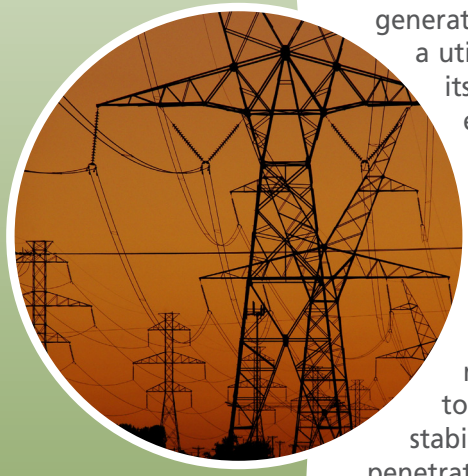
Sandia National Laboratories

Energy, Climate, & Infrastructure Security

Sandia National Laboratories' Stationary Energy Storage Research Program

Sandia collaborates with industry, academia, and government to reduce the cost of storage, demonstrate the effectiveness of storage technologies in the grid, and analyze policy options to value and perpetuate storage integration.



The contemporary grid limits renewable energy and other distributed energy sources from being economically and reliably integrated into the grid. While a national renewable energy portfolio standard (RPS) has yet to be established, 35 states have forged ahead with their own RPS programs and policies. As this generation becomes a larger portion of a utility's portfolio, it may decrease its ability to provide dispatchable energy and maintain grid frequency, voltage, and interia, which could disrupt the utility's ability to provide reliable service.

Currently, utilities use controllable generators to meet electricity demand and to maintain grid reliability and stability. As renewable energy penetration increases, these controllable generators will be replaced, making it difficult to meet demand and provide reliable and stable services.

Energy storage provides a solution to this issue. By incorporating energy storage into their network, a utility can compensate for renewable generation variability through energy time-shifting and maintain network stability. Additionally, even without increased renewables penetration, the grid requires many services for reliable and stable operation. Energy storage has the potential to provide a more cost-effective solution than current grid assets.

The 1 MW Energy Storage Test Pad integrated with renewable energy generation at Sandia's Distributed Energy Technology Laboratory.

Sandia provided technical guidance to Beacon Power as part of a DOE project to design a large-scale flywheel-based frequency regulation power plant (shown above).

Sandia collaborates with industry, academia, and government to reduce the cost of storage, demonstrate the effectiveness of storage technologies in the grid and analyze policy options to value and perpetuate storage integration. Sandia deploys an integrated approach to grid storage challenges from technology development through testing and demonstration.

Sandia: A Leader in Energy Storage

Sandia is the lead laboratory of the DOE Office of Electricity Delivery & Energy Reliability's (OE) Energy Storage Systems program. Sandia leverages the capabilities, expertise, and resources developed through cradle-to-grave responsibility for DOE defense program power sources to address national grid storage challenges. Conducting

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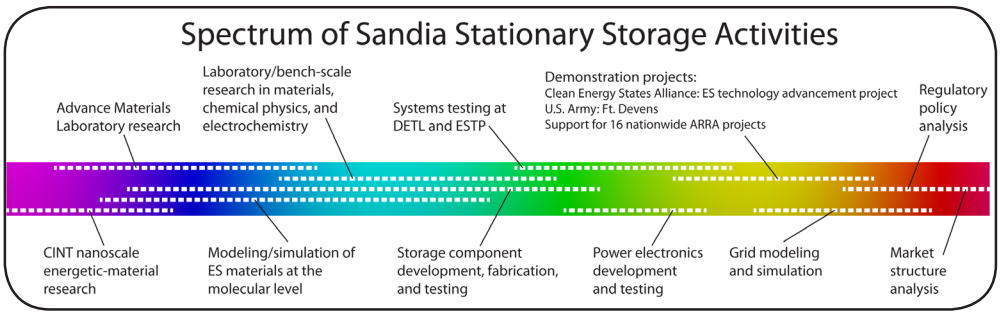
advanced development in electrochemistry, materials science, in situ diagnostics, and modeling and simulation, Sandia advances the technology for large-scale, stationary energy storage solutions. Facilities such as the Center for Integrated Nanotechnologies (CINT), the Advanced Materials Laboratory, and the Red Sky computing platform provide unique capabilities for fundamental science and university and industry partnerships.

Investigating a Variety of Solutions for the Grid

Because of the wide range of services demanded by grid applications, Sandia researches a variety of energy storage technologies to provide these services. These technologies can be broken down into two areas: electromechanical and electrochemical.

Electromechanical solutions include compressed air energy storage (CAES) and flywheels.

Sandia is working with industry partners to develop and understand the effects of carbon additions on the life cycle of lead-acid batteries.



Electrochemical solutions include

- lead-acid and advanced carbon-enhanced lead-acid chemistries,
- sodium-based chemistries,
- multiple flow-battery chemistries, and
- nitrogen electrochemistry.

Sandia's efforts in electrochemical development focus on cost-effective technologies that employ earth-abundant elements and engage U.S. industry.

Comprehensive Investigation of Storage Challenges

To advance electrochemical and electromechanical technologies, Sandia conducts research from the nanoscale to the national level with market and policy analysis.

Laboratory testing, coupled with modeling and simulation capabilities, are used to simulate storage systems to develop the next generation of energy storage technologies in prototyping facilities. Sandia's Distributed Energy Technologies Laboratory (DETL) and its Energy Storage Test Pad (ESTP) test experimental battery cells, market-ready battery packs, and large-scale modules in a grid environment. Sandia uses higher level modeling and simulation tools to envision many types of grid environments. These capabilities are used to explore new technologies to meet national needs into the future.

Sandia's capabilities feed into each other to strengthen the laboratories' research. For example, large-scale simulation can identify better technology solutions, leading to new research directions. Investigating new technology in electrochemistry or materials will lead to new capabilities or devices that improve the performance and lower costs of energy storage.

Sandia economists and policy analysts work with industry and regulators to identify the barriers that prevent storage from large-scale adoption. This includes determining the market structures that assign a proper value to the services that energy storage can bring to the grid and analyzing the policies that dictate electricity system operations to facilitate energy storage deployment.

Using its wide spectrum of capabilities, Sandia deploys a fully integrated approach to solving the nation's electricity problems with critical research into stationary energy storage.

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