturing

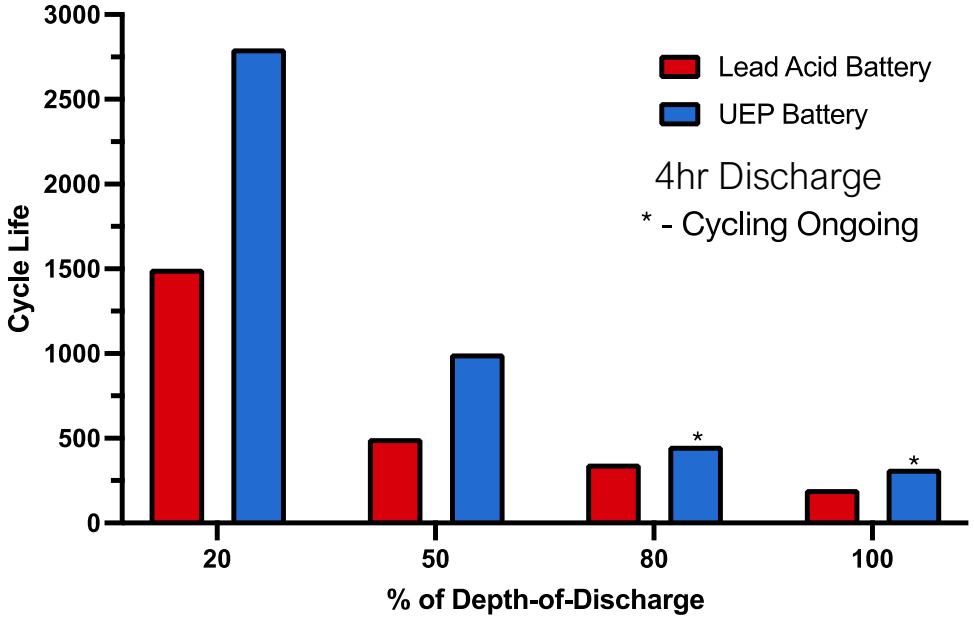


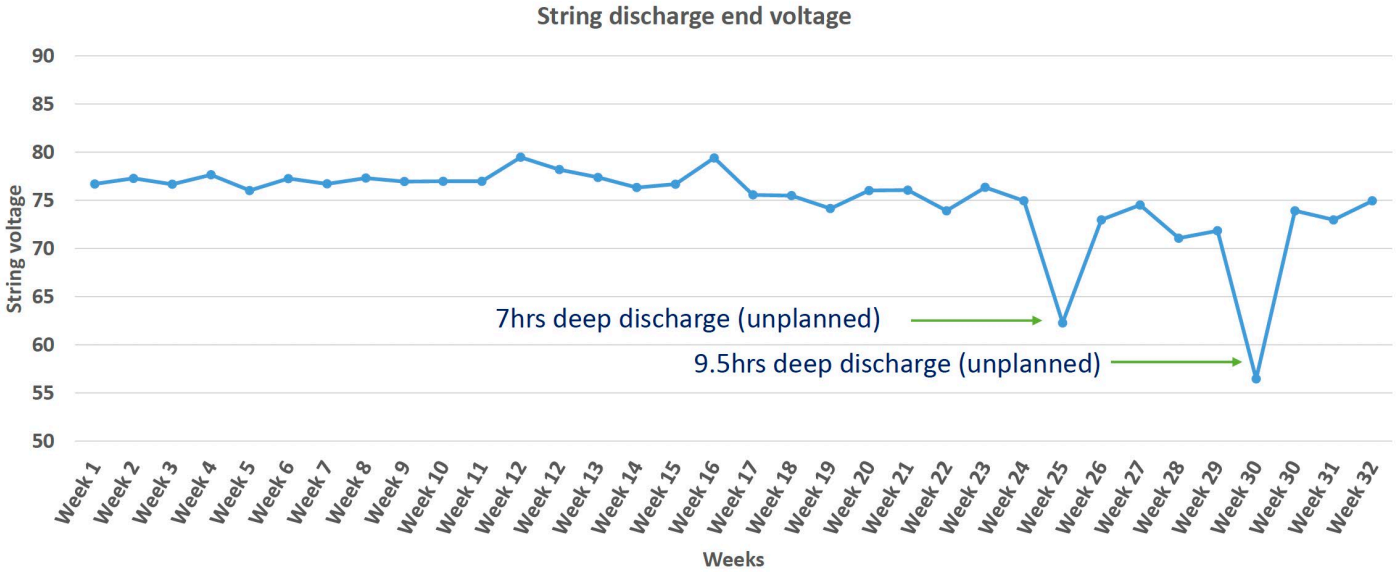
Citation: Godrej & Boyce (2024)

Rechargeable Zn|MnO_2 Cell

5. *Performance of Cells from Automated Plant*



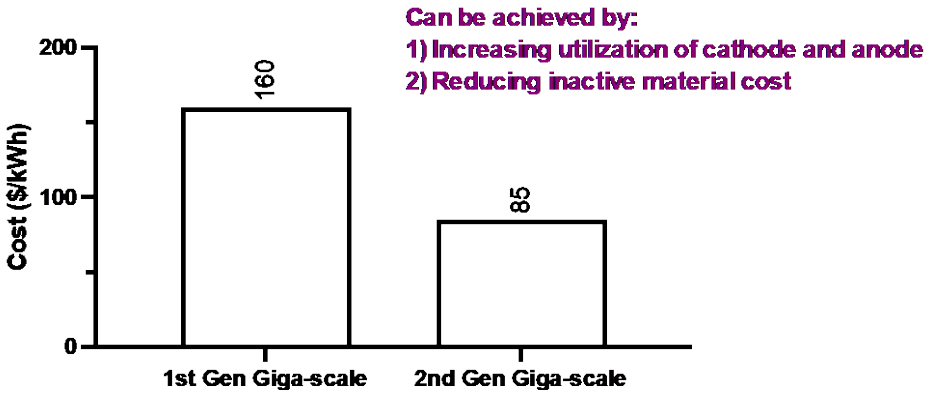


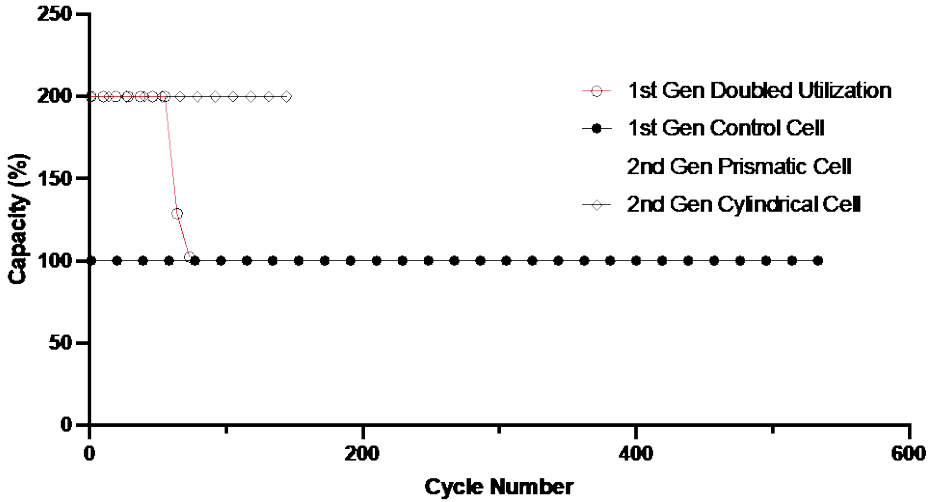


Citation: Godrej & Boyce (2024)

Next Generation Rechargeable Zn|MnO_2 Cell

1. 2nd Generation Cell (Coming This Year)

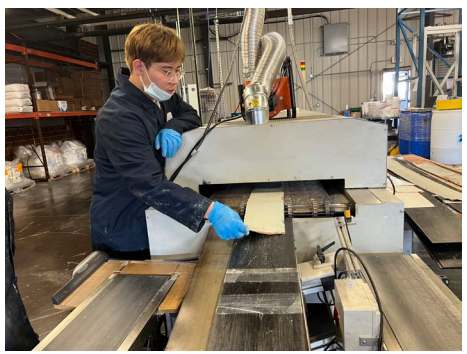


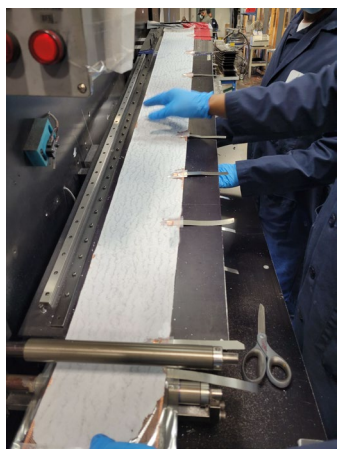


1) 2nd Gen cells use additives that double the utilization of the active materials

2) We have replaced expensive current collectors with cheaper materials and achieved along cycle life

Manufactured in New York Plant





Manufactured in Automated India Plant

Citation: UEP & Godrej & Boyce Data (2024)

Next Generation Rechargeable Zn|MnO_2 Cell

2. Materials Improvement and LDES Application Space

Current and Future UEP Projects

Prior and Current Awards

1) Numerous SBIR/STTR awards with DOE, DOD (Navy, Air Force), options for Phase 3 contracts

2) Project STORED (DOE) – 7.2MWh of demonstration projects for long duration storage in New York State

3) Clean Power for Hours Grand Prize Winner (DHS) – Cash prize and networking/matchmaking opportunities for Federal work

4) Sandia National Laboratories partnership – Multi-year partnership focused on battery and product development

Market Drivers

1) Pentagon banned DOD procurement of Chinese lithium-ion batteries starting in 2027

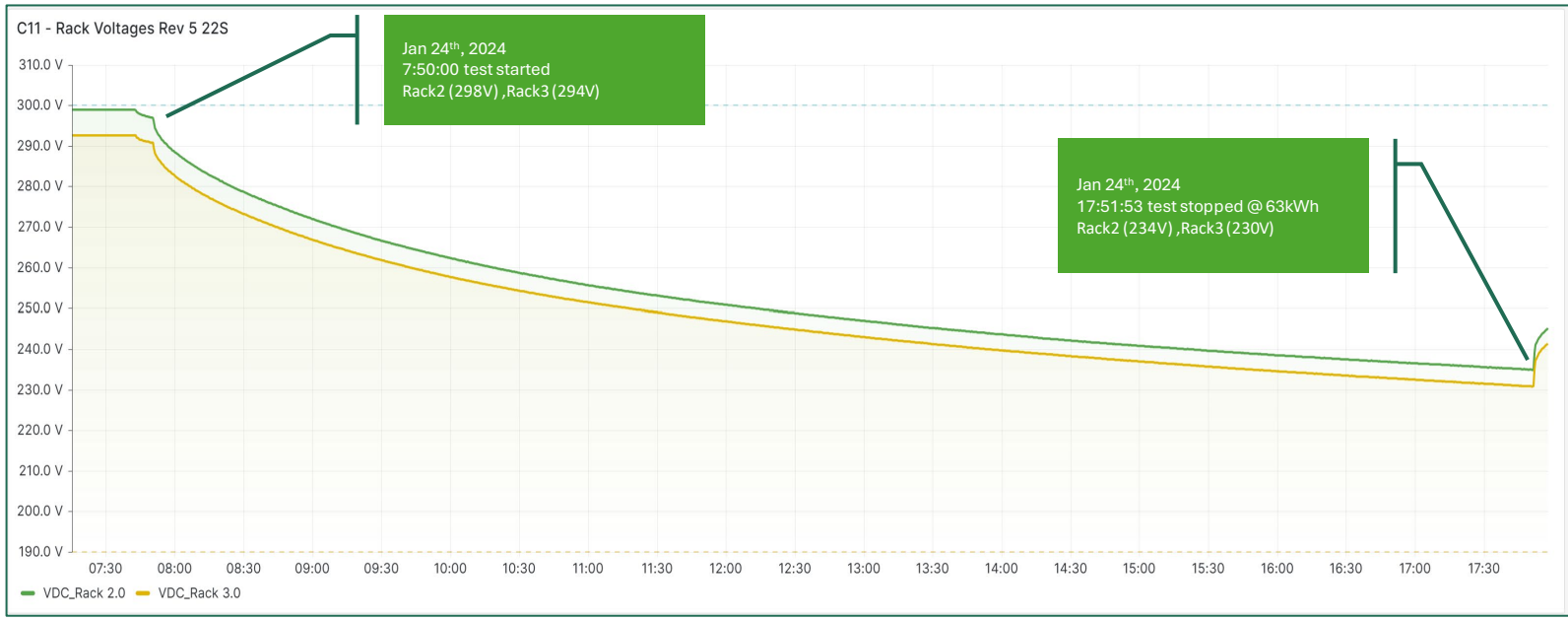
2) Congressional lawmakers call for ban on CATL lithium battery products in June 2024

3) Domestic, non-lithium sourcing becoming a key objective for DOE.

Citation: UEP Data (2024)

Current and Future UEP Projects

100kW/400kWh system at the City College of New York

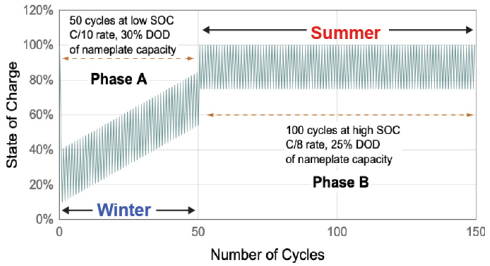


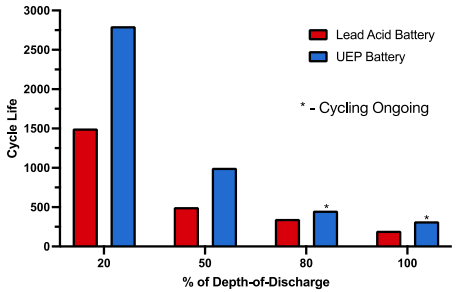
10-hour discharge on system conducted on Jan 24th, 2024, won the Department of Homeland Security Grand Prize Powers for Hours to support critical infrastructure across the USA

Citation: UEP Data (2024)

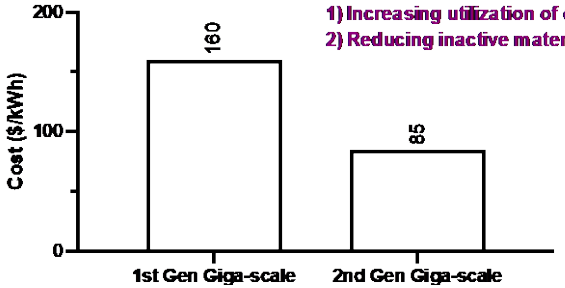
Summary

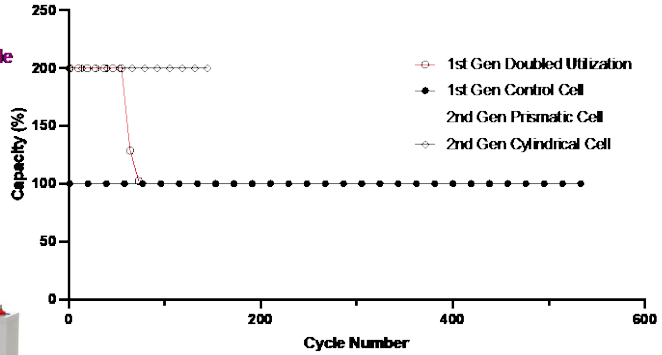
1. UEP's 1st Generation Product validated in different applications and demonstrated to be an ideal replacement for Pb-acid batteries



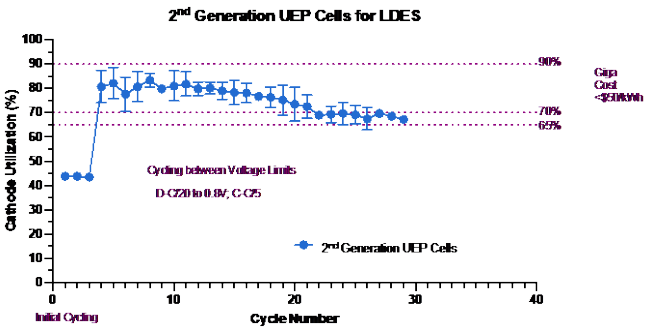


2. 2nd Generation cell is developed. Performance, cost and manufacturing has been validated





3. UEP has won grants and a prize demonstrating Zn|MnO_2 technology for LDES. 2nd Generation cell has been shown to be superior for this application space



4. New materials chemistry and electrochemical characteristics observed in the 2nd Generation cell. Working with Sandia (Dr. Timothy Lambert) to uncover the science. We are also working with Sandia to build and test modules using 2nd Generation cell

Citation: UEP Data (2024)

Thank you!

Contact

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