Flatirons Campus Research Laboratories & Facilities

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Flatirons Campus Research Laboratories and Facilities

NREL s Flatirons Campus features state of the art, accredited equipment and facilities that help researchers and industry partners pursue wind energy innovations to create a clean, sustainable energy future powered by reliable, low cost wind energy.

ARIES

Advanced Research on Integrated Energy Systems

Facilities that support scaling up the physical size of new energy technologies and the number of interconnected devices into larger systems—includes Integrated Energy Systems at Scale (IESS)

Structural Research Facilities

Facilities that enable the characterization and validation of wind turbine blades and components

Field and Technology Research Validation Facilities

Field research pads, expert engineers, and specialized facilities at one of the best meteorologically characterized research sites in the world

Dynamometer Research Facilities

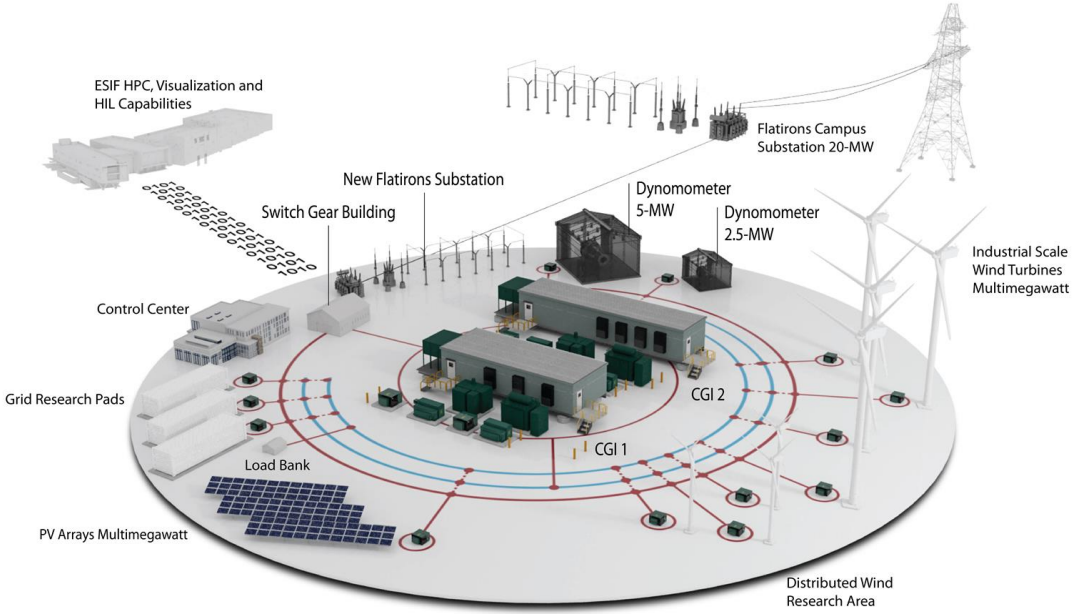
Dynamometers that can perform research validation on wind turbine drivetrains and generators from 1 kW to 5 MW

Composites Manufacturing Education and Technology

An industrial-scale workspace, research, and education center for wind industry composites research

ARIES

Advanced Research on Integrated Energy Systems



The ARIES research platform will:

- Provide a virtual emulation environment that uses advanced computing and digital real-time simulators.
- Help researchers address the challenges of integrated energy systems at scale in five areas of expertise (text box, right)—each of critical importance as devices scale up from the hundreds to millions.
- Include Integrated Energy Systems at Scale (IESS)—next slide.

Areas of Expertise

- Cyber security
- Energy storage
- Power electronics
- Hybrid systems
- Future energy infrastructure

IESS

Integrated Energy Systems at Scale (IESS)

IESS is transforming the Flatirons Campus from a single-program site to a multiple-program campus. It includes:

- Addressing the fundamental challenges of how to scale up the physical size of new energy technologies and the number of interconnected devices into larger systems.
- Determining how the integration of multiple diverse technologies into future energy systems can provide a range of benefits—including improved efficiency, security, resiliency, lower costs, and greater customer choice.
- Advanced Research on Integrated Energy Systems (ARIES)—see previous slide.

Areas of Expertise

- Grid integration
- Wind energy, water power, solar photovoltaics
- Energy storage
- Advanced manufacturing

Current Projects

FlexPower

ARIES

CHALLENGE

- Improve the resilience of our energy infrastructure.

APPROACH

- Through the ARIES research platform, demonstrate a fully operational, scalable, multimegawatt hybrid power plant consisting of wind, solar photovoltaic, hydropower, and various energy storage technologies.

IMPACT

- FlexPower will result in the development of a new national asset—a grid-scale hybrid system research platform—that can be used by industry and the research community.

Structural Research Facilities

- NREL helps verify and improve new component designs, analyze structural properties, and improve manufacturing processes.
- State-of-the-art equipment and data acquisition systems are capable of validating blades and components from 1 meter to 50+ meters in length.
- Three structural research facilities offer 1,800 square meters of laboratory space that share servo-hydraulic control and actuation equipment.
- Accredited to IEC 61400-23 for wind turbine blade research.
- NREL combines custom data acquisition software tailored for static strength and fatigue validation with a data acquisition system capable of recording hundreds of data channels.

Areas of Expertise

- Experimental design and performance for material and structural validation
- Composite multiscale validations
- Composite performance characterization.

Current Projects

Investigating core gaps and developing subcomponent validation methods for wind turbine blades

STRUCTURAL RESEARCH FACILITIES

CHALLENGE

Reduce the necessity for costly and time-intensive validation of complete wind turbine blades.

APPROACH

Develop methods to validate structural details and interfaces at the subcomponent level. Core gaps are one example of a manufacturing defect observed in wind blade composite sandwich construction. Beam specimens are characterized with and without core gaps in sandwich panels using multiple types of infusion resins. Results are used to develop appropriate methodologies for more complex subcomponents – all as part of a broad wind blade structural validation and damage tolerance program.

IMPACT

This research enables state-of-the-art validation methods that will inform standards development to certify large blades at the subcomponent level.

Field and Technology Research Validation Facilities

- NREL designs and executes experiments to support validation of models and characterize new technology throughout the R&D portfolio—and develops new validation methods for wind turbine technology to address industry needs
- NWTC field research validation staff belong to these committees: International Electrotechnical Commission (IEC), International Measuring Network of Wind Energy Institutes (MEASNET), American Wind Energy Association (AWEA)
- Accredited to perform acoustic noise to IEC 61400-11 and MEASNET, power performance to IEC 61400-12-1 and MEASNET, mechanical loads to IEC 61400-13, power quality to IEC 61400-21 and MEASNET, duration research to IEC 61400-2, safety and function to IEC 61400-2 and IEC 61400-22.

Areas of Expertise

- Design and execute bespoke experiments
- Facilities and capabilities that anticipate R&D needs
- Field tests conducted according to set standards—domestic and international.

Current Projects

Segmented Ultralight Morphing Rotor (SUMR) Blades

FIELD AND TECHNOLOGY RESEARCH VALIDATION FACILITIES

CHALLENGE

Strong and variable wind speeds can adversely affect the durability of wind blades and increase costs for offshore wind applications. Will highly flexible, segmented ultralight morphing rotor (SUMR) blades make a difference?

APPROACH

- Use the 600-kilowatt CART2 to support a University of Virginia (UVA) project funded by the U.S. Department of Energy's Advanced Research Projects Agency-Energy (ARPA-e)
- Retrofit the CART2 wind turbine with two SUMR blades

IMPACT

This project shows how flexible blades can help offshore wind turbines withstand strong, hurricane-force winds and how these blades perform in a downwind configuration.

Dynamometer Research Facilities

- NREL experts can assess a variety of components and subsystems, including generators, gearboxes, power converters, bearings, brakes, lubrication, cooling, and control systems
- Manufacturers and design engineers use NREL facilities to perform accelerated lifetime experiments, to develop customized software, and to study generator and power electronics system performance and grid integration
- NREL's dynamometer research facilities help ensure wind turbine reliability, which reduces both risk and cost.

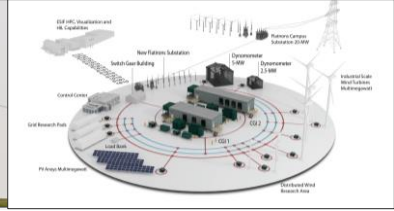
Areas of Expertise

- Mechanical and electrical power system validation
- Infrastructure and hardware—225-kW, 2.5-MW, and 5-MW dynamometers
- Data acquisition and results—to emulate rotor, tower, pitch, and yaw systems—and computer simulations operating in real time.

Current Projects

Impedance characterization of inverter-based generation

DYNAMOMETER RESEARCH FACILITIES



CHALLENGE

With increased penetration of inverter-based renewable generation, increased risk exists for control interactions between different generators.

APPROACH

NREL researchers developed a new power-hardware-in-the-loop impedance characterization method and demonstrated it using the controllable grid interface, a 4-megawatt wind turbine generator, and a power converter connected to the 5-megawatt dynamometer.

IMPACT

New impedance characterization methods help improve dynamic generator models, which, in turn, allow for higher penetration of inverter-based renewable generation on the grid.

CoMET

The Flatirons Campus hosts the Composites Manufacturing, Education, and Technology (CoMET) facility to enable NREL to lead composite research for renewable energy. The CoMET is:

- Accelerating the manufacture of advanced wind turbine components
- Driving composites science and education
- Demonstrating initial work on the Manufacturing USA Institute for Advanced Composites Manufacturing Innovation (IACMI)
- Providing a real-world classroom to educate tomorrow's highly trained advanced composites workforce
- Partnering with research universities and industry.

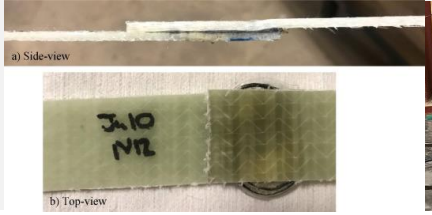
Areas of Expertise

- Rapid prototyping of new blade materials and production methods
- Full-scale blade component tooling and fixtures (root, spar cap, tip, shear web)
- Modeling and manufacturing simulation

Current Projects

Thermoplastic resin for wind turbine blades

CoMET



CHALLENGE

Thermoset (epoxy, polyester) resins used to manufacture wind turbine blades are hard to recycle and require high-cost adhesive joints.

APPROACH

Design, manufacture, and validate thermoplastic articles with increasing complexity to develop manufacturing processes, characterize new materials, and validate their performance.

IMPACT

Characterization of thermoplastic materials and thermo-welded joints at different scales and complexity enables adoption of new, fully-recyclable materials by the wind energy industry.

Accomplishments & Impacts

NREL's Flatirons Campus is a world-class research facility for renewable energy. Its equipment, technical experts, and facilities support fundamental research, development, experimentation, and validation of components and systems, including:

- Enabling future research initiatives that are aimed at ensuring reliability and resiliency of the U.S. power grid as increasing levels of megawatt-scale renewable energy generation and storage technologies are added
- Partnering with industry and research institutes to provide insight into the design of offshore wind blades and improving blade service life
- Performing cutting-edge research on the performance, cost, reliability, sustainability, manufacturability, and resilience of complex hybrid energy systems
- Demonstrating the potential for renewable power generation to not only integrate onto the grid but to positively contribute to grid stability by providing grid services.