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# Sandia DOE OE Energy Storage Program

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Supported by the DOE Office of Electricity – Dr. Imre Gyuk, Energy Storage Program Manager



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# Goal: Making Energy Storage Cost Competitive Sandia National Laboratories

- R&D focus is on solving critical problems to make energy storage cost competitive
  - Batteries, power electronics, PCS
  - Lower BOS and Integration Costs
  - Engineered safety of large systems
  - Scalable technologies to cover all markets
  - Codes and Standards
  - Optimal use of storage resources across the entire electricity infrastructure
- Support demonstration projects and outreach to utilities, regulators, and the industry
- Multidisciplinary team leveraging resources across the laboratory and outside partners

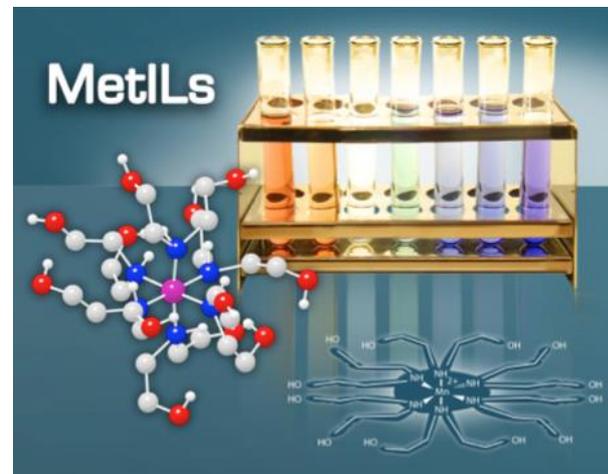
# Energy Storage Program - Thrust Areas

- Materials and Systems Development (Babu Chalamala)
  - Development of next-generation technologies
  - Improving current technology (flow batteries, flywheels, membranes, etc.)
- Power Electronics (Stan Atcitty)
  - Development of power electronics and power conversion systems.
- Energy Storage Systems Safety and Reliability (Summer Ferreira)
  - Fundamental Safety R&D of utility class storage systems
  - Laboratory testing and analysis from individual cells to 1MW systems
- Grid Analytics and Policy (Ray Byrne)
  - Analytics and Modeling
  - Distributed Controls
- Industry Acceptance (Dan Borneo)
  - Field deployments; State-Initiated Demonstration Project Development
- Outreach (Jaci Hernandez)
  - ESHB, US DOE/SNL Global Energy Storage Database, DOE ESS Web Portal
  - PUC Workshops, EESAT and DOE Energy Storage peer review

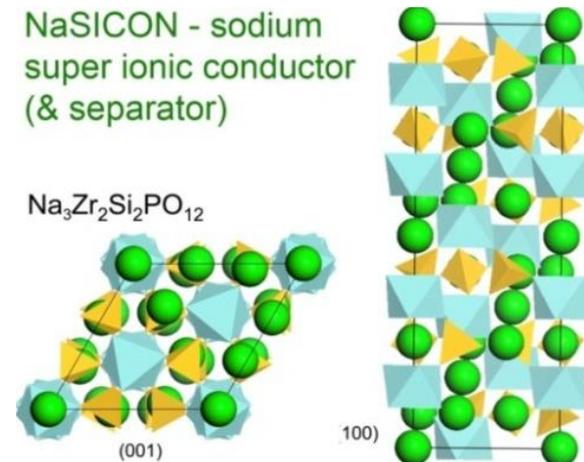
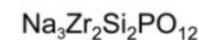
# Energy Storage Materials Thrust

## Materials R&D projects covering battery chemistry and component technologies

- Low Cost Membranes for Flow Batteries
- New Electrolytes for Flow Batteries
- Sodium Based Batteries
- Zn-MnO<sub>2</sub> Rechargeable Batteries
- Lightweight Composites for Flywheels
- Magnetics

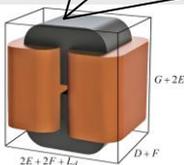
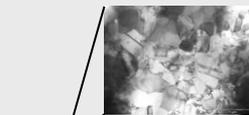
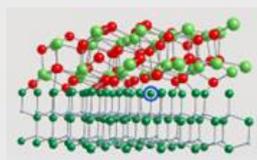


NaSICON - sodium  
super ionic conductor  
(& separator)



# Power Electronics Thrust

## Materials R&D



- Gate Oxide R&D
- Advanced Magnetics

## Devices



- ETO
- SiC Thyristors
- Monolithically integrated SiC transistors
- WBG Characterization & Reliability
- High energy dielectric capacitors

## Power Modules



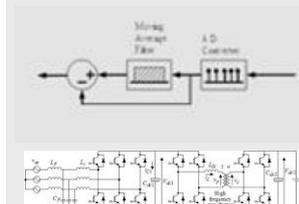
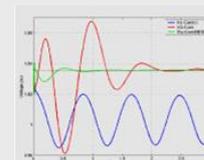
- SiC High Temp/density Power Module
- HV SiC JFET Module
- HV, HT Reworkable SiC half-bridge modules

## Power Conversion System



- Dstatcom plus energy storage for wind energy
- Optically isolated MW Inverter
- High density inverter with integrated thermal management
- High temp power inverter

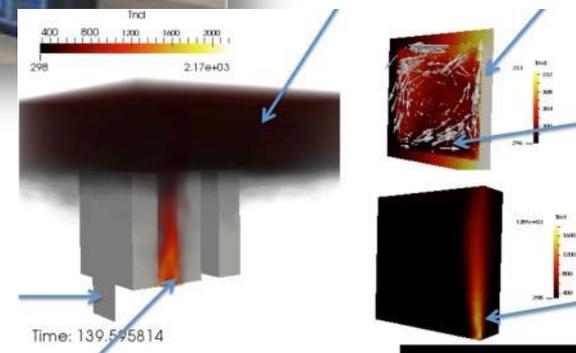
## Applications



- FACTS and Energy Storage
- Power smoothing and control for renewables
- Dual active bridge for advanced energy storage system designs

# Energy Storage Safety Thrust

- Fundamental Safety R&D of utility class storage systems
- Laboratory testing and analysis from individual cells to 1MW systems
- Experimental work at Energy Storage Test Pad (ESTP) and BATlab. Coupled with Advanced simulation and modeling of energy storage systems
- Focus on developing a fundamental understanding of safety and reliability through R&D in four areas:
  - Materials origin of safety and reliability
  - Device level failures
  - Cascading failures
  - Software's role in system safety



# Grid Analytics and Policy Thrust

- Estimating the value of energy storage
  - Production cost modeling
  - Stochastic unit commitment and planning studies
- Control strategies for energy storage
  - Wide area controls
  - Control algorithms to maximizing revenue
- Public policy: identifying and mitigating barriers
- Standards development
  - Energy storage protocols
- Project evaluation
  - Technical performance
  - Financial performance
- Model development (e.g. for dynamic simulation)

# Industry Acceptance Thrust

- ES System Field deployments and commissioning
  - Energy Storage System Project Technical Support
  - Preliminary grid analysis & modeling to determine applications, ES sizing, and technologies
- State-Initiated Demonstrations
  - Assist states in developing request for Information and Proposals (RFI & RFP).
  - Assist in the project design, procurement specifications, and construction of ESS
- Technical support
  - Assist in the design of Data Acquisition Systems
  - Assist in developing and implementing the ESS commissioning plan. Support testing.
  - Analyze operational test data and develop system optimization algorithms (with PNNL)

# Strategic Outreach Thrust

- DOE/OE ESS Website
- DOE SNL Global Energy Storage Database
- DOE/EPRI/SNL/NRECA Electricity Storage Handbook
- Workshops for PUCs and Utilities
- EESAT
- DOE OE Energy Storage Annual Peer Review
  
- Peer Review Organizational Team
  - Jaci Hernandez, Sharon Ruiz, Thu Ngo, Meagan Brace, Gina Fresquez, Gail Kaplan, Dan Borneo
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