CLEMSON

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Energy Innovation at Clemson University

A high-level overview of the centers and research surrounding Energy Innovation and related activities.

01 Introduction

Clemson scientists are working every day to find solutions to the world's growing demand for reliable energy to fuel our economy and our quality of life. Clemson is home to unique world-class facilities that power innovations in energy distribution, generation and storage. Clemson teams are identifying new materials for energy storage that could be cheaper and more abundant than lithium. Researchers are collaborating with the private sector to build secure, resilient energy-distribution systems. They aim to enhance renewable energies and reduce energy consumptions. They are also working with educators throughout the state to prepare a workforce ready to support this critical industry sector. Energy has long been one of Clemson's strategic innovation clusters and continues to grow with support from federal funding agencies and industry and community partners.

Topics (nonexhaustive):

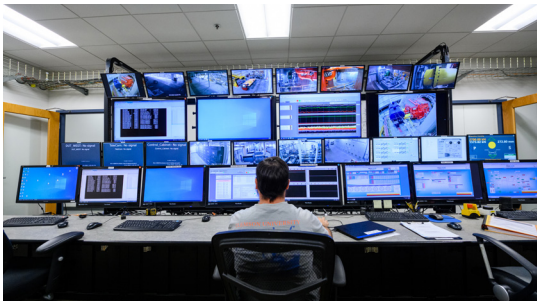
- Energy conversion, storage and transmission
- Grid resiliency/security
- Battery technologies
- Nuclear
- Renewables
- Geothermal
- Future materials
- Advanced manufacturing
- Conservation
- Energy waste
- Semiconductors

02 Centers and Strategic Initiatives

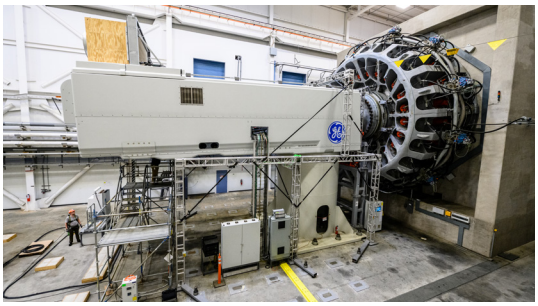
Dominion Energy Innovation Center

The Dominion Energy Innovation Center (EIC) is strategically located at the Clemson University Restoration Institute's (CURI) campus at the former U.S. Naval Base in North Charleston, South Carolina. The EIC houses the Duke Energy eGRID — an electrical grid simulator that can simulate the electrical grid of any country in the world — and the world's most advanced wind-turbine drivetrain testing facility.

Duke Energy eGRID



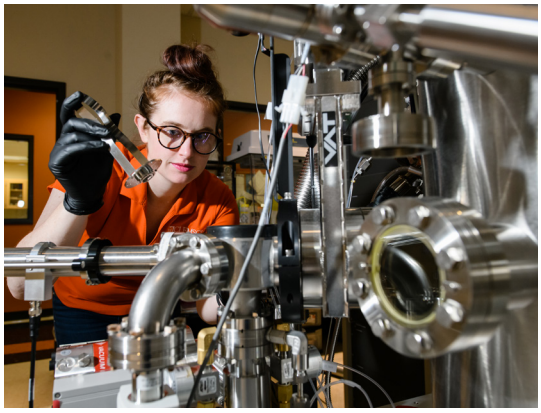
The Duke Energy eGRID (Electrical Grid Research Innovation and Development) center allows for testing of new inverters, converters, generators, energy storage systems and other elements to evaluate performance and resiliency in a working grid used to distribute energy on a commercial scale. It is already one of the premier facilities of its kind and is being expanded and mobilized from its base at Clemson's Charleston Innovation Campus with a $12.5 million investment from the U.S. Department of Commerce's Economic Development Administration.



Wind Turbine Test Beds

The wind-turbine drivetrain testing facility is capable of full-scale, highly accelerated mechanical and electrical testing of advanced drivetrain systems for wind turbines. The larger of the two test stands is a flexible unit that accommodates complete geared and direct-drive wind-turbine nacelles up to 15 MW in addition to large turbine gearboxes and generators. The drive unit consists of two 8,700-kW, asynchronous, water-cooled motors and an adaptation gearbox. The "smaller" test stand is a flexible unit designed to handle gearboxes and nacelles for wind turbines up to 7.5 MW. The drive unit consists of one 8,700-kW, asynchronous, water-cooled motor.

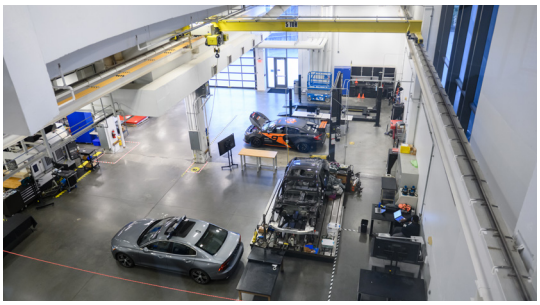
02 Centers and Strategic Initiatives (continued)



Battelle Savannah River Alliance

Clemson is a core member of the Battelle Savannah River Alliance that manages the U.S. Department of Energy's Savannah River National Laboratory (SRNL). SRNL is working to advance practical, cost-effective solutions to the nation's environmental, nuclear security, nuclear materials management and energy manufacturing challenges. Clemson's strong relationship with SRNL spans decades, providing a unique opportunity to advance energy research, innovation and workforce development programs.

Clemson University International Center for Automotive Research



Energy is core to the work of scientists at CU-ICAR. Innovations in manufacturing processes, powertrains, performance and materials are making vehicles more efficient to operate and produce. With world-class labs, long-standing relationships with the region's storied and growing automotive sector and a strong national reputation, CU-ICAR is driving applied research that is put to use. CU-ICAR also is home to the Clemson Composites Center, Clemson University Center for Advanced Manufacturing and Clemson University Center for Workforce Development, all assets to the state's energy sector.

Center for Nuclear Environmental Engineering Sciences and Radioactive Waste Management (NEESRWM)

The center serves as a focal point for research and education in the characterization, evaluation and remediation of radioactive contamination, as well as the evaluation and development of processes for the management of radioactive wastes.

02 Centers and Strategic Initiatives (continued)

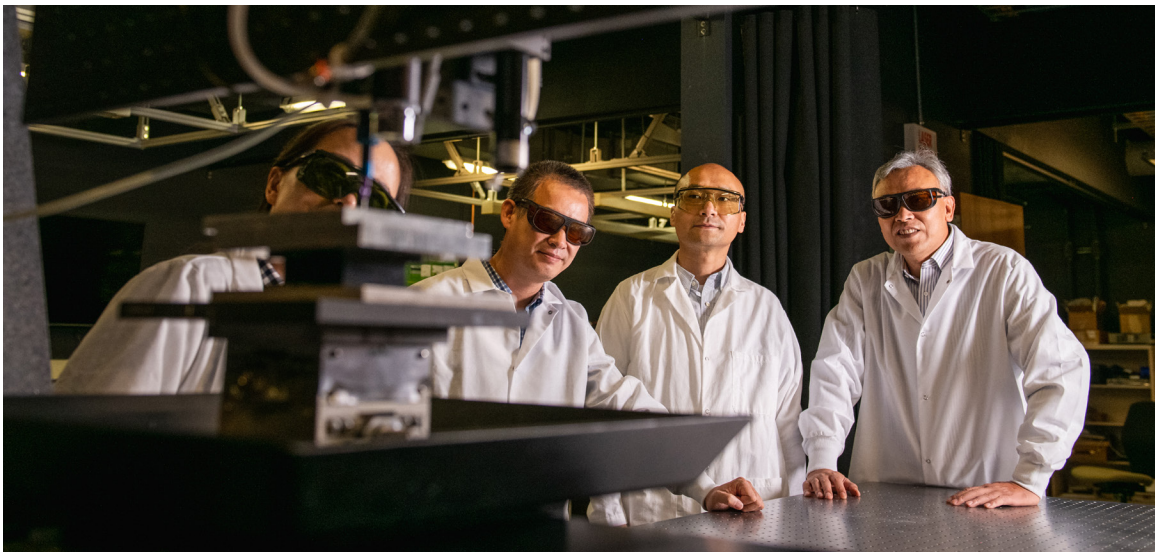
Advanced Materials Research Lab

The Clemson University Advanced Materials Center (AMRL), an innovative campus and technology park located in Anderson, is a state-of-the-art facility that houses internationally recognized research programs in optoelectronics, chemistry, and materials science. It also houses one of the nation's most outstanding electron microscopy facilities and a professional staff that provides services to private industry and academic clients. The research done here will have a positive global impact and will help bring world-renowned companies to the Upstate. The National Science Foundation, the Department of Defense and NASA have all recognized the laboratory's work and have contributed to Clemson's efforts to fuel future innovation.

Advanced Materials Innovation Complex

The new Advanced Materials Innovation Complex (AMIC) set to open in late 2025 will be a 143,000-square-foot facility designed for education and research into new types of materials with special properties useful in a wide range of applications. These materials help make lasers more powerful, cars and planes more fuel efficient and sustainable energy more reliable and economically viable. The new facility will be Clemson's most technologically advanced and central to efforts to nurture a workforce for the advanced materials industry.

03 Innovation and Workforce Development



Materials for Energy Storage

A Clemson University team at the Advanced Materials Research Laboratory discovered a method for making self-healing material designed to improve the durability of batteries and other energy-storage devices and reduce dependence on the limited and costly resource lithium.

Energy Resiliency

A Clemson researcher was selected by the U.S. Fulbright Program to visit South Africa to help the country transition to renewable energy and identify a solution to its rolling energy blackouts. The scientist's research focuses on power systems, smart grids and artificial intelligence.

System Modeling

The Savannah River National Laboratory tapped a Clemson scientist to serve a joint faculty appointment as it works to nurture innovation in electrical grid infrastructure. The scientist's work focuses on power and energy system modeling and simulation, integration, testing and standardization of distributed energy resources, microgrids control, power system stability studies, controller hardware-in-the-loop (CHIL) and power hardware-in-the-loop (PHIL) testing, and co-simulation environment for power systems.

03 Innovation and Workforce Development (continued)

Energy Materials

A Clemson team discovered a method to optimize electrolytes that could open the door for the use of sodium-sulfur batteries in next-generation grid-level storage systems. Such batteries are less expensive and more readily available than lithium, which is better suited for mobile uses.

Conservation

Clemson precision-agriculture experts are working directly with growers in South Carolina's $50 billion agriculture industry to develop and introduce new technologies and management practices that can lower energy use, reduce potentially harmful and costly inputs such as fertilizers and pesticides, and help farmers minimize cost and maximize profit.

Workforce Development

GE Vernova, which includes GE Gas Power, pledged $710,000 in 2023 to support three Clemson initiatives aimed at widening the STEM talent pipeline and fostering inclusive excellence: the GE John Lammas Annual Scholarship, the Women's Roundtable and a variety of STEM opportunities for middle school students.

Manufacturing

Clemson University researchers devised a novel way of 3D printing protonic ceramic fuel cells, a renewable energy device that shows promise for generating electricity more sustainably than burning fossil fuels. Instead of using coal or petroleum, protonic ceramic fuel cells run on renewable fuels, such as hydrogen, ammonia, hydrocarbons and alcohols.

Semiconductors

A team of Clemson University chemists constructed a novel two-dimensional electrically conductive metal-organic framework (MOF), a breakthrough that could help advance modern electronics and energy technologies. MOFs are nano-sized architectures that resemble miniature buildings made of metal ions linked by organic ligands. Certain MOFs can conduct electricity, making them potential next-generation semiconductors.

03 Innovation and Workforce Development (continued)

Solar

Clemson University researchers designed a smart supercapacitor using a novel stack of metal oxides — vanadium pentoxide and zinc oxide — that can efficiently harvest energy from sunlight and simultaneously store it. Like batteries, supercapacitors store and release electricity. But unlike batteries, supercapacitors don't need a chemical reaction to store energy. Instead, electric charge is stored electrostatically, which allows supercapacitors to be rapidly charged and discharged. The research could pave the way for future self-charging consumer electronics such as health monitoring devices.

Hydrogen

Clemson University researchers are working to develop a new type of coating that could facilitate the use of hydrogen-fueled turbines. Hydrogen burns hotter than other fuels, with temperatures in the turbine inlet reaching about 1,700 degrees Celsius. This new coating would protect turbine blades from the intense heat and high-velocity steam.

Geothermal

A Clemson University team has developed precision sensing instruments to help unlock geothermal resources to feed the world's appetite for inexpensive, reliable electricity. The new instruments, called "strainmeters," use optical fiber sensors to measure tiny movements that occur in response to changes in hot rock deep below the Earth's surface. The work is part of the U.S. Department of Energy's effort to tap into the potential of enhanced geothermal systems (EGS) to provide clean and reliable electricity to power tens of millions of homes across the country.

Hydrogen Fuel Cells

Clemson is developing a hydrogen fuel cell prototype aimed at boosting efficiency and longevity. The project, supported by $860,000 from SCRA, focuses on integrating advanced fuel cell technology into existing systems, avoiding costly retrofits while offering wide-ranging energy benefits.