# Improving the Power Grid with Superconducting Technology

New superconducting technology will help America reduce the demand for additional electric power generation and increased delivery infrastructure during the next three decades. This, in turn, will minimize our dependence on foreign oil and greenhouse gas emission. Superconducting materials are important to meeting the nation's future energy needs because they have virtually no resistance to electric current, offering the possibility of new electric power equipment with more energy efficiency and higher capacity than today's systems.

The U.S.-Canadian power outage of August 2003 underscored the importance of improving the adequacy and reliability of the nation's power grid. ORNL's High Temperature Superconductivity Program is helping to make the goal of high temperature superconductivity a reality by blending materials research, wire development and device demonstration through industry partnerships.

## The Second Generation of Superconducting Wires

ORNL's high temperature superconducting wire research is focused on the development of a second generation of superconducting wires, made from rare earth-barium-copper oxide (REBCO), that will outperform current first generation bismuth-strontium-calcium-copper oxide (BSCCO) wires at a lower cost per unit length. These superconducting REBCO wires will be capable of carrying current in higher magnetic fields than their first generation counterparts. The technology will enable utilities to maximize the current carrying capacities of existing power infrastructures with smaller footprints, and thus minimize the need to establish new and expensive transmission and distribution line corridors.

*ORNL's breakthrough RABiTS™ superconducting wire*

American Superconductor Corporation is in the pilot stage of commercializing a superconducting wire based on ORNL's rolling assisted biaxially textured substrate, or RABiTS™, technology. By working closely with ORNL researchers, American Superconductor is scaling up the production of RABiTS™-based wire, and is the first in the world to achieve the Department of Energy intermediate goal of 300 amperes-per-centimeter performance in 100-meter class wire. American Superconductor has already delivered thousands of meters of wires to customers worldwide.


*ORNL and SuperPower scientists inspecting a SuperPower research superconductor deposition system*

Similarly, SuperPower Inc. is scaling up its wire production, which incorporates ORNL's buffer technology into the wire architecture. This novel buffer technology has enabled SuperPower to increase its wire throughput while maintaining long length uniformity, and established many world records. Among these are the world's longest second generation wire and the world's best long length wire performance of 158,950 amp-meter. In addition to template research, SuperPower and ORNL are collaborating closely to further develop SuperPower's proprietary superconductor deposition process in order to accelerate the broad market adoption ot high temperature superconducting technology.

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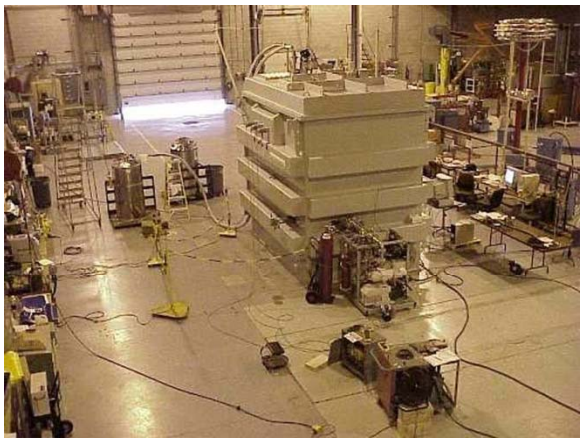
**Working with Industry to Develop Electric Power Applications**

Superconducting technologies developed in partnerships between ORNL and industry have the potential to increase dramatically the electricity delivery capacity, reliability and stability of the power grid while remaining within existing urban power system infrastructures.

- ORNL and Ultera (Southwire of Carrollton, GA. and nkt cables of Denmark joint venture) are demonstrating a 3,000-amp, 3-phase superconducting cable at American Electric Power's Bixby Substation in Columbus, Ohio. Energized on Aug. 8, 2006, the superconducting cable is providing reliable power to more than 8,600 customers. The cable utilizes an innovative triaxial cable design that is the most compact yet developed, with the world's highest current delivery capability. Developed jointly by Ultera and ORNL through a Superconductivity Partnerships with Industry agreement, these superconducting cables have a current capacity that is three to five times the transmission capability of a conventional copper cable. Other project partners include Praxair and American Superconductor.

*AEP Columbus superconducting cable. Inset is a schematic of the innovative triaxial cable design with concentric superconducting layers*

- ORNL is participating in two new superconducting power cable projects that are based on the innovative triaxial cable design. One cable, sponsored by the Department of Energy, will be installed in the greater New Orleans area. The other cable features a novel fault current limiting functionality to enhance the resiliency of power delivery in lower Manhattan, and is sponsored by the Department of Homeland Security.
- Waukesha Electric Systems of Waukesha. WI and ORNL are cooperating to establish the technical and economic feasibilities and benefits of high temperature superconducting transformers. These medium-to-large >10 MVA (million volts amps) transformers are expected to be more efficient and more compact than conventional transformers. More importantly, superconducting transformers do not contain oil and therefore will not result in severe environmental impact in case of leakage or fire.



*Demonstration superconducting transformer*

- In addition, ORNL is cooperating with industry to develop superconducting industrial motors and fault current limiters.