

ARIES: Advanced Research on Integrated Energy Systems

A National Research Platform for Transforming Energy Systems

One of the primary challenges to achieving a clean energy future is closing the gap between ambitions and real-world deployment.

To accelerate solutions for a clean energy future, the National Renewable Energy Laboratory (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 community energy needs to technology developers and service providers—rather than evaluating clean energy and technologies in isolation. This innovative approach uncovers opportunities and risks in the spaces where energy technologies and sectors—such as transportation, industry, buildings, and the electric grid—meet.

Illustration by Anthony Castellano



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

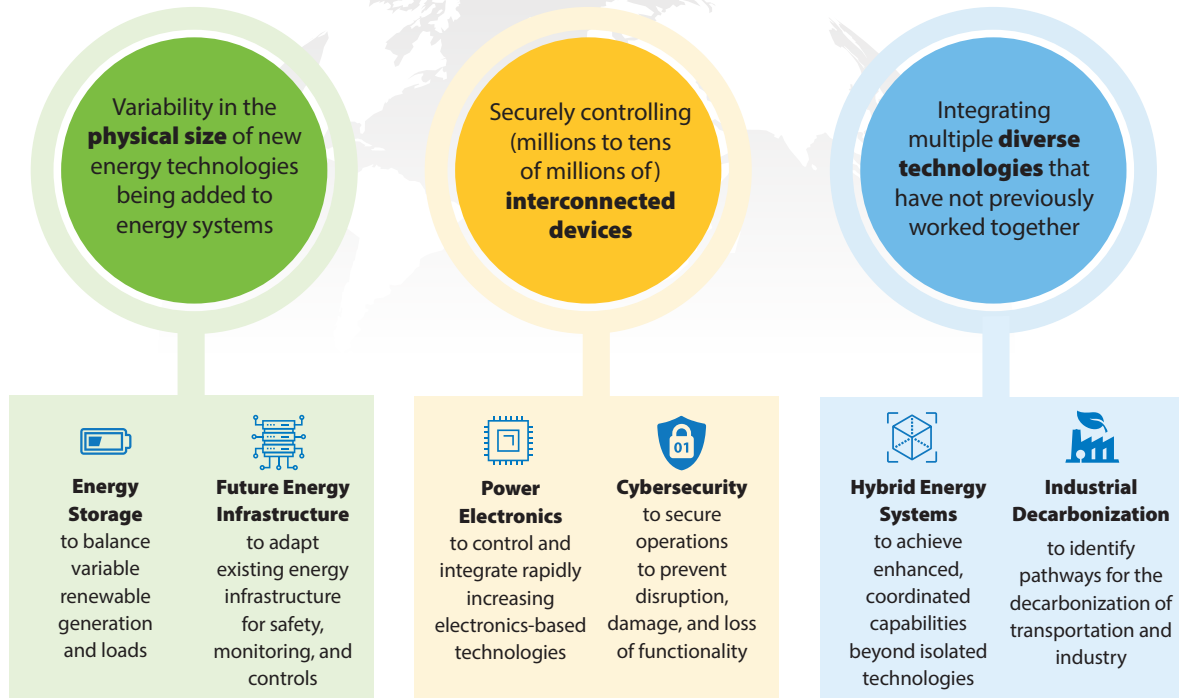
- **The Energy Systems Integration Facility (ESIF)** houses an unparalleled collection of state-of-the-art capabilities and technologies—including hundreds of research devices—to study clean energy technologies at scales up to 2 megawatts (MW) and voltage levels up to 13.2 kilovolts (kV).
- **The Flatirons 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

- Replicates energy system complexities at a real-world scale
- Demonstrates energy system transition pathways using unique physical and virtual assets for equitable local and national deployments
- Reduces risk through system validation of new technologies, cybersecurity strategies, and resilient design
- Amplifies the scale and impact of research projects through collaboration across the national lab complex
- Provides data-driven insights to regulators and other stakeholders to assess the impacts of clean energy deployment scenarios



ARIES focuses on solving three key challenges by addressing them through our strategic research areas.



Leveraging ARIES to Get from Research to Reality

NREL's world-class researchers use ARIES to advance our understanding of the risks and opportunities of systems with high amount of renewable generation. Examples of ground-breaking ARIES projects include:

Energy transformations 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 value of renewable resources. With the ARIES platform, NREL demonstrated how hybrid clusters of solar PV, wind turbines, batteries, and other resources can be controlled for advanced flexibility and high-value services.

DOE's Clean Energy to Communities (C2C) program helps local governments, utilities, and community-based organizations achieve their clean energy goals. Using the R&D 100 award-winning ARIES software, Simulation and Emulation for Advanced Systems (SEAS), NREL showed how

large-scale wind power and a new battery energy storage system could be added to the grid in Fairbanks, Alaska to improve reliability and facilitate Fairbanks's retirement of its 50-MW coal plant and 20-year-old nickel-cadmium battery.

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.

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

