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ARIES: A National Research Platform for Transforming Energy

Some of the most important and consequential research challenges to realizing a decarbonized economy are at the system level. A research platform is needed to support development and demonstration at this level—and at the real-world scale.

To address this, the National Renewable Energy Laboratory (NREL), in partnership with the U.S. Department of Energy’s Office of Energy Efficiency and Renewable Energy, has developed a visionary Advanced Research on Integrated Energy Systems (ARIES) platform.

ARIES is designed to mirror the complexity and scale of real energy systems. Rather than evaluating new clean energy and energy-efficiency technologies in silos, ARIES expands the research view to take in the full picture—from consumers, to industry, to utilities. This perspective uncovers opportunities and risks in the spaces where energy technologies and sectors like transportation, buildings, and the electric grid meet.

Never before has there been a research platform that could support integrated research at a scale relevant to large metropolitan cities and regions. But now—powered by advanced energy research equipment and the unparalleled expertise of national laboratory researchers and engineers—ARIES is breaking these limitations for the first time.

It is the right platform at the right time to accelerate solutions for a clean energy future.

What Is ARIES?

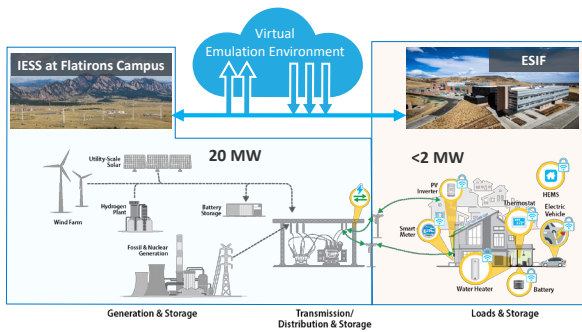
ARIES is a globally unique research platform for the scientific community and industry. It is designed to support the transition to a modern energy system that is clean, secure, resilient, reliable, and affordable.

To get there will require new approaches to some fundamental challenges. These include coordinating many different types and sizes of energy technologies, securely controlling tens of millions of devices, and integrating diverse technologies with high penetrations of renewable generation.






ARIES’s core capabilities to address these challenges include:

- **State-of-the art research equipment** to support integrated energy research, analysis, modeling, and hardware experiments
- **The ability to create, prove, and validate complex energy systems** by interconnecting hardware and software capabilities that imitate varied renewable energy configurations and solutions for carbon-free energy and transportation systems
- **Interconnected grid-scale devices and distributed energy resources** for highest-fidelity experimentation
- **An 8-petaflop high-performance computer to break through existing limitations** and achieve metropolitan- and regional-scale research resolution
- **A team of national laboratory experts** with a depth and breadth of knowledge in energy systems integration and clean energy innovation at the leading edge nationally and internationally.





The ARIES platform is built to be highly flexible with the ability to plug and play different technologies into the core integrated system. This makes it possible to pivot and stay ahead of the rapidly evolving energy sector. ARIES was designed to support research of critical importance, including:

-  **Energy storage** to balance variable renewable generation and demand
-  **Power electronics** to control and integrate rapidly increasing electronics-based technologies
-  **Hybridization** to achieve enhanced coordinated capabilities beyond isolated technologies
-  **Infrastructure** to adapt existing energy infrastructure for safety, monitoring, and controls
-  **Cybersecurity** to secure operations to prevent disruption, damage, and loss of functionality.

Leveraging ARIES to Get from Research to Reality

NREL's world-class researchers have made huge advancements in understanding the risks and opportunities of systems with high penetrations of renewable generation. Some examples of NREL projects that have paved the way and are using the first-phase buildout of ARIES's assets 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. This advanced modeling is helping other hubs to analyze how upcoming technologies like electric vehicles and autonomous vehicles can be integrated into their own operations.

Hybrid power plants maximize value of renewable resources. NREL is leading a large national collaboration named FlexPower to pioneer new approaches for multi-technology power plants to provide grid services for resilient, stable, and efficient operations. With the ARIES platform,

NREL is demonstrating how hybrid clusters of solar PV, wind turbines, batteries, and other resources can be controlled for advanced flexibility and high-value services.

Final stop for solar-plus-storage plant before going live. Prior to deploying a new hybrid power plant that would serve 65,000 customers in Kauai, owners AES Distributed Energy wanted to ensure an optimized and risk-free system for the electric grid. ARIES brought the Hawaiian grid to NREL's campus and created an environment for AES Distributed Energy to safely develop their renewable solution.

Powering military bases (and communities) with microgrids. Using early ARIES capabilities, the U.S. Department of Defense Environmental Security Technology Certification Program provided funding for teams of industry partners to develop microgrids using large-scale energy storage solutions for U.S. military bases. Results from this effort apply to a wide range of military and nonmilitary applications.

Making a Carbon-Free Energy System a Reality

The energy transition is underway, and we have the potential to reach a carbon-free energy sector by 2050. ARIES connects industry with the equipment, modeling, and expertise needed to collaboratively design future energy systems that power the entire nation safely and sustainably.

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



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