Power Cable

P R O J E C T • F A C T • S H E E T

SPI Projects are Co-Funded by the U.S. Department of Energy
Superconductivity for Electric Systems Program and Industry Partners

Superconductivity Partnership with Industry

3-phase HTS cable installation, switchyard, and control room buildings constructed in the earlier Southwire SPI project. (Southwire)

What are its Primary Applications?

HTS transmission cables are used for power transmission and distribution.

This project will involve field-testing of the long-length cable under real environmental stresses and real electrical loads. The cable system will be installed in a utility substation, replacing conventional cables with limited current carry capacity.

What are the Benefits to Utilities?

HTS cable, carrying three to five times more power than conventional cable, can meet increasing power demands in urban areas via retrofit applications, eliminating the need to acquire new rights-of-way. Power transmission in underground HTS cables can substitute for overhead transmission lines when environmental and other concerns prohibit overhead installation.

Exceptionally low losses made possible by HTS cable will enhance overall system efficiency, increase flexibility, and reduce electricity costs.

What is the Market Potential?

As energy demands increase and environmental concerns heighten, underground HTS cable will provide the necessary alternative to meet power supply needs. The development of commercially viable HTS transmission cable will allow U.S. industry to capture a large portion of the growing national market. In addition, international markets are estimated to be 10 times larger than the U.S. market, and growing more rapidly.

Superconducting cables have the potential to create an efficient "electricity superhighway," much like the advent of fiber optic cable has aided the development of the "information superhighway."

What are the Project Accomplishments to Date?

The 1,000 foot cable project was awarded in late 2002. Southwire and Oak Ridge National Laboratory (ORNL) have already performed extensive research on a new "tri-axial" cable design, including bending and termination design and testing. The cable is expected to begin operation in a utility substation by late 2005.

The project builds on an earlier, very successful partnership between Southwire and DOE in which three 30-meter long cables were constructed. These cables exceeded direct-current (DC) critical current (Ic) design goals by over 100 percent. The cables were installed and began delivering power to three Southwire manufacturing plants on February 18, 2000. Since that day, the system has been in continuous, unsupervised operation at 100% load.

How Does it Work?

Conventional conductors of copper or aluminum are replaced by HTS wire, enabling the cable to carry greater amounts of current with fewer losses to resistance. The cable requires a cooling system to refrigerate the HTS conductors to a temperature at which resistance is minimized.

To further reduce costs and alternating current (AC) losses in the 3-phase power line, Southwire has been investigating the "tri-axial" design for a power cable. In

Goal:

Complete the development, installation, and testing of a 1,000 foot, 3-phase high-temperature superconducting (HTS) power cable at a substation in Columbus, Ohio. The project will demonstrate how HTS cables may be used in the future to replace existing oil-filled undergroud copper cables and greatly increase line capacity.

Team:

Southwire Company (team leader)

American Electric Power (host utility)

PHPK (closed-cycle refrigeration)

3M (coated conductor evaluation)

Oak Ridge National Laboratory (supporting technology and research)

Integrations Concepts Enterprises (power controls)

Period of Performance:

2002-2006

Cumulative Project Funding:

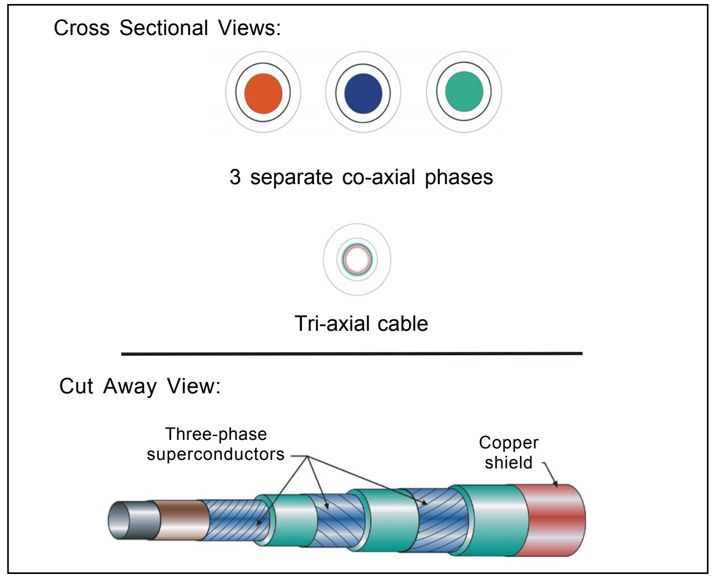
Private $4.32 million (50%)
DOE $4.33 million (50%)
Total: $8.65 million

What is it?

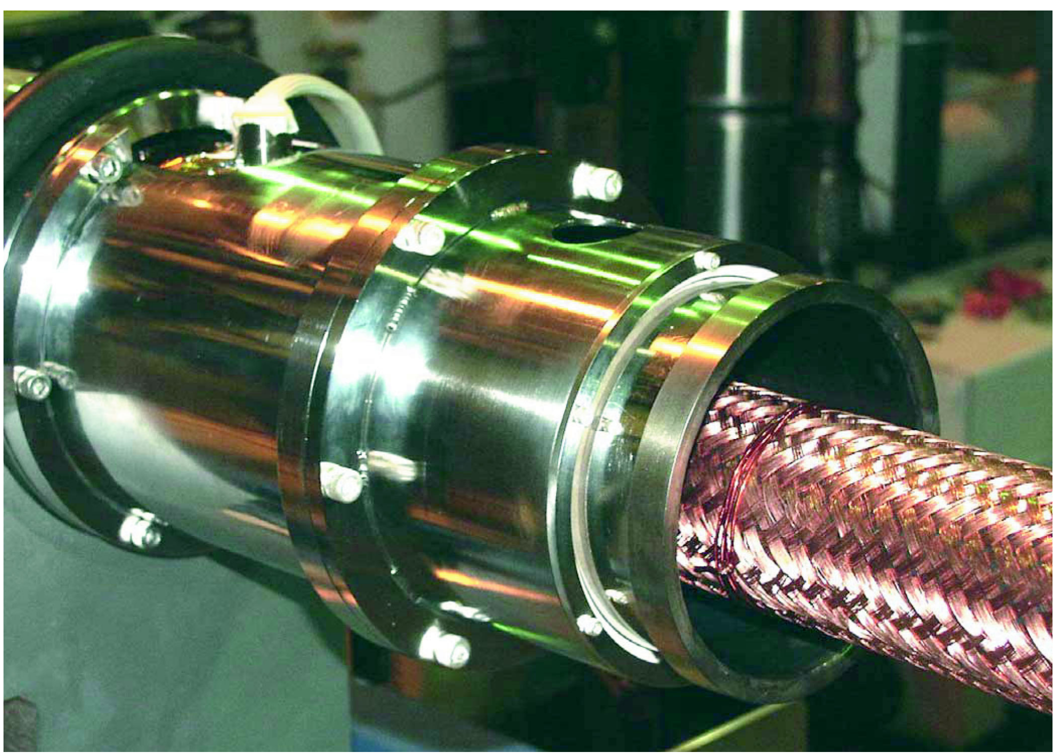
A power cable is designed to carry large amounts of electrical current over short or long distances.

this scheme, rather than having three independent HTS cables comprising the three phases, a single cable is constructed with three electrically insulated layers of superconductor built around the same axis. Southwire believes the new design will reduce the cooling load of the system, and less superconducting tape will be required. Having concentric phases will also lead to reduced electro-magnetic fields.

Like its predecessor, the cable will be "cryogenic dielectric" cable design in which a central former is wrapped with three HTS layers of tape and electrical insulation. The entire assembly is then insulated and jacketed to protect it from thermal and physical damage. The cable is cooled by passing liquid nitrogen through the hollow central former along the length of the cable, which is then returned through gaps in an outer layer of the cable assembly.



Graphical depiction of the tri-axial cable design.



A five meter section of tri-axial cable being inserted into the cryostat for lab testing.

What is the Status of the Project?

The project was awarded late in 2002. Southwire and ORNL have undertaken extensive testing on the tri-axial cable design, using a 5-meter protototype for bend and termination design and testing. Meanwhile, a 30-meter HTS cable developed in an earlier Southwire/DOE partnership continues to supply power successfully and reliably to three Southwire manufacturing plants.

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