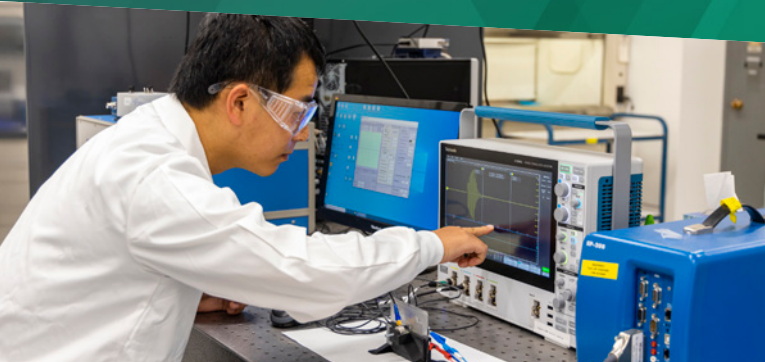




OAK RIDGE NATIONAL LABORATORY

# Energy Storage

Energy storage technologies are essential to advancing the U.S. transportation sector and enabling a reliable and resilient power grid. Oak Ridge National Laboratory (ORNL) translates scientific discoveries into scalable technologies and works closely with industry to develop energy storage solutions that boost energy efficiency, increase energy security, and support domestic supply chains and manufacturing. Capabilities include world-class high-performance computing; materials discovery, scaling, prototyping, manufacturing, and multiscale evaluation; battery reuse and recycling; and energy storage system integration.



**Energy storage materials research at ORNL**

**Battery storage for the grid**—Creating systems that can store large amounts of electricity for long periods to stabilize the power grid

**Fast charging for electric vehicles**—Developing new battery technologies and wireless charging that can power a vehicle as quickly as fueling up at the pump

**Roll-to-roll battery manufacturing**—Boosting America's competitiveness through new production processes and technologies

**Cobalt-free cathodes**—Demonstrating the effectiveness of new materials to enable high-performance lithium-ion batteries without cobalt, increasing U.S. energy independence

**Fuel cells and electrolyzers**—Developing earth abundant and recyclable electro-catalysts for electrolyzer and fuel cell technologies

**Solid-state batteries**—Advancing the development of new solid electrolytes for a system with high energy density and safety

**Battery reuse and recycling**—Supporting the US Department of Energy's (DOE's) efforts to develop advanced lithium-ion battery recycling technologies to recover critical materials from end of life battery cells and scraps, with a focus on automation and battery pack disassembly for reuse

**Beyond vehicle batteries**—Developing novel approaches ranging from transactive control of building energy loads and geothermal energy storage to battery technologies for aircraft platforms and security applications



**PROTOTYPING**  
new technologies



**INTEGRATING**  
energy storage systems



**IMPROVING**  
battery safety and performance



**DEVELOPING**  
energy storage solutions for vehicles and the grid



**EVALUATING**  
materials from nanoscale to pilot scale



"At ORNL, we try to build practicality into our work, using our deep bench of scientists and engineers to address science gaps across scales for an approach that can be readily adopted by industry."

—Electrification and Energy Infrastructure Section Head **Ilias Belharouak**

# Comprehensive Capabilities



**Rapid prototyping**—The DOE Battery Manufacturing Facility at ORNL, the nation's most comprehensive roll-to-roll research facility, prototypes new materials and processes with scalable results



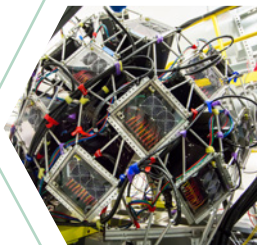
**High-performance computing**—The world's first exascale supercomputer



**Materials synthesis and characterization**—Deep expertise in the synthesis and evaluation of new materials, including polymers and electrolytes, and the study of material interfaces



**Power electronics and controls**—Development of new controls, devices, and systems, including transactive controls and wireless charging technologies



**Neutron science**—Two of the world's most powerful sources of neutrons for research, provides a nondestructive view inside energy storage devices



**Grid monitoring and analysis**—Dynamic modeling of interconnections, cyber-aware advanced sensors, and secure communications and controls

## Recent Impacts

- Discovered a new class of cobalt-free materials derived from lithium iron aluminum nickelate to reduce the cost of vehicle batteries
- Continued to explore the structure and performance of novel composite electrolytes to advance solid-state batteries
- Developed cell design and electrolyte solutions for the extremely high-power battery applications required for urban air mobility
- Provided the Open-Access Virtual Integrated Battery Environment platform, simulating battery performance from cells to packs
- Delivered a fast formation protocol that shortens battery production steps by a factor of six and improves capacity retention
- Developed novel components to advance low-cost, redox flow batteries for megawatt-scale energy storage
- Developed solventless electrode coatings using electron beam, UV curing, and freeze-tape casting
- Provided the new Ground-Level Integrated Diverse Energy Storage system for low-cost, efficient, flexible mechanical storage of electricity in pressurized vessels
- Developed methods for efficient, nontoxic battery recycling and reuse
- Analyzed the interface and bulk of solid-state battery materials using advanced characterization techniques



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