SUPERCONDUCTIVITY

PROGRAM FOR

ELECTRIC SYSTEMS ...

RESEARCH

AND DEVELOPMENT

SUPERCONDUCTIVITY PROGRAM RESEARCH AND DEVELOPMENT

High Temperature Superconductivity (HTS) is a technology with the potential to significantly increase the efficiency of the electric power industry. Some of the possible benefits include reduction in pollution from electric generating facilities, better electric system reliability, and better power delivery systems in urban areas without new rights-of-way. The Department of Energy's efforts to advance High Temperature Superconductivity combine major national strengths: private sector entrepreneurship, leading university research, and the resources of the National Laboratories.

Cost-sharing agreements allow the program to leverage funds, maximizing research and development achievements. This on-going program has offered competitive opportunities for three major program thrust areas: the Superconductivity Partnership Initiative (SPI), the 2nd Generation Wire Initiative, and Strategic Research.

SUPERCONDUCTIVITY PARTNERSHIP INITIATIVE
LARGE SCALE ELECTRIC TECHNOLOGIES

Participants in this program element are asked to consider new approaches to bring HTS technology to the marketplace. Several projects demonstrating pre-commercial utility applications of HTS technology have emerged and new projects are being developed including transmission cable and power transformer designs, a flywheel electrical system, and a reciprocating magnetic separator project.

SECOND GENERATION WIRE INITIATIVE
SCALING UP NATIONAL LABORATORY DISCOVERIES

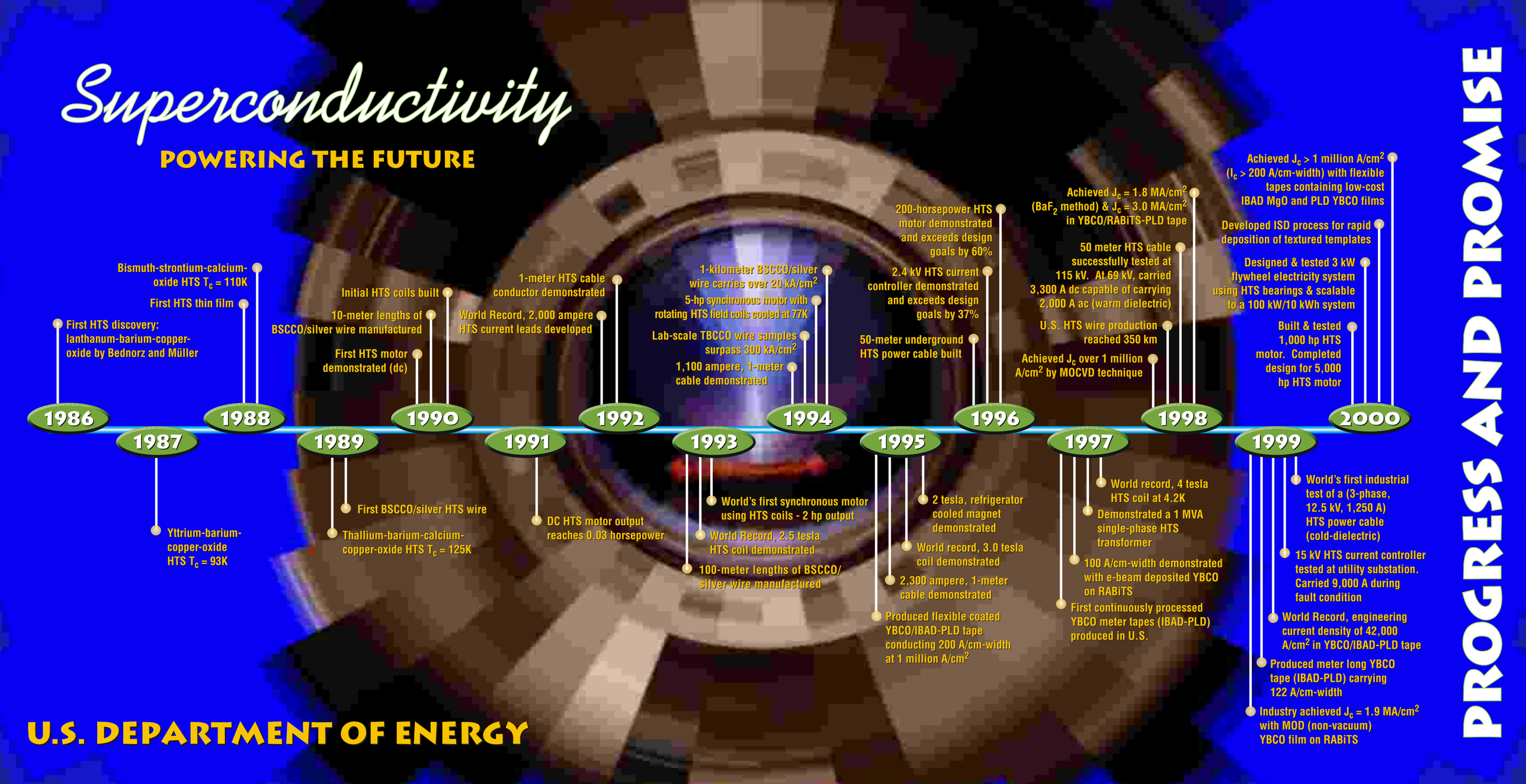
This part of the program is aimed at completing research needed for U. S. industry to scale-up new superconducting wire manufacturing processes. Innovative approaches discovered at National Laboratories are being developed into commercially viable processes by public companies. Only short lengths of second-generation wire have been produced thus far, but the performance is far better than any existing wire and the cost-savings potential is significant. The goal is to enable U.S. industry to manufacture long-length wire, suitable for wide-spread use in industrial and commercial settings.

STRATEGIC RESEARCH SOLVING FUNDAMENTAL PROBLEMS

National Laboratories also engage in research aimed at investigating underlying principles of superconductivity and to address fundamental technological issues. A close working relationship between the National Labs and academia ultimately benefits both organizations through the use of university expertise and facilities that, in turn, strengthen and expand the National Laboratories' capabilities.

PROGRESS AND PROMISE

With the support of the Department of Energy, the Superconductivity Program has realized over a decade of far-reaching discoveries and achievements. Continued DOE support for Industry, Academia and National Laboratory partnerships promises realization of the program's goals for cost effective, reliable, and environmentally friendly energy technologies in the 21st century.


Superconductivity
POWERING THE FUTURE
PROGRESS AND PROMISE
1986
First HTS discovery: lanthanum-barium-copper-oxide by Bednorz and Müller
1987
Yttrium-barium-copper-oxide HTS T_c = 93K
1988
Bismuth-strontium-calcium-oxide HTS T_c = 110K
First HTS thin film
1989
First BSCCO/silver HTS wire
Thallium-barium-calcium-copper-oxide HTS T_c = 125K
1990
Initial HTS coils built
10-meter lengths of BSCCO/silver wire manufactured
First HTS motor demonstrated (dc)
1991
DC HTS motor output reaches 0.03 horsepower
1992
1-meter HTS cable conductor demonstrated
World Record, 2,000 ampere HTS current leads developed
1993
World's first synchronous motor using HTS coils - 2 hp output
World Record, 2.5 tesla HTS coil demonstrated
100-meter lengths of BSCCO/silver wire manufactured
1994
1-kilometer BSCCO/silver wire carries over 20 kA/cm²
5-hp synchronous motor with rotating HTS field coils cooled at 77K
Lab-scale TBCCO wire samples surpass 300 kA/cm²
1,100 ampere, 1-meter cable demonstrated
1995
2 tesla, refrigerator cooled magnet demonstrated
World record, 3.0 tesla coil demonstrated
2,300 ampere, 1-meter cable demonstrated
Produced flexible coated YBCO/IBAD-PLD tape conducting 200 A/cm-width at 1 million A/cm²
1996
200-horsepower HTS motor demonstrated and exceeds design goals by 60%
2.4 kV HTS current controller demonstrated and exceeds design goals by 37%
50-meter underground HTS power cable built
1997
World record, 4 tesla HTS coil at 4.2K
Demonstrated a 1 MVA single-phase HTS transformer
100 A/cm-width demonstrated with e-beam deposited YBCO on RABiTS
First continuously processed YBCO meter tapes (IBAD-PLD) produced in U.S.
1998
Achieved J_c = 1.8 MA/cm² (BaF_2 method) & J_c = 3.0 MA/cm² in YBCO/RABiTS-PLD tape
50 meter HTS cable successfully tested at 115 kV. At 69 kV, carried 3,300 A dc capable of carrying 2,000 A ac (warm dielectric)
U.S. HTS wire production reached 350 km
Achieved J_c over 1 million A/cm² by MOCVD technique
1999
World's first industrial test of a (3-phase, 12.5 kV, 1,250 A) HTS power cable (cold-dielectric)
15 kV HTS current controller tested at utility substation. Carried 9,000 A during fault condition
World Record, engineering current density of 42,000 A/cm² in YBCO/IBAD-PLD tape
Produced meter long YBCO tape (IBAD-PLD) carrying 122 A/cm-width
Industry achieved J_c = 1.9 MA/cm² with MOD (non-vacuum) YBCO film on RABiTS
2000
Achieved J_c > 1 million A/cm² (I_c > 200 A/cm-width) with flexible tapes containing low-cost IBAD MgO and PLD YBCO films
Developed ISD process for rapid deposition of textured templates
Designed & tested 3 kW flywheel electricity system using HTS bearings & scalable to a 100 kW/10 kWh system
Built & tested 1,000 hp HTS motor. Completed design for 5,000 hp HTS motor
U.S. DEPARTMENT OF ENERGY