Photo by Dennis Schroederr, NREL 57447

Strengthening U.S. National Security With Clean Energy Innovation

The National Renewable Energy Laboratory's (NREL's) work in strategic energy 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 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 that energy security, an intrinsic element of U.S. national security, can be achieved 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 the nation's energy security.

On June 6, 2022, President Biden invoked the Defense Production Act to accelerate domestic manufacturing of clean energy to lower energy costs for families, strengthen national security, and achieve lasting American energy independence that reduces the demand for fossil fuels and strengthens the nation's clean energy supply chain.

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.
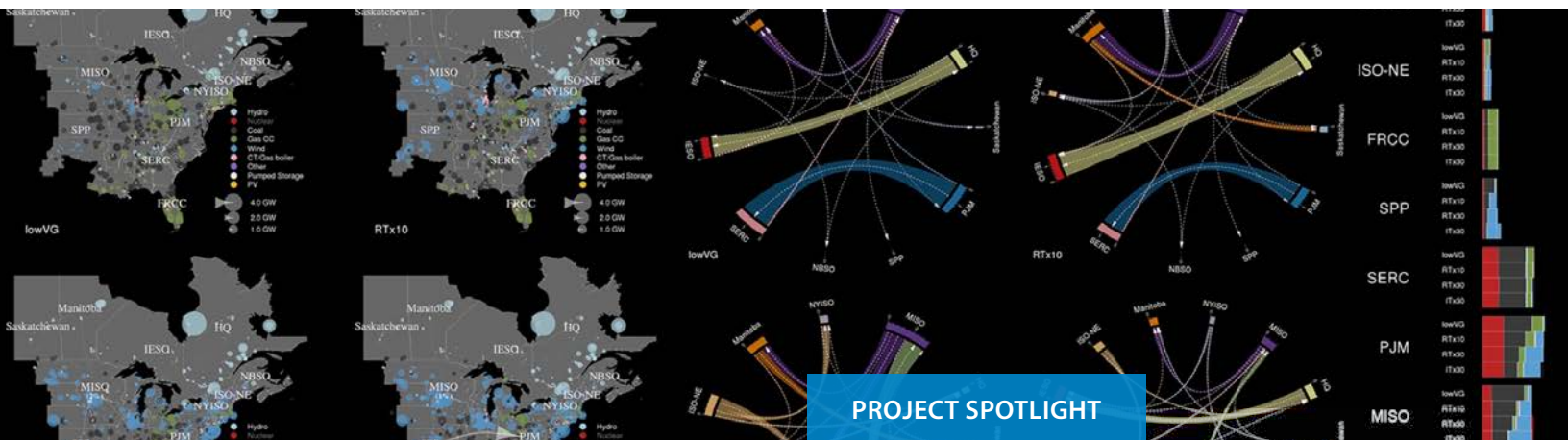
Unique Capabilities

NREL's strategic energy security program acts 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 lab's strategic energy security portfolio enhances understanding 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 energy and national security of the United States by:

- Advancing technologies that improve the security, reliability, and resilience of energy generation, transmission, storage, and distribution

- Helping partners understand the implications of technological developments in energy systems on geopolitical and economic factors

- Helping partners understand energy systems at their installations and within their areas of responsibility, their vulnerabilities, and how to enhance their security and resilience

- Analyzing energy systems and their component materials to advise partners on capabilities

- Conducting supply chain analysis for critical minerals and electronic components of distributed energy resources

- Helping partners consider the benefits of distributed energy technologies where they are reliant on overseas energy infrastructures for materials and/or manufacturing

- Benefiting future investments by creating resilient systems that can withstand numerous disruptive events.

PROJECT SPOTLIGHT

🔲 Modeling and Analysis

NREL has long led and supported international energy projects to inform strategic energy security analysis. The lab's energy analysis demonstrates extensive capabilities in resource and infrastructure assessments for domestic and foreign installations, baseline grid integration and power system transformation analysis, international energy market policy, and analysis for operational technology networks and distributed energy resources. NREL's work in future system scenarios analysis includes several high-impact studies—including the Electrification Futures Study, the Interconnections Seam Study, and the North American Renewable Integration Study, all of which evaluate future system scenarios and analyze cost, operability, and sustainability.

With high-performance computing and innovative visualization tools, NREL demonstrated how the power grid of the Eastern United States could accommodate upwards of 30% wind and photovoltaic power. The Eastern Renewable Generation Integration Study (ERGIS) project resulted in a model for notably high-resolution analysis—including an expanded range of resources analyzed, increased temporal resolution to 5 minutes, and increased spatial resolution to include all synchronous components of the Eastern Interconnection and Quebec Interconnection. Through ERGIS, NREL produced a high-resolution model of the entire Eastern Interconnection including more than 5,600 electricity generators and more than 60,000 transmission lines in a power system that spans from Florida to Canada and as far west as New Mexico.

Visualization developed by NREL

🌊 Energy System Resilience

NREL's resilience assessments focus on risks to primary missions and infrastructure as well as ancillary and cascading risks to sites that rely on that infrastructure. NREL capabilities in modeling and simulation, visualization, and tool development combine data and stakeholder input to guide the analysis, resulting in site-specific and implementable solutions that work at different scales and contexts. NREL's proven methodology incorporates assessment of baseline resilience of a site or region, identification and scoring of hazards, threats, and vulnerabilities, and risk analysis to prioritize mitigation actions based on cost, difficulty, and risk reduction.

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

🔒 Cybersecurity

NREL is at the leading edge of cybersecurity research for future energy technologies and highly distributed energy systems. The lab's cybersecurity research involves cyber threat emulation, novel security technology for complex energy systems, site risk analysis, and development of new cyber-inclusive standards for renewables. NREL's researchers leverage the lab's unique and state-of-the-art cyber range to conduct system-level security evaluations of bulk power renewables and distributed energy systems. Powered by a virtual environment that connects with physical research hardware and visualizes system dynamics, the cyber range simulates complex energy systems for the evaluation of emerging threats, natural hazards, and energy disruption impacts. The cyber range supports proactive defense and automated response, improved situational awareness, and telecommunications innovation.

With support from the U.S. Department of Energy's Federal Energy Management Program (FEMP), NREL developed an in-depth tool for organizations with distributed energy resources to assess and improve their cybersecurity posture. The Distributed Energy Resource Cybersecurity Framework (DERCF) supports a holistic assessment of the cybersecurity health of these systems—filling an important gap that expands on existing cybersecurity frameworks for modern energy systems.

Photo by Dennis Schroeder, NREL 51931

🤝 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.

With support from FEMP, NREL and the Pacific Northwest National Laboratory 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.

Image courtesy of the Federal Bureau of Investigation

Partnerships

NREL offers partners the opportunity to leverage our energy security and resilience research expertise and state-of-the-art capabilities, including our cyber range and high-performance computing and data visualization capabilities. For additional information, contact:

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Image by Dennis Schroeder, NREL 56328