Energy Storage in the Southwest:
Battery Case Studies from Albuquerque Public Schools and the Navajo Tribal Utility Authority

December 1, 2022
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The Energy Storage Technology Advancement Partnership (ESTAP) is a US DOE-OE funded federal/state partnership project conducted under contract with Sandia National Laboratories.

ESTAP Key Activities:

1. Facilitate public/private partnerships to support joint federal/state energy storage demonstration project deployment

2. Disseminate information to stakeholders
   - ESTAP listserv >5,000 members
   - Webinars, conferences, information updates, surveys.

3. Support state energy storage efforts with technical, policy and program assistance

ESTAP Project Locations:
Thank You!

Dr. Imre Gyuk
Director, Energy Storage Research, U.S. Department of Energy

Dan Borneo
Engineering Project/Program Lead, Sandia National Laboratories
Webinar Speakers

Dr. Imre Gyuk  
Director of Energy Storage Research, DOE Office of Electricity

Anthony Sparks  
Staff Project Manager for HVAC Systems, Albuquerque Public Schools

Henry Guan  
Electrical Engineer, Sandia National Laboratories

Galina Kofchock  
CFO, OE Solar

Todd Olinsky-Paul  
Senior Project Director Clean Energy States Alliance (moderator)
Energy Storage
In Town and Desert

IMRE GYUK, DIRECTOR,
ENERGY STORAGE RESEARCH, DOE-OE
Both projects:
Solar + Storage
Similar Location
Commissioned in 2022
Social Equity related
Tribal vs. Hispanic
Small vs. Large
Non-Lithium vs Lithium
Navajo Nation, AZ

Partnering with DOE-OE, Sandia, NTUA, UEP

3 kW / 3.6 days
Rechargeable Zn Mn O$_2$
Battery Developed by UEP.

Commissioned May 2022

There are 18,000 Residents off-Grid on the Reservation
Capacity 3kW / Average Load 150W = 87hrs = 3.6 days Backup
PV = 1kW Available for daily Recharge
Other Tribal Projects:

- Navajo – 2 Projects
- Picuris Pueblo
- San Carlos Apache
- Seminole
- Levelock, AK
Atrisco Heritage Academy, Albuquerque, NM
Energy Storage for Social Equity

85% Hispanic,

Reduce peak demand during occupied hours

Battery: 721 kW/4hr = 2884 kWh
plus roof-mounted PV = 850 kW

Total cost with PV: $3.1 M

Contract awarded – May 2021
BESS ground work – 1/22 – 3/22
Commissioned – October 13, 2022
DOE Initiative ES4SE: Energy Storage for Social Equity

14 communities selected to receive detailed Technical Assistance

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5+ communities will be chosen to partner in constructing an energy storage facility.

https://www.pnnl.gov/projects/energy-storage-social-equity
Atrisco Heritage Academy HS – Battery Storage for Peak Shaving
Atrisco Heritage Academy HS – Battery Storage for Peak Shaving

APS’ largest campus, largest utility bills.

Summertime electricity bills over $50K; demand charges more than 50%.
Atrisco Heritage Academy HS – Battery Storage for Peak Shaving

Project objectives

• Charge from grid ‘off-peak.’

• Deploy strategically during ‘on-peak.’

• Reduce daily peak demand to below 500 kW.

• Test case for replication elsewhere in District.

• Potential for resiliency during power emergency.
The importance of partners

- Expertise, experience
- Detailed, reliable analysis
- Many eyes, many viewpoints
- Shared financial burden

A win for everybody!
Atrisco Heritage Academy HS – Battery Storage for Peak Shaving

Added PV to improve the payback

- 850 kW to optimize payback
- 2200 PV panels . . . one per student!
- Without PV – 17 years*
- PV *plus* battery – <13 years

* Entirely dependent on utility rate structure.

Doubled project cost, but provides net savings of $3.5 M over life of battery.
BESS System - TESLA Megapack 2

BESS Enclosure
- 1,924 sq ft
- 10 ft Block Wall
- Automatic Gates
- Switchgear
- Transformer

BESS Site Location
• Tesla Megapack 2- Battery System
• Battery Meter - Measures power output from the battery
• Site Controller- Supervisory Control & Data Acquisition (SCADA system)
• Opticatser - Optimally dispatches battery system
• Powerhub - Monitoring system
• Site Meter - Measures power pulled from the grid
• Switch - Disconnecting Means
• Transformer - Optimally dispatches the battery system
Integrated heating and cooling at the cell level with dedicated hazard venting.

Internal Cooling

Internal Cooling

Uninterrupted

Module-level DC/DC converters that can keep the system running uninterrupted in case of partial failure.

Turnkey

Megapack ships as a turnkey system and arrives fully assembled and tested keeping install costs down.

Software

Proprietary optimization software developed in parallel with the Megapack hardware, learns and predicts local energy patterns.

Reducing Carbon Emissions

The PV system will reduce the carbon footprint in the area by 25%.

Uninterrupted
PV System Design
Solar PV System

- 850KW/DC Over 5 buildings
- Each Interconnecting at the buildings main service panel
- Produces 1.3 Gigawatt Hours Annually
- REC 385W Modules 2,208 Solar Panels
  - (About 1 Per Student in enrollment)
- 16 Inverters
- Unirac RM 10 ballast mounted system
Project BENEFITS

COST SAVINGS
The school will be able to reallocate millions towards educational programs and infrastructure upgrades.

LOAD MANAGEMENT
The energy storage system will reduce the electrical demand on the power lines allowing for the conserved energy to be diverted to the surrounding community via the PNM grid.

FUTURE GENERATIONS
The installation sets an example for future generations to bring new/clean technology that gives back to the environment.
This project received grants from the U.S. Department of Energy, the Office of Electricity, and the New Mexico Department of Energy, Minerals, and Natural Resources.

Along with the installation, OE Solar will be conducting a study on the infrastructure necessary to utilize the Tesla Megapack energy during emergency events.

The school will be able to offset energy consumption and rising utility rates by producing and storing energy on site.

The PV system will reduce the carbon footprint in the area by 25%.
Atrisco Heritage Academy HS – Battery Storage for Peak Shaving

**BENEFITS**

- Cost Savings
  - Energy Savings
  - Model for Replication
    - Education
  - Awareness / Exposure
    for students and community

More to be discovered!
Atrisco Heritage Academy HS – Battery Storage for Peak Shaving

Center of the Community

Large disadvantaged population.
Adding PV to battery storage allowed opportunity for ‘islanding’

- Conduct feasibility study to identify grid disconnect requirements, critical loads, etc.
  - Create islanding implementation plan & design
  - Pursue funding for implementation project

Many new opportunities opened up.
Atrisco Heritage Academy HS – Battery Storage for Peak Shaving

Resiliency

CHALLENGES

• UTILITY CO. ACCEPTANCE/INTEGRATION – Technology is still new
• OBsolescence – Technology is changing fast
• COST – Early adopter; schools are publicly funded
• EQUITY – Placement at one site excludes others
• LEADERSHIP – Needs a champion and buy-in from District

Can We Lead the Way? Will You?
Introduction – Demonstration Projects Team

**What we do and why:** Support utilities, state energy offices, academia, and the overall ES industry to **proliferate the use of energy storage on the nation’s grid**. Sandia's work allows the DOE to **inform the nation’s** understanding of ES application optimization, energy storage operation, system reliability, and the economic impact of energy storage in different market environments.

**Provide project implementation guidance from initiation through operation**
- Engineering Analysis (technical and economical)
- Design, Procurement, & Construction Consultation
  - RFP Document Development
  - Vet technologies
  - Review construction documentation
  - Safety design consultation
- Commissioning Plan Review, Implementation, and Operational Guidance
  - Monitoring, Installation Best Practices, Training

**Public outreach through papers, webinars, presentations**
- Develop public information programs
- Demonstrate innovative installations to inform industry of best practices

**Why is this program important?**
- To help develop more safe, effective, and reliable systems
  - Aims to increase user confidence by showing that energy storage is a mature technology and showcase its range of benefits to the user
  - Validate technical analysis models and results, demonstrate benefits
  - Inform codes and standards & best practices for installation and operation
  - Monitor, gather, and analyze operational energy storage project data
  - Learn...Learn...Learn!!
Introduction

- Project Partners
  - Department of Energy – Office of Electricity, Energy Storage Program
  - Sandia National Laboratories
  - Navajo Tribal Utility Authority
  - Urban Electric Power, Inc.
Project Objective

- **Deploy** rechargeable zinc manganese dioxide battery energy storage system at an off-grid location on the Navajo Nation as a replacement for an existing lead acid battery storage system.

- **Install** a data acquisition system to monitor the operation of the system and collect data for performance validation.

- **Conduct** laboratory scale testing of zinc manganese dioxide batteries to predict cycling performance in the field using IEC 61427-1 protocol to simulate batteries connected to solar panels.

- **Compare** and validate performance of field deployed ZnMnO₂ battery system to lab scale test results.
Project Location

- Located near Dilkon, AZ
- Dilkon is a census-designated place in Navajo County, AZ
- Population of 1,235
- Location of the deployment site is approximately 2 miles from Dilkon
  - Single Family Home
  - Existing off-grid battery system installation

The Navajo Nation is the largest Native American reservation in the United States, with an area of approximately 17.5 million acres. The Navajo Tribal Utility Authority (NTUA) was established in 1959 and provides electrical, water, and natural gas services to residents of the Navajo Nation. However, many still do not have electricity due to the rural nature of the reservation and the expense of installing electrical infrastructure. There currently are over 15,000 residents on the reservation without electricity.

System Overview

- **UEP Rechargeable Alkaline Battery System**
  - Zinc Manganese Dioxide (ZnMnO$_2$) Chemistry

- **Outback Inverter and Charge Controller**

- **Custom data acquisition system**

- **System Size: 3kW / 13 kWh**
  - 10 cells per module
  - 4 modules per string
  - 3 parallel strings
System Overview

- **BESS Size: 3kW / 13 kWh**
  - 10 cells per module
  - 4 modules per string
  - 3 parallel strings

- **Existing Solar PV**
  - 1800W PV System
  - 6x 300W panels
The ZnMnO$_2$ was delivered from the manufacturer to Sandia and assembled at the Energy Storage Test Pad (ESTP) for pre-commissioning testing and integration of data collection.

Load measurements at the deployment site were taken concurrent with these activities in order to better determine final battery management system setpoints.

Improvements were made during system assembly and pre-commissioning which include design and installation of a racking system for the BMS hardware to improve ergonomics and ease of installation.
On May 5, 2022, the 3 kW / 13 kWh rechargeable zinc manganese dioxide (ZnMnO$_2$) battery system was successfully deployed to replace lead acid batteries at an off-grid home on the Navajo Nation in Arizona.

It is estimated that the battery can supply the home for 8-12 days without solar power.

The new UEP battery system is the first of three demonstration deployments that will provide power to off-grid homes while assessing the performance of the rechargeable ZnMnO$_2$ batteries in an applied environment.
Laboratory testing was performed to predict performance of these cells in the field by simulating the cycling conditions the cell would experience.

This was done using a solar aging protocol that simulates one year of cycling per round of testing.

Temperature was varied to match the average temperatures observed at the deployment site during each season (Fall: 17°C, Winter: -4°C, Spring: 17°C, Summer: 30°C).

It was found that low temperatures can adversely impacted cell performance, which recovers at higher temperatures.

New lab experiments are currently underway to evaluate how long the cells can be expected to last under these new operating conditions.
Data Collection

- A data acquisition system was developed using off the shelf hardware and an open-source platform.

- The hardware was integrated with the manufacturer supplied battery management system for the BESS.

- Data for the BESS and solar PV system is transmitted to an InfluxDB database through a cellular modem. Data from the database can be visualized in Grafana or exported for further analysis.

- The hybrid battery management system/data collection system also allows for remote communication and control to the BMS.
This work was directed by Dr. Imre Gyuk through the Department of Energy Office of Electricity Delivery and Energy Reliability (DOE-OE) Stationary Energy Storage Program.

Thank You

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BESS Enclosure

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- 10ft Brick Wall
- Automatic Gates
- Switchgear
- Transformer
- Tesla Megapack
• Tesla Megapack 2- Battery System
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• Transformer - Steps down Power from 12470 to 480v
TESLA MEGAPACK BENEFITS

TURNKEY
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INTERNAL COOLING
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This webinar was presented by the DOE-OE Energy Storage Technology Advancement Partnership (ESTAP)

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ESTAP Website: https://cesa.org/projects/energy-storage-technology-advancement-partnership/

ESTAP Webinar Archive: https://cesa.org/projects/energy-storage-technology-advancement-partnership/webinars/
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• New Federal Money for Energy Storage: The Inflation Reduction Act (12/16)

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