

ARIES: Advanced Research on Integrated Energy Systems

A National Research Platform for Energy Systems Integration and Innovation

One of the primary steps to achieve an affordable, reliable, and secure energy future is closing the gap between ambitions and real-world deployment.

To accelerate integrated solutions for advanced energy systems, NREL, in partnership with the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy, developed a visionary research platform called Advanced Research on Integrated Energy Systems (ARIES).

ARIES takes in the full picture—from local up to the nation, and all the industries and infrastructure in between—rather than evaluating energy technologies in isolation. This innovative approach uncovers opportunities and risks in the spaces where sectors such as transportation, industry, buildings, and the electric grid meet.



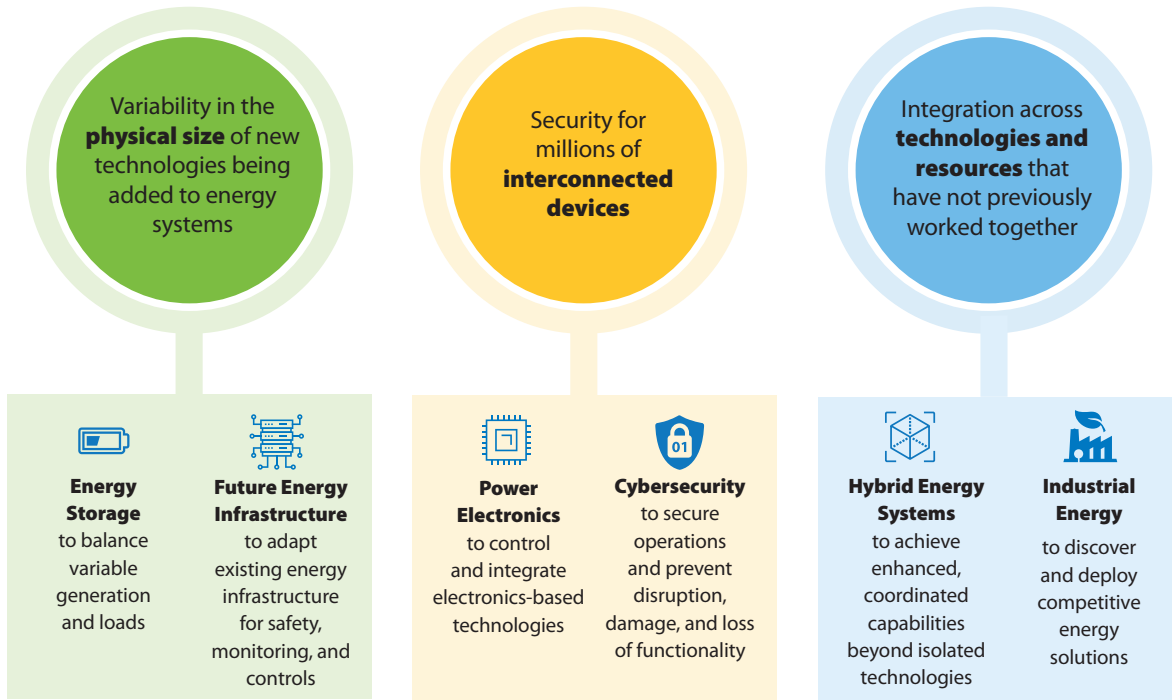
ARIES is comprised of three pillars networked together to provide an interconnected and scalable research platform.

- **The Energy Systems Integration Facility (ESIF)** houses an unparalleled collection of state-of-the-art capabilities and technologies—including hundreds of research devices—to study energy technologies at scales up to 2 megawatts (MW) and voltage levels up to 13.2 kilovolts (kV).
- **The Flatirons Campus** hosts hardware and simulation capabilities supporting experiments for thousands of research devices, power levels up to 20 MW, and voltage levels up to 34.5 kV, and represents the interface between the distribution and bulk power systems.
- **The Virtual Emulation Environment (VEE)** is a sophisticated digital platform that can incorporate physical assets at both the ESIF and Flatirons Campus with millions of emulated devices at any utility power and voltage level, from local to national-scale research.

The Value of ARIES

- Reduces risk through system validation of new technologies, cybersecurity strategies, and resilient design
- Amplifies the scale and impact of innovation through collaboration across the national lab complex
- Informs regulators, governments, and stakeholders around the impacts of energy technology deployment
- Replicates energy scenarios for in-depth analysis and improvement
- Evaluate and validate advanced energy strategies for organizations of any size

ARIES addresses three key energy challenges through strategic research.



Leveraging ARIES to Get from Research to Reality

NREL's world-class researchers use ARIES to advance our understanding of connecting energy across generation types and energy sectors. Examples of ground-breaking ARIES projects include:

Integrated energy solutions for U.S. ports and transit hubs. NREL has modeled traffic flow at one of the busiest transit hubs in the world—Dallas-Fort Worth International Airport—by creating a “digital twin” of the airport with artificial intelligence tools to determine optimal designs and energy-saving decisions.

Hybrid power plants maximize the value of multiple energy resources. With the ARIES platform, NREL demonstrated how hybrid clusters of solar PV, nuclear reactors, batteries, and other resources can be controlled for advanced flexibility and high-value services.

The ARIES Cyber Range is used for security and resilience analysis. It visualizes data and communications between assets to understand the cyber-physical nature of new energy technologies. The ARIES Cyber Range has been used by cybersecurity companies, grid operators, communities, and more.

Microgrid sensing and controls have enhanced the resilience of the city of Cordova, Alaska with support from ARIES. Using ARIES, Cordova validated its improved microgrid against plausible events, such as power loss from an earthquake or avalanche, allowing the local electric cooperative to observe and control the network with better precision. This is important for Cordova and indigenous communities throughout Alaska because microgrids are their last resort for energy, and controls make it easier to adapt during critical events.

For more information on ARIES, please contact aries@nrel.gov and visit www.nrel.gov/aries.

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Aerial view of ARIES assets at NREL's Flatirons Campus.
Photo by Josh Bauer, Bryan Bechtold, NREL 82075



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