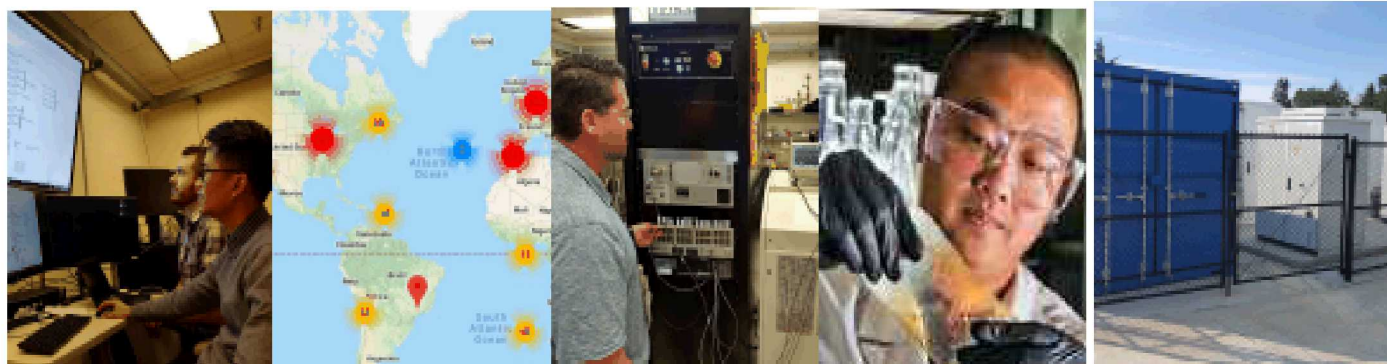


# Demonstration of Energy Storage Benefits Around the Nation

September 24, 2019



Ben Schenkman

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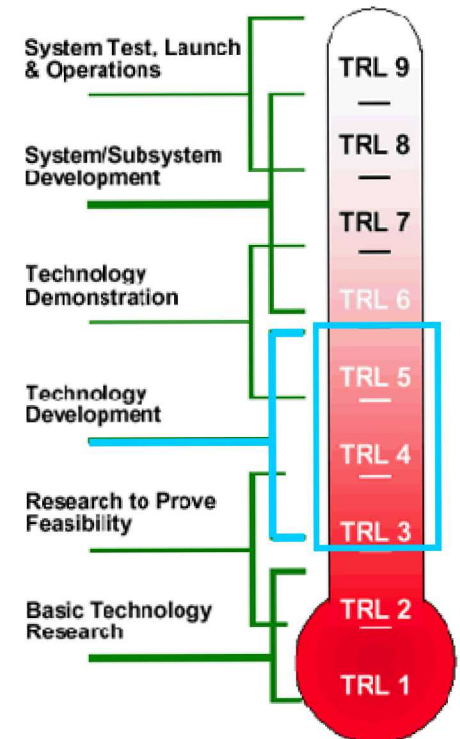
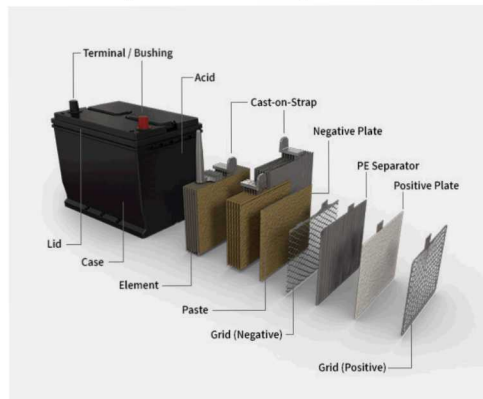
## **Mission:**

Provide understanding of Energy Storage technologies and operations to the industry for grid and standalone applications, optimization, system reliability, and economic impact.

- Demonstration Areas and Projects
- Breakdown of Projects
- Tribal Demonstration

# Demonstration Areas (New Products)

- New Technology Development
  - Technology Readiness Level 3-5
  - Engineering Research on Materials and System
  - Control Development (BMS, EMS, etc.)



# Demonstration Areas (New Systems/Control)

## Urban Electric Power (ZnMnO<sub>2</sub>)

- **Overview:** Develop Grid Tied Controls for 0.5kW / 2.0kWh
- **Impact:** Grid tied ZnMnO<sub>2</sub> performing grid applications would be a new innovation and alternative to the traditional pb-acid system
- **Partners:** Urban Electric Power
- **Status:** BMS and inverter controls have been paired and successful charge and discharge has been performed
- **Next Steps:** Create grid tied application algorithms in standalone computer and evaluate in the Energy Storage and Analytics Lab (ESCAL)

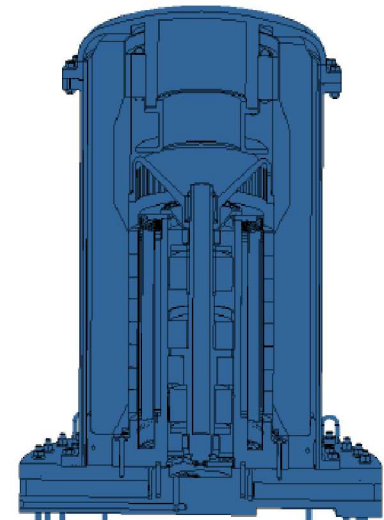


UEP System under test at ESCAL

# Demonstration Areas (New Systems/Control)

## HELIX

- **Overview:** Develop 1000kW / 25kWh flywheel with >1 Million cycles
- **Impact:** New design will enable heavy usage profiles to be performed on a regular basis using a single flywheel unit. Unit is also designed to be cheaper than existing flywheels with less components
- **Partners:** Helix
- **Status:** Engineering and assembly drawings have been completed and in the process of procuring material and developing a pipeline to build a prototype.
- **Next Steps:** Complete material procurement, build the prototype flywheel and test the system for safety and performance.



Helix 1000kW / 25kWh flywheel depiction

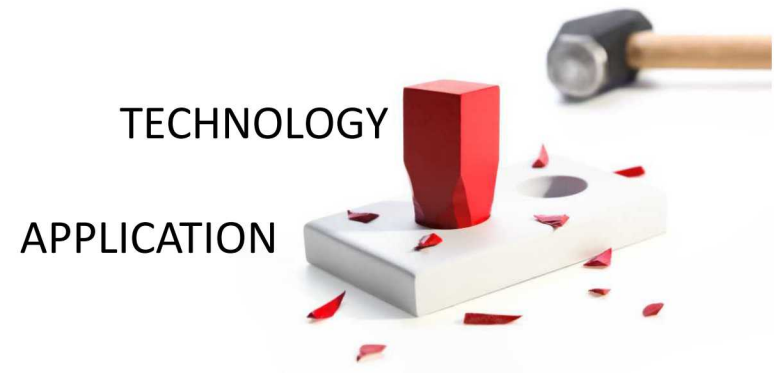
# Demonstration Areas (Analytics)

- Economic

- Sandia Developed Tool Quest
- Determine Optimal Size
- Application Space

- Technical

- Steady State
- Dynamic



# Demonstration Areas (Analytics)

- **Gunnison (Colorado)**

- **Objective:** Evaluate ESS sizes for peak shaving application to reduce monthly electric costs
- **Partners:** Gunnison Electric Cooperative
- **Result:** Analysis is ongoing. Preliminary results have been created and are currently being finalized. Gunnison's load is relatively flat and peak shaving may not be providing the expected benefit. Other applications to be considered.

- **Homer (Alaska)**

- **Objective:** Optimally schedule for thermal units and energy storage that minimizes the daily operating cost.
- **Partners:** Homer Electric Association
- **Result:** Approximate ESS size 40MW/10MWh and \$430,244 avoided cost savings per year

- **Grand Rapids Community Solar (Minnesota)**

- **Objective:** Determine size and operation of Solar plus Storage to reduce overall electric cost to Grand Rapids Community
- **Partners:** Minnesota Power
- **Result:** Approximate ESS Size 2MW / 6 hour and \$636,000 avoided cost savings per year

- **Roanoke (North Carolina)**

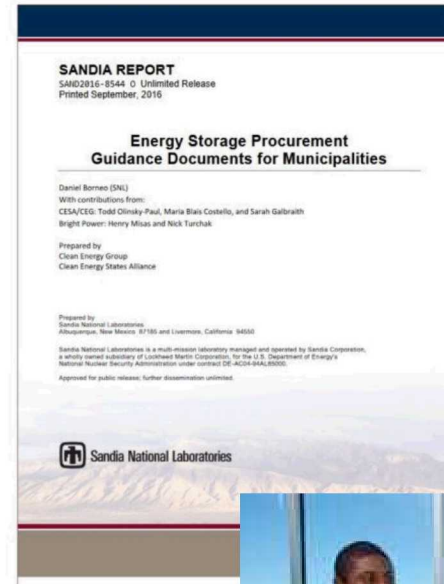
- **Objective:** Determine size and operation of Solar plus Storage for peak shaving and resiliency
- **Partners:** Roanoke Electric Cooperative, National Rural Electric Cooperative Association, North Carolina Electric Cooperatives, North Carolina University, Booth Associates
- **Result:** Analysis kick off September 3, 2019.

- **Villalba (Puerto Rico)**

- **Objective:** Evaluate up to 5 networked municipal microgrids within the PREPA territory using energy storage to enable hydroelectric. Application is increasing rural resiliency and minimizing operational costs.
- **Partners:** Municipalities of Villalba, Ciales, Morovis, Orocovis and Barranquitas
- **Result:** Analysis is Ongoing. First Pass of Analysis will Perform Sweep of ESS sizes for Various Hydroelectric Capacities.

# Demonstration Areas (Project Development)

- Request for Proposals
  - Develop RFP
  - Review Review
  - RFP Down Selection Matrix
- Design and Commissioning
  - Design Review
  - Factory Acceptance Test Plan
  - Site Acceptance Test Plan
    - Functional
    - Operational



# Demonstration Areas (Project Development)

- **Albuquerque Public Schools (New Mexico)**

- **Objective:** Reduce electric load demand for a public school to create budget resiliency. This project will be a pilot project for the rest of the schools
- **Partners:** Albuquerque Public School
- **Status:** Albuquerque School Board just approved to move forward with the ESS project September 9, 2019. Request for Proposals is being developed. Size of ESS in RFP will be 250kW / 500kWh, 500kW / 1000kWh

- **Anza (California)**

- **Objective:** Use an energy storage system to defer the cost for distribution upgrades and increase resiliency for end of feeder load
- **Partners:** Anza Electric Cooperative, Arizona Electric Power Cooperative, National Rural Electric Cooperative Association
- **Status:** Proposals from vendors have been received and reviewed. Size of ESS in RFP 1MW / 2MWh, 2MW / 8 MWh, 4MW / 16MWh

- **EPB (Tennessee)**

- **Objective:** Provide back up power to the Electric Power Board control room using an energy storage system and evaluate other application spaces.
- **Partners:** Electric Power Board
- **Status:** EPB has issued RFP and proposal from vendors are being reviewed. Size of ESS in RFP is minimum 100kW and 400kWh

- **HELCO (Hawaii)**

- **Objective:** Incorporate an energy storage system into HELCO generation portfolio for the primary application of peak shaving and evaluate other benefits.
- **Partners:** Hawaii Electric Light Company, Natural Energy Laboratory of Hawaii Authority, UniEnergy Technologies
- **Status:** UET is building new 100kW / 400kWh REFLEX system to be installed on NELHA's campus.

- **NTUA (Arizona)**

- **Objective:** Procure, install and evaluate performance of three ZnMnO<sub>2</sub> for off-grid residential applications. This install will be a pilot project in determining the effectiveness and performance of the new technology compared to the traditional pb-acid system.
- **Partners:** Navajo tribal Utility Authority, Urban Electric Power
- **Status:** Contracts are being placed between Sandia and contractors (NTUA and UEP).

- **Seminole (Florida)**

- **Objective:** Review and Develop Request for Proposals for Solar plus Storage for 8 buildings within the Seminole Tribe of Florida.
- **Partners:** Seminole Tribe of Florida
- **Status:** RFP is being created by Seminole Tribe of Florida and Sandia. Issuance of RFP is to be determined.

# Demonstration Areas (Data Collection)

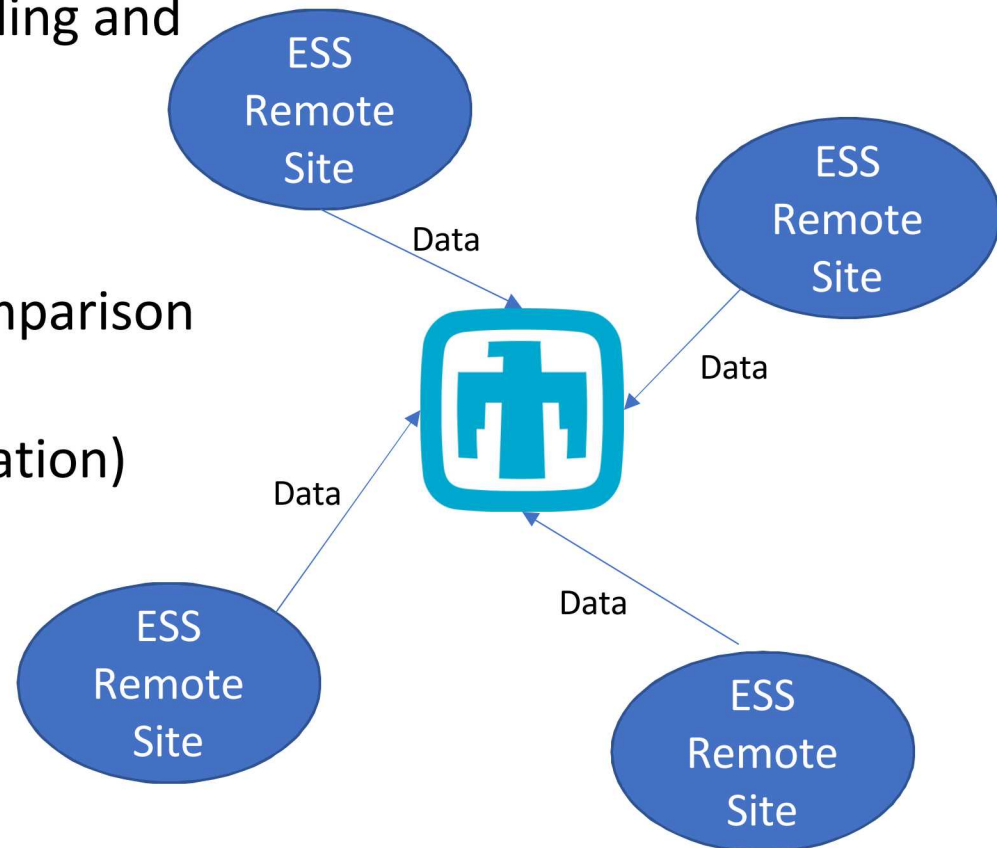
- Data Collection

- Develop Data Submission Standard

- Parameters to collect
    - Frequency of data (sampling and reporting)

- Performance Evaluation

- Degradation
    - Vendor Specification Comparison
    - Model Refinement
    - Optimize Control (Application)



# Demonstration Areas (Data Collection)

- **Data Collection greater than 1 year**

- Green Mountain Power (Vermont)
  - Dynapower, Li-Ion and Advanced Lead Acid, 4MW / 3.4MWh
- Sterling Municipal Lighting Department (Massachusetts)
  - NEC, Li-Ion, 2MW / 3MWh

- **Data Collection less than a year or coming online**

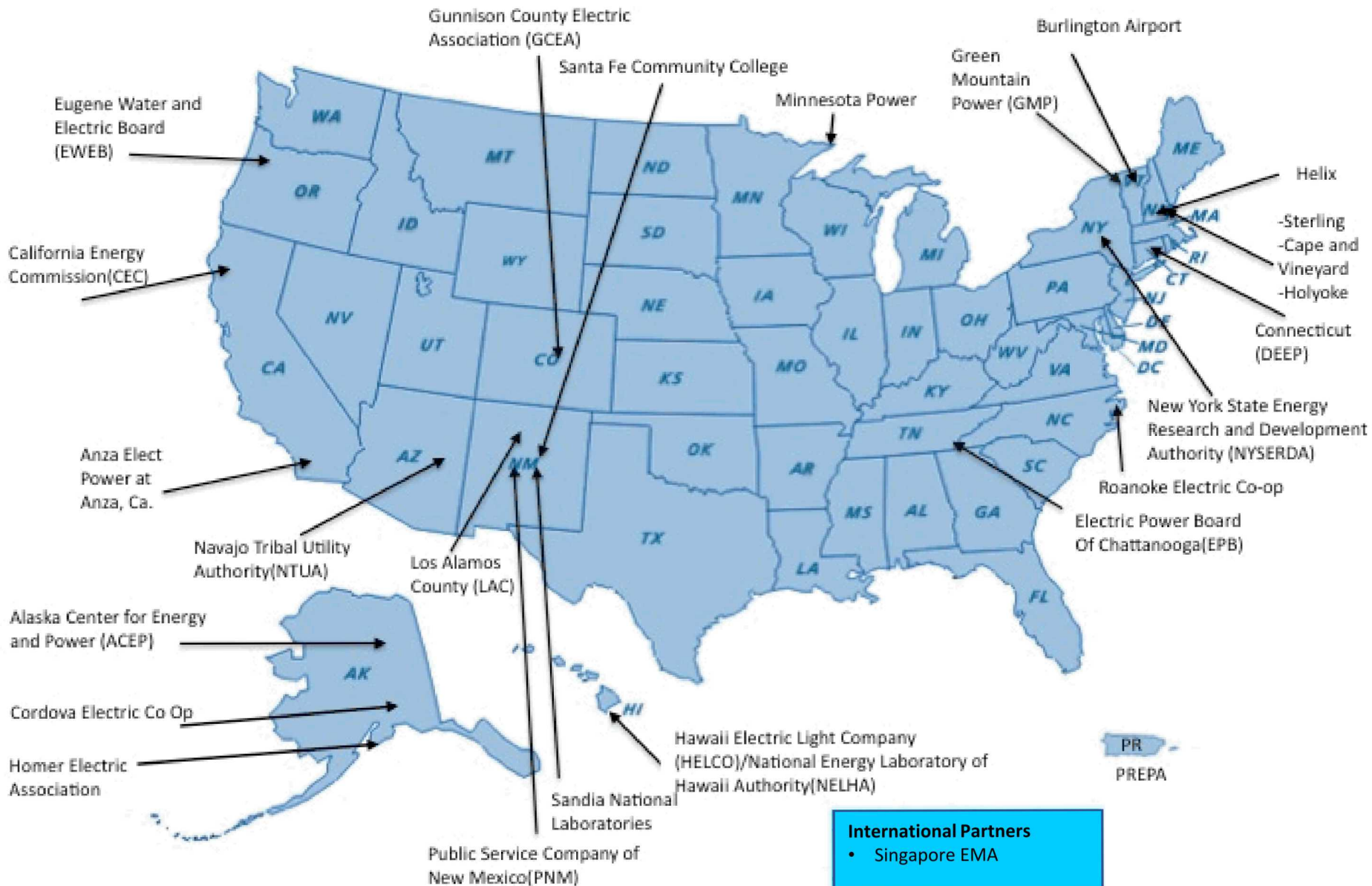
- Cordova Electric Cooperative (Alaska)
  - SAFT, Li-Ion, 1MW / 1MWh
- Eugene Water and Electric Board (Oregon)
  - NEC, Li-Ion, 500kW / 1000kWh
- Sandia (New Mexico)
  - UEP,  $\text{ZnMnO}_2$ , 500W / 1500Wh
  - UET, Vanadium Redox Flow, 250kW / 1000kWh
- Santa Fe Community College (New Mexico)
  - NEC, Li-Ion, 100kW / 170kWh
- Energy Market Authority (Singapore)
  - Wartsila, Li-Ion, 2.4MW / 2.4MWh

# Overview




























- Demonstration Areas and Projects
- Breakdown of Projects
- Tribal Demonstration

# DOE/SNL Energy Storage Projects



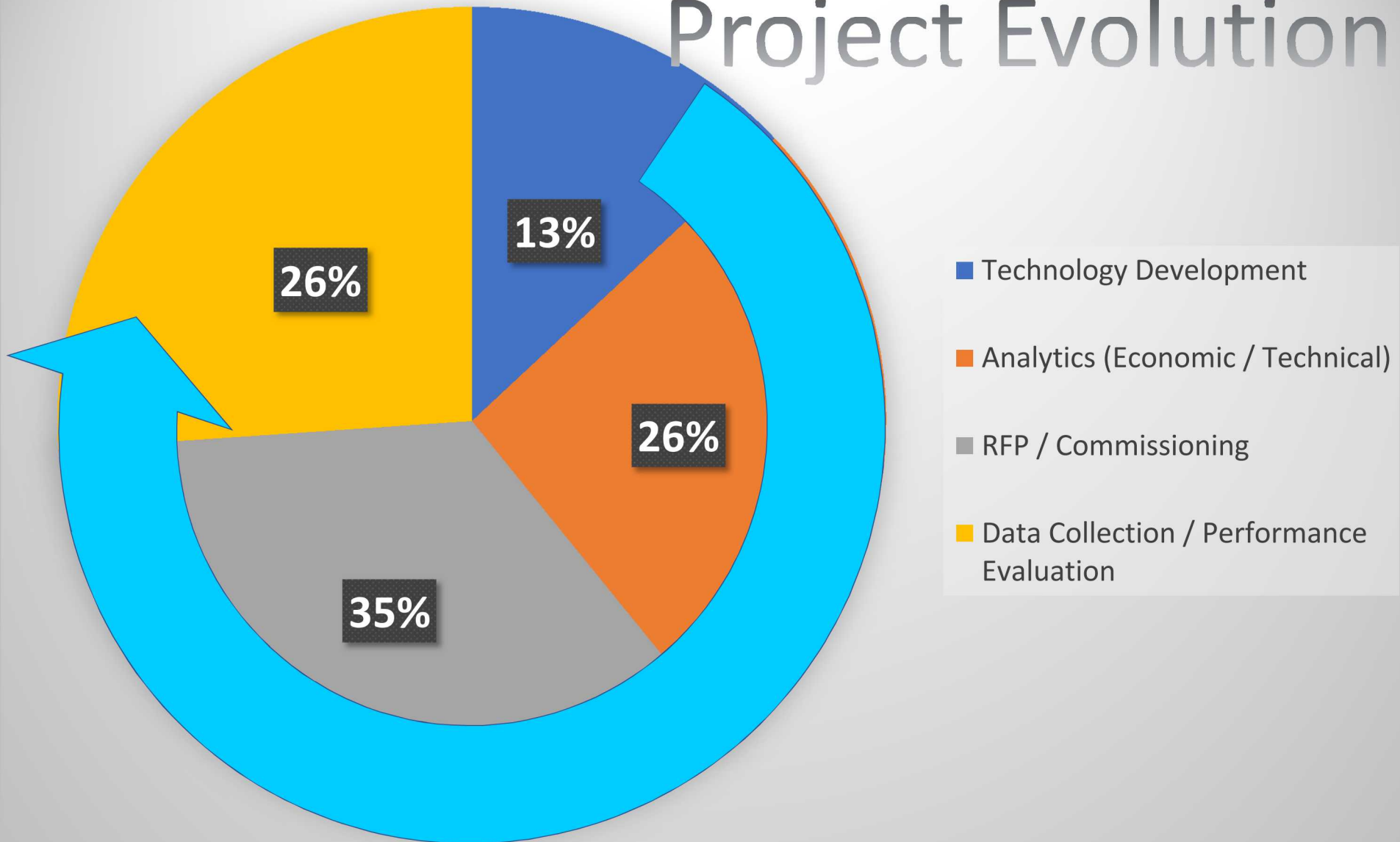
# Energy Storage Project Phases

Project	Technology Development	Analytics (Economic / Technical)	RFP / Commissioning	Data Collection / Performance Evaluation
ACEP				
Albuquerque Public Schools				
ANZA				
Burlington Airport				
California Energy Commission				
Cordova Electric Coop				
CUNY				
EWEB				
EPB				
GMP				
Gunnison				
HELCO				
Helix				
HOMER				
Los Alamos				
Minnesota Power				
NTUA				
PNM				
Roanoke				
Sandia				
SFCC				
Singapore				
SMLD				
Villalba				

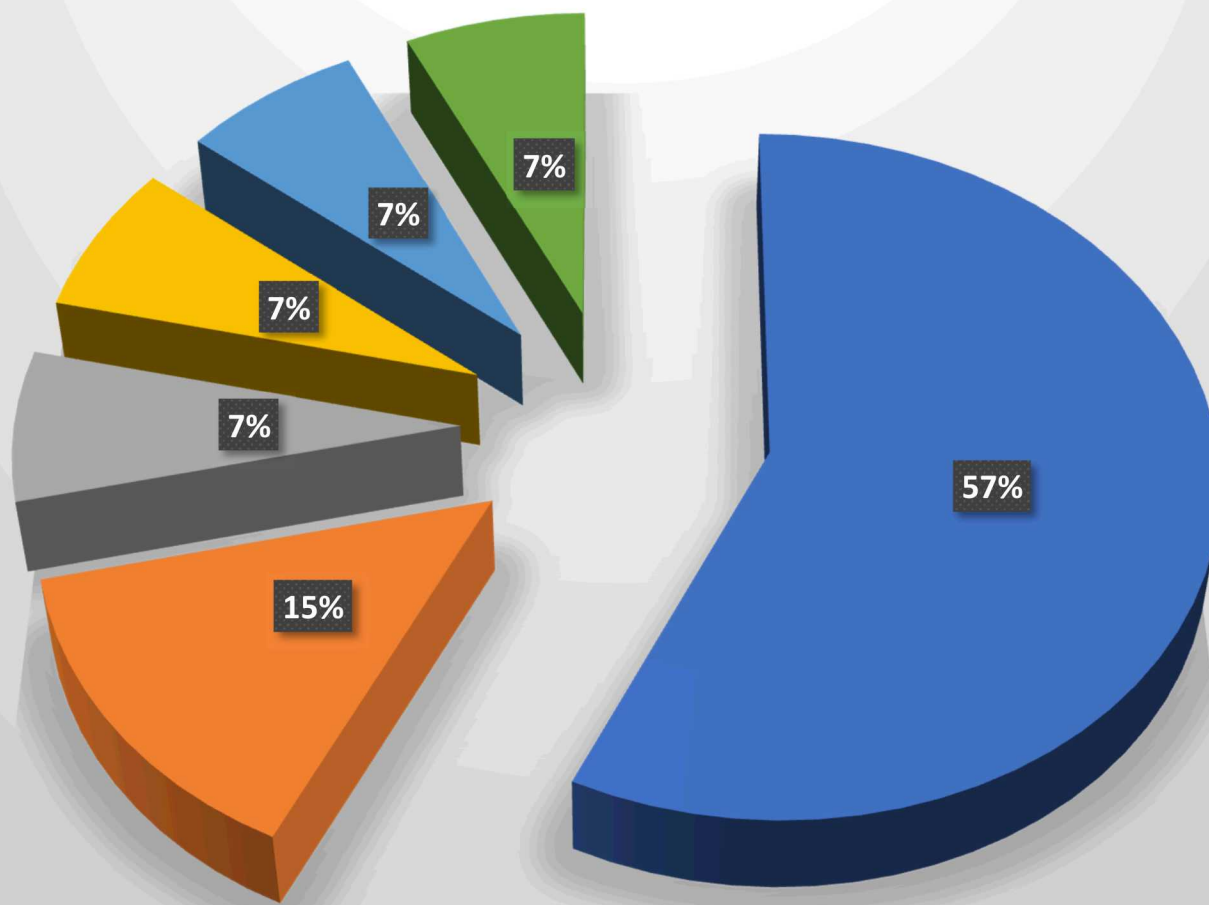
# Energy Storage Project Phases



## Project Evolution



# Energy Storage Project Technologies



■ Li-Ion ■ ZnMnO2 ■ Advanced Pb-Acid ■ Flywheel ■ NaS ■ REDOX Flow

# Overview



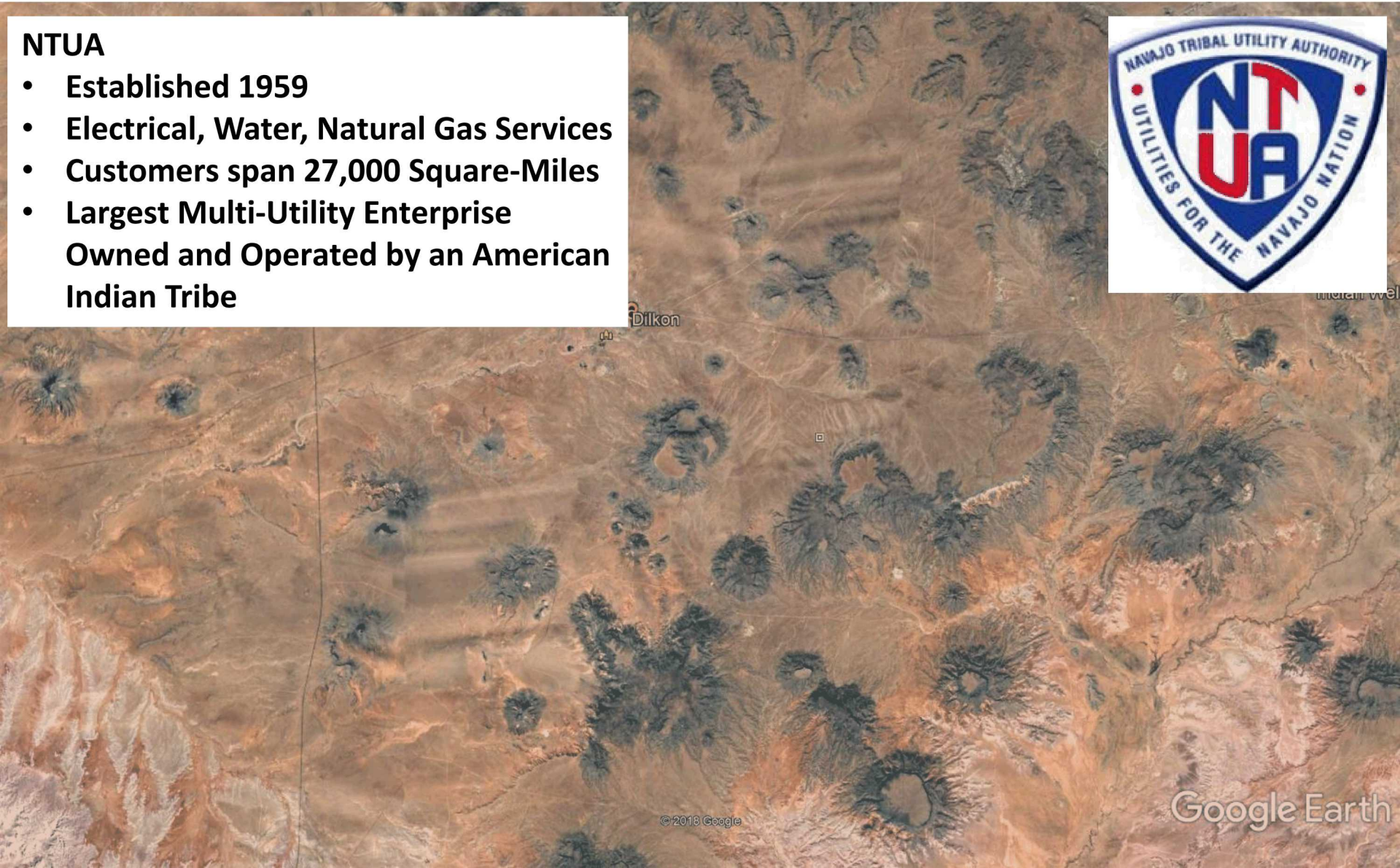
- Demonstration Areas and Projects
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# Navajo Tribal Utility Authority (Dilkon, AZ)



## NTUA

- Established 1959
- Electrical, Water, Natural Gas Services
- Customers span 27,000 Square-Miles
- Largest Multi-Utility Enterprise  
Owned and Operated by an American Indian Tribe



# Navajo Tribal Utility Authority

## Objectives

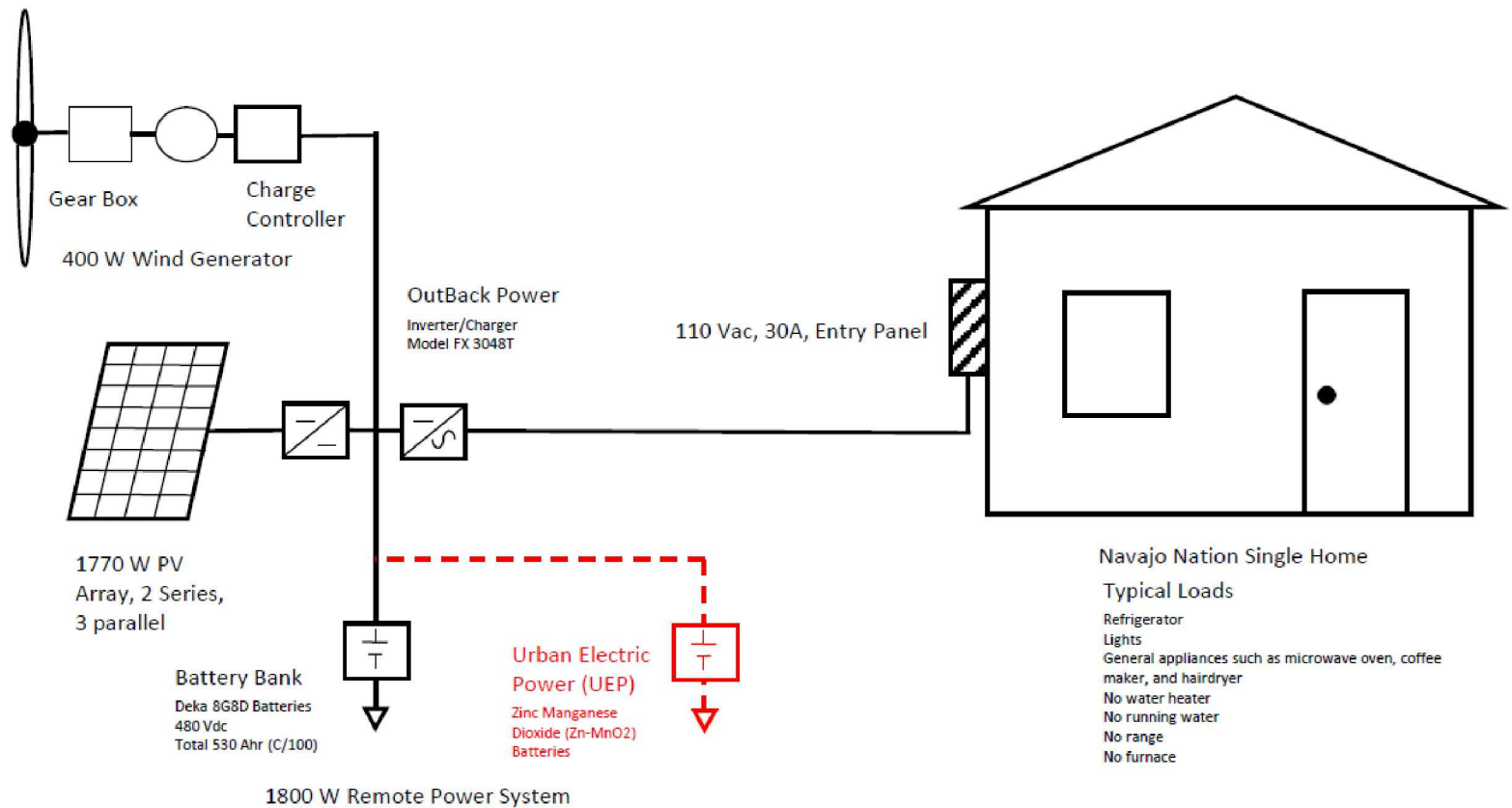
- Develop grid tied/off grid inverter controls for Urban Electric Power (UEP) ZnMnO<sub>2</sub>
- Install 3 UEP systems (2.5kWh @ 10-hr) replacing traditional lead acid technology at off-grid homes
- Evaluate performance of UEP system and provide technology comparison

## Project Phase

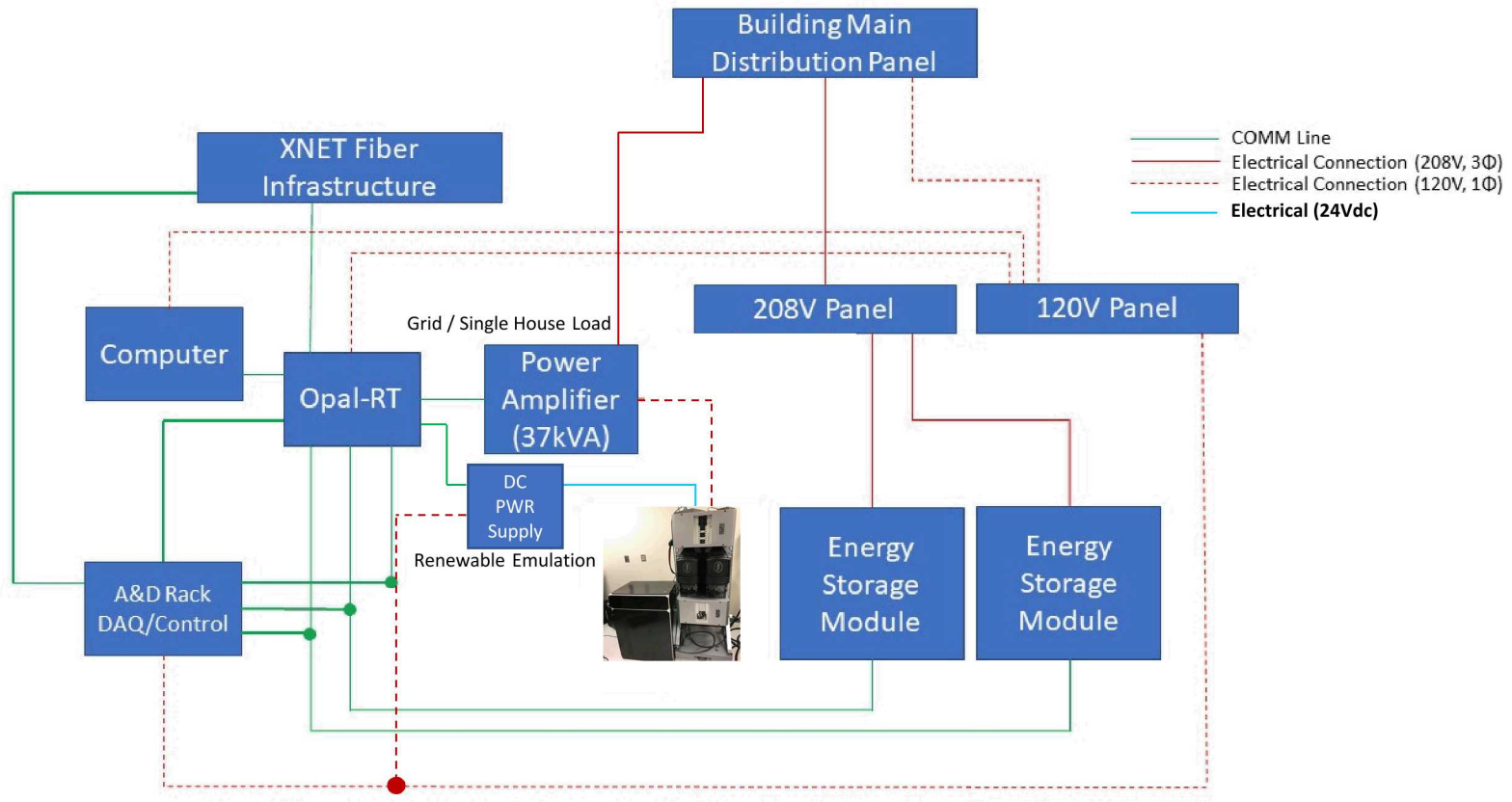
- Technology Development – Energy Management and Operation Controls are being developed for the UEP System and Outback Inverter
- Project Development – Contractual stage with UEP and NTUA



# Navajo Tribal Utility Authority



# Energy Storage Control and Analytics Lab



# Issues and Accomplishments

## Issues:

- Outback inverter does not have a simple P/Q command (PI Controller using voltage setpoint)
- Outback inverter Response and Reaction time is around 3-5 seconds

## Accomplishments:

- Communication using SUNSPEC standard has been created for UEP
- Discharged and Charged UEP system at desired output from Outback

## Next Steps:

- Develop various control algorithms for off-grid optimization
- Deploy UEP systems within NTUA
- Evaluate Grid Tied application Performance
- Collect Performance Data and Analyze



# ACKNOWLEDGEMENT and CONTACTS



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- Dan Borneo ([drborne@sandia.gov](mailto:drborne@sandia.gov))
- Ben Schenkman ([blschen@sandia.gov](mailto:blschen@sandia.gov))
- Frank Currie ([fmcurri@sandia.gov](mailto:fmcurri@sandia.gov))