

# Advanced power grid slowly takes shape at NC research hub

June 23 2011, By John Murawski

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It takes up enough space to cover a billiards table, but next year it will fit inside a backpack.

The electronic contraption, only in its first generation, was named this year by experts at Massachusetts Institute of Technology as one of the 10 most important technology innovations of 2010. MIT ranked the "smart transformer," created by the [FREEDM Systems Center](#) in Raleigh, alongside recent advances in cancer genomics and synthetic cells.

The digital transformer will form the electronic guts of the vaunted Smart Grid, the automated power network that is expected to replace the nation's aging mechanical power grid in the coming decade. Relying on semiconductors rather than brainless mechanisms, the device controls energy flow in both directions, managing interconnections with solar-powered rooftops and plug-in [electric cars](#), while minimizing energy waste.

"Think of it as an Internet router for the [electrical grid](#)," said Stephen Cass, special projects editor at MIT's Technology Review. "This contribution fits into that transformational ideal in that it will enable other changes."

The solid state transformer is one of several dozen Smart Grid-related projects under way at the 3-year-old FREEDM Center, which is headquartered at N.C. State University and coordinates research among five U.S. universities. The acronym stands for Future Renewable

Electric Energy Delivery and Management, a research consortium formed in 2008 with an \$18.5 million grant from the National Science Foundation.

The rising profile of the FREEDM Center is a major reason why North Carolina's Research Triangle, as the Raleigh area is known, has come to be regarded as a national Smart Grid hub. But there also are nearly 60 local companies here involved in developing software, components, utility meters or some other aspect of the smart [electricity network](#).

"This technology is probably five years ahead of its time," said Alex Huang, the N.C. State professor of electrical and computer engineering who directs the FREEDM Center. "We are pushing electronics into the power grid."

The Obama administration has pumped \$4.5 billion nationwide into Smart Grid development in the past two years, with North Carolina companies and organizations receiving more than \$600 million, more than any other state. The administration regards the Smart Grid transformation one of the nation's primary drivers for job growth, spanning manufacturing, marketing and maintenance.

Just last week, the FREEDM Center hosted an energy discussion forum for the White House Council on Jobs and Competitiveness, including Duke Energy CEO Jim Rogers, General Electric CEO Jeffrey Immelt, Southwest Airlines CEO Gary Kelly and U.S. Commerce Secretary Gary Locke.

Many of the supporters and members of the FREEDM Center collaborate on research, donate equipment and provide technical expertise. In exchange for annual membership fees, member companies have access to intellectual property developed at the center.

Utility industry stalwarts, like ABB and Eaton, are involved because they want to be in early for an opportunity to develop promising products for commercial markets.

ABB, which specializes in heavy electrical equipment, employs 300 people at its North American headquarters in Cary, N.C., and 300 more in Raleigh. This summer ABB plans to open its own Smart Grid Center of Excellence on N.C. State's Centennial Campus.

The FREEDM Center, whose membership roster has grown to 49 companies, a year ago moved into a new facility, where more than 200 graduate and undergraduate students conduct research on smart transformers, smart breakers and high-performance batteries.

While devices like the smart transformer work in a laboratory setting, it may take years before electricity providers are ready to buy the costly equipment. One hurdle for solid state components is that they last about 20 years in the field, compared to the 40-year life span of a conventional transformer. The bucket-shaped device attached to neighborhood utility poles is limited to one function: It lowers voltage as electrical current passes through it.

"The old-fashioned transformer is very dumb, but also very reliable," Huang said.

Chad Eckhardt, an independent industry consultant in Raleigh, said the FREEDM center can build all the prototypes it wants, but mass production will require engagement with a global contractor like ABB, Eaton, Siemens or General Electric. To get companies on that scale interested, utility companies will first have to commit to field-testing the smart components.

The FREEDM Center facility itself is designed as a living laboratory,

with a 40 kilowatt solar panel on the roof, donated by member company AEG Power Solutions. FREEDM also has an indoor cabinet with lithium ion batteries, two electric plug-in cars and plans to add a fuel cell to simulate a fully developed Smart Grid in which homes and businesses participate in electricity production and energy storage.

The center's goal is to become temporarily energy independent - which Huang calls "islanding mode" - in the event of a power outage or other emergency.

Eventually the Smart Grid will be used to manage thousands of solar homes and electric cars in which power flows in multiple directions, Huang said, as opposed to the current system in which electricity originates at several large power plants and moves one way along transmission lines and down distribution lines into neighborhoods.

It's widely believed that when the Smart Grid is developed, the nation will shift away from AC (alternating current) to DC (direct current) electricity. The reason: Most technology today runs on DC power, which is why consumers can't plug their laptops and plasma TVs into wall outlets directly and have to use boxy adapters instead.

LED lighting and solar panels also operate on DC power, and require inverters and adapters today to convert back to AC power.

Both the ABB and FREEDM Smart Grid labs are developing sections that run on DC power, simulating the home of the future in which adapters are unnecessary and electronic equipment is all interconnected directly and managed by software.

"Today we basically have a legacy system," Huang said.

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## FREEDM SYSTEMS CENTER:

- Full name: Future Renewable [Electric Energy](#) Delivery and Management Systems Center
- Year created: 2008
- Primary funder: National Science Foundation, which seeded FREEDM with \$18.5 million
- Headquarters: N.C. State University Centennial Campus
- Director: Alex Huang, NCSU professor of electrical and computer engineering
- University partners: Arizona State University, Florida State University, Florida A&M University, Missouri University of Science and Technology, RWTH Aachen University (Germany) and the Swiss Federal Institute of Technology-Zurich (Switzerland)
- Research programs: electric vehicles, long-life batteries, solid state transformers, fault isolation technology, semiconductor transistors, [Smart Grid](#) demonstration projects
- Member companies: 49
- Members include: ABB, Cisco Systems, Cree, Duke Energy, Eaton, Elster, Intel, Itron, Progress Energy, Siemens, General Electric, TVA (Tennessee Valley Authority)
- Ph.D. student researchers: 113
- Master's student researchers: 67

-Professor researchers: About 50

-Academic papers published: 76

-Conference presentations: 192

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