



Photo by Dennis Schroeder, NREL 57447

Strengthening U.S. National Security With Clean Energy Innovation

The National Renewable Energy Laboratory's (NREL's) work in national security is focused on keeping the United States secure and its citizens safe by applying expertise in clean 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 transformations; novel installation, facility, and operational energy solutions; access to NREL R&D capabilities to incorporate renewable energy technologies and biomaterials into mission requirements; and the ability to test future technologies using large scale grid modeling.

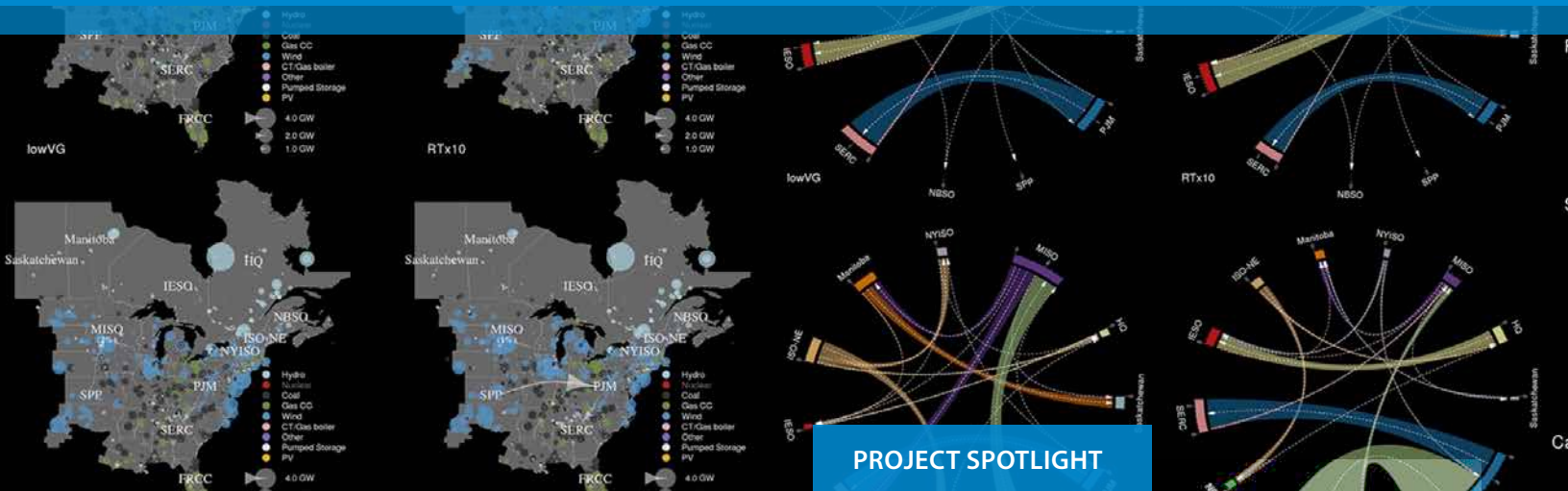
NREL was founded in response to the energy security impact of the 1973 oil crisis, when it was clear that energy resources beyond foreign oil were needed. Recognizing U.S. national security could be enhanced through innovation and renewable resources that are local, abundant, and reliable, the Solar Energy Research Institute was established in 1977. The institute would later be named NREL, setting the course to improve the country's access to independently owned and renewable energy—and strengthening U.S. national security.

As the world transitions to a clean energy economy, global demand for new grid components and devices is escalating significantly—and it will be critical for the United States to lessen its reliance on foreign imports that expose the nation to supply chain vulnerabilities. Enabling America's manufacturing, processing, and installation capacity to power the clean energy economy will strengthen U.S. energy security while creating new jobs and reducing the demand for fossil fuels.



About NREL

NREL is the U.S. Department of Energy's primary national laboratory for renewable energy and energy efficiency research. From scientific discovery to accelerating market adoption, NREL deploys its deep technical expertise and unmatched breadth of capabilities to drive the transformation of our nation's energy resources and systems. NREL's innovations span the spectrum of clean energy, renewable electricity, and energy efficiency. The laboratory is home to three national research centers—for solar, wind, and bioenergy—and several programs that advance cutting-edge research in areas such as strategic energy analysis and energy systems integration. At NREL, we are transforming 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, which informs NREL's research to the benefit of populations adopting clean energy solutions around the world.

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

PROJECT SPOTLIGHT

NREL's Advanced Research on Integrated Energy Systems (ARIES) platform is a versatile tool designed to optimize energy systems by integrating various renewable energy sources, energy storage technologies, and grid infrastructure into a single platform. 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 transitioning toward a more secure and resilient clean energy future. It enables the exploration of innovative energy solutions, including hybrid systems and integrated approaches that maximize efficiency and minimize environmental impacts.

Visualization developed by NREL

- 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

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 creating new cyber-inclusive standards for renewables. Leveraging its state-of-the-art cyber range, NREL evaluates system-level security for bulk power renewables 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 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 by Dennis Schroeder, NREL 58572

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

Installation Support

Microgrids, advanced photovoltaics, energy storage systems, 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 portability, 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.

NREL created the [Technical Resilience Navigator \(TRN\)](#), a 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 from the Federal Bureau of Investigation



PROJECT SPOTLIGHT

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.

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.

Photo by John McCord, NREL 74201

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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