National Laboratory of the Rockies

Energy Systems Integration Facility

Researching Multidomain, Integrated Energy Systems

The Energy Systems Integration Facility (ESIF) is the U.S. Department of Energy's (DOE's) Office of Critical Minerals and Energy Innovation's only user facility and the United States' premier laboratory for integrated energy systems research, development, and demonstration. The ESIF, which is 180,000 square feet, provides a controlled environment for companies, utilities, and researchers to validate performance, demonstrate interoperability, and resolve technical risks with real hardware under realistic operating conditions—before undertaking costly field demonstrations.

As a DOE user facility, the ESIF offers access to state-of-the-art test beds, models, secure research spaces, high-performance computing, and a catalog of more than 300 energy devices, all supported by a dedicated operations team.

The ESIF's integrated test beds and high-performance simulation environments enable industry, academia, and government partners to accelerate technology maturation, reduce integration risk, and validate real-world performance. Since its opening in 2013, the ESIF has supported hundreds of partners and projects across critical infrastructure, national security, and commercial technology sectors, amplifying its impact through consistent engagement with DOE, industry, utilities, universities, and state/local governments.

Scalable, Interconnected Research Environment

The ESIF integrates megawatt-scale electrical testing, thermal systems, real-time simulation, cybersecurity, advanced controls, and high-performance computing in a single, reconfigurable facility unmatched in the U.S. national lab system. The facility enables:

- At-scale validation of technologies before market deployment
- Cross-domain research that reflects real-world complexity

- Industry–government collaboration to solve emerging energy challenges
- Scalable infrastructure that evolves with user needs and national priorities.

The ESIF's capabilities underpin DOE-funded breakthroughs and increasingly serve industry validation needs as companies transition from prototype development to full systems integration. Key capabilities include:

- **A research electrical distribution system**—the heart of the ESIF's electrical system evaluation capability—facilitates power flow among various grid and experimental equipment in a research microgrid arrangement. Equipment distributed across the facility can be interconnected through a research microgrid and controlled through a facility-level supervisory control and data acquisition system. This hardware-in-the-loop environment ties directly into the ESIF's real-time digital simulation capabilities—creating true hardware–software–simulation convergence for next-generation grid systems.
- **Integrated thermal distribution systems** comprising hot- and cold-water loops that provide precise and efficient control of the water temperature delivered to laboratories. The thermal distribution bus allows researchers to study and characterize industrial cooling, heating, ventilating, and air-conditioning systems as well as combined heat and power applications.

- **A high-performance-computing and visualization environment**, Kestrel, which provides 56 petaflops of computing capacity. Data can stream directly between laboratory hardware, simulations, Kestrel, remote partners, and the National Laboratory of the Rockies' Insight Center for real-time visualization and analysis. This makes the ESIF uniquely capable of bridging advanced computation with physical test beds. This multiscale simulation environment enables partners to validate performance, optimize designs, and predict system behavior across grid, campus, and critical infrastructure.

ESIF Expertise

The ESIF's state-of-the-art capabilities and in-house experts are addressing key challenges for managing modern energy systems in the most secure, affordable, and reliable way.

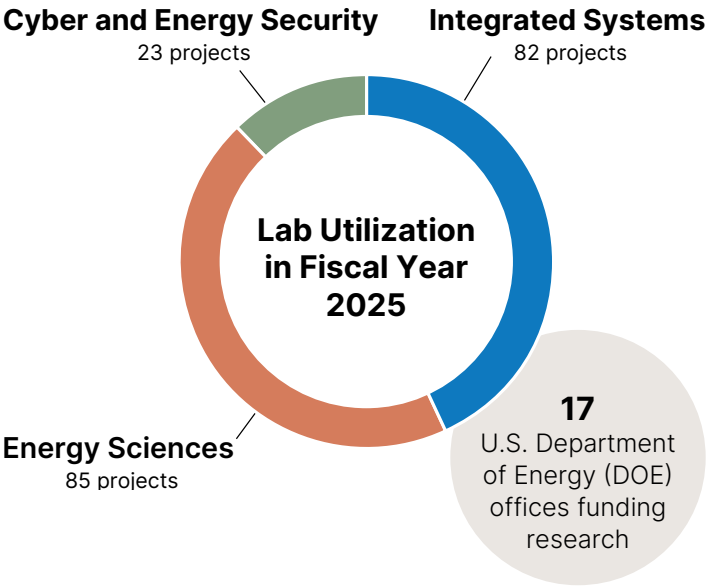
Expertise includes:

- Grid controls and automation
- Energy materials
- Utility digitization and data
- Cybersecurity
- Advanced modeling and analysis
- Thermal systems
- Managing large loads
- Power electronics
- Microgrids
- And much more.

Impact and Collaboration

Within the national lab complex, the ESIF is distinguished by its broad, flexible, and reconfigurable focus on integrating and validating complete energy systems at the megawatt scale. Its impact is also complemented by collaborations with other national laboratories, like Oak Ridge National Laboratory, Idaho National Laboratory, and Pacific Northwest National Laboratory.

Facility Projects at a Glance



In 2025, the ESIF hosted:

572 users across 190 multidisciplinary projects with 81 partners, advancing priorities for secure, reliable, and affordable power, with emphasis on digital loads, domestic manufacturing, and artificial intelligence in power systems planning and operations

855 high-performance computing users

302 tours and 16 workshops for DOE, key industry leaders, and other notable visitors

Learn more

To learn more about the ESIF and its unique capabilities, contact Andrew Hudgins: andrew.hudgins@nlr.gov

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