



Overview of **Battery R&D** Activities

Ahmad Pesaran, Chief Energy Storage Engineer

Transportation & Hydrogen Systems Center
National Renewable Energy Laboratory
Golden, Colorado



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NREL Snapshot

Golden, CO

NREL focuses on creative answers to clean energy challenges, from breakthroughs in fundamental science to new clean technologies to integrated energy systems.



World-Class Staff

2,200

Including postdocs
interns, and visiting
professionals



Recognition

61

R&D 100 awards



Partnerships

750

With government,
industry, and academia



Campus

Operates as a living
laboratory with
world-class facilities
and capabilities



Impact

\$872M

Annual national
economic impact



Sustainable Mobility

NREL's sustainable transportation research focuses on new, innovative, and integrated mobility strategies with the potential to:

- Transform the movement of people and goods
- Enhance national energy security
- Boost the domestic economy
- Save individuals and businesses time and money



Battery R&D Program

NREL's energy storage program develops & enhances battery technologies

Working to meet key targets:

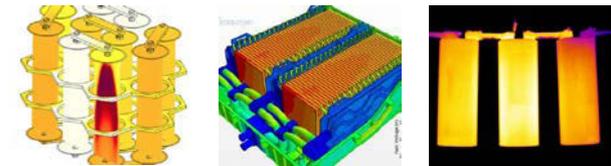
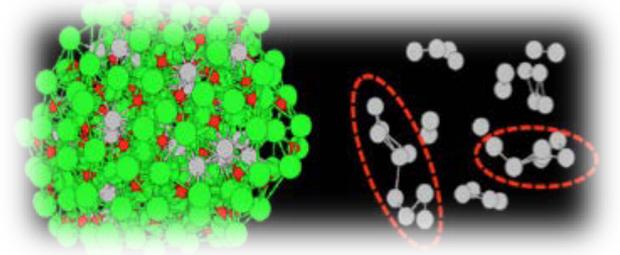
- Energy and power densities
- Cost
- Life
- Safety
- Extreme fast charging
- Sustainability

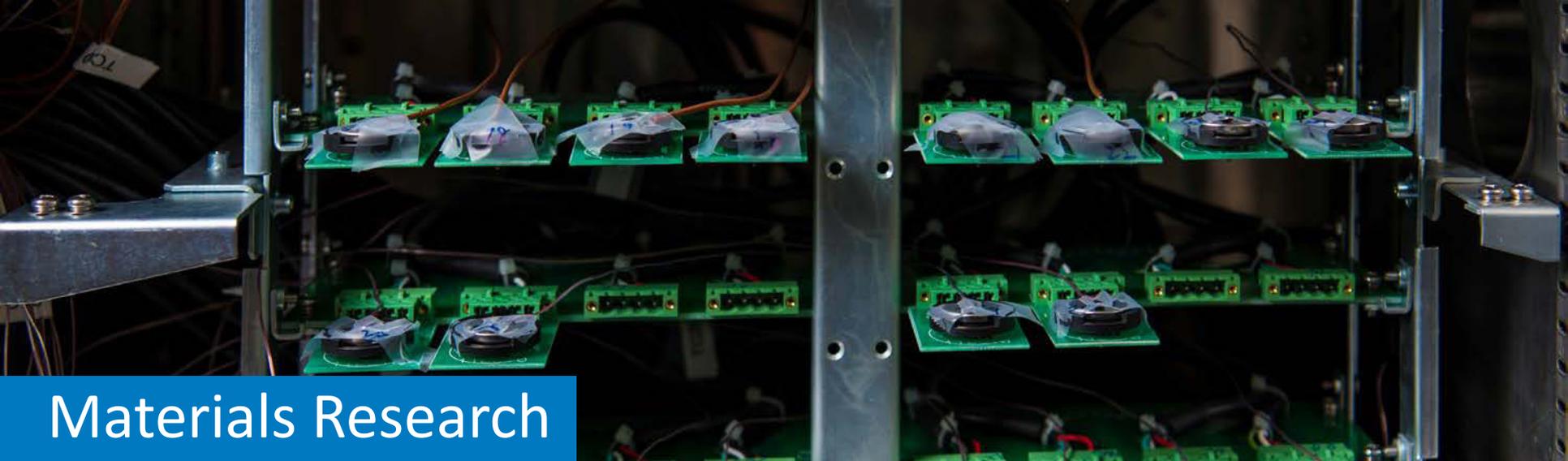
Working on transportation and stationary applications:

- Materials science
- Modeling
- Engineering
- System integration of energy storage

Energy Storage R&D Activities

- 1 Materials Research
- 2 Thermal Characterization and Evaluation
- 3 ECT Performance and Life Modeling
- 4 Extreme Fast Charging
- 5 Safety Modeling and Characterization
- 6 Battery Recycling
- 7 Strategic Partnerships





Materials Research

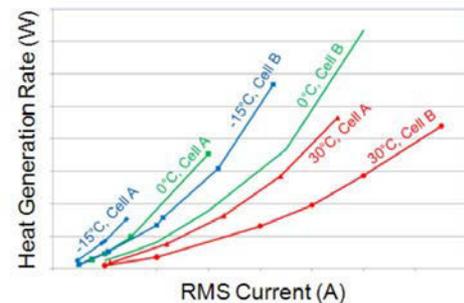
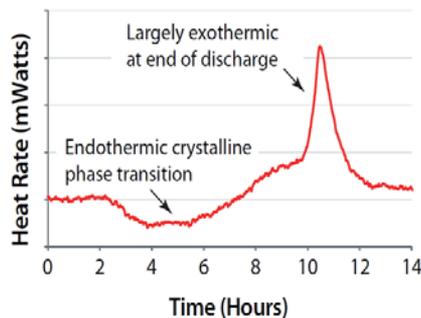
- Stabilization studies to enhance cyclability of high-energy silicon-based anodes
- Atomic layer deposition for improving life and safety of electrodes
- Development and evaluation of high-nickel, low-cobalt cathodes
- The Cell Fabrication, Analysis and Breakdown (CFAB) laboratory

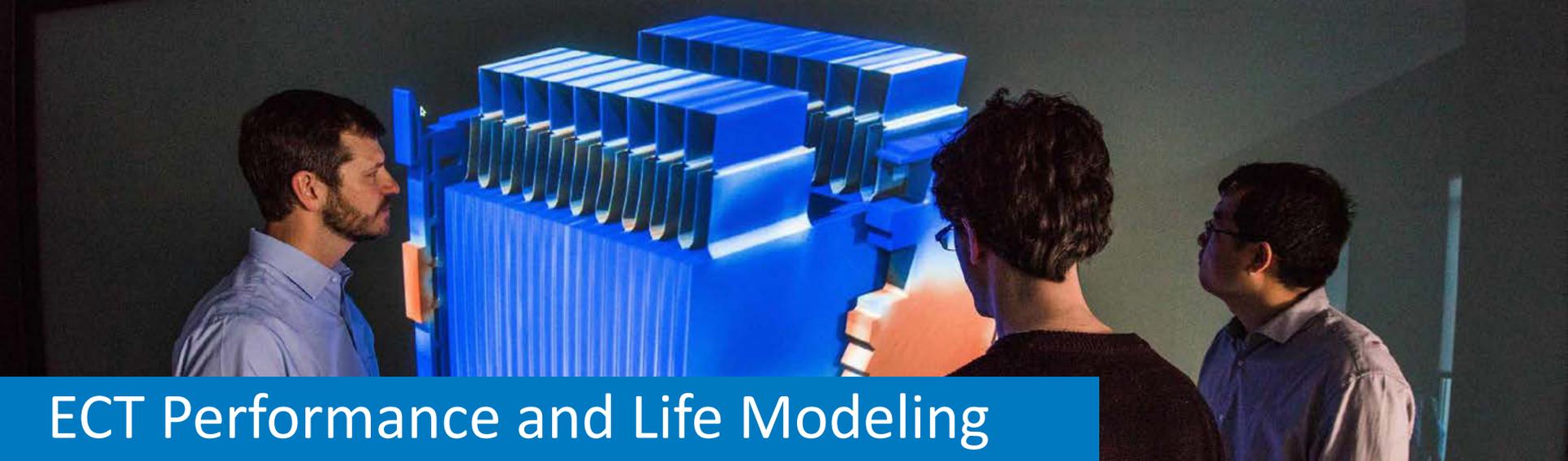


Thermal Characterization and Evaluation

Thermal characterization of cells and batteries to design improved thermal management systems

- Calorimetry
- Infrared thermal imaging
- Thermal conductivity measurements
- System thermal evaluation testing



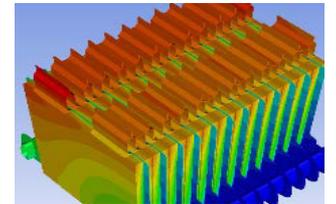
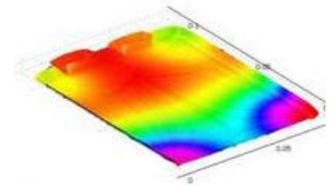


ECT Performance and Life Modeling

CAEBAT: Computer-Aided Engineering for Electric-Drive Vehicle Batteries
Accelerating design of high-performance lithium-ion batteries through the development of multi-scale, multi-physics modeling tools

- Three commercial software tools developed
- Developing microstructure models to design better electrodes

Life Models: Cell-level capacity fade and resistance growth capturing various degradation mechanisms





Extreme Fast Charging (XFC)

Using CAEBAT tools, NREL is developing 3D microstructure models to increase rate of charging

- Simulate tortuosity
- Simulate morphology and particle alignments
- Modify electrode design for faster Li transport
- Validate with experiments and advanced diagnostics



Safety Modeling and Characterization

- NREL has developed models to predict thermal runaway under overheating, internal short circuit, nail penetration, and mechanical crush
- NREL has developed a patented **Internal Short Circuit Device** that induces a true internal short within a lithium-ion battery cell – licensed with KULR





Battery Recycling

Performing research as part of U.S. Department of Energy (DOE)'s program with Argonne National Laboratory and Oak Ridge National Laboratory

- Refurbishing and rejuvenating electrodes
- Design for recycling
- Materials and powder modeling

Administering the U.S. DOE's Lithium-Ion Battery Recycling Prize

- Increase collection, sorting, storing, and transporting of all Li-ion batteries



U.S. DEPARTMENT OF ENERGY

Strategic Partnerships



Thank You

Ahmad.Pesaran@nrel.gov

www.nrel.gov

www.nrel.gov/transportation/energy-storage.html

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