# Project Fact Sheet

## Columbus HTS Power Cable

This project involves field-testing of a long-length high-temperature superconducting (HTS) cable under real environmental stresses and real electrical loads. The cable system forms an important electrical link in a utility substation in Columbus, Ohio.

### What are its Primary Applications?

HTS power cables are used for electricity transmission and distribution. The Columbus cable is a distribution cable, conducting electricity within a local grid.

### 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. The new cable design incorporated in this project has the potential to further reduce space requirements by running all three phases of a power line through a single cable. 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 and environmental concerns increase, underground HTS cable will provide the necessary alternative to meet power supply needs. The development of commercially viable HTS transmission cable will enable 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 those markets are growing more rapidly than the U.S. market.

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?

ULTERA was created as a partnership between U.S. cable manufacturer Southwire and nkt cables of Denmark, formed to continue the development and eventual commercialization of HTS cables.

*Triax cable being pulled into the underground duct at Bixby substation.*

The 200-meter cable project was awarded in late 2002. The cable has been installed at the Bixby substation, the cable splice has been built, the terminations are complete, and the cryogenic system is fully operational. The HTS cable carries the full 13-kilovolt station load. Cryogenic requirements are met by a base vacuum system, while new Pulse-Tube cryocoolers will provide approximately 40 percent of the cooling requirement and demonstrate high reliability and low maintenance for future commercial applications.

The cable was energized August 8, 2006, and serves a section of Columbus, Ohio, including both residential and industrial customers. The cable is designed to operate at 13.2 kilovolts and carry up to 3,000 amps. A majority of the cable was pulled into conduit underground, and a cable splice was built in a man-hole to demonstrate joining multiple cable sections.

### What is the Status of the Project?

The team has developed, installed, and tested a 200-meter, three-phase HTS power cable at an AEP substation in Columbus, Ohio. This is a new cable design with all three phases in one cable and uses one-half the amount of superconducting cable compared to other systems. The cable was energized August 8, 2006, and has operated successfully for over a year and a half, serving the equivalent of 36,000 homes. Two 1 kilowatt pulse tube cryocoolers were installed and are operating as expected.

## Goal:
The project will demonstrate how a triaxial HTS cable may be used to replace existing oil-filled underground copper cables and greatly increase the capacity of a power link.

## Team:
Southwire (project leader)

nkt Cables (cable partner)

American Electric Power (host utility)

Oak Ridge National Laboratory (supporting technology and research)

Praxair (cryogenics)

American Superconductor (HTS tapes)

## Period of Performance:
4/2002-7/2008

## Cumulative Project Funding:
Private $5.59 million (50%)
DOE $5.59 million (50%)
Total: $11.8 million

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

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*13 kV Triax cable terminations fully assembled at AEP's Bixby station.*

The project builds on an earlier, very successful partnership between Southwire and DOE in which three 100-foot-long cables were constructed and installed above ground in Carrollton, Georgia. These cables exceeded design goals by over 100 percent and began delivering power to three Southwire manufacturing plants on February 18, 2000. That system operated continuously at 100 percent load for over 40,000 hours and was recently taken offline for inspection. The analysis of the system showed no significant degradation in the conductivity of the HTS wire over that time. In addition to incorporating a new design, the new project will carry about twice the current of the earlier pilot project.

### 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 due to resistance. The cable requires a cooling system to refrigerate the HTS conductors to a temperature at which resistance is minimized, about –321 °F.

*Alignment with Administration Priorities:*

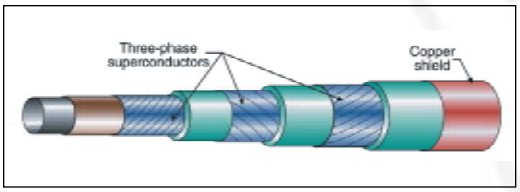
**National Energy Policy:** " …expand the Department's research and development (R&D) on transmission reliability and superconductivity."

**National Transmission Grid Study:** " … accelerate development and demonstration of its technologies, including high-temperature superconductivity…"

**Secretary of Energy:** "… focuses R&D dollars on long-term, potentially high-payoff activities that require Federal involvement to be both successful and achieve public benefit."

**Energy Information Administration:** "Of [advanced power delivery] technologies, superconductivity holds the most promise for yielding significant efficiency gains."

To further reduce costs and alternating current (AC) losses in the three-phase power line, Southwire has been investigating the "triaxial" design for a power cable. In 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 having concentric phases will also lead to reduced electro-magnetic fields. In addition, the new design will require only about one-half of the superconducting materials required by the earlier design and will take up less space, because a single cable will perform the job of what previously required three separate cables.




*Graphical depiction of the triaxial cable design.*

Like its predecessor, the cable is a "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 returned through gaps in an outer layer of the cable assembly.

The cable is expected to lose only about one-half of a percent of the power that it transmits, compared to the five to eight percent lost by traditional power cables.