Advanced Research on Integrated Energy Systems Cyber Range

The Advanced Research on Integrated Energy Systems (ARIES) Cyber Range is a state-of the-art cyber-physical modeling, simulation, and emulation platform to study and advance the cybersecurity of energy systems.

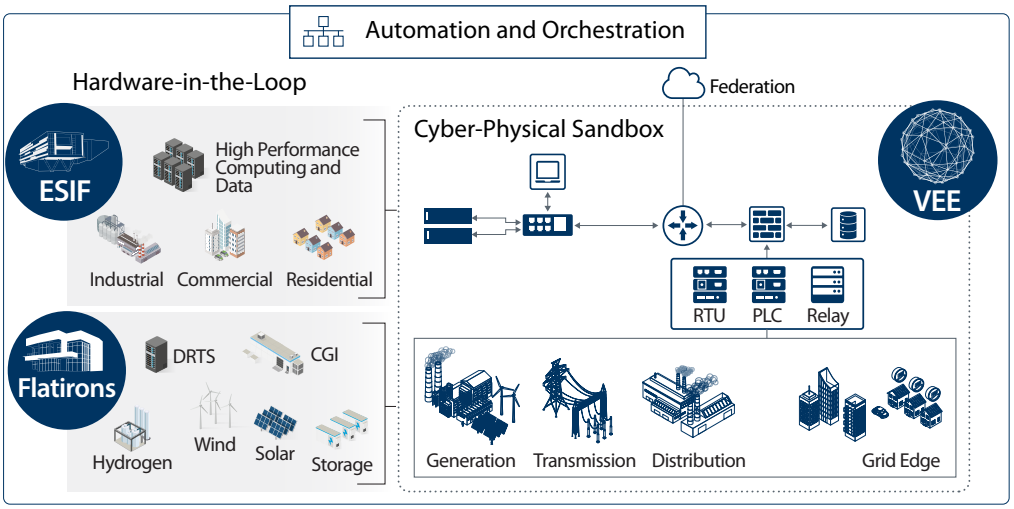
As digital technologies expand to meet the needs of a more autonomous, interconnected, and advanced power system, new cybersecurity complexities and vulnerabilities arise. The ARIES Cyber Range (www.nlr.gov/security-resilience/cyber-range) enables the energy sector to evaluate these evolutions and validate cybersecurity solutions without impacting live systems.

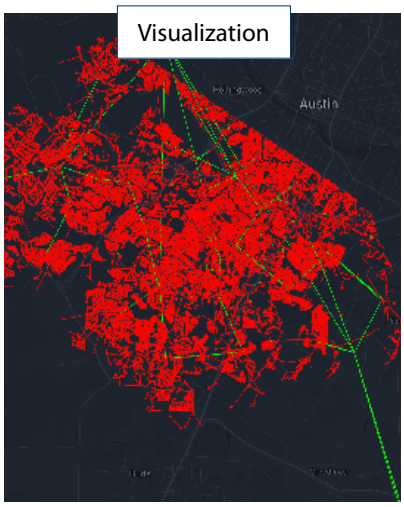
Combining power grid-scale hardware with emulation and simulation approaches, the ARIES Cyber Range can faithfully replicate modern energy systems—from grid physics to communication networks, and everything in between—with real-world fidelity. At the National Laboratory of the Rockies (NLR), researchers and partners are answering complex power system cybersecurity questions, examining emerging threats to the electric sector, and de-risking new security technologies, all at a mission-relevant speed that keeps pace with rapidly evolving systems and hazards.

ARIES
by NATIONAL LABORATORY OF THE ROCKIES

Types of questions the ARIES Cyber Range can answer:

- Is my system capable of responding to and rapidly recovering from disruptions?
- Is my workforce prepared to respond to current and future risks?
- What risks do unverified software supply chains pose to the energy sector?
- How do we quantify the benefits of cyber-resilient energy infrastructure?
- How can we protect a modern energy grid with, of, and from AI?
- How efficient will the existing commercial tools be in a future with an exponential increase in the number of connected devices?
- How big is the threat of living-off-the-land attacks to advanced energy technologies?





Features and Capabilities

Cyber Range Hardware

The ARIES Cyber Range spans multiple data centers with high-performance computing power. Equipped with unique services and mathematical models representing grid equipment and physics, it can simultaneously emulate entire utility networks while running multiple large-scale power system experiments. With physical computing hardware at NLR and a virtual operating environment, NLR researchers can deploy high-fidelity cyber testing environments on demand.

Cyber-Physical Emulation

The ARIES Cyber Range takes software simulation a step further with the integration of real operating systems, networks, and applications that appear within live grids, including real grid software that communicates using real grid protocols. This functionality precisely replicates the behavior of power systems, operations, and controls, bringing real-world fidelity to experimentation.

Automation and Orchestration

NLR constructed automated orchestration techniques within the ARIES Cyber Range to make it flexible and easily configurable for a wide range of use cases. With the emulation library and a catalog of laboratory devices, users can reserve assets and even integrate their own devices and configurations to design and build experiments that meet their research needs.

Visualization

To make this large amount of data intelligible, the ARIES Cyber Range features interactive ground truth visualizations. These visualizations show how the power system and digital communication systems dynamically interact throughout a given scenario, providing real-time awareness, historical analysis, and future planning and operation support.

Hardware-in-the-Loop Connections

Integrated with the ARIES platform, the cyber range connects to world-class hardware across NLR's Energy Systems Integration Facility and Flatirons Campus for higher-fidelity cyber-physical experiments. Devices include connected buildings, utility distribution components, cloud servers, inverter-based resources, megawatt-scale battery systems, and power grid infrastructure.

Getting Started

Each partner has unique objectives and challenges—and we want to hear yours. Utilities, industry, academia, and more are invited to partner with us to test their energy-cybersecurity use cases.

Contact Robert.Biestman@nlr.gov, cyber systems analysis group manager, for more information.

A Unique, World-Class Capability

- Integrates distribution and transmission emulation, full-scale systems, and cyber-physical visualizations
- Leverages industry-validated, high-fidelity reference architectures for rapid experimentation and analysis
- Automates the rapid deployment of grid edge energy technologies at high scales
- Federates with real cloud service provider infrastructure
- Facilitates multi-domain analysis of compounding cyber and natural impacts
- Generates synthetic datasets for testing and evaluation, including AI/ML applications.

Cover image: *Photo from iStock 931575044, modified by Anthony Castellano National Laboratory of the Rockies*

NATIONAL LABORATORY OF THE ROCKIES

15013 Denver West Parkway
Golden, CO 80401
303-275-3000 • www.nlr.gov

The National Laboratory of the Rockies prints on paper that contains recycled content.

The National Laboratory of the Rockies is a national laboratory of the U.S. Department of Energy, Office of Critical Minerals and Energy Innovation, operated under Contract No. DE-AC36-08GO28308.

NLR/FS-6A42-93235 • February 2026