Future Renewable Electric Energy Delivery and Management (FREEDM) Systems

North Carolina State University (lead institution)

Developing an "energy internet" suitable for plug-and-play of distributed renewable energy generation and energy storage

A National Science Foundation Engineering Research Center since 2008

Partner Institutions:

- *Arizona State University*
- *Florida A&M University*
- *Florida State University*
- *Missouri University of Science and Technology*

The vision of the Future Renewable Electric Energy Delivery and Management (FREEDM) Systems Engineering Research Center (ERC) is to create an efficient electric power grid that integrates highly distributed and scalable alternative generating energy sources and storage with existing power systems to facilitate a green-energy based society, mitigate the growing energy crisis, and reduce the impact of carbon emissions on the environment.

The Center's mission is to develop the necessary fundamental and enabling technology to demonstrate the FREEDM System, foster a revolution in the electric power and renewable energy industries, and educate a new workforce for a green-energy based economy.

The ERC's goals include developing the following:

- Fundamental knowledge base for the FREEDM System
- Enabling technologies for subsystem and system demonstrations
- A one-megawatt FREEDM green-energy hub system on campus
- Long-term partnerships with large and small firms along with middle and high school teachers and students
- Diversity of the Center's leadership, faculty, and staff.

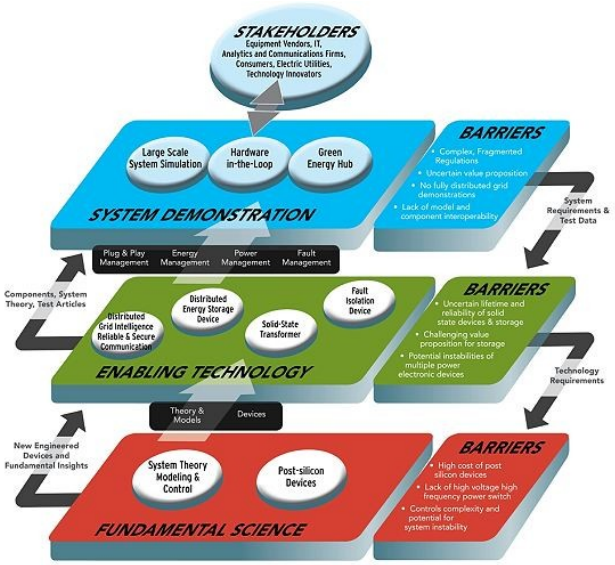
The overall objective of the ERC is to develop a diverse group of adaptive, creative, globally connected, and innovative undergraduate and graduate students trained in the growing field of renewable energy systems.

Research

The FREEDM Systems Center's strategic plan calls for tightly coupled research that will be conducted in nine subthrusts, leading to the demonstration of the 1 MW FREEDM System green energy hub at NCSU. The strategic plan also calls for breakthrough improvement in the areas of post-silicon power semiconductor devices, solid state transformers, energy storage devices, and distributed smart grid control.
Researchers from across partner campuses provide critical expertise, research capabilities, and leadership that focus on three main cross-disciplinary thrusts:

- Post-silicon Devices
- Energy Storage
- System Theory Modeling and Control.

Key barriers include the need to transform the nation's electrical grid infrastructure, the lack of energy storage and management systems, along with the need to take global action by persuading residential and commercial users to utilize alternate sources of energy.



Education

The ERC Education Program focuses on a team-based environment where students work in a cross-disciplinary mix of faculty and postdoctoral research associates. Undergraduate curriculum goals include training students for renewable The ERC Education Program focuses on a team-based environment where students work in a cross-disciplinary mix of faculty and postdoctoral research associates. Undergraduate curriculum goals include training students for renewable electric energy careers through a new graduate concentration in renewable energy systems, funding the Research Experiences for Undergraduates program, and sponsoring senior design projects through renewable energy systems. Graduate curriculum goals include training students capable of providing leadership in renewable energy systems through a new master's degree program and customizing a portfolio of professional development experiences for ERC PhD students.

To increase K-12 student awareness of the importance of renewable energy systems, the ERC has developed strategic outreach partnerships with schools that enhance teachers' engineering content knowledge and involve high school students in ERC research.

Industrial Collaboration / Technology Transfer

The Industry Collaboration and Innovation Program aims at forming a national and international partnership network to speed center results to practical application. The program seeks to provide active collaboration with researchers in universities, industry, and national laboratories to leverage the NSF investment in research and education. Industrial partners are encouraged to interact with the center through joint research project teams and active participation in research planning, and by educational involvement through mentoring and internship opportunities.

Facilities

The Center currently has a 20,000 sq. ft. headquarters with over 7,000 sq. ft. of lab space. Additionally, the Center has a packaging research center (PREES) and the Advanced Transportation Energy Lab, a shared clean room facility, and a dedicated GaN fabrication facility.

Center Configuration, Leadership, Team Structure

The cross-disciplinary team consists of exceptional faculty and industry leaders committed to providing undergraduate and graduate students with real-world challenges in classroom, field, and laboratory settings. Leveraging these partnerships will enable the ERC to make advances in technology, produce creative innovators for today's global economy, and achieve the ERC's primary goals.

Center Headquarters

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Dr. Iqbal Husain (left) explains the Center's challenges to Duke Energy CEO Lynn Goode (right).

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The Keystone Science Center

The FREEDM Systems Center's 40 kW Green Energy Hub Dedicated Solar Array