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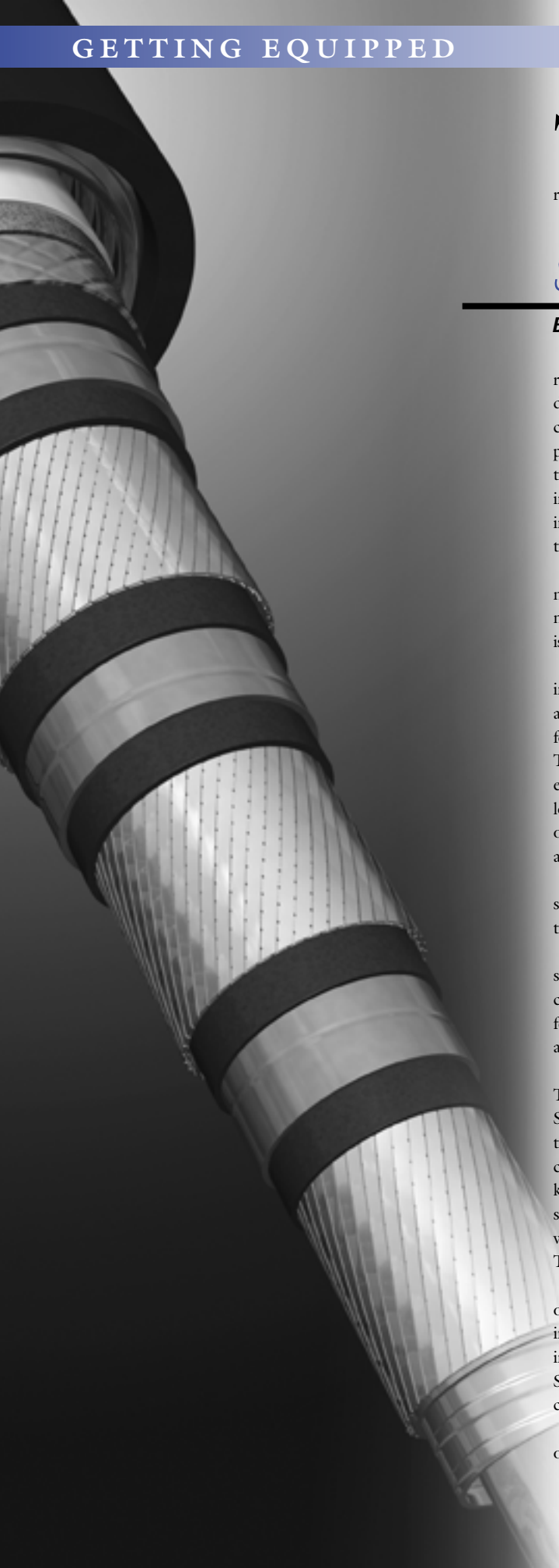

The past few summers have seen much ink spilled over the shortcomings of the U.S. power grid. Each heat wave brings a greater threat of brownouts, blackouts and—from a utility standpoint—the very real potential for a costly public relations nightmare.

Questions then abound about the causes and what actions will be taken to remedy the problem. Utilities, of course, face the harshest criticism, as evidenced by the July 2006 blackout in Queens, N.Y. Only lately has any press coverage been devoted to the increased strains placed on the grid thanks to the proliferation of air conditioners, PC's, plasma televisions and iPods. According to a recent Energy Information Administration report, electricity consumption in the U.S. is expected to increase by another 41 percent by 2030. Investment in the grid is now on the rise, and new products are coming out of the pipeline to meet these 21st century electricity demands.

Superconductor Power Cables For Sale

By Chuck Stankiewicz, AMSC (American Superconductor Corp.)

High-temperature superconductor (HTS) cables are one of the emerging technologies that's likely to have great impact. With the ability to carry many times more current than copper cables, HTS systems have long held tremendous promise, particularly for systems in congested urban and metropolitan areas.

High-temperature superconductors are ceramic materials that were discovered in 1986 by two IBM scientists. These materials are able to carry a tremendous amount of power with virtually no resistance. The first decade of HTS research focused on how to make a brittle ceramic material into a durable electrical wire. The second decade of research focused on how to apply the tremendous benefits of this wire in different applications. Power cables, of course, were the most logical candidate. Numerous power cable demonstrations have been undertaken over the past 10 years, and, today, at least 10 HTS cable projects are ongoing around the world.

Now in its third decade of existence, HTS is transitioning from a research stage to commercialization. The year 2006 was a time of emergence for HTS technology as several critical milestones were achieved:

In Albany, N.Y., a distribution-level HTS cable between two National Grid substations was formally energized. This 34.5-kV, 350-meter-long cable was commissioned in National Grid's system and has now been running successfully for nine months. Japan-based Sumitomo Electric Industries is the HTS wire and cable supplier for this program.

Another distribution-level cable was energized near Columbus, Ohio. The Columbus project was the first demonstration of a new cable design, Southwire's patented Tri-axial HTS cable design, which dramatically reduces the cost of superconductor systems and brings the technology much closer to commercial viability. This cable, which is 200 meters long and operates at 13.8 kV, has been serving 8,600 of American Electric Power's (AEP) local residents since August 2006. Ultera, a joint venture between Southwire and nkt cables, was project lead in Columbus, manufacturing, installing and terminating the Triax HTS cable, utilizing HTS wire supplied by American Superconductor.

Also in August 2006, ground was broken on Long Island for the installation of the world's most powerful HTS cable. The 138-kV system being installed in Long Island Power Authority's (LIPA) network is nearly one-half mile in length and is scheduled to be commissioned in summer 2007. American Superconductor is the HTS wire supplier for this program, and Nexans is the cable provider.

These projects, along with the seven others ongoing in other key markets outside of the U.S., provide a compelling body of evidence about the advan-

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tages of HTS cable systems. These include:

- **Increased power density:** One HTS cable can carry up to 18 times the amount of power as a copper cable of equivalent size. This frees up significant space in existing conduits and significantly reduces installation costs for new installations.
- **Improved grid security:** Certain key features of HTS cables, including its underground location and variable impedance in response to overloads, help make power grids more secure and self-protecting from potential external threats such as natural disasters and terrorist attacks.
- **Higher efficiency:** The inherently high electrical efficiency of HTS circuits translates into total energy savings, net of cooling requirements, particularly for lines that operate at a high capacity factor.
- **Reduced costs:** The ability to leverage existing power cable conduits and avoid taking land through eminent domain proceedings can shorten a project's implementation schedule and lead to cost savings. Non-cable construction costs typically represent 75 percent or more of the cost of an urban power cable installation. In addition, by using ecologically friendly liquid nitrogen in the cooling process, the threat of environmental damage and costly litigation and cleanup is virtually nonexistent.
- **Less regional congestion:** At present, regional grid bottlenecks impose economic penalties on consumers that can be measured in the hundreds of millions or even billions of dollars on a region-wide basis. New grid technologies like HTS cables could play a key role in achieving Congress's vision of a more competitive wholesale power marketplace.
- **Longer system life:** Heat resulting from overcapacity is the primary cause of failure in urban power delivery systems. Over time, high cable loadings degrade cable insulation and can cause conductors to anneal. HTS cables can be surgically implanted in certain critical parts of the grid, thereby extending the life of conventional system elements. This approach improves overall asset utilization and defers the need for larger-scale overhauls of aging and worn-out grid infrastructure.
- **Greater siting flexibility:** The low impedance of HTS cables enables more flexible placement of generators, allowing them to be moved away from urban load centers (reducing land, labor and other costs) while furnishing robust voltage support.

The HTS wire industry is ramping up production to make these systems cost competitive with their copper counterparts. One of the greatest advances in HTS wire technology has been the emergence in recent years of what the industry is calling second generation, or 2G, wire. While a commercially available first-generation wire is able to carry 150 times more direct current than a copper wire of the same dimension, the high production cost of this wire presented an enormous obstacle to mainstream adoption. Companies are now producing 2G wire with production lines that are able to reduce costs by five times when compared with first-generation wire.

In parallel with this scale-up, of course, the price of copper has risen significantly. With continued improvements in manufacturing efficiency and capacity, it is expected that 2G wire will reach a price-performance ratio equivalent with copper for underground cable applications within the next three years. This is sure to accelerate the adoption cycle of HTS technology.

HTS is Ready for Prime Time

The shift from the controlled environment of the laboratory to the demanding, results-driven world of the utility substation has taken place. So what does the future hold for HTS power cables? There is no doubt that the demands placed on our utility grid will continue to grow; the only question remaining is to what extent. With plug-in cars and numerous other advances on the horizon, utilities need to brace themselves for the next step up in electricity needs.

Investment in the grid is ongoing and on the rise. According to a recent Edison Electric Institute report, utilities have recognized their challenges and are opening their purse strings. In 2007, spending is expected to increase 16 percent to nearly $8 billion, and current spending levels are 65 percent higher than they were when the Northeast blackout of 2003 occurred. Unfortunately, the vast majority of spending is being aimed at traditional products intended for yesterday's energy needs.

HTS-based power cables offer a practical and sensible solution to our growing energy challenge. The Department of Energy continues to support the technology's advancement and will soon be awarding contracts for a record-sized HTS cable project. Governments and utilities in various countries such as China, Japan, South Korea and Mexico also are supporting and deploying these products.

Meanwhile, HTS costs are declining rapidly as HTS wire manufacturers increase production and cable manufacturers expand their product portfolios. Corporations are now offering these systems on a commercial basis, and cryogenics equipment manufacturers are offering compelling warranties. The public is calling for action. All that is needed now are more utilities like National Grid, LIPA and AEP that are willing to boldly go where others have gone before. An affordable and powerful solution is ready to meet today's electricity demands. «

Stankiewicz is senior vice president at AMSC Power Systems. He joined AMSC in July 1998 as general manager of the company's Power Electronic Systems business unit based in Middleton and New Berlin, Wis. Prior to joining AMSC, Stankiewicz held senior electric power industry positions in engineering, sales and business development with ABB and Westinghouse Electric. A New Jersey native, he holds a B.S. degree in mechanical engineering from Duke University.