Office of Electricity Delivery and Energy Reliability

Superconductivity Partnerships with Industry

Plugging America Into the Future of Power

HTS Cable Projects

"A National Effort to Introduce New Technology into the Power Delivery Infrastructure"

What is being done to modernize electricity transmission and distribution?

In a national effort to introduce new technology into the power delivery infrastructure, the U.S. Department of Energy's (DOE) Office of Electricity Delivery and Energy Reliability is partnering with industry to sponsor projects showcasing the use of high-temperature superconducting (HTS) cables in modernizing electricity transmission and distribution systems. Three teams have formed to focus on different aspects of cable design and different electric system needs. This is the most important such effort worldwide and involves equipment manufacturers and suppliers from around the nation.

These projects are hosted by electric utility companies in Albany, New York; Columbus, Ohio; and Long Island, New York. Two of the cables have been installed and are waiting to be energized while the third is scheduled to be energized in mid 2007.

The planned total investment in the three projects is $81,710,000 (DOE $40,855,000; private sector $40,855,000) appropriated over a 4-year period.

A team led by American Superconductor will build and demonstrate a power cable on Long Island that will connect two Long Island Power Authority (LIPA) substations nearly half a mile apart. The 138 kV cable will be the first ever application of an HTS cable in the utility grid at transmission voltages.

A team led by SuperPower is demonstrating a 350-meter, 34.5 kV HTS cable connecting two National Grid Company substations, along the Hudson River in Albany, New York. A section of the cable will be the first ever grid installation of a device using "Second Generation" HTS wire, a conductor made with new materials that are expected to enable a better cost/performance ratio. Research breakthroughs at Los Alamos and Argonne National Laboratories have contributed to the development of this wire. The Albany cable project also includes the first ever HTS cable splice, and integrated three-phase terminations installed in a utility grid.

ULTERA (a partnership between Southwire and nkt cables) is leading the development of a 200-meter, 13.2 kV HTS cable that has been installed in a substation in the American Electric Power grid in Columbus, Ohio. The cable is designed to carry 3,000 amps of current and features a promising new design in which all three phases are carried in a single cable through three different concentric layers of HTS wires.

What is Superconductivity?

Superconductivity is a property that only a few materials are known to possess. When cooled to very cold temperatures, these materials are able to carry electricity

"Promising technologies exist that will improve the transmission, storage, and reliability of renewable energy. An example of the recent technological success that will allow for increased access to all forms of energy, including renewable energy, is the high-temperature superconducting underground power transmission cables that the DOE is developing in partnership with industry. The cables will allow a 300 percent increase in capacity without excavation to lay new transmission lines." *–The President's National Energy Policy*

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without resistance, meaning that less electricity is lost while being conducted through those materials. Prior to 1986, it was thought that materials needed to be cooled to near absolute zero to exhibit superconductivity, but two IBM researchers in that year discovered a class of materials that would superconduct at much "warmer" temperatures, around minus 320°F. This meant they could be cooled with inexpensive, abundant, and inert liquid nitrogen.

Today the DOE participates in a suite of projects in which electric utility devices using superconducting wires are being demonstrated. Called the Superconductivity Partnership with Industry, this program is matching industry funding with federal funding to demonstrate devices that will typically be half the size and have half the energy losses compared to conventional equipment.

What can HTS cables do for me?

HTS cables, with their increased efficiency, have the potential to reduce the amount of electricity lost in transmission and distribution. The grid in the United States loses an estimated 10 percent of all electricity generated before it can be sold to the customer — an amount roughly equal to the electricity generated in the entire continent of Africa. The amount of lost electricity is growing every year, as load centers move further away from power plants, and electricity must be conducted for longer distances. The cost of this lost electricity is passed on to electric utilities and ultimately to consumers. HTS cables have the potential to reduce that cost.

More immediately, HTS cables can pack more current through available spaces. In congested urban areas, expanding the capacity of an underground power line can involve digging up streets and can be expensive and disruptive. In addition to improved efficiency, HTS cables offer additional environmental and safety benefits. HTS cables use liquid nitrogen as a coolant instead of the dielectric oil commonly used in some conventional high-voltage cables.

Why are public sector dollars funding these projects?

Traditional systems for generating, transmitting, and using electrical current have been designed with a brute-force approach to overcoming electrical resistance. Since high-temperature superconductors make it possible to conduct electricity without resistance, they offer the potential to dramatically re-shape the nature of the electrical grid.

However, the materials used in HTS wires are brittle, expensive, and often difficult to work with, making HTS research a very high-risk, high-reward endeavor. Electric transmission and distribution companies face a growing uncertainty that investments in new technology can be recovered through the rate base. DOE started the Superconductivity Program in 1992 to assist U.S. industry to become a leader in HTS commercialization. In 1996, the Superconductivity Program initiated the Superconductivity Partnerships with Industry thrust to enable industry to better fund demonstrations of HTS technology in utility devices.

In recent years, several studies have reinforced the need for transmission and distribution research, including the National Transmission Grid Study and the report on the August 2003 blackout in the northeast. With these three projects, the DOE is addressing that need.