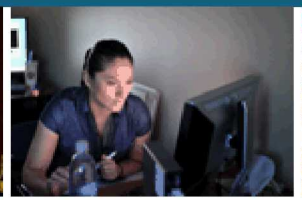
SAND2019-11290C

DOE OE Energy Storage Program at Sandia – FY19 Summary



Dr. Babu Chalamala

Program Manager, Grid Energy Storage

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.

FY19 Accomplishments by the Numbers

30

Journal Articles

22 published

8 under peer review

10

Conference Proceedings

5 Technical Reports

12

Patents

6 granted

6 Applications filed

23

Invited Talks

50

Technical Presentations

12

Seminars and Webinars

CESA, IEEE, and prominent universities

Where We Focus Our Energy

Materials

Advancing battery chemistries through development and commercialization

Safety & Reliability

Testing, Analysis, Standards, Protocols

Power Electronics

Reduce installed cost and footprint

Improve control capability
Increase reliability

Regulatory Outreach

Collaborating with States and other National Labs

State Policy Analysis

Demonstration Projects

Support, Analysis, Implementation, Monitoring

Outreach

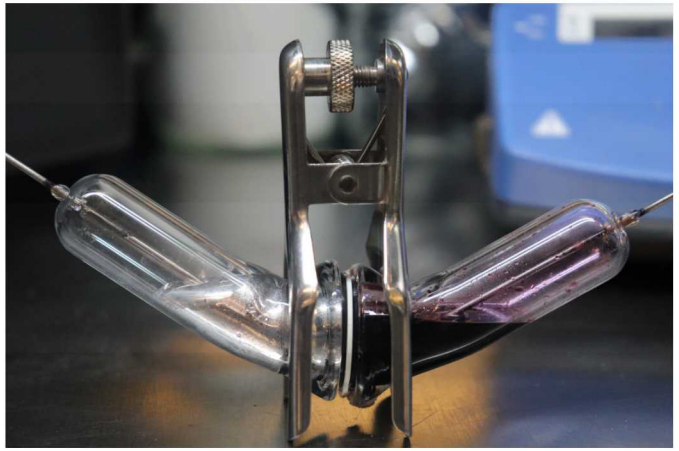
DOE ESS Website

Global Energy Storage Database

Regulatory Outreach & Education

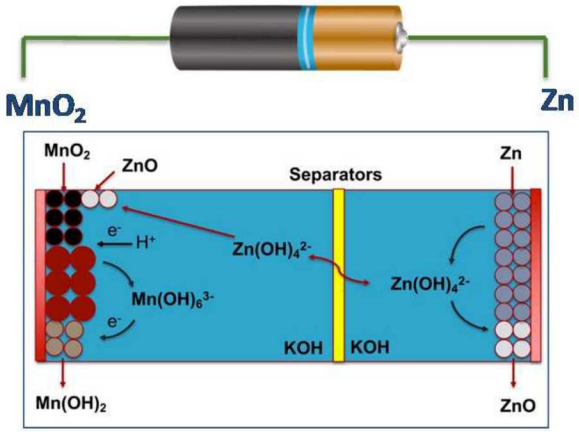
Materials

SODIUM BATTERIES



- New Na-battery cell testing design implemented that exhibits improved sealing, chemical compatibility, and molten reagent utilization
- Solid state separator development has yielded improved in-house NaSICON production and new alternative ion conductive ceramics and composites
- Interfacial modifications in both anode and cathode have led to drastically improved cell cycling performance, enabling >100 cycles in lab-scale prototypes

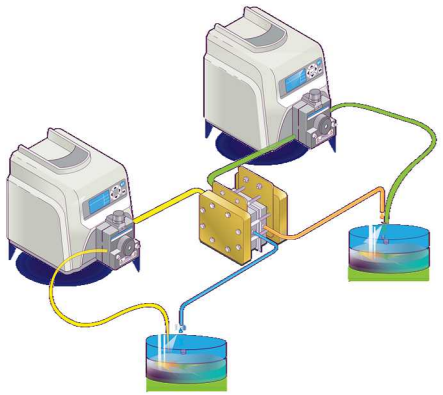
ZINC BATTERIES

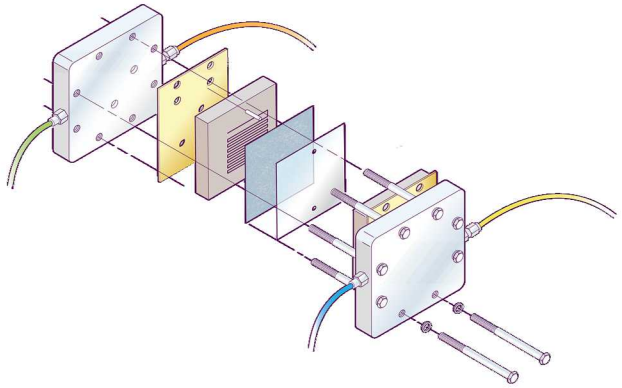


- Developed permselective polymer separators to block zincate crossover while promoting promising ionic conductivity competitive with current commercial materials
- Using Zn/Ni analogs, developed strategy in which ZnO-saturated KOH electrolyte leads to increased cycle life and more effective utilization of Zn-anodes
- Developed high voltage aqueous Zn-MnO2 rechargeable battery operating at 2.8 V without the use of expensive ion selective membranes

Materials

FLOW BATTERIES





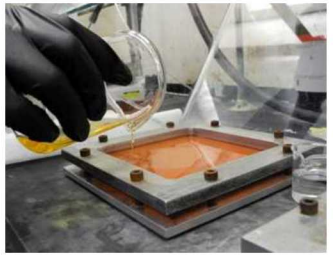
- Through testing of variable electrolyte compositions and membrane chemistries, determined new insights into the the foundation of flow batteries: the interplay between solvent, salt, and membrane
- Several university collaborations are developing new models and promising tunable redox active materials for flow batteries

MEMBRANES

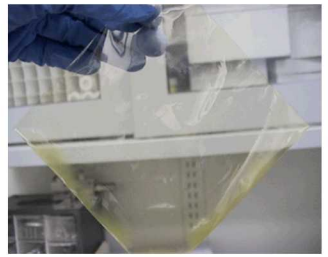
Developed new process of synthesizing SNL anion exchange membrane for the specific use in flow batteries

Currently looking for commercial partners

Solvent cast



Film



Public Data and Open-Source Tools

To enable risk assessment, selection, and adoption of ESS, we are developing:

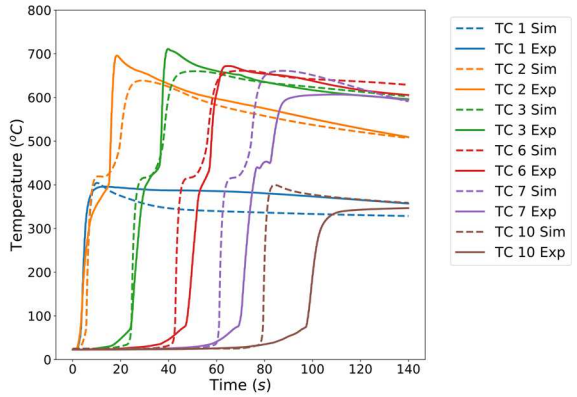
- Battery data repository and open source analytics tool in collaboration with UT-Austin
- Open-source python tool for modeling thermal runaway propagation
- Multi-institution battery calorimetry collaborative and workshop series to identify best practices for data collection and analysis
- Thermodynamics calculator for lithium ion battery cathodes
- Thermal runaway database with risk scores in collaboration with ORNL

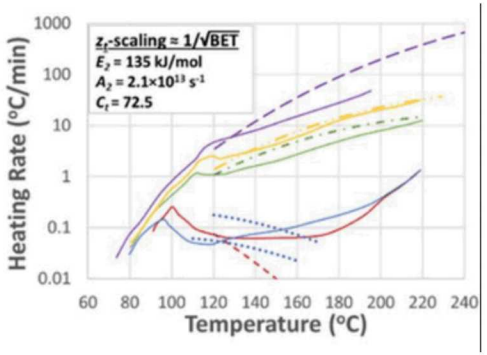
Safety & Reliability

Modeling

Spearheading advancements in multi-scale modeling of Li-ion battery failure, including development of:

Models for thermal runaway propagation in pouch cells



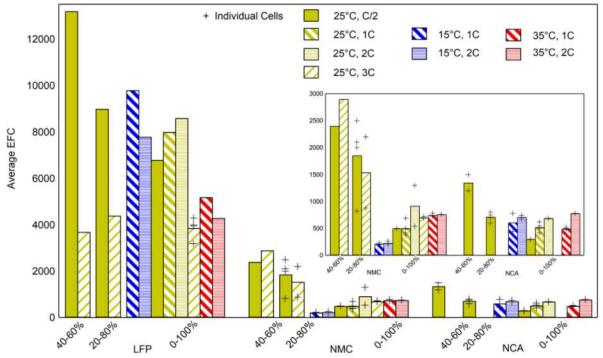


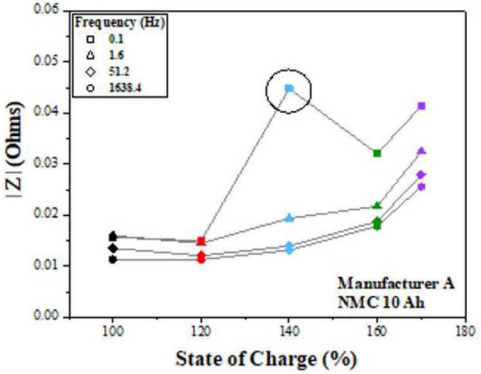
Comprehensive models of lithiated graphite and metal oxide cathode decomposition

Experimental

Advancing quantification of battery degradation and failure at the cell and materials level, including:

Completed multi-year head-to-head comparison of cycling, materials stability, and whole cell thermal runaway of popular commercial Li-ion cells





Identified universal degradation markers for NMC cells, providing early warning of failure

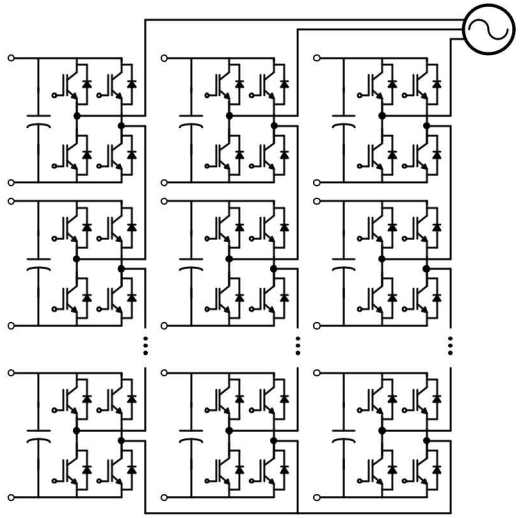
Power Electronics

FY19 Accomplishments

- Review of challenges and opportunities for power electronics in utility-scale storage applications
  - Review paper on power electronics for energy storage in IEEE Access
- Commissioning APEX laboratory
  - Jump-start internal power electronics research program
  - Leverage Sandia's unique strengths in component and material R&D
  - Maximize strategic impact of external collaborations

FY20 Plans

- Power conversion systems for next-generation energy infrastructure
  - Modular, fault-tolerant, reconfigurable hardware architectures
- Applications of power electronics in storage system safety
  - Stranded energy extraction
  - Active responses to thermal runaway



Regulatory Outreach

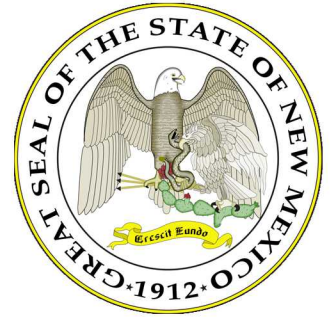
Hawaii PUC – December 2018 – Energy Storage Introductory Workshop

California Energy Commission (CEC) – June 2019 – Energy Storage Academy

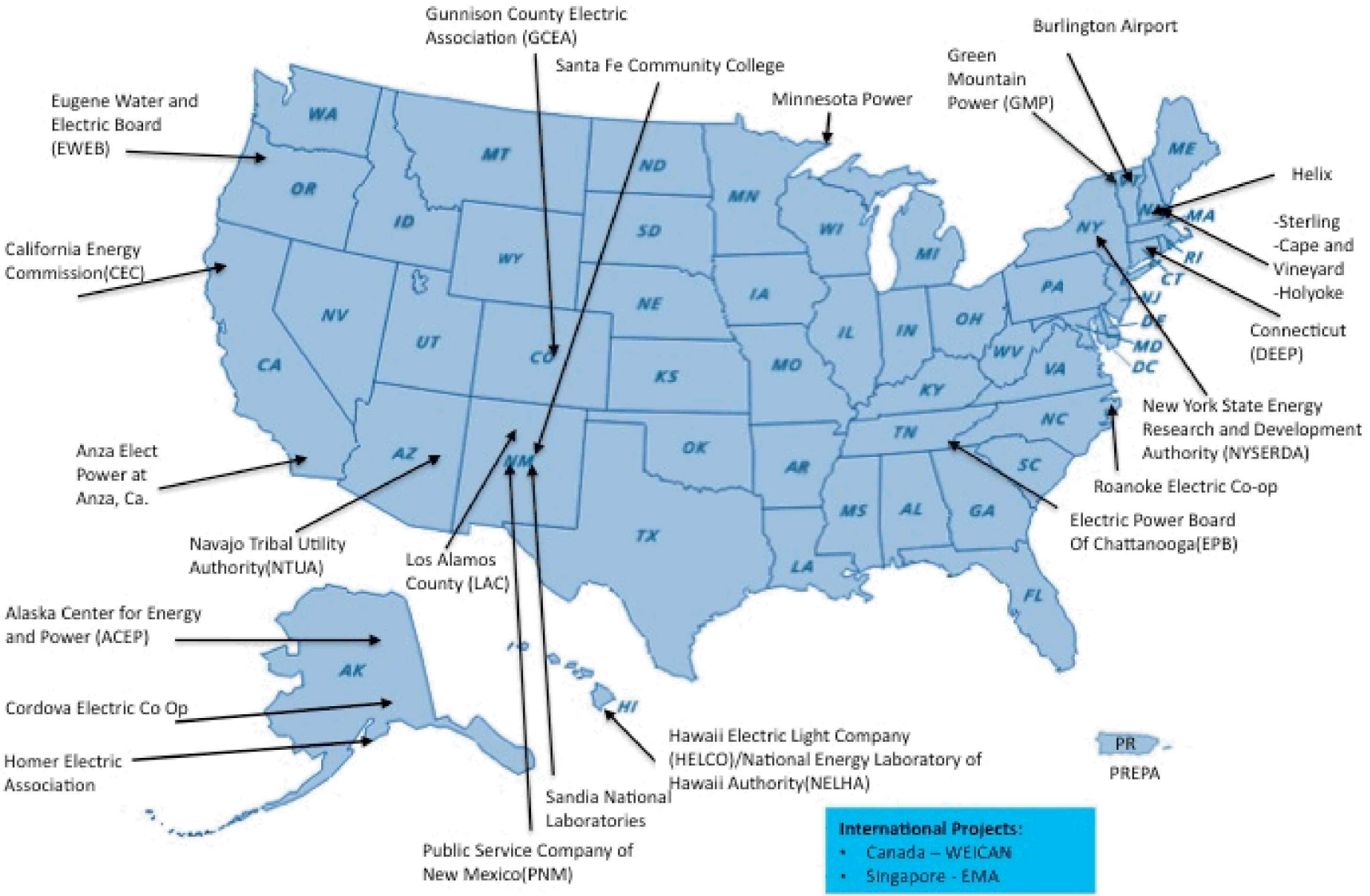
Southeastern PUCs – **Alabama**, **Arkansas**, **Florida**, **Georgia**, **Kentucky**, **Maryland**, **New Jersey**, **North Carolina**, **Virginia** – July 2019 – 2nd Southeast Energy Storage Symposium and PUC Workshop

New Mexico PRC and **Nevada** PUC – workshops in planning stages

New Jersey, **Texas**, **Minnesota, Iowa** PUCs – in the pipeline

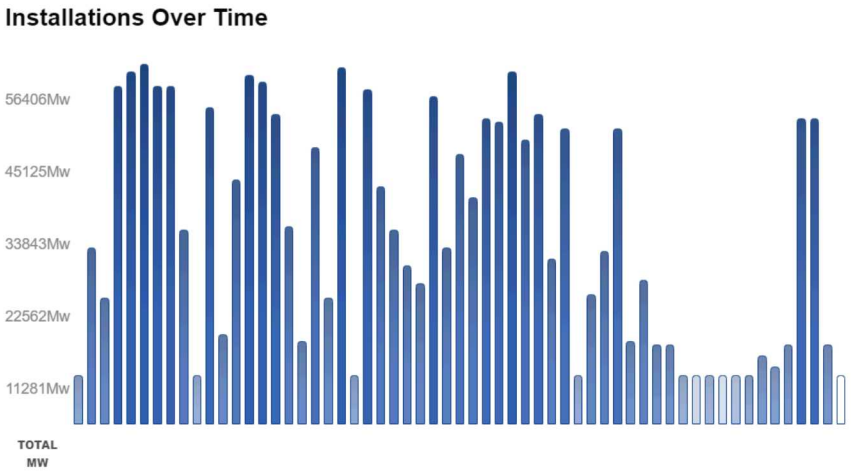


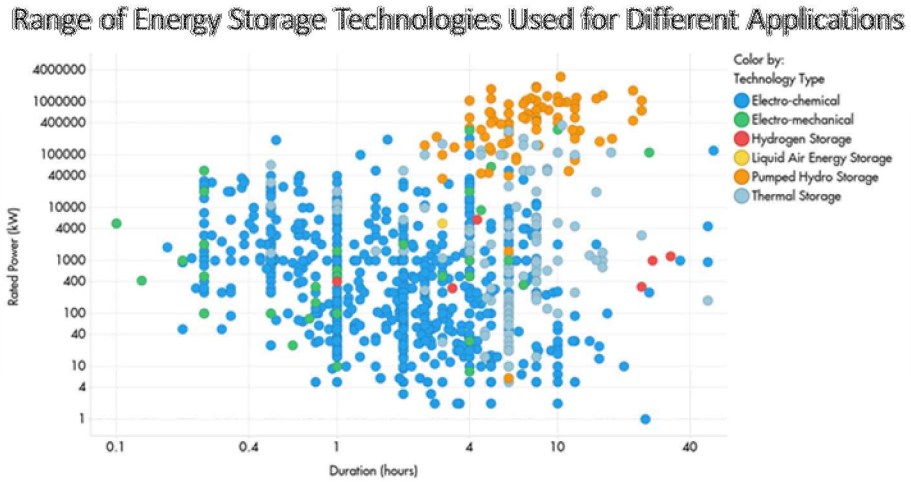
Demonstration Projects



Global Energy Storage Database

- 1,579 total energy storage project profiles
- Over 178 GW operational capacity
- 9,600 unique users have exported the data 70,000+ times since its inception in 2013.
- There have been 3500+ exports since September 2018.
- There is no widely available alternative source of information – all known private data sources reference data from DOE's Global Energy Storage Database.





Source: US DoE Energy Storage Database, June 2018, http://www.energystorageexchange.org/
Analysis by Shell Intangible Exploration & Production (US) Inc.; presented by Shell 11 March 2019, ARPA-e DAVE Kickoff meeting

Partnerships

ACADEMIA

Partnerships (cont.)

INDUSTRY

Anza Electric Cooperative, Inc.
A Touchstone Energy® Cooperative

Burlington Electric Department

Greare

EPRI Electric Power Research Institute

epb

East ecoult Energy Storage Excellence

ESA Energy Storage Association

EWEB

Green Mountain Power

Hawai'i Electric Light

GeneSiC Semiconductor

Strategen

WattJoule

Urban Electric Power

Helix Power

Los Alamos where discoveries are made

PNM

UET UniEnergy Technologies

NAATBatt International

Mustang Prairie

NRECA America's Electric Cooperatives

STATE PARTNERS

California Energy Commission

NELHA

emnrd

DOER Massachusetts Department of Energy Resources

STANDARD BODIES

IEC

IEEE Advancing Technology for Humanity

NFPA

FEDERAL PARTNERS

Bonneville Power Administration

NHTSA

INTERNATIONAL

Energy Market Authority

nite

Acknowledgements

Organization Team

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Facilitator

Jim Greenberger, NAATBatt, Facilitator

Partner Laboratories

Oak Ridge National Laboratory
Pacific Northwest National Laboratory

Other Collaborating Partners

Universities, utilities, companies, state and regional entities

Department of Energy

DOE Office of Electricity and Dr. Imre Gyuk, Director of the Energy Storage Program