

Superconductivity News Update

Bringing New Power to Electricity

November 2008

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HTS POWER CABLE PROJECT UPDATE

The ever-increasing demand for electric power has led to congestion on our electrical grids. This demand has generated a necessity for more reliable, higher efficiency cables to modernize our aging electrical infrastructure. High Temperature Superconducting (HTS) cables technology provides a solution by utilizing less wire and transmitting five times more electricity than currently used conventional cables.

Since HTS cables carry three to five times the amount of power compared to their antiquated copper cable counterpart, they make an attractive alternative to relieve cable system congestion in densely populated urban areas. They also occupy less space and can be retrofitted into existing underground conduits, eliminating the need for additional trenching, tunneling and new right-of-way corridors.

To establish HTS cables as an attractive new technology, it is necessary to prove their value to utilities and end users. To accomplish this effort, the Department of Energy (DOE), Oak Ridge National Laboratory (ORNL) and Los Alamos National Laboratory (LANL) established partnerships with various cable companies, utilities, state agencies and many stakeholders to enact cable projects. DOE, as of today, has funded the demonstration of HTS power cables in four U.S. power grids and just announced the funding of a fifth. The cable projects to date have proven the technology's transmission potential, its reliability, and most importantly provided power to people in constrained urban settings, such as Albany, New York.

DOE's efforts have also facilitated other HTS cable projects, such as the cable project in development in NYC. The Resilient Electric Grid (REG) program, a.k.a. Project Hydra, in NYC-Manhattan will build on the foundation of DOE and U.S. private industry's 10+ years of expertise in collaborative research and development. The project will implement a prototype Inherent Fault Current Limiting High Temperature Superconductor Cable which will make the grid more reliable and increase the security of the infrastructure.

"The Department of Energy believes HTS technology is vitally important to the modernization of the nation's power grid," said Kevin Kolevar, Director of the Office of Electricity Delivery and Energy Reliability. "We are pleased to see the Secure Super Grid project in New York City building on the platform DOE helped to create over the past 20 years in partnership with U.S. industry. The Secure Super Grid project is the next logical step for short-length HTS applications as the Department continues to improve wire performance and materials challenges required for longer length projects and higher voltages. Together, these activities will help propel HTS technology toward commercialization."

Each cable project leads HTS cables and technology a step closure to commercialization and utilization. These cable projects demonstrate the reliability, security, and potential benefits to our nation's power grid.

Carrollton, GA

On January 6, 2000, Southwire energized the first superconducting cable system in a commercial/industrial setting. The pioneering cable project, a partnership between DOE and Southwire, was constructed and installed above ground with three, 100-foot, single-phase, HTS cables rated 12.4 kV, 1,250 Amps. The cables delivered power to Southwire manufacturing plants. The system operated continuously for 7 years at 100 percent load for over 40,000 hours. When taken offline to perform an inspection of the system, it was concluded that there was little to no significant degradation in the conductivity of the wire. This cable project enabled the development of newer cable designs that carry twice the current of this original project.



Carrollton, 30-m 6 Yrs Operation
12.47 kV, 1.25 kA, Single-Phase
cables (Southwire, 2008)

Albany, NY

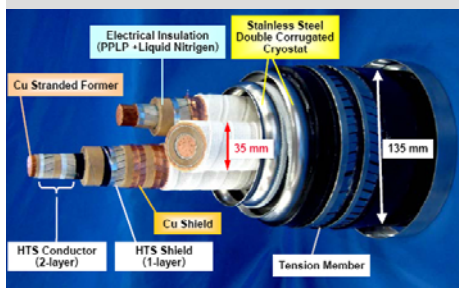
Albany's cable project began development in 2001 with a partnership between the DOE, New York State Energy Research and Development Authority (NYSERDA) and Superpower, Inc. The team also included BOC (Germany), Sumitomo Electric Industries (Osaka Japan), and National Grid (Westborough, MA). The first phase on the Albany project consisted of two sections; a 320 meter long section connected to another 30 meter section of HTS cable made with first generation HTS wires. The cable connected two substations from Riverside to Menands and was energized July 19, 2006. It operated flawlessly as an integral part of the grid's 35kV network in Albany and served an equivalent of 25,000 homes. On May 1, 2007, the system was taken offline to execute phase II of the project which involved installing a 30m section of cable made with second generation HTS wires (2G Wires). On January 8, 2008 the system was reenergized. This milestone demonstrates the first use of 2G wires in HTS device of any kind in a live grid application. All aspects of this program have been successfully demonstrated and completed.

The Albany cable project was highly successful in meeting all required milestones and goals. As it concludes in 2009, the project will be shut down, removed from service and its current location will be restored to its original condition.

Albany Team includes:
SuperPower, Inc, BOC,
Sumitomo Electric
Industries, New York
State Energy Research
and Development
Authority, and National
Grid

Cable Used

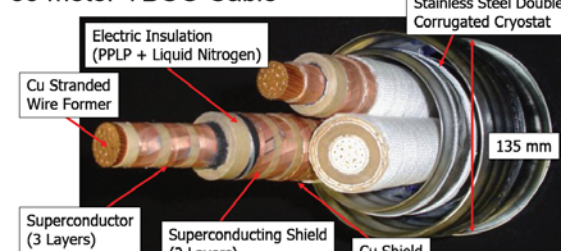
Phase one: first generation HTS wire



Structure and Properties of Albany BSCCO Cable
(SuperPower, Inc., 2008)

Phase two: 2G HTS wire

30 meter YBCO Cable



YBCO cable, (SuperPower, 2008)



Site Location
Superpower 2008



Albany, NY
Aerial view of the cable project
Picture owned by Superpower

Project Accomplishments

- 3.5 times the length of any previously installed HTS cable
- Installation is in a standard underground right-of-way (other installations have been within an industrial site or a substation)
- Addresses future commercialization by including a 30m YBCO cable section with potential for improved price/performance characteristics.
- Demonstrates an underground cable-to-cable joint which enables long cable runs.
- Demonstrated World's first in-grid demonstration of 2G wire-based HTS cable.

Columbus, OH

This 200 meter cable project was awarded in late 2002. The cable was installed in the Bixby substation and was energized August 8, 2006. The cable project serves residential and industrial customers in parts of Columbus, Ohio. The cable is designed to operate at 13.2 kV and carries up to 3,000 amps. A majority of the cable was pulled into its conduit underground, and a cable splice was built in a man-hole to demonstrate joining multiple cable sections. Since being energized, the cable system has worked flawlessly and has served power to 36,000 homes. Its peak load has been charted at 2,700 A.

The project will continue into 2009 with the continued monitoring of the cable system and installation of two 1kW pulse tube coolers.

Cable Used

AEP Tri-axial HTS cable – The cable consists of three concentric superconducting phases made of BSCCO-2223 HTS tape that are separated by layers of Cryoflex™ cold-dielectric tape, which provides the phase-to phase electrical insulation.



13.2 kV, 69MVA Triax cable design
(Southwire, 2008)

Project Accomplishments

- ½ HTS tape usage means substantially cheaper
- Smaller cold surface area equates to lower cooling and operating costs
- Single conductor equals simplified manufacturing and installation



Southwire Triax Cable Termination
(Southwire, 2008)

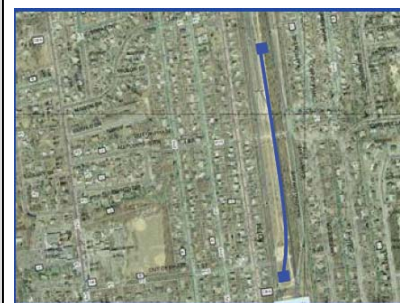
Columbus Team Includes: ULTERA a team derived of Southwire and nkt cables of Denmark, American Electric Power, Oak Ridge National Laboratory, Praxair and American Superconductor.

Long Island

On April 22, 2008 American Superconductor Corporation (AMSC) and its partners energized the world's first high temperature superconducting transmission-voltage power cable system in a commercial power grid. AMSC's partners included Long Island Power Authority (LIPA), Nexans, Air liquide and the Department of Energy (DOE). The 138,000 volt (138kV) system consists of three individual HTS power cable phases running in parallel. Since being energized, the system has operated successfully. When operating at full capacity, the HTS cable system is capable of transmitting up to 574 megawatts (MW) of electricity, enough to power 300,000 homes.

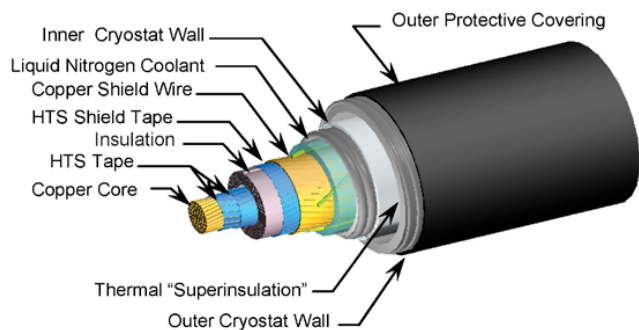
Phase II of Long Island Cable Project

Phase II of the project consists of an extension of the cable system by replacing one of the existing cables with a 600-meter long cable made with AMSC's proprietary 344 superconductors, also known generically as 2G HTS wire. The project is expected to be completed March 2010.



LIPA Project site location
(American Superconductor, s008)

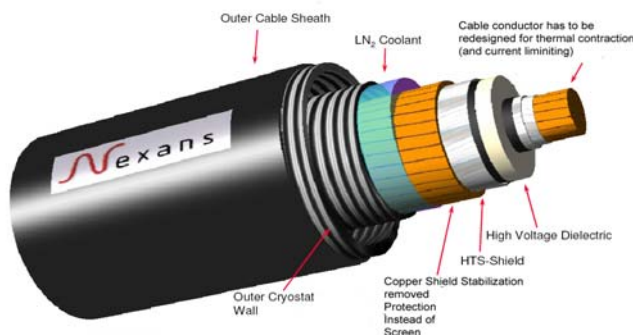
Long Island Cont. Cable Used



PHASE 1

138kV HTS cable
(American Superconductor, 2008)

PHASE 2—LIPA HTS Cable Concept (American Superconductor, 2008)

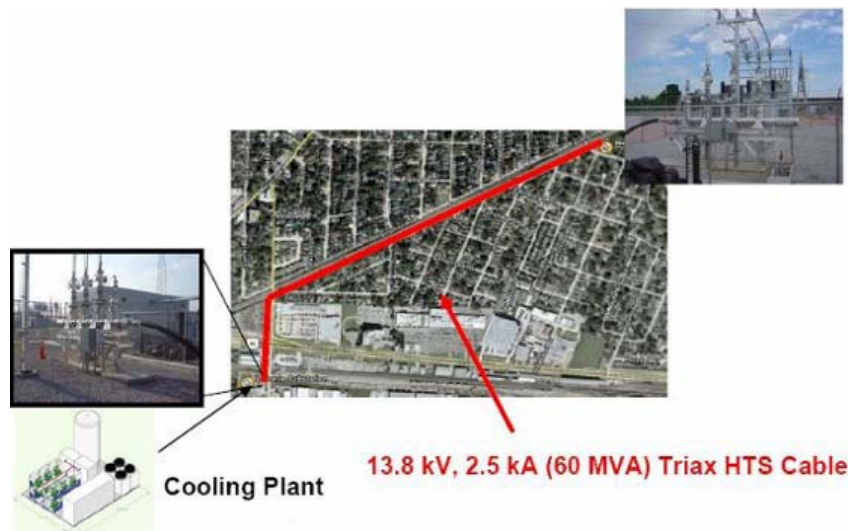


Long Island Team
Includes: American
Superconductor,
Nexans, Air Liquide,
Long Island Power
Authority

New Orleans

June 2007, the Department of Energy announced that it would provide \$51.8 million for five cost-shared projects to help accelerate the modernization of the Nation's electrical grid. One of these projects is in New Orleans. Southwire Company will use 13.8 kilovolt superconducting cable to connect two existing substation sites in greater New Orleans. This project will solve a real-world electrical load problem, specifically, eliminating congestion on the power grid caused by high demands for electricity. The cable project will also demonstrate commercial viability for long length HTS cables in a utility grid. The cable will connect the La-Barre and Metairie substations, owned by Entergy Corporation of New Orleans. The full team includes DOE's Oak Ridge National Laboratory and nkt cables of Germany. The project is in design phase now and is expected to be energized in 2011.

New Orleans Team
Includes: Southwire,
DOE's Oak Ridge
National Laboratory,
Entergy Corporation
and nkt cables of
Germany



New Orleans HTS Project Overview
(Southwire, 2008)

New York City—A.K.A. Project Hydra



The Resilient Electric Grid (REG) program, also known as Project Hydra, intends to demonstrate a prototype Inherent Fault Current Limiting High Temperature Superconductor (IFCL-HTS) Cable in the existing NYC-Manhattan power grid. The IFCL-HTS cable will provide a redundant connection between 2 substations, enabling them to share excess capacity during emergencies. The prototype will demonstrate attributes required by urban utilities, such as high current capacity (approximately 4000 amps), voltage withstand (13.8 kV) and current limiting capabilities (rapidly limiting 40 kA to less than 20 kA).

**Hydra Team
Includes:
American
Superconductor,
Con Edison,
Southwire, and
Department of
Homeland
Security**

Superconducting technologies were chosen in part because they offer sufficient power density to fit in available underground real estate in dense urban areas like New York City. Additionally, using HTS cable to link substations in the grid allows area substations to share excess capacity in emergencies, increasing electrical grid resilience and providing a more secure delivery network. The inherent fault current limiter allows substations to be continuously connected under normal and contingency conditions and limits current flow between substations during fault conditions, thereby preventing cascading failures. This new, internet-like electric grid architecture provides multiple paths for delivering power to and between sub-grids, adding resilience to the critical electrical infrastructure.

A proof of concept test for a 3 meter IFCL-HTS cable was successfully completed earlier this year (2008). Testing of the cable proved that it remained superconducting while carrying 4,000 amps and demonstrated FCL capability at more than 9,000 amps. Another set of tests subjected the IFCL-HTS to an alternating current (AC) fault of 7,200 amps for 2 seconds to measure the cable's reaction to long-duration, high current faults. The cable rode through the fault and successfully provided the expected current limiting.

Demonstration and testing of a 25 meter IFCL-HTS cable is planned for early 2009 for an overall Technology Readiness Level of 5. The final in-grid 300 meter prototype demonstration is planned for 2010 in Manhattan.

The prime contractor for Project Hydra is American Superconductor, who is developing the IFCL-HTS cable. Subcontractors include Southwire, and Consolidated Edison, who is the host utility for the in-grid prototype.

For further information regarding this program, please contact Patrick Murphy, 703-338-5528.

Conclusion

HTS cable projects demonstrate the potential superconductivity plays in the modernization of our electrical power grid. The cable projects show the reliability, security, and potential benefits they would bring to our aging electrical infrastructure. These cable projects also lead one step closer to full commercialization and utilization of HTS cable and system technology.

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Traute Lehner	Superpower, Inc.	518-346-1414	tlehner@superpower-inc.com
Chuck Weber	Superpower, Inc.	518-346-1414	cweber@igc.com
David Lindsay	ULTERA/Southwire	770-832-4916	david_lindsay@southwire.com
Jason Fredette	American Superconductor	978-842-3177	jfredette@amsc.com
Patrick Murphy	Department of Homeland Security	703-338-5528	patrick.m.murphy@dhs.gov
Sarah Mahmood	Department of Homeland Security	202-254-6721	Sarah.Mahmood@associates.dhs.gov

ABOUT THIS UPDATE

The High-Temperature Superconductivity News Update is compiled by Bob Lawrence & Associates Inc. on behalf of the Department of Energy's superconductivity program and is issued periodically as events warrant. Current and past issues are available at <http://www.superconductivitynewsupdate.com/>.

Please let me know if you would like more information or story ideas on any of these news items involving high-temperature superconductivity---a clean and capable new electricity technology for the 21st century. If you have any other comments or questions, please let me know.

Thank you very much.

Jodi Hamrick

703-836-3654

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