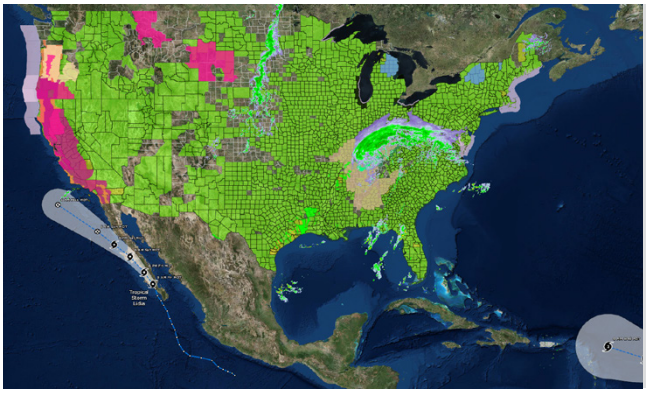
Solutions for a Secure, Resilient Grid

America's safety, security, and vitality depend upon the uninterrupted delivery of electricity to homes, businesses, and public spaces. The nation's power grid, one of our greatest strengths, is uniquely vulnerable to both cyber and physical disruption, whether from natural events or malicious attacks. At Oak Ridge National Laboratory (ORNL), our scientists and engineers are working in close partnership with the private sector to develop innovations to harden the grid's defenses and ensure it can quickly recover from disruption.



ORNL researchers are mapping energy system interdependencies as part of the North American Energy Resilience Model project to enhance reliable and resilient energy delivery.

MODELING grid functions for improved resilience

PROTECTING the grid with novel cyber-physical security methods

AUTOMATING control monitoring with sensors

SECURING communications, controls with a private network

ENGINEERING power systems with modern electronics

Innovations for a Modern Grid

Monitoring—Increasing the visibility of grid assets by developing and embedding high-fidelity sensors to provide essential data

Modeling—Creating a reliability and resilience model of the North American power grid that identifies energy system interdependencies and infrastructure investments needed for faster recovery

Advanced controls—Developing software to dynamically network microgrids for system resilience and potential blackstart operations; creating algorithms for transactive control of customer loads in response to price signals for better demand response and load balancing

Megawatt-scale energy storage—Providing greater control of power demand and supply for a more flexible, responsive grid, with solutions ranging from networked microgrids and low-cost redox flow batteries to mechanical electricity storage, hydrogen fuel cells, and recycling of electric vehicle batteries

Cyber-physical risk mitigation—Advancing a strategy to eliminate cyber and physical threats to the grid with a focus on real-time interdependency monitoring and critical facilities defense

"We're developing the most comprehensive system in the world to monitor the grid state and ensure resilience."

Yilu Liu, ***Governor's Chair for Power and Energy Systems***

OAK RIDGE National Laboratory

U.S. DEPARTMENT OF ENERGY

Partnerships and Collaborations

We work closely with organizations such as Southern Company, EPB of Chattanooga, Duke Energy, Tennessee Valley Authority, Electric Power Research Institute, and the Center for Ultra-Wide-Area Resilient Electric Energy Transmission Networks (CURENT) at the University of Tennessee–Knoxville. ORNL also partners with other universities, hardware and cybersecurity firms, and other national laboratories to devise and deliver solutions for a secure, reliable, and resilient electric grid.

Recent Impacts

Smart neighborhood—Deploying unique transactive controls to harness Internet of Things devices for better load balancing in neighborhoods with Southern Company

Microgrid controls—Creating and testing open-source, cyber-secure software for the efficient control of distributed energy resources and developing advanced controls for networked microgrids

Protective relay modeling—Ensuring optimal design and location of hardware to protect the flow of power to utility workers, customers, and equipment

Energy storage—Creating new, low-cost methods for grid-scale electricity storage, including new redox flow battery components, a system to store electricity in pressure vessels, and packs using secondary electric vehicle batteries

Sensors—Developing low-cost, high-fidelity sensors to increase situational awareness of the grid and protect critical assets

DarkNet—Exploring methods to move grid communications and controls onto a secure, private network

Cybersecurity solutions—Developing unique, trusted software to automatically detect and deter cyberintrusion

Comprehensive Capabilities

Goal Operations Analytics Laboratory—Grid control room simulation fed by real-time operating information

Digital Twin Framework—Cyber-physical test bed provides a living simulation of a working grid

Distributed Energy Communications and Controls Facility—Controls lab for ORNL's working microgrid

SI-GRID—Low-voltage test bed for microgrid controllers and cybersecurity solutions

Powerline Conductor Accelerated Test Facility—Accelerated testing of components for power transmission lines

Power Electronics and Electric Machinery Lab—Advanced power electronics to enable a modern grid

Eagle-I™—Real-time grid monitoring using data science and utility feeds

Manufacturing Demonstration Facility—Innovative low-cost manufacturing methods and materials

ORNL and Southern Company's Smart Neighborhood features a networked microgrid and transactive controls for intelligent load balancing.

The Grid Integration and Deployment Center at ORNL combines multiple electrification research activities across the utility, buildings, and vehicle space into one 52,000 sq ft facility.

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