# Energy Systems Integration Facility Stewardship Summary: Fiscal Year 2025

## 2025 brought a national focus on energy, and National Laboratory of the Rockies (NLR) Energy Systems Integration Facility (ESIF) is meeting the moment.

All eyes are on data centers and domestic manufacturing and bringing the benefits of artificial intelligence (AI) to power system planning and operations. In step with key priorities for the U.S. Department of Energy (DOE), ESIF is building out capabilities that advance secure, reliable, and affordable power.

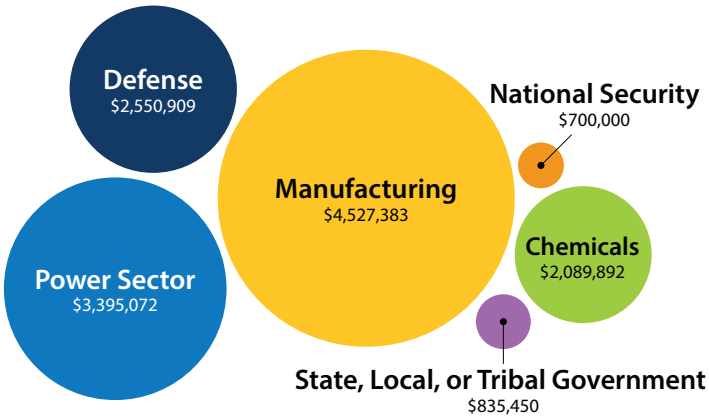
## Facility Performance Metrics

**190** multidisciplinary research projects

**855** high-performance computer users

**81** partners from industry, academia, research, and federal agencies

## New Partnership Funding by Sector




## Partnerships and Engagement

**302** tours for DOE, key industry leaders, and other VIPs

**49** new partnership agreements executed

**46%** of publications authored with an external partner

**16** workshops with industry and academia

As a DOE user facility, the ESIF offers a unique space for collaboration and innovation. These are a few ways the ESIF supported knowledge sharing in the last year:

- Led by the DOE Office of Cybersecurity, Energy Security, and Emergency Response, the Energy Threat Analysis Center facilitates in-person collaboration between government and energy sector partners to secure critical energy infrastructure. Seven core partners are co-located at the center in the ESIF to use the Advanced Research on Integrated Energy Systems (ARIES) Cyber Range and other capabilities.
- The ESIF hosted the U.S. Electricity Subsector Coordinating Council for the second such visit held at a national laboratory.
- NLR led a cybersecurity workshop for utility and non-utility actors emerging from new energy sector business models, such as aggregators.
- A two-day forum brought together more than 300 experts focused on meeting the rising demand for energy to power data centers.

**Visit the ESIF Stewardship Summary web page[1] for more stories on the facility's capabilities and research.**

[1] https://www.nlr.gov/esif/stewardship-summary-2025

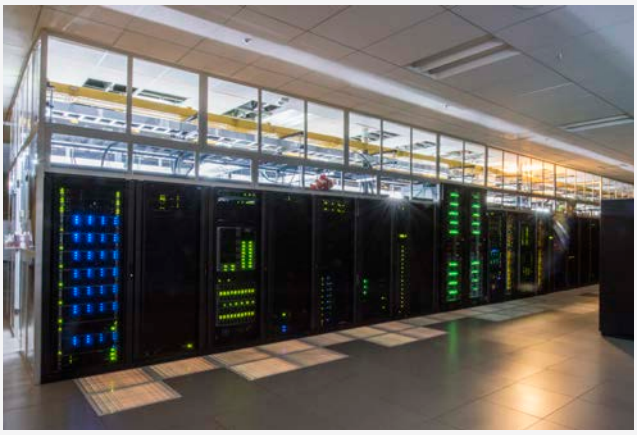
# Capability Upgrades

NLR closely manages the ESIF's research technologies to maximize use of existing resources and build new ones to meet emerging needs in the energy sector. Here are some recent capability upgrades and expansions:

- Cybersecurity reference architectures added to the ARIES Cyber Range for more rapid experimentation and greater fidelity.
- Enhancements to the existing thermal research system and initial designs for a geothermal research network.
- A revamped supervisory control and data acquisition (SCADA) system, providing more tools for researchers and improving facility efficiency and safety.
- An inverter setup with two 1-MVA bidirectional inverters, an AC interface capable of 480 or 13,200 volts, and a DC interface capable of 250–1,250 volts.
- New hardware, system controls, and computing for enhanced power-hardware-in-the-loop experiments.

## Capability Spotlight: High-Performance Computing Data Center

NLR's high-performance computer supports hundreds of projects per year, including expanding AI workloads. Meanwhile, the data center achieved an average power usage effectiveness of less than 1.08, which is considered highly efficient by industry standards. Through the Chip-to-Grid approach, NLR analysts can optimize and balance data center performance, cost, and resource use and assist partners in streamlined data center development.



# Facility R&D Impact

These R&D achievements from 2025 were powered by ESIF laboratories, capabilities, and expertise:

**Practical Cybersecurity Steps Enhance Defenses In NLR Modeled Attack**

NLR identified role-specific cybersecurity actions and validated them in a simulated attack on the cyber range.

**Algorithms for Networked Microgrids Are Ready for Widespread Adoption**

Open-source algorithms allow grid operators to partition their systems into interlocking, self-organizing microgrids.

**AI Finds Power Line Faults Before Wildfires Spark**

NLR developed an AI method, trained against real-world fault data provided by Eaton, that can detect high-impedance faults with greater than 90% accuracy.

**Heating Solution Is Tested for Arctic Military Base**

Electric thermal storage is a method that heats bricks or ceramics when electricity is inexpensive and releases that heat when power is costly—or lost entirely. NLR researchers are assessing this solution in the lab before it is deployed at a large U.S. military base in Alaska.

**NLR's EdgeFlex Tool Handles Smart Dispatch**

EdgeFlex leverages the latent flexibility in home energy devices and computes optimal dispatch schedules. Tantalus Systems used the tool to automate water heaters and thermostats in a neighborhood in Connecticut.

**Inductor Benefits From ESIF Emulations**

Using a range of medium-voltage test setups, NLR engineers validated the thermal stability, power density, and power quality of CorePower's flagship inductor.

**Schneider Explores Grid Impacts of Smart Panel**

ESIF lab simulations showed how the controls of Schneider's home energy smart panel can help utilities avoid costly upgrades and deliver measurable benefits to homeowners.

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*Photos by the National Laboratory of the Rockies: Cover, Energy Security and Resilience Lab by Greg Cooper, 097303; Top, Systems Performance Lab by Agata Bugucka, 104206; Left, ESIF Data Center by Dennis Schroeder, 045351.*

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