DOE-OE Energy Storage Technology Advancement Partnership (ESTAP) Webinar

Energy Storage in the Southwest:

Battery Case Studies from Albuquerque Public Schools and the Navajo Tribal Utility Authority

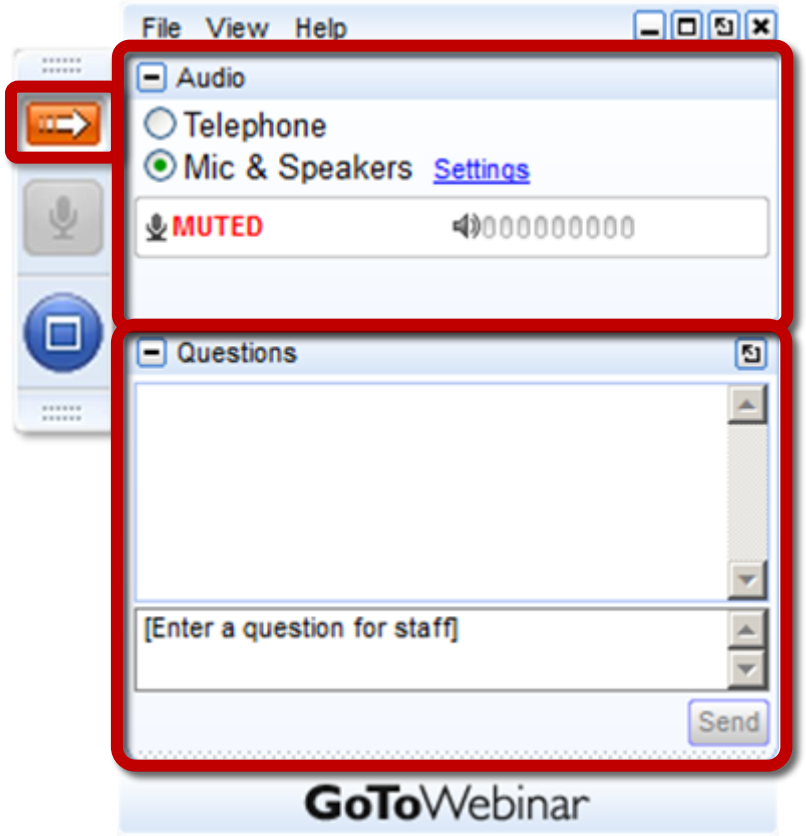
December 1, 2022

U.S. DEPARTMENT OF ENERGY

Sandia National Laboratories

CleanEnergy States Alliance

Webinar Logistics



Join audio:

- Choose Mic & Speakers to use VoIP
- Choose Telephone and dial using the information provided

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Submit questions and comments via the Questions panel

This webinar is being recorded. We will email you a webinar recording 48 hours. This webinar will be posted on CESA's website at www.cesa.org/webinars


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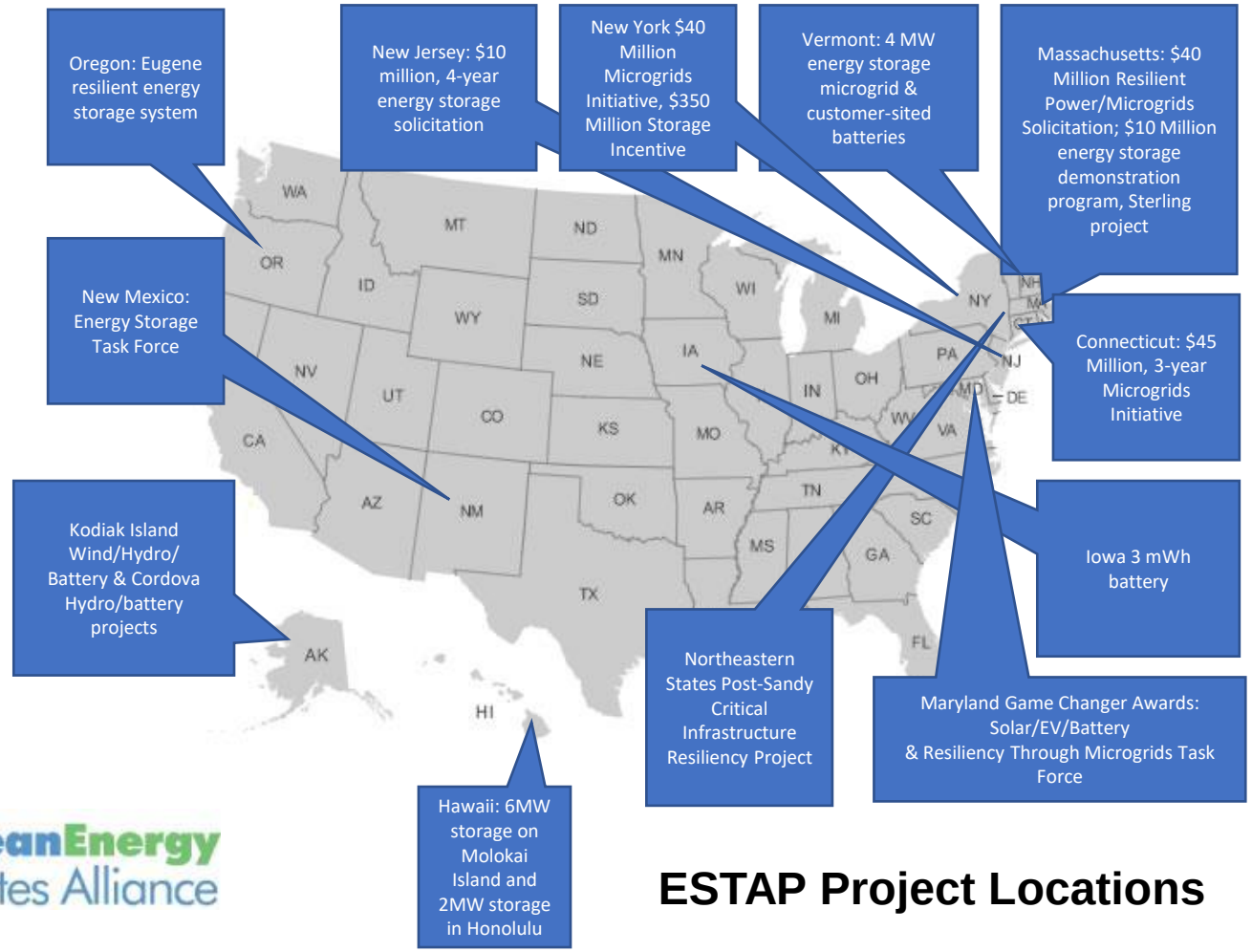
DOE-OE Energy Storage Technology Advancement Partnership

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

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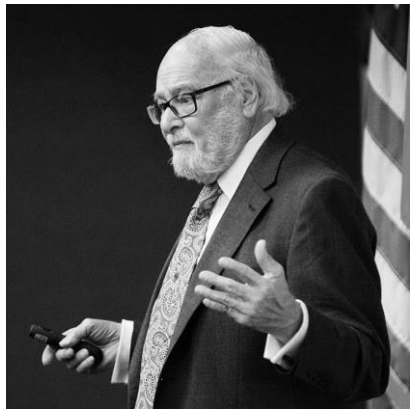
Thank You!



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

Dan Borneo
Engineering Project/Program Lead,
Sandia National Laboratories

U.S. DEPARTMENT OF ENERGY

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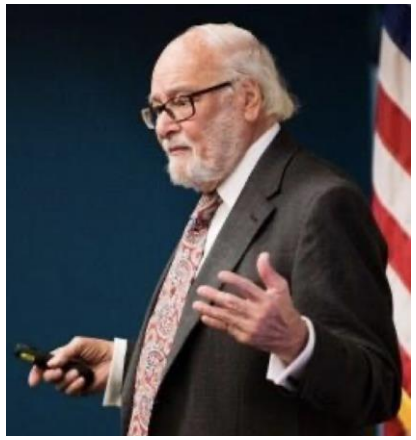
Webinar Speakers



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Director of Energy Storage Research, DOE Office of Electricity

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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)

U.S. DEPARTMENT OF ENERGY

APS

Sandia National Laboratories

OE SOLAR

CleanEnergy States Alliance

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

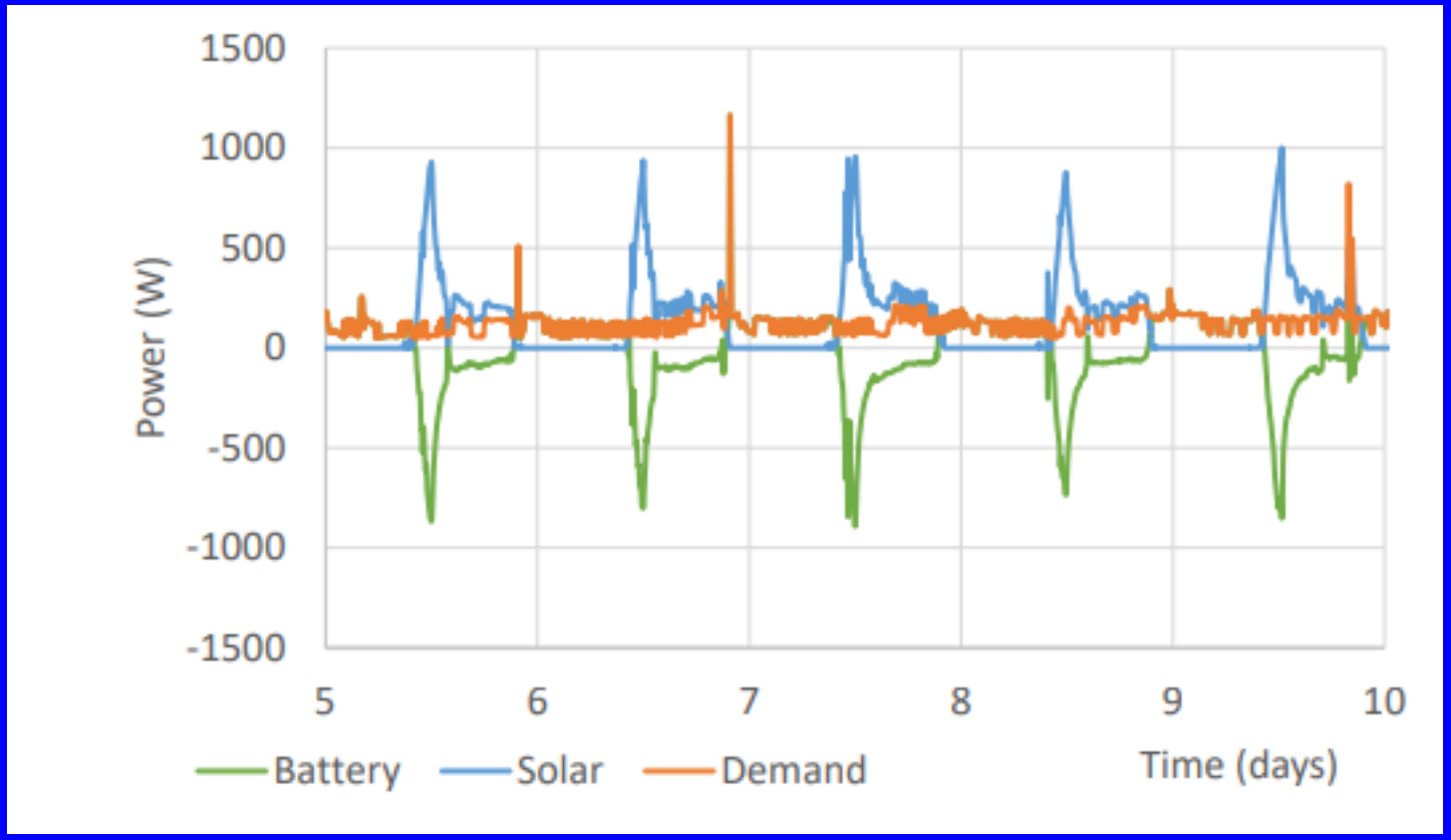
Navajo Nation , AZ

Partnering with DOE-OE, Sandia, NTUA, UEP

Commissioned May 2022

There are 18,000 Residents off-Grid on the Reservation

3 kW / 3.6 days
Rechargeable Zn Mn O_2
Battery Developed by UEP.



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

***

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

ALBUQUERQUE PUBLIC SCHOOLS

ATRISCO HERITAGE ACADEMY HIGH SCHOOL

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.

Is it cost-effective?

ALBUQUERQUE PUBLIC SCHOOLS

WECC Water and Energy Conservation Committee

Atrisco Heritage Academy HS – Battery Storage for Peak Shaving

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.

ALBUQUERQUE PUBLIC SCHOOLS

WECC Water and Energy Conservation Committee

BESS System - TESLA Megapack 2

BESS Enclosure

1924 sq ft

10 ft Block Wall

Automatic Gates

Switchgear

Transformer

BESS Site Location

BESS Main System Components

- Tesla Megapack 2- Battery System
- Battery Meter - Measures power output from the battery
- Site Controller- Supervisory Control & Data Acquisition (SCADA system)
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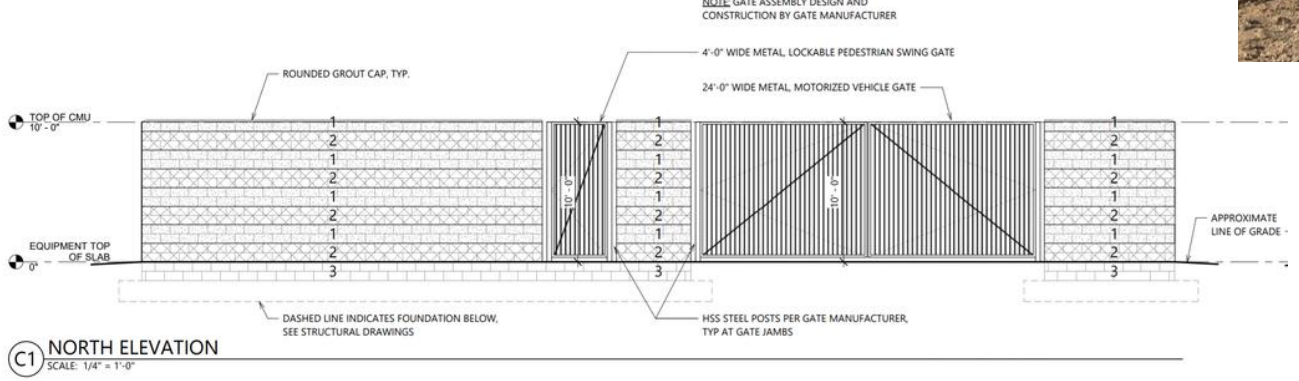

TESLA MEGAPACK BENEFITS

TURNKEY

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INTERNAL COOLING

Integrated heating and cooling at the cell level with dedicated hazard venting

SOFTWARE

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

UNINTERRUPTED

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

REDUCING CARBON EMISSIONS

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

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)
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Project BENEFITS

COST SAVINGS

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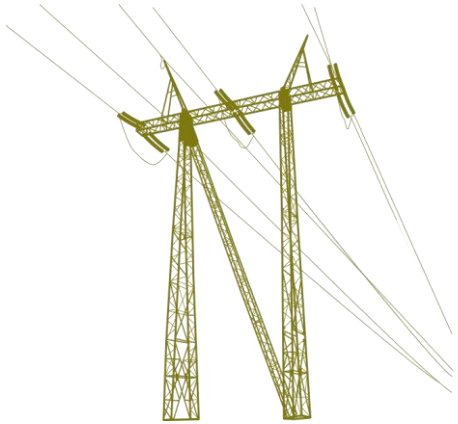

LOAD MANAGEMENT

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.

PROJECT SUMMARY

PROJECT COST

Overall cost $3,252,000

FINANCIAL PARTNERS

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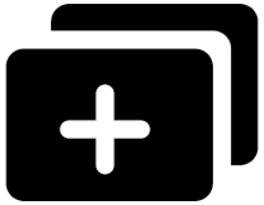
Atrisco Heritage Academy HS – Battery Storage for Peak Shaving

BENEFITS

- Cost Savings
  - Energy Savings
    - Model for Replication
      - Education
        - Awareness / Exposure

          for students and community



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More to be discovered!

Atrisco Heritage Academy HS – Battery Storage for Peak Shaving

Center of the Community

Large disadvantaged population.

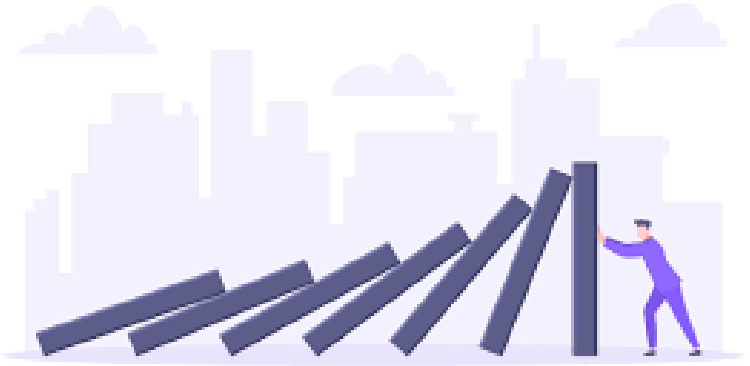
ALBUQUERQUE PUBLIC SCHOOLS

WECC Water and Energy Conservation Committee

Atrisco Heritage Academy HS – Battery Storage for Peak Shaving

Resiliency

- 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

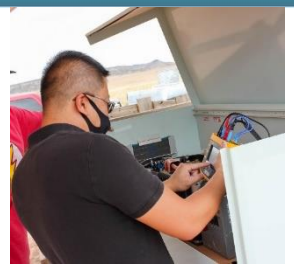
Resiliency

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?

Off-grid Deployment of Zinc Manganese Dioxide BESS on the Navajo Nation



Presented by:

Henry Guan

ESTAP Webinar – Energy Storage in the Southwest

December 1st, 2023

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

SAND2022-XXXXX

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

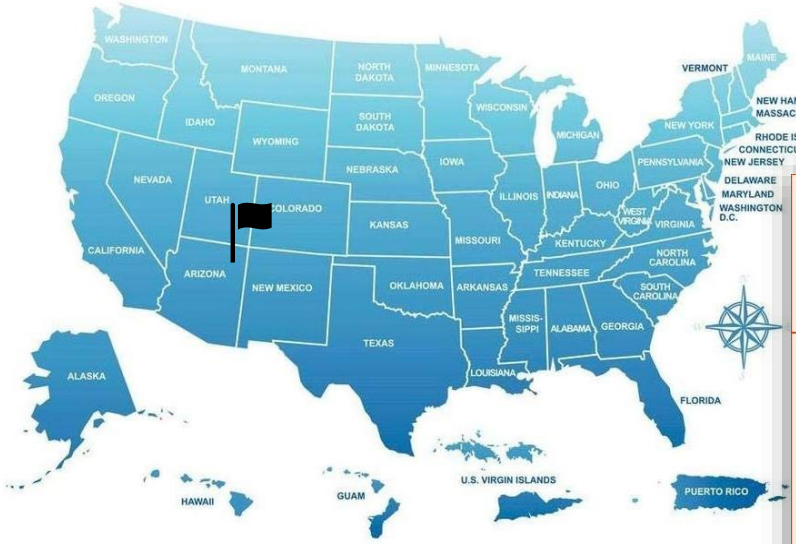
- **Project Partners**
  - **Department of Energy – Office of Electricity, Energy Storage Program**
  - **Sandia National Laboratories**
  - **Navajo Tribal Utility Authority**
  - **Urban Electric Power, Inc.**

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 $ZnMn0_2$ 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 [1]**
- **Location of the deployment site is approximately 2 miles from Dilkon**
  - **Single Family Home**
  - **Existing off-grid battery system installation**

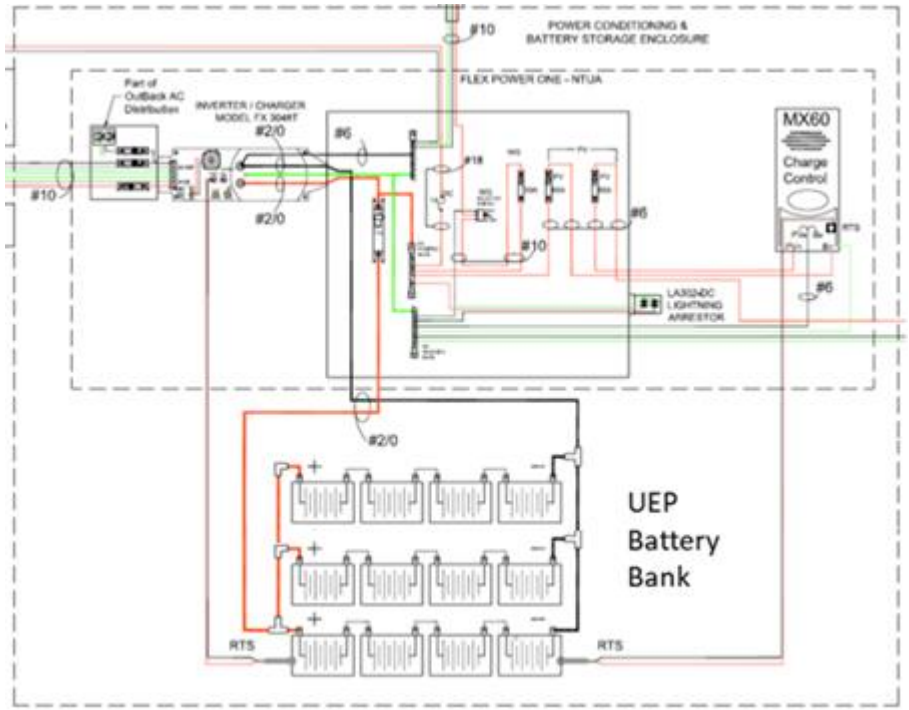


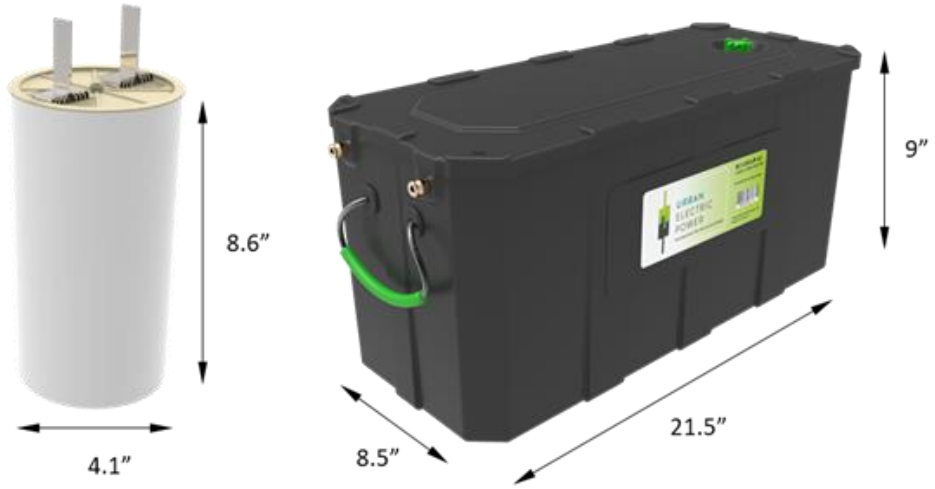
The **Navajo Nation** is the **largest Native American reservation** in the United States, with an area of approximately 17.5 million acres. The Navajo Tribal Utility Authority (NTUA) was established in 1959 and provides electrical, water, and natural gas services to residents of the Navajo Nation. However, 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**.

[1] Retrieved from: https://censusreporter.org/profiles/16000US0419280-dilkon-az/

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





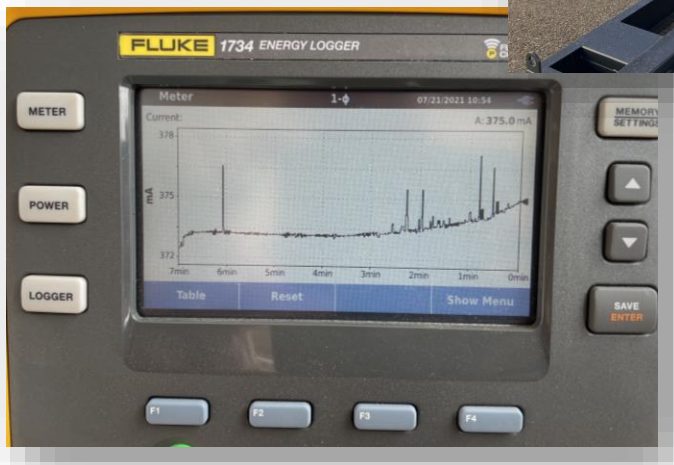
System Overview

- **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

System Integration

- The $ZnMn0_2$ 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.

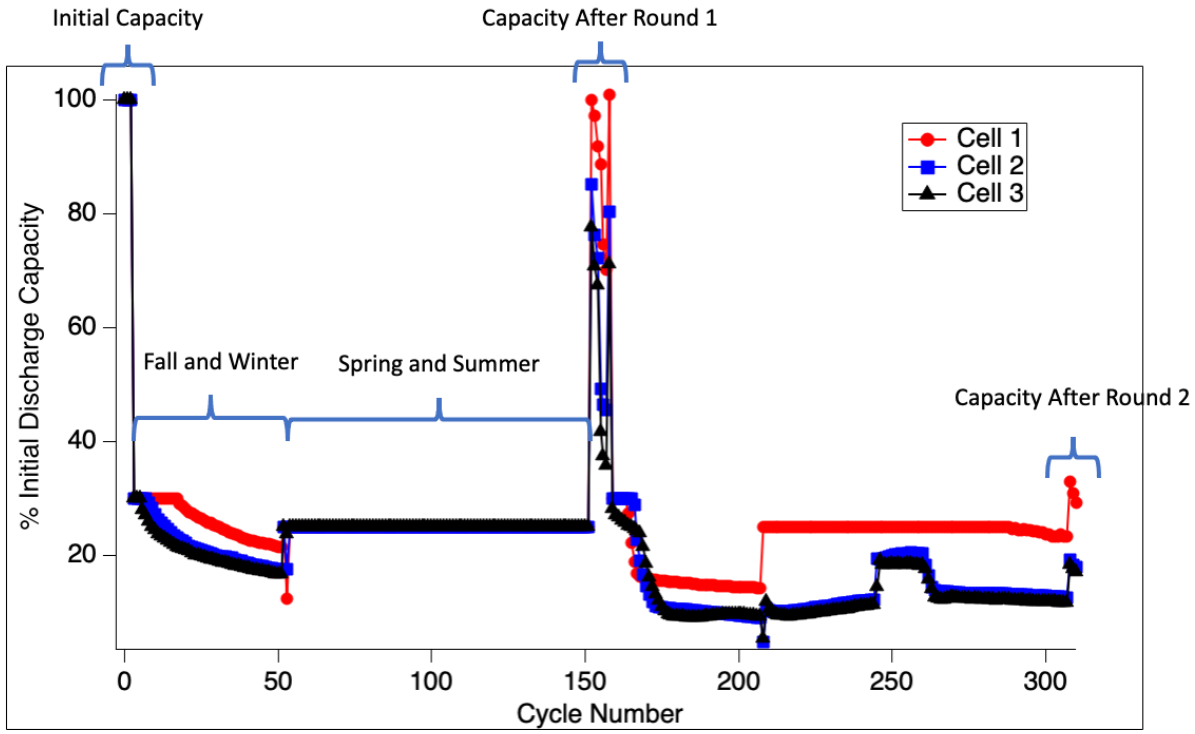


Deployment

- 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.

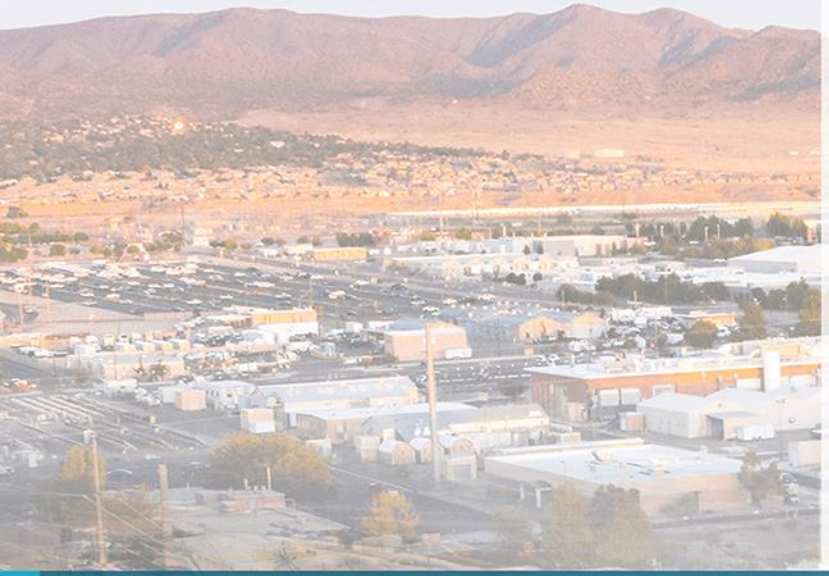
Laboratory Testing

- 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: 17oC, Winter: -4oC, Spring: 17oC, Summer: 30oC).
- 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.

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NAVAJO TRIBAL UTILITY AUTHORITY NTUA UTILITIES FOR THE NAVAJO NATION

URBAN ELECTRIC POWER

Thank You

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O: (505) 845-7524 | **C:** (505) 206-2257

BESS System TESLA MEGAPACK 2

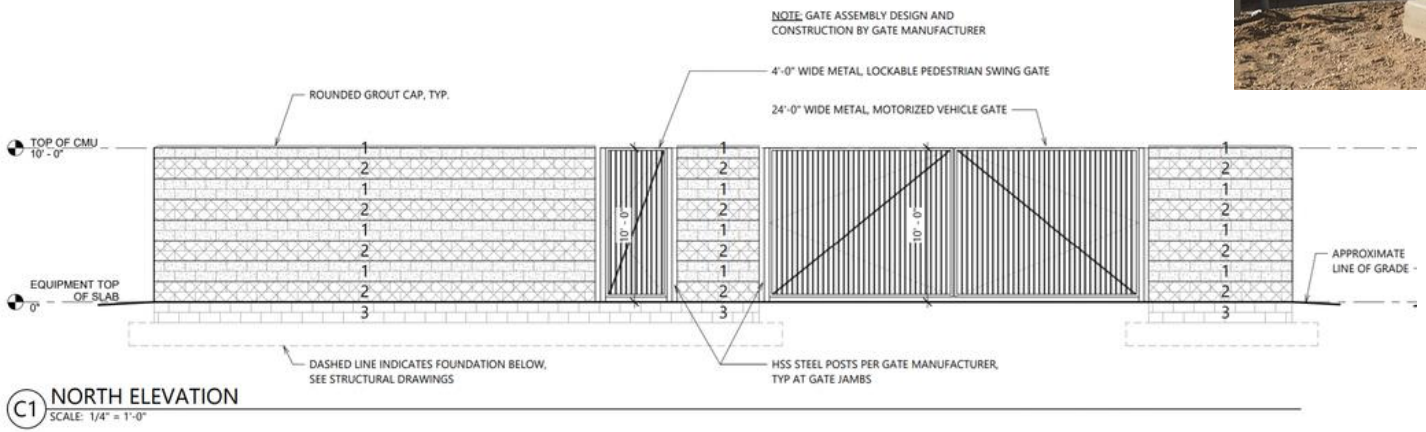
BESS Enclosure

- 1,924 Sqft
- 10ft Brick Wall
- Automatic Gates
- Switchgear
- Transformer
- Tesla Megapack

BESS Site Location

BESS MAIN SYSTEM COMPONENTS

- 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 - Steps down Power from 12470 to 480v



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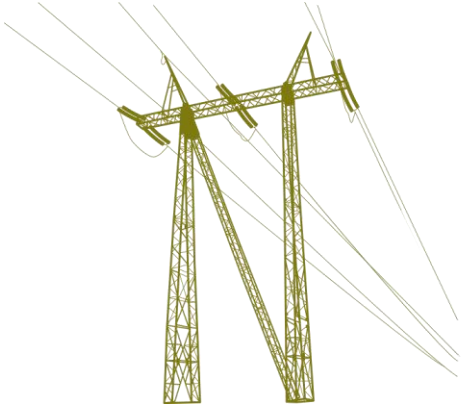

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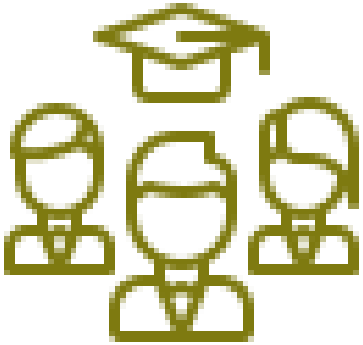

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Upcoming Webinars

- California's Solar for Multifamily Affordable Housing Program: Effective Collaboration for Equitable Solar (12/2)
- State Leadership in Solar+Storage, Featuring Maryland and Oregon (12/9)
- Environmental Justice Strategies for Hydrogen Opposition (12/15)
- New Federal Money for Energy Storage: The Inflation Reduction Act (12/16)

Read more and register at: www.cesa.org/webinars