



Sandia's Grid Modernization and Energy Storage Efforts in Support of New Mexico's Energy Transition



Sandia National Laboratories
Charles Hanley, Senior Manager

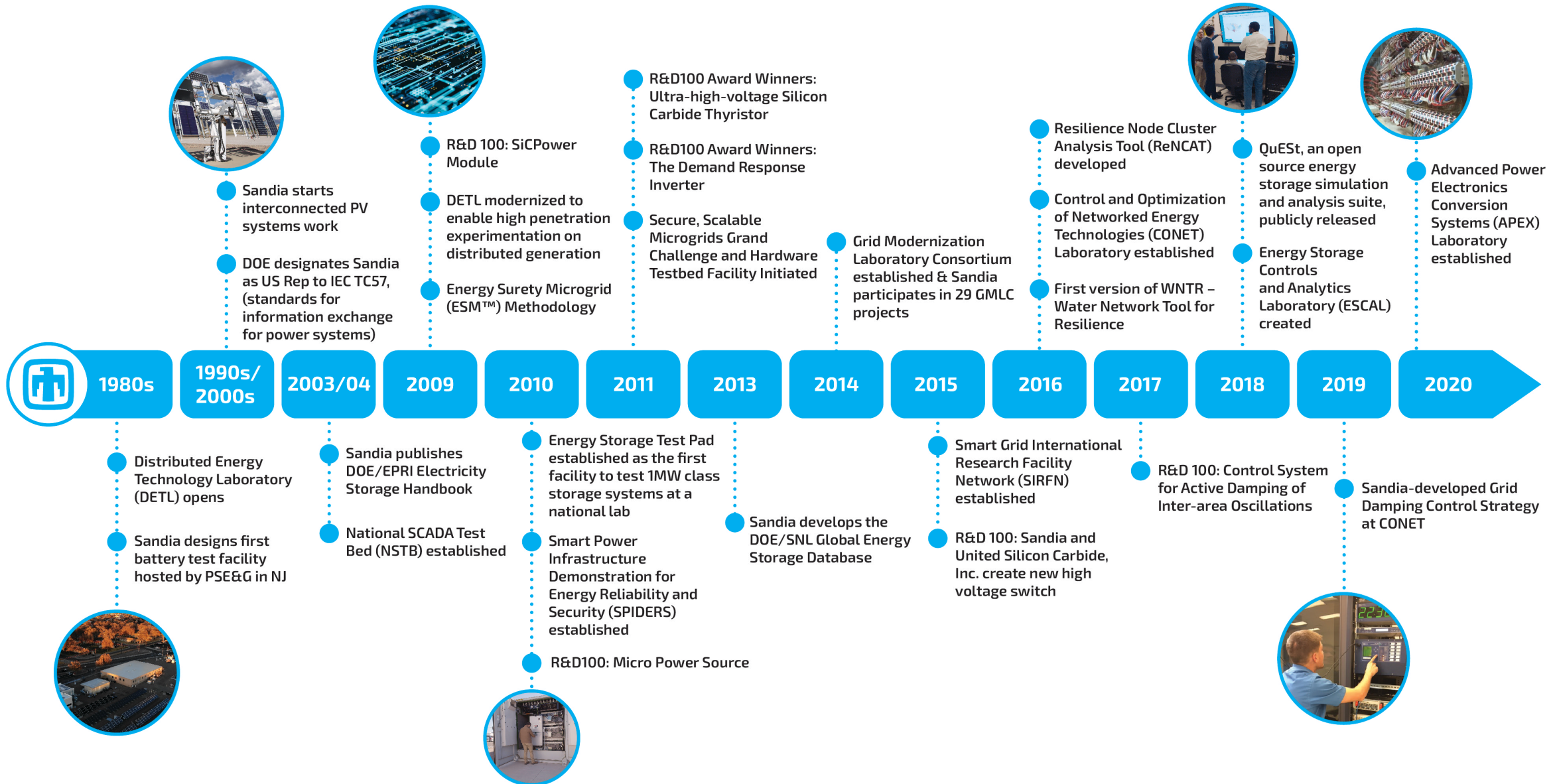


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HISTORY OF GRID MODERNIZATION AT SANDIA



GMES FACILITIES



APEX

Advanced Power Electronic Conversion Systems supports the development of advanced power conversion topologies and intelligent control strategies.



CONET

Control and Optimization of Networked Energy Technologies Laboratory conducts research, development, and testing of coordinating networked and distributed systems.



ESCAL

Energy Storage Controls and Analytics Laboratory dedicated to the development of next-generation energy storage control systems to increase battery performance and lifetime.



DETL

Distributed Energy Technologies Laboratory designed to integrate emerging energy technologies into new and existing electricity infrastructure



ESTP

Energy Storage Test Pad provides long-term testing and validation for electrical energy storage systems.

SANDIA FACILITIES WE LEVERAGE

- Advanced Materials Laboratory
- Battery Abuse Testing Laboratory
- Battery Test Facility
- Brayton Cycle Lab
- Burn Facility
- Center for Integrated Nanotechnologies
- Cyber Emulytics Laboratory
- MESAFab
- National Infrastructure Simulation & Analysis Center
- National Solar Thermal Test Facility
- Photovoltaic Systems Engineering Laboratory
- Sandia Wave Energy Power-Takeoff Facility
- Secure Scalable Microgrid Facility
- Scaled Wind Farm Technology Facility
- Thermal Test Complex





IN SUMMARY

The U.S. *needs* a reliable, predictable, & resilient electrical system to maintain our way of life.

Sandia *uses* a National Security focus and strategic core competencies to provide the tools and technologies needed to drive the changes for a resilient electrical system.

Sandia *leverages* our partnerships to ensure our discoveries meet priority needs and provide solutions ready for commercialization and application.



SANDIA ENSURES THE U.S. CAN DEPEND ON A RESILIENT ELECTRIC GRID AS A FOUNDATION OF ECONOMIC STABILITY AND NATIONAL SECURITY.



Some Key Points Regarding Sandia's Efforts in NM



- Sandia is a technology research organization (as is LANL)
 - With a wealth of world-class S&T capabilities
 - Grid, storage, renewables, nuclear, carbon, hydrogen, cybersecurity, supply chain
- Our efforts in New Mexico serve as excellent national leadership for clean energy
- Lasting impact comes through the right partnerships
 - Energy equity with communities, tribes, NGOs
 - Workforce development with educational institutions
 - Manufacturing and technical sustainability with private sector
 - Policy outreach with decision-makers
- We work towards impact in different ways:
 - Developing the right analytical tools for others to use
 - Demonstrations that highlight new technologies or applications
 - Associated outreach and informing decision-makers

PROJECT HIGHLIGHTS



Microgrid Design Toolkit (MDT)

A decision support software that, based on user-defined objectives, provides information designers need in the early stages of the design process.

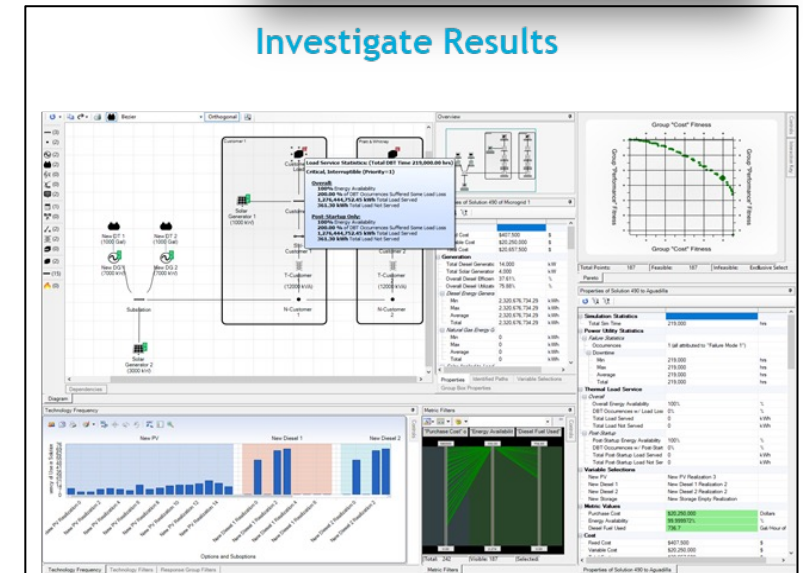


- Perform mid-level topology optimization
- Account for both grid connected and islanded performance
- Account for power and component reliability in islanded mode
- Account for dozens of metrics when performing the trade space search
- Present a user with an entire trade space of information from which to draw conclusions



Simulation Process

- **Define baseline** – loads defined with demand profiles and criticality, system topology and infrastructure details.
- **Design options** – new assets, size and location, to be considered. PV and wind profiles defined. Failure modes. Purchase costs.
- **Simulation settings** – Grid outage settings, simulation length, optimization metrics.
- **Results Analysis** – solution comparisons, detailed fuel data and statistics.



QuEST: An Energy Storage Evaluation Application Suite

A free, open source, Python-based application suite for energy storage simulation and analysis developed to bring Sandia energy storage analytics research tools to user's desktops.

QuEST consists of three distinct yet interconnected applications:

These applications individually and collectively help project engineers and researchers evaluate energy storage systems for different use cases.

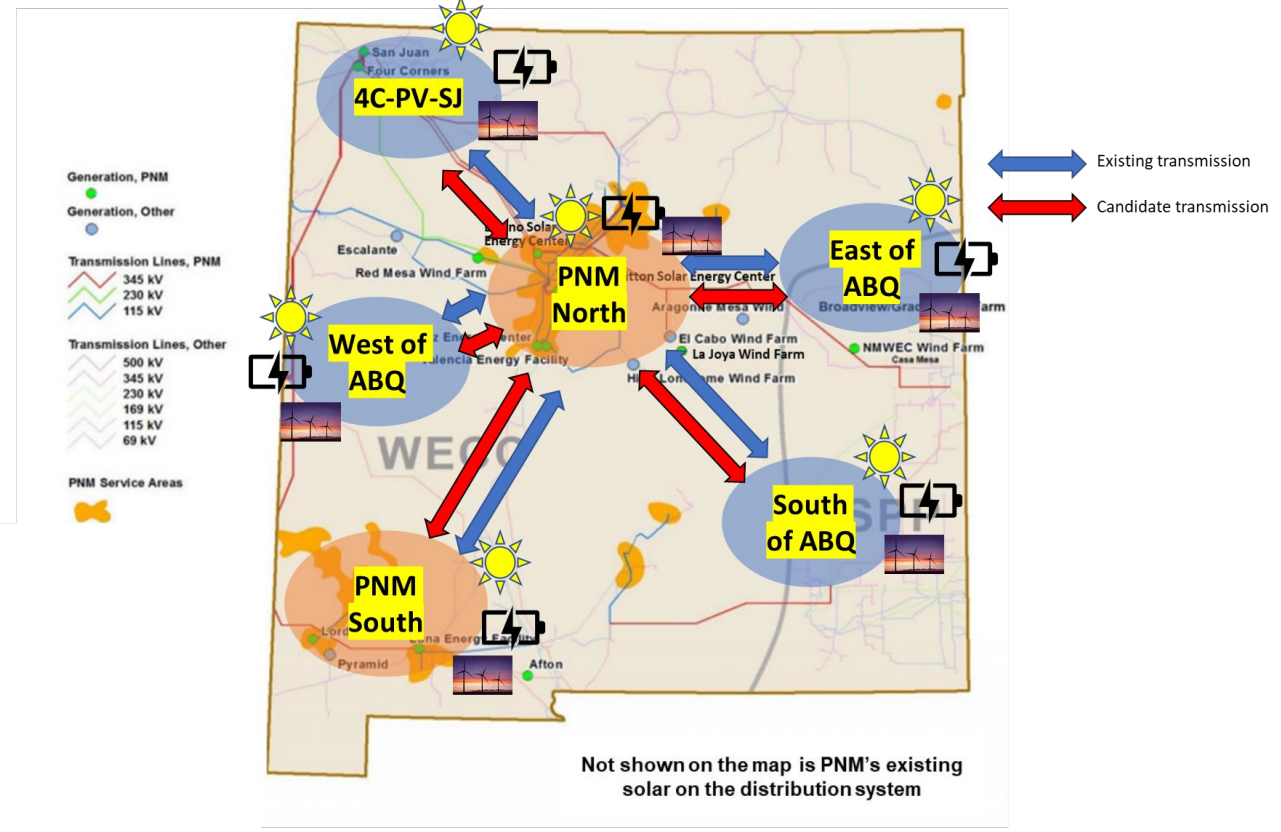
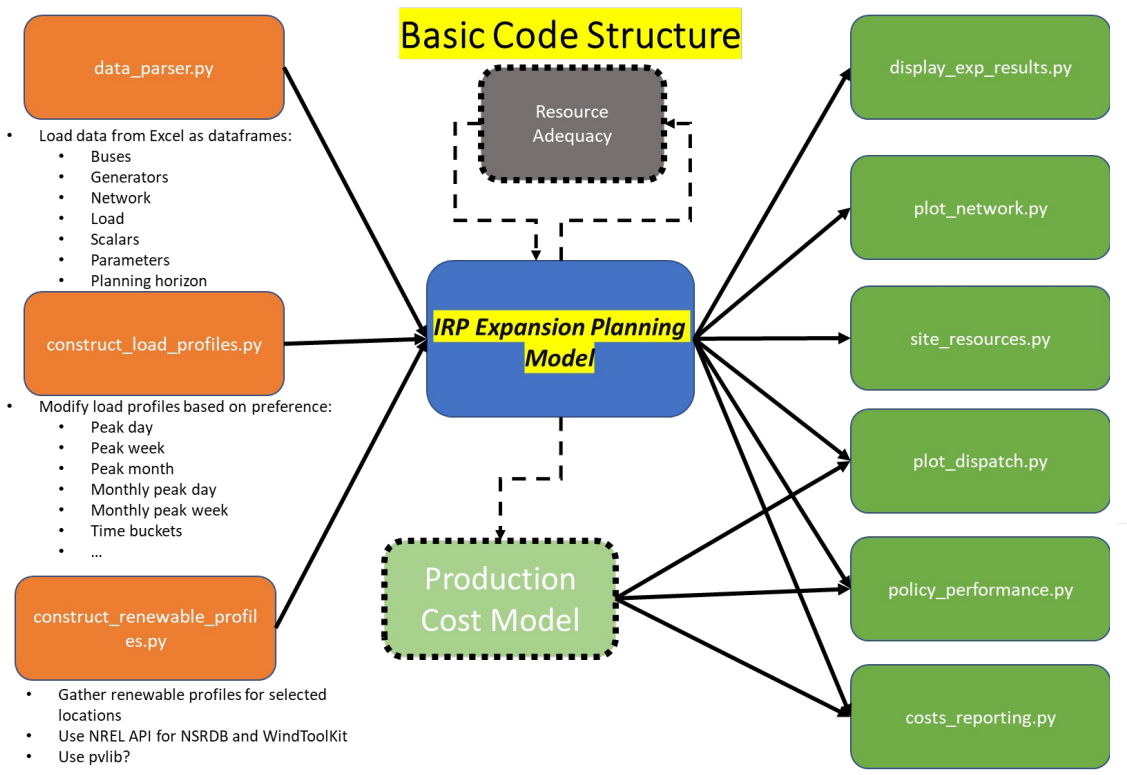
- **QuEST Data Manager:** *Manages acquisition of ISO market data, US utility rate data, commercial and residential load profiles, etc.*
- **QuEST Valuation:** *Estimate potential revenue generated by energy storage systems providing multiple services in the electricity markets of ISOs/RTOs.*
- **QuEST BTM:** *Estimate the cost savings for time-of-use/net energy metering customers using behind-the-meter energy storage systems.*

Impact: QuEST plays a vital role in energy storage industry acceptance by empowering the energy storage community with decision support tools for energy storage projects.

For example, QuEST has been used for **feasibility studies of Albuquerque Public School and San Carlos Apache Tribe** projects. In such projects, QuEST provided answers as to **how the technical capabilities of an energy storage system translates to monetary value**. As a result, stakeholders can have the confidence to move forward if it makes financial sense.



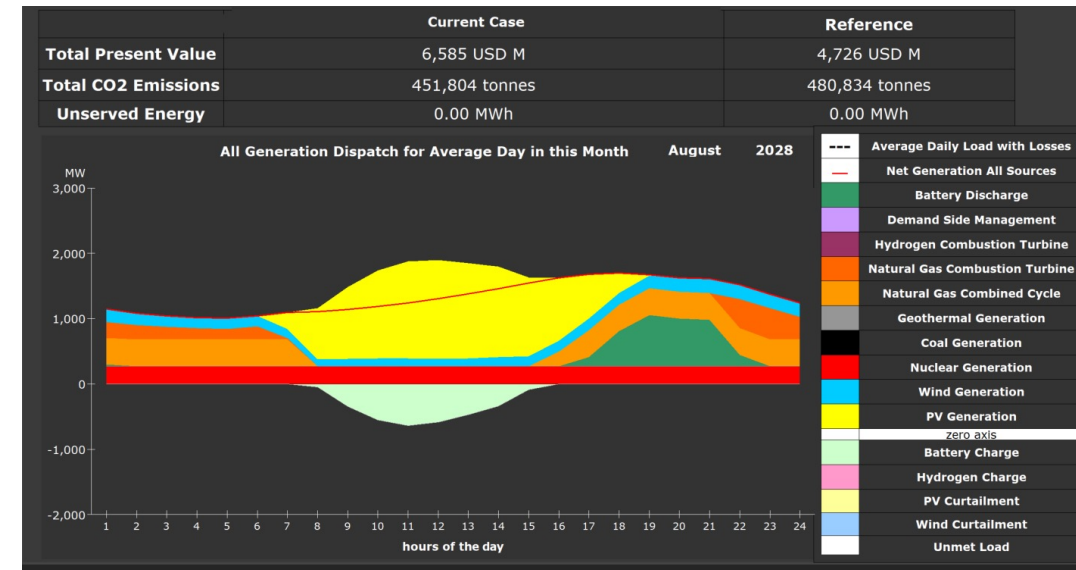
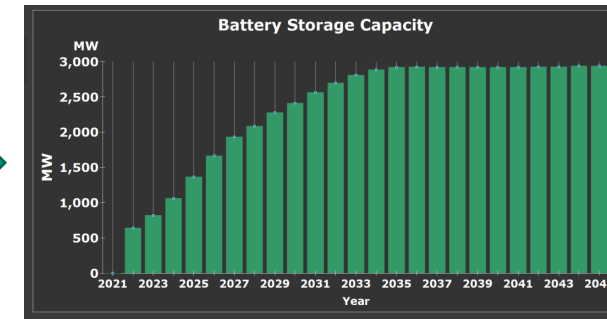
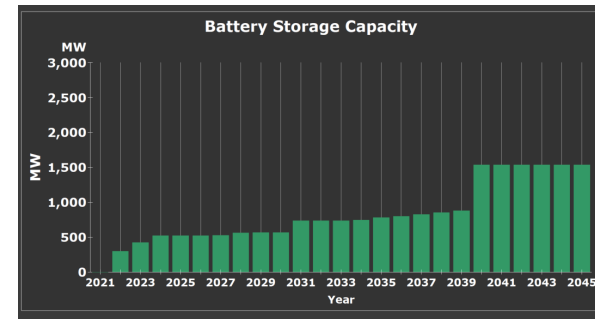
With PNM: Expansion Planning and Production Cost Modeling to Meet ETA Targets



- ❖ **Stage 1:** specify regulating reserve based on renewable output
 - ❖ **Deliverable:** SAND technical report was published in Mar 2022
- ❖ **Stage 2: (In progress)**
 - ❖ Conduct expansion planning considering transmission zonal model
- ❖ **Stage 3: (Future work)**
 - ❖ Develop production cost model with an emphasis on representing energy storage technologies
 - ❖ Evaluate several planning scenarios and explore stochastic programming features

Stakeholder-Driven Systems-Dynamics Modeling for Energy Storage and Decarbonization in NM

- Partnering with several NM entities: PRC, EMNRD, and PNM
- Allows policy makers to experiment with different strategies for meeting NM's ETA requirement for carbon-free electricity
- Stakeholder-driven process assures that:
 - stakeholders understand abilities and limitations of the model
 - modelers understand the system and have all the right data and info
 - model will be used by policy makers and other stakeholders
- System dynamics (SD) modeling environment accommodates systems thinking, including interconnections, interdependencies, non-linearities, time lags, and unintended consequences
- User-friendly, graphical, real time modeling provides great tool for exploration, education, and consensus building



Energy Storage Demonstration Projects - New Mexico



Albuquerque Public Schools



**ATRISCO HERITAGE ACADEMY
HIGH SCHOOL**



- Battery storage and rooftop PV project to reduce school's demand charges.
- Largest energy footprint for any school in the district with a large percentage due to peak load demand charges.
- The school is in a disadvantage area of SW Albuquerque amongst impoverished neighborhoods.
 - Most families are below the median household income for the area and 14% of families are below the federal poverty level.
 - 99% of students on free/reduced lunches
 - 20% of the students are English language learners.
- The school also functions as a community gathering center during emergencies and hosts an onsite health clinic. Saving will go toward student programs and other expenses for the school.

Energy Storage Demonstration Projects - New Mexico



Albuquerque Public Schools



■ Current status:

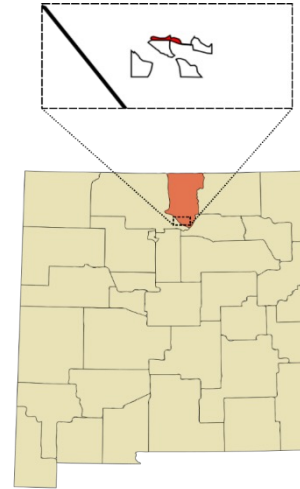
- Engineering analysis to quantify the potential savings from ESS. Determined the size of system necessary to optimize cost savings based on the school's rate structure. **COMPLETE**
- Assisted APS with the development of their RFP. Review and providing feedback on the submittals. Select vendor. **COMPLETE**
- Provided engineering feedback design documents and construction drawings. **COMPLETE**
- Provided engineering assistance in the utility interconnection application process. **IN PROGRESS**
- Monitor construction status. BESS site construction and PV installation is underway. **IN PROGRESS**
- BESS is scheduled for delivery June 2022

Energy Storage Demonstration Projects - New Mexico



Picuris Pueblo

The Picuris Pueblo reservation is nestled in the Sangre De Cristo Mountains in northern New Mexico. The tribal reservation covers around 25,000 acres of land. There are less than 200 tribal members who live on the reservation. The total number of members of the tribe is over 300. The tribal lands are crossed by Rio Pueblo. The tribe is the smallest American Indian community in the state of New Mexico and it has little sources of revenue.



▪ **Energy Challenges:**

- Unreliable power
 - 2 – 3 power interruptions a month
 - Outages impact communications to the tribe and first responders
- High cost of power
 - Many residents use wood based heating – health concerns
 - Currently no natural gas infrastructure. Electric heating is cost prohibitive

▪ **Current status:**

- Engineering analysis to quantify benefits of a BESS for energy cost reduction and resiliency. Determine size of BESS. **COMPLETE**
- Development of statement of work for RFP. **IN PROGRESS**
- Development of contract with Sandia. **IN PROGRESS**

El Rito Campus Microgrid – Applying Sandia’s Microgrid Design Tool

Input Options:

- 5-battery site options
 - 100 or 300 kW
 - 4 hours
- 2-propane site options
 - 25 kW
- Existing 1.5 MW PV

Results:

Energy Availability

Critical	99.5%
Priority	99.2%

Cost: \$XXXX

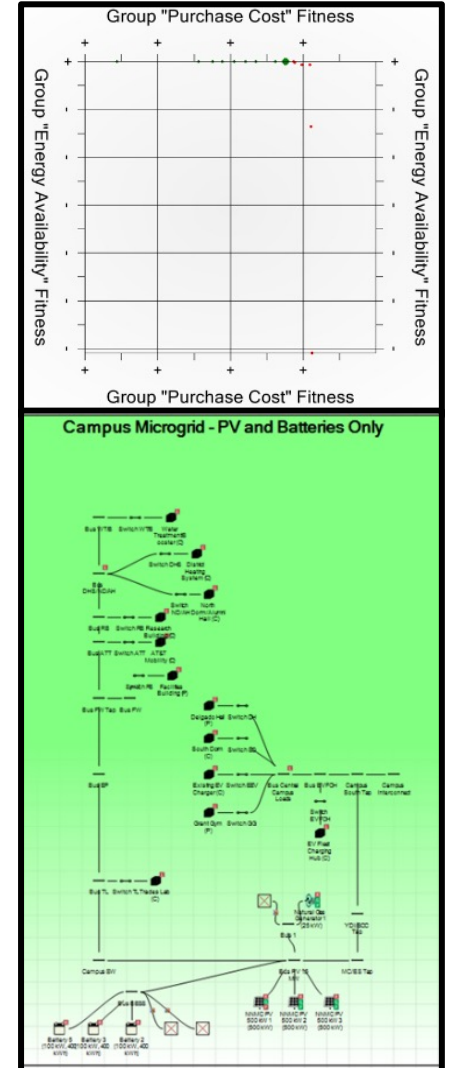
Options Chosen (lowest cost solution):

Batteries			
Unit #	kW	kWh	Rated Hours
1	100	400	4
2	100	400	4
3	100	400	4
TOTAL:	300	1200	12

Propane

Unit #	kW
1	25

Max propane used:
15.5 MMBTU
169 gallons
(10.9 gal/MMBTU)



Kirtland Air Force Base Resiliency Microgrid: An Emera, Kirtland AFB, Sandia Partnership

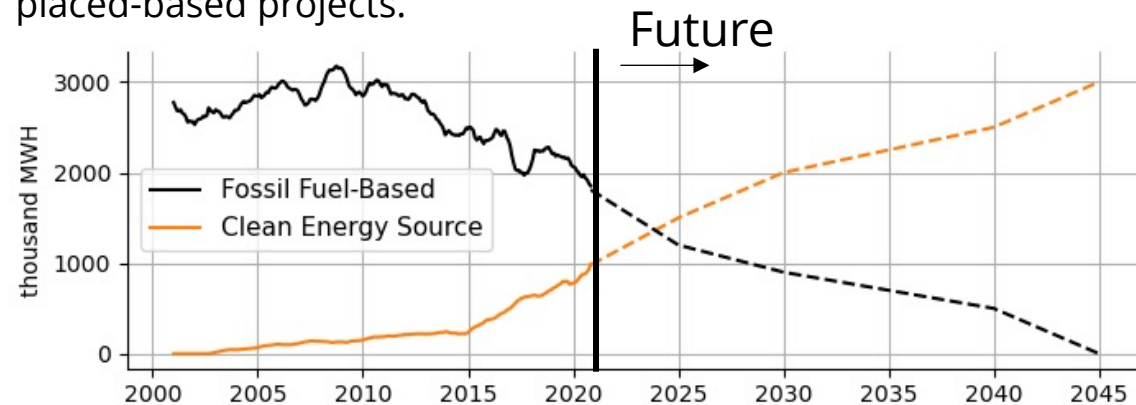


New Mexico Engagement: Clean Energy Integration Progress & Plans

A New Mexico place-based exercise to identify potential clean energy integration R&D, in order to showcase New Mexico as a National Leader in a clean, equity energy future.

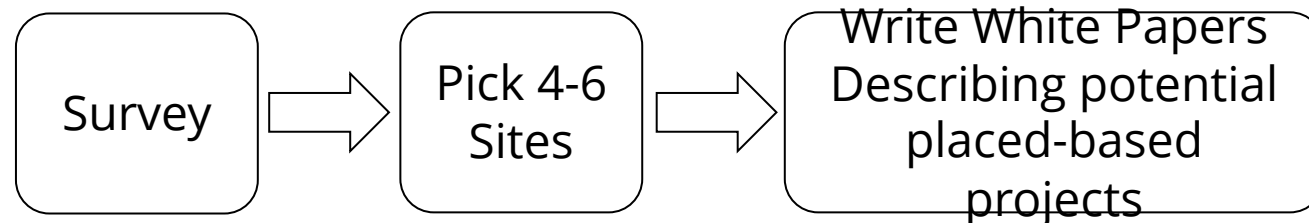
GOALS/PURPOSE

Identify clean energy R&D that will lead New Mexico to be 100% carbon-free by 2045. We plan to engage partnerships among energy providers, communities, and others to specify placed-based projects.

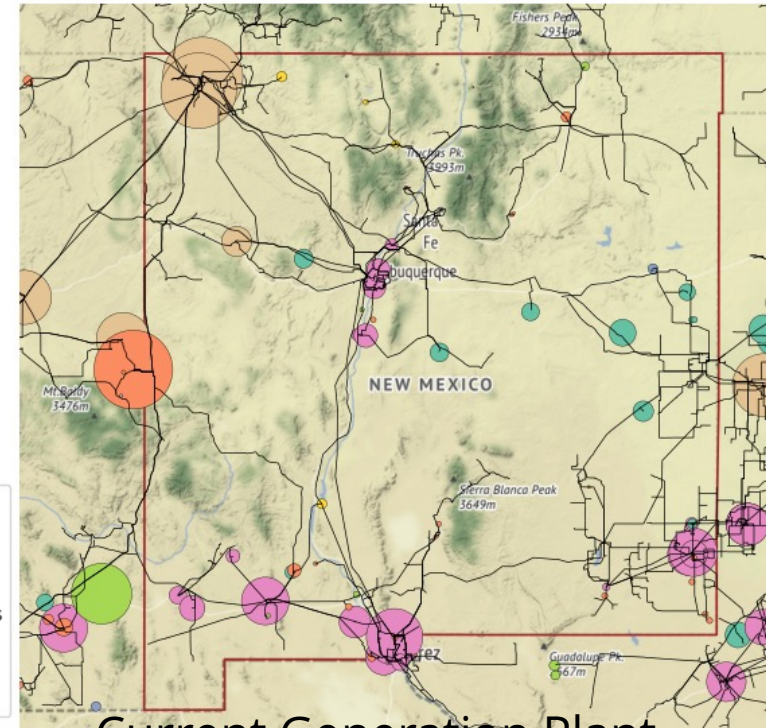


Question: How can Sandia help NM transition to clean energy and provide a showcase for the rest of the country?

PROPOSED PLAN



- Biomass
- Coal
- Hydro
- NA
- Natural Gas
- Petroleum
- Solar
- Wind



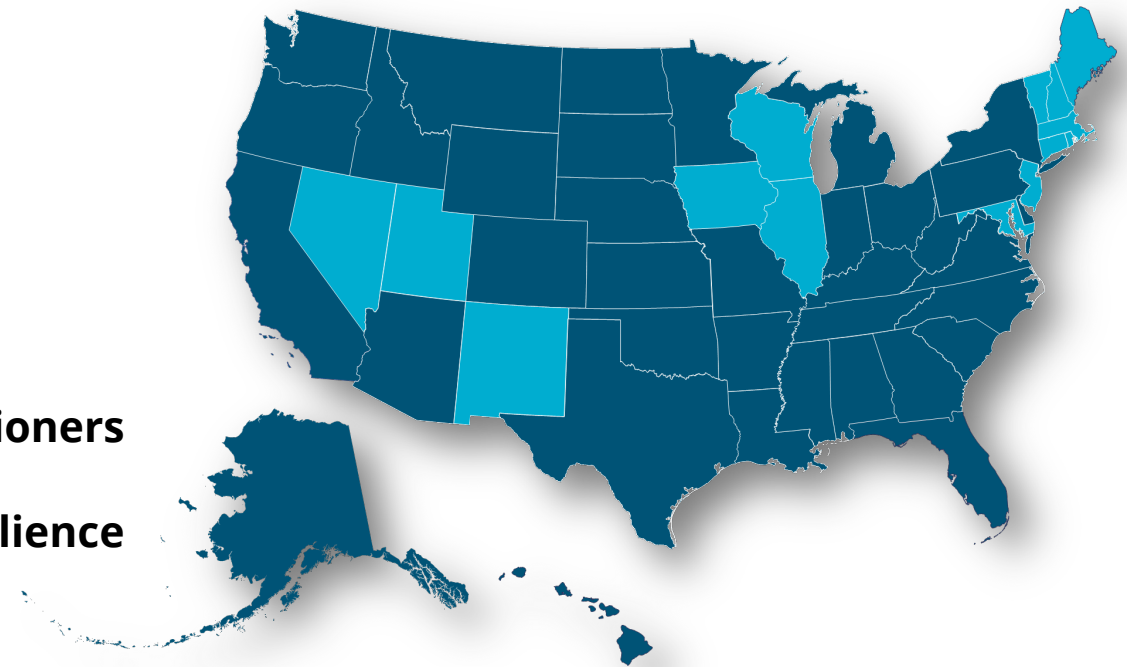
Current Generation Plant Map

Energy Storage Webinar for Regulators

The Energy Storage Policy & Outreach team works with stakeholders to develop educational webinars that focus on different topics related to Energy Storage.

Webinar Series:

- **Public Utilities Commission of Nevada**
- **Maryland Public Service Commission**
- **Utah Governor's Office of Energy Development**
- **ISU/Organization of MISO States**
- **New Mexico Public Regulation Commission**
- **New Jersey Board of Public Utilities**
- **New England Conference of Public Utilities Commissioners**
- **Wisconsin Public Service Commission**
- **Microgrids & Energy Storage for Emergency Grid Resilience**
- **Illinois Commerce Commission**



Impact: Assist regulatory commissions and related institutions around the United States develop the expertise they need to more quickly and efficiently integrate energy storage into their regional operations. Connections made during webinars open the door for Sandia to provide technical assistance.

Energy Storage Safety

As energy storage is used to improve the resiliency of the electric grid, the safety and resiliency of the energy storage systems themselves must also be well characterized to not create additional vulnerabilities.

Battery Lifecycle Framework:

- **Battery Lifecycle Framework (BLC)** is an open-source platform that provides tools to visualize, analyze, and share battery data through the technology development cycle.
 - Linking data across steps key to accelerating development of safe and reliable batteries.
 - BLC permits linking of multiple data sources, queries, and dashboards to track data from materials to systems.

Supporting grid energy storage incident:

- 2019 battery energy storage system (BESS) fire in **Surprise, Arizona** – first instance of injury to first responders
- Safety team members **provided neutral subject matter expertise** to utility and first responders
- **Published follow-up report** on “Grid-scale Energy Storage Hazard Analysis and Design Objectives for System Safety”

Sharing Battery Safety Tools with the Community:

- **Thermodynamic heat release calculator** based on Li-ion battery materials composition
- Launched **heat release calculator** based on Li-ion battery materials composition

Leading outreach in energy storage safety:

- **Energy Storage Safety Collaborative** formed in 2014 in response to a series of grid-scale battery fires
- **Energy Storage Safety Strategic Plan** published (currently undergoing revision)
- **Annual Energy Storage Safety and Reliability Forum** brings ~150 stakeholders annually to review the latest concerns and research
- **Quarterly reports** on the status of safety related codes and standards
- **Engagement with NFPA, IEEE, and UL** on education and standards development

Other Energy Storage Safety Projects:

- Mitigation of Thermal Runway Propagation
- Performance Beyond 80% Capacity
- Developing BatteryArchive.org - first multi-institution battery cycling database
- Collaborating with EPRI on energy storage data and alarm management guide



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