The Energy Science and Technology Directorate (ESTD) at Oak Ridge National Laboratory (ORNL) plays a pivotal role in America’s drive toward a flexible, secure, and decarbonized energy future. Our researchers deliver breakthroughs in energy science and technology ranging from generation to distribution, storage, and end use, all in support of US Department of Energy (DOE) priorities. ESTD is intensely focused on developing and demonstrating advanced technologies for at-scale deployment to address the immediate global carbon challenge while performing long-term research and development to enable future technologies at the nexus of energy and security.

ESTD’s researchers draw on the immense scientific and engineering capabilities at ORNL to develop applied solutions to address national energy priorities. Our culture of creativity and innovation in action drives us to partner with some of America’s best innovators, businesses, and academic institutions. This effort is enabled by four unique DOE national user facilities and several collaborative centers within ESTD.

We bring a multidisciplinary focus to some of the biggest challenges in energy, developing new technologies for buildings and transportation, driving innovations to increase US competitiveness in efficient manufacturing, and developing technologies for a flexible and secure future energy grid.

“By utilizing DOE’s national user facilities and our scientific expertise, we’re building a portfolio of world-class applied energy research and technology and leading transformational scientific breakthroughs in clean energy.”

**Xin Sun, Associate Laboratory Director, Energy Science and Technology**
Our Research

**Buildings and Transportation Science**—Delivers scientific discoveries to accelerate transformative buildings- and transportation-related technical solutions to ensure a safe, secure, and sustainable energy future

- **Propulsion science**—Drives decarbonized mobility solutions, including electrification and efficient utilization of net-zero carbon fuels with a focus on hard-to-electrify sectors in marine, rail, air, and other off-road applications
- **Vehicle and mobility systems research**—Accelerates development of advanced vehicles and mobility systems through autonomous vehicles, systems integration, and decision science
- **Building technologies research**—Develops and integrates advanced building equipment and dynamic envelope materials to enable affordable, efficient, and resilient buildings

**Manufacturing Science**—Develops advanced manufacturing technologies through research and scale-up of processes and technical capabilities enabling new materials, systems, and products

- **Composites science and technology**—Develops sustainable advanced fiber and polymer processing to create lightweight structures for multiple applications
- **Energy and industrial decarbonization**—Scales up renewable feedstocks for manufacturing processes to reduce energy use and conducts technoeconomic and life cycle analyses
- **Precision manufacturing and machining**—Designs and implements next-generation manufacturing systems through integration of robotics, automation, controls, and machine tools
- **Secure and digital manufacturing**—Develops a digital manufacturing platform and cyber-secure ecosystem by integrating manufacturing systems enabled by data analytics, process control, and secure communications

**Electrification and Energy Infrastructure**—Generates innovative capabilities for electric energy devices and systems to improve reliability, sustainability, and efficiencies of energy storage systems, electric grid protections and controls, and power electronics

- **Electrification**—Develops innovative energy storage technology solutions and charging infrastructures at scale for transportation and grid
- **Energy systems integration and controls**—Advances energy systems integration and controls to improve the efficiency and resiliency of systems-of-systems architectures
- **Energy sensing, analytics, and communications**—Creates sensing and communications solutions through advanced sensors, computational sensing, and analytics

**Research Facilities**

**DOE Manufacturing Demonstration Facility (MDF)** houses integrated capabilities that drive the development of new materials, software, and systems for various advanced manufacturing technologies. MDF delivers manufacturing energy efficiency improvements and supports the secure production of clean energy products.

**DOE National Transportation Research Center** helps industry, academia, and other agencies accelerate the development and deployment of efficient and secure transportation technologies. Research focuses on electrification, emissions reduction, connected and autonomous vehicles, materials, and data and decision science for a decarbonized future.

**DOE Building Technologies Research and Integration Center** delivers breakthroughs to improve the energy efficiency and environmental compatibility of residential and commercial buildings, focusing on building envelopes, equipment, building systems integration, energy storage, building-to-grid interactions, sensors, transactive controls, and modeling and simulation.

**DOE Carbon Fiber Technology Facility (CTFT)** provides a platform for evaluating new processing technologies and identifying high-potential, low-cost raw materials including textile, lignin, polymer, and hydrocarbon-based precursors. Leveraging the CFTF’s capabilities, ORNL is developing low-cost carbon fiber materials with desired structural properties and co-optimizing feedstocks and processing conditions.

**ORNL Grid Research Integration and Deployment Center** delivers hardware and software solutions for the grid, including power electronics and battery innovations from concept to deployment, in support of decarbonizing the utility, buildings, and electric vehicle infrastructure sectors while advancing an integrated, secure, and resilient power grid.

**By the numbers**

- 1,967 journal publications
- 767 invention disclosures
- 243 patent applications
- 200 issued patents
- 65 patent licenses
- 155 cooperative R&D agreements
- 105 strategic partnership projects

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January 2022