High-Temperature Superconductors:
Meeting Global Electricity Demands

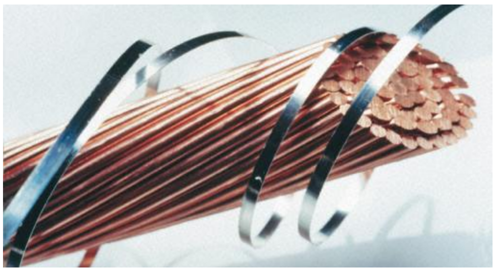
The International Energy Agency's (IEA) *Implementing Agreement for a Co-Operative Programme for Assessing the Impacts of High-Temperature Superconductivity on the Electric Power Sector* has conducted detailed studies for experts of its topic. Because of the increasing promise of superconductivity, the IEA Agreement prepared this document for ready reference by citizens and policy makers in the Agreement's member countries.

The modern world depends on electric power today more than ever. It has long provided light and power. Now, electricity enables communication, record keeping, computation, accounting, and information retrieval for all aspects of business, finance and medicine, as well as our personal lives. The internet, mobile phones, and personal computers would not be everywhere desired without affordable and reliable electricity. All these uses drive the wish for more electric power in both the developed world and the developing world.

As a result, the International Energy Agency and the U.S. Department of Energy each project the world's electricity consumption will double by 2030. Much this increase is projected to occur in the developing world. More than one trillion dollars of new electrical equipment will be built, sold and installed—an important commercial opportunity.

Not just more, but better electrical equipment is wanted for reasons that are discussed among the world's experts: uncertain reliability; fear of profound environmental impacts, near and long term; as well as sheer lack of availability of infrastructure and fuel.

The world's utilities are virtually unanimous in their agreement that, if successfully developed, a superconducting "fault current limiter" would offer reliability increases that are available from no other equipment by enabling utilities to better handle short-circuits. If and when successfully developed, superconducting transformers would offer a combination of increased overload capability, decreased fire hazard, and decreased size and weight that will make them valuable in cities. Superconducting underground electric power transmission cables promise to transmit more power into



A tiny HTS tape, as shown, may replace the bulky copper in today's equipment, enabling smaller, lighter, safer, more efficient, future power equipment.

densely populated cities where space is limited and valuable, and concerns with environment, safety and health are paramount. Indeed, prototype High-Temperature Superconducting transmission cables are being developed and tested in China, Korea, Japan, Western Europe, Russia and the US, where three different demonstration cables now provide electricity to homes, commercial, and light industrial buildings.

Sumitomo's HTS "triplex cable"

Concerns over the environmental impacts of either hydro-carbons or fissionable material (i.e., uranium and plutonium), which fuel conventional generating stations, prompt governments to fund research and development for the long term success of fusion, a technology that depends on superconductivity. Others seek nearer term alternatives from renewable energy, particularly the near-term generation of electric power by wind. Europe has led the way in demonstrating wind's technical feasibility but

On 8 August 2006, a Southwire-NKT collaboration began demonstrating a prototype HTS cable (3 kA, 13.2 kV) of new design on the grid in Columbus, Ohio.

wind remains more expensive and less reliable than conventional generation. A key to greater use is lowering cost by building more powerful off-shore wind turbines. High-Temperature Superconductors offer the prospect of lighter, more powerful generators that can be supported by today's off-shore infrastructure thus, lowering the cost of the project and so reducing the cost of electricity from wind. Indeed, a European project is underway to explore this attractive possibility.

The benefits of High-Temperature Superconductivity have not escaped the attention of others. Maritime interests have also involved themselves in the development. A European project to develop a shipboard fault current limiter is underway, as well as other projects in Europe, Japan and the USA to develop ship motors and generators. The most powerful (36.5 MW) of these is being built for the US Navy.

Distribution Voltage Fault Current Limiter demonstrated successfully by the EC-funded CURL10 project.

High-Temperature Superconductivity has come a long way since its discovery in 1986. In this short time, the technology has progressed from basic materials research, to laboratory testing, and, in many cases, to large-scale demonstrations of pre-commercial equipment.

Yet much remains to be accomplished. Young engineers and scientists must be funded to advance the field. They must continue to improve performance and lower cost before the promise of High-Temperature Superconductivity can be realized in commercial applications.

HTS enables smaller, lighter, more efficient rotating machines (motors, generators and synchronous compensators) with hitherto unattainable performance. After years of tests, TVA ordered several of AMSC's SuperVar machines to increase the stability and power quality on TVA's system.

Cost sharing between the public and private sectors will encourage the best use of resources to further practical ends. Task-sharing among the private sector, government laboratories and research universities will promote cooperation among researchers with diverse training and complementary facilities that is necessary for progress. With appropriate public and private investment, high temperature superconductors can become commercially attractive and address the world's energy and environmental concerns.

High-Temperature Superconductivity Agreement

The International Energy Agency's *Implementing Agreement for a Co-Operative Programme for Assessing the Impacts of High-Temperature Superconductivity on the Electric Power Sector* draws its participants from the following countries:

Canada
Hydro-Quebec, Montreal

Finland
Univ. of Tampere, Tampere

Germany
FZK, Karlsruhe
Siemens, Erlangen

Israel
Ministry of National Infrastructure, Jerusalem

Italy
CESI RICERCA, Milano

Japan
NEDO, Kawasaki

Norway
Nexans, Oslo

Republic of Korea
KEPRI, Taejon

Sweden
Elforsk, Stockholm

Switzerland
Univ. of Genève, Genève

United Kingdom
Dept of Trade and Industry, London

United States
Dept. of Energy, Washington, DC

For more information:

Dr. Alan M. Wolsky, Operating Agent
IEA Implementing Agreement on HTS
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439-4815 USA

Phone: +1 630 252-3783
Fax: +1 630 252-1677
Email: AWolsky@ANL.gov

Prof. Guy Deutscher, Chmn of ExCo
IEA Implementing Agreement on HTS
Raymond and Beverly Sackler
Faculty of Exact Sciences
Tel Aviv University
Ramat Aviv 69978 ISRAEL

Phone: +972 3 640 8636
Fax: +972 3 642 2979
E-mail: GuyDe@post.tau.ac.il

For an introduction to the Agreement's work, visit

http://spider.iea.org/tech/scond/scond.htm

May 2007