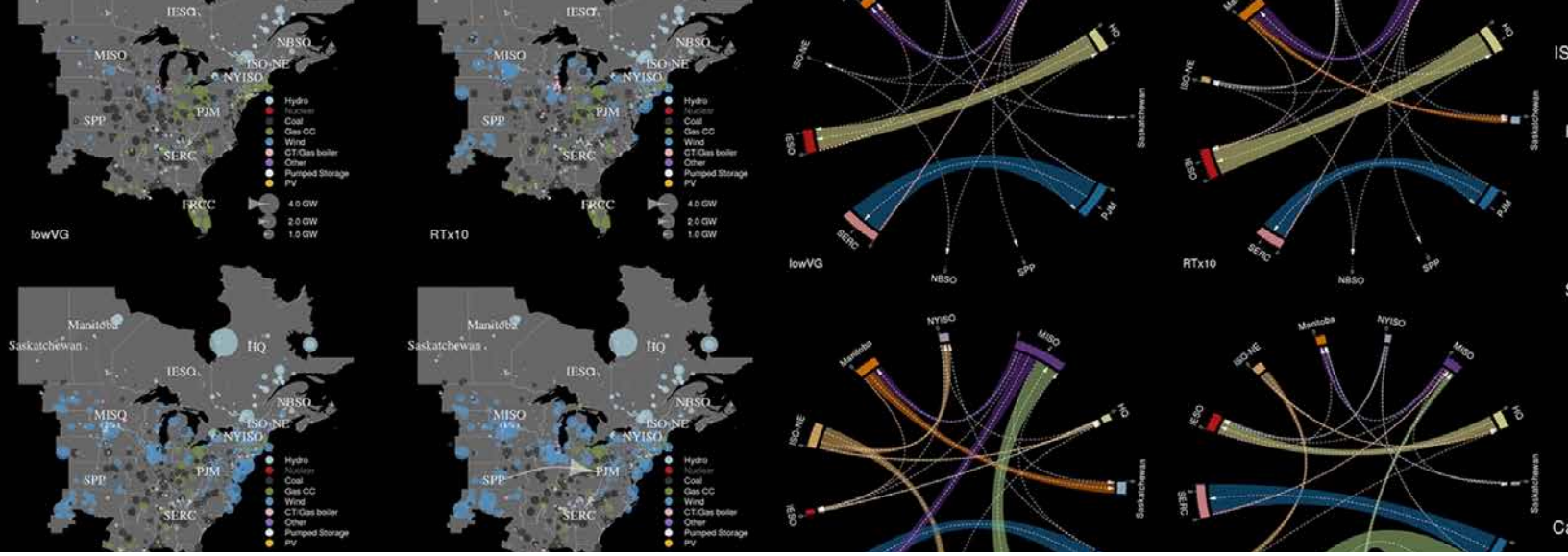
Strengthening U.S. National Security Through Advanced Energy Innovation

NREL's work in national security is focused on keeping the United States secure and its citizens safe by applying expertise in advanced energy systems and technologies to prevent energy system disruptions from any source, natural or human.

NREL pursues national security objectives by providing partners an accurate understanding of national and international security implications of global energy trends; novel installation, facility, and operational energy solutions; access to NREL R&D capabilities to incorporate advanced energy technologies and biomaterials into mission requirements; and the ability to test future technologies using large-scale grid modeling.

As global energy demand continues to grow, so does the need for new grid components and devices. It will be critical for the United States to lessen its reliance on foreign imports that expose the nation to supply chain vulnerabilities. Unleashing America's manufacturing, processing, and installation capacity to power an abundant and resilient energy economy will strengthen U.S. energy security while creating new jobs and ensuring energy is available when and where it's needed.



Visualization developed by NREL

About NREL

NREL is the U.S. Department of Energy's primary national laboratory for advanced energy systems research and development. From scientific discovery to accelerating market adoption, NREL deploys its deep technical expertise and unmatched breadth of capabilities to drive advancements in our nation's energy resources and systems. With a focus on security and reliability, NREL leads energy systems integration and innovation—enhancing existing technologies and developing new, cutting-edge solutions that unlock economic opportunity and fuel America's global competitiveness.

NREL bridges foundational research with practical applications across fuels, storage, buildings, renewables, and emerging technologies. By fostering strategic partnerships, NREL accelerates energy innovation to market and delivers resilient systems that lower costs, bolster national security, and ensure abundant energy.

Energy Security Analysis

NREL's national security partnerships act as a conduit to share expertise from across the laboratory to inform government partners about vulnerabilities and applications associated with new energy technologies and the systems into which they are integrated. The laboratory's research enhances understanding of the implications of novel and emerging threats—ensuring essential services, critical missions, and communities can withstand and recover from these threats.

NREL's research capabilities contribute to the national security of the United States by providing analysis, modeling, and simulation on:

- Technologies that improve the security, reliability, and resilience of energy generation, transmission, storage, and distribution
- Implications of technological developments in energy systems on geopolitical and economic factors
- Supply chain analysis for critical minerals and electronic components of distributed energy resources
- Capabilities of global energy systems and their component materials
- Global technological and energy policy developments
- Grid integration and power system transformation, operational technology networks, and distributed energy resources
- Application of high-performance computing, artificial intelligence/machine learning, and data visualization to energy research.

Project Spotlight

NREL's Advanced Research on Integrated Energy Systems (ARIES) platform is the nation's most advanced energy systems research platform—offering unmatched scale and complexity to accelerate the validation of secure, affordable, and integrated energy technologies across all sectors of the modern grid. It facilitates the simulation and analysis of complex energy scenarios, allowing researchers and policymakers to assess the economic, environmental, and technical feasibility of different energy pathways. Through advanced modeling capabilities, ARIES supports decision-making processes for ensuring a secure and resilient energy future. It enables the exploration of innovative energy solutions, including hybrid systems and integrated approaches that maximize efficiency.

Photo by Dennis Schroeder, NREL 58572

Cybersecurity and Energy System Resilience

NREL is at the leading edge of cybersecurity research for future energy technologies and distributed systems, conducting cyberthreat emulation, developing cutting-edge security solutions, and minimizing impact of energy system disruptions. Leveraging its state-of-the-art cyber range, NREL evaluates system-level security for bulk power advanced and distributed energy systems. This cyber range, integrating a virtual environment with physical hardware, enables simulation of complex energy systems to assess emerging threats and disruptions, supporting proactive defense and innovative telecommunications. Concurrently, NREL assesses resilience, analyzing risks to primary missions, infrastructure, and dependent sites.

Through modeling, visualization, and stakeholder input, NREL devises site-specific resilience solutions adaptable to various contexts. NREL's methodology incorporates assessment of baseline resilience of a site or region, hazard identification, and risk analysis to prioritize mitigation actions based on cost, difficulty, and risk reduction.

Project Spotlight

Through a partnership with the U.S. Air Force, NREL created a 3D visualization of an Air Force base that showed resilience gaps and vulnerabilities and highlighted opportunities for on-site solutions to improve resilience within critical loads. An accompanying web application provided situational awareness around hazards, threats, and vulnerabilities to inform master planning at the base level.

Photo from the Federal Bureau of Investigation

Installation Support

Microgrids, energy storage systems, geothermal heating and cooling, and innovative biofuels are all examples of technology advancements that have increased resilience, improved mission capabilities, and provided significant cost savings for federal partner facilities and installations. These innovations have helped to increase energy reliability, improve performance and efficiency, and broaden applications for federal partners such as the Department of Defense, Department of Homeland Security, and the Federal Bureau of Investigation. Within this work, NREL provides technical assistance to partners tackling energy challenges for their data centers, including air to liquid cooled conversion, energy and thermal management, and secure siting.

Project Spotlight

NREL created the Technical Resilience Navigator (TRN), a resilience planning tool that leads users through a series of modules to build stakeholder engagement, an organizational resilience assessment, and an actionable plan. The TRN supports a range of agency- and site-specific requirements, like those at the Federal Bureau of Investigation's Training Academy in Quantico, Virginia. By defining the energy and water systems that support critical missions and operations, NREL's technical assistance and use of the TRN provided the Quantico base with a site-level view of the hazards and risks that could threaten those operations.

Photo by John McCord, Coastal Studies Institute 74201

Operational Energy and Unique Mission Requirements

NREL utilizes its full range of research capabilities to develop innovative energy generation methods and materials that meet the needs of its partners' most challenging missions. By employing cutting-edge technologies, NREL supports our national security partners in powering operations and remote sites while also addressing materials development needs. This includes providing energy solutions for aviation, maritime, and space-based missions, as well as leveraging biomaterials research for creation of novel materials used in construction, clothing, and operations.

Project Spotlight

With NREL's partnership, the Department of Homeland Security deployed sensors in the field to monitor transportation along the northern U.S. border. The sensors required remote power due to many locations lacking grid access. Using remote-power capabilities, the sensors could detect and track aircraft or vehicles despite natural obstacles that prevent traditional detection methods. To ensure continuous power in harsh conditions without grid access, portable systems were used, incorporating adjustable-angle photovoltaics, lithium-ion batteries, and fuel cells. NREL provided insights into the design, installation, and long- term deployment of these innovative power systems, achieving 100% uptime.

Partnerships

NREL offers partners the opportunity to leverage our research expertise and state-of-the-art capabilities for advancement of strategic national security objectives and unique mission requirements. For additional information, contact:

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Photo by Dennis Schroeder, NREL 56328

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NREL

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