



Board Meeting

18 June 2003

New York City

# The SuperGrid: Combined Delivery and Storage of Electricity and Hydrogen

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<ftp://grant:marulo@ftp.epri.com/Nat%20Lab%20SuperGrid%20Proposal/>



# Board Meeting

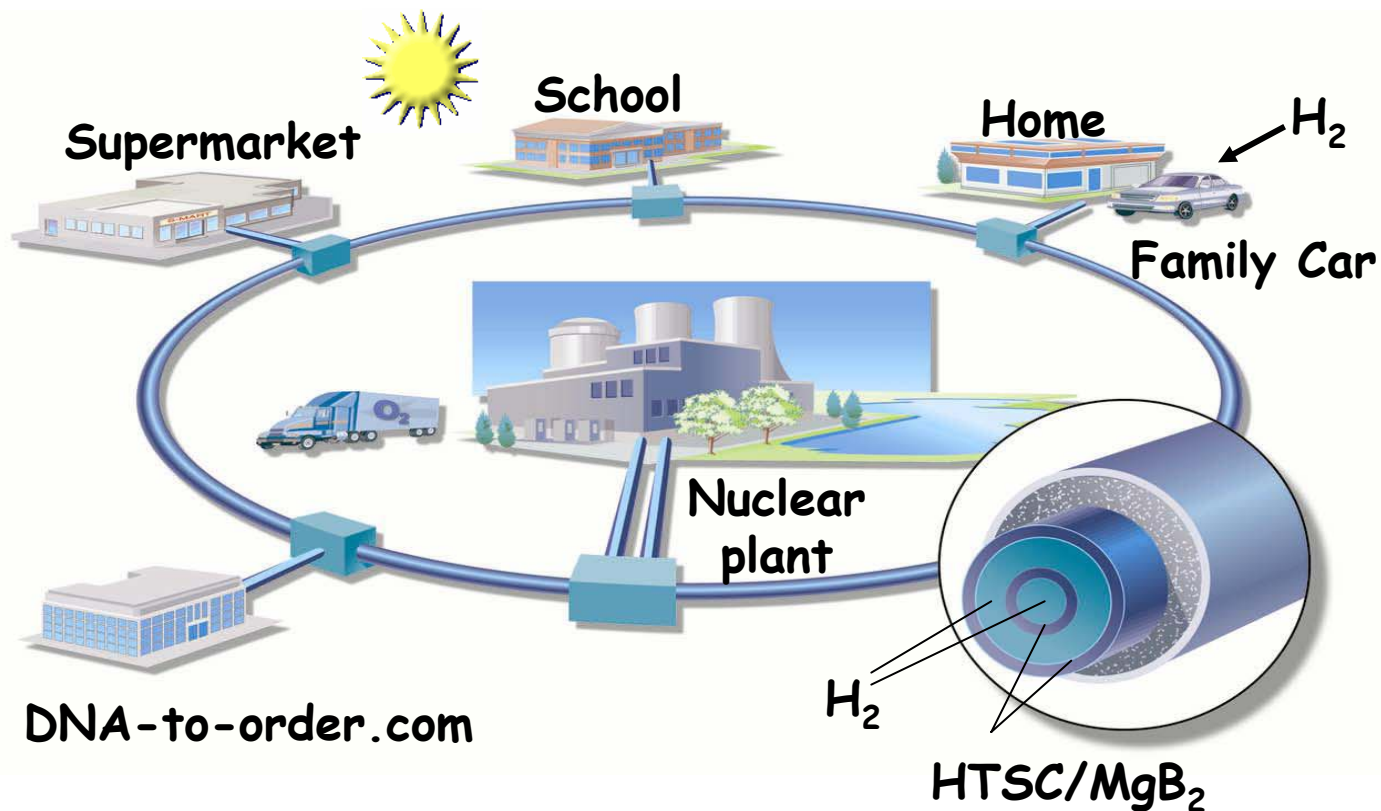
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CCAS

Coalition for the  
Commercial Application  
of Superconductors

# SuperCity



P.M. Grant, *The Industrial Physicist*, Feb/March Issue, 2002

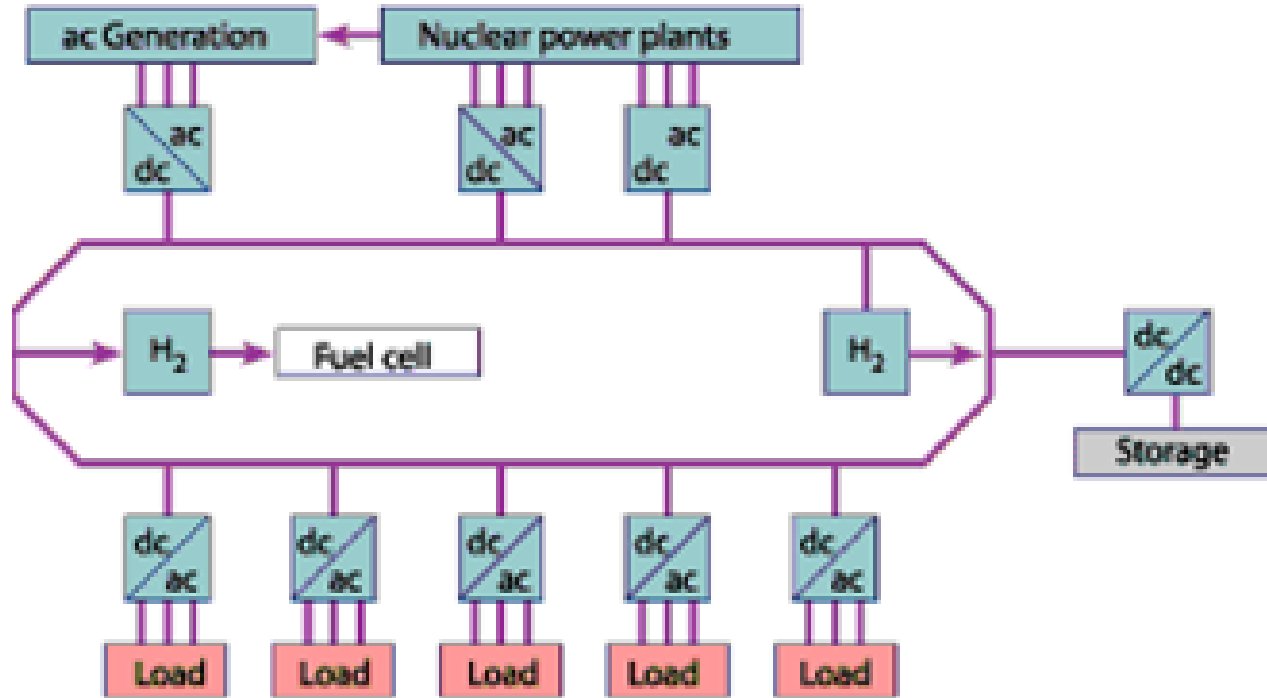
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EPRI

The SuperGrid: Combined Delivery and Storage of Electricity and Hydrogen

Paul M. Grant

# SuperGrid



## Continental SuperGrid

“Continental SuperGrid Workshop,” UIUC/Rockefeller U., Palo Alto, Nov. 2002

<ftp://grant:marulo@ftp.epri.com/Energy%20SuperGrid%20Workshop%20Proceedings/>

<http://www.epri.com/journal/details.asp?doctype=features&id=511>

Board Meeting

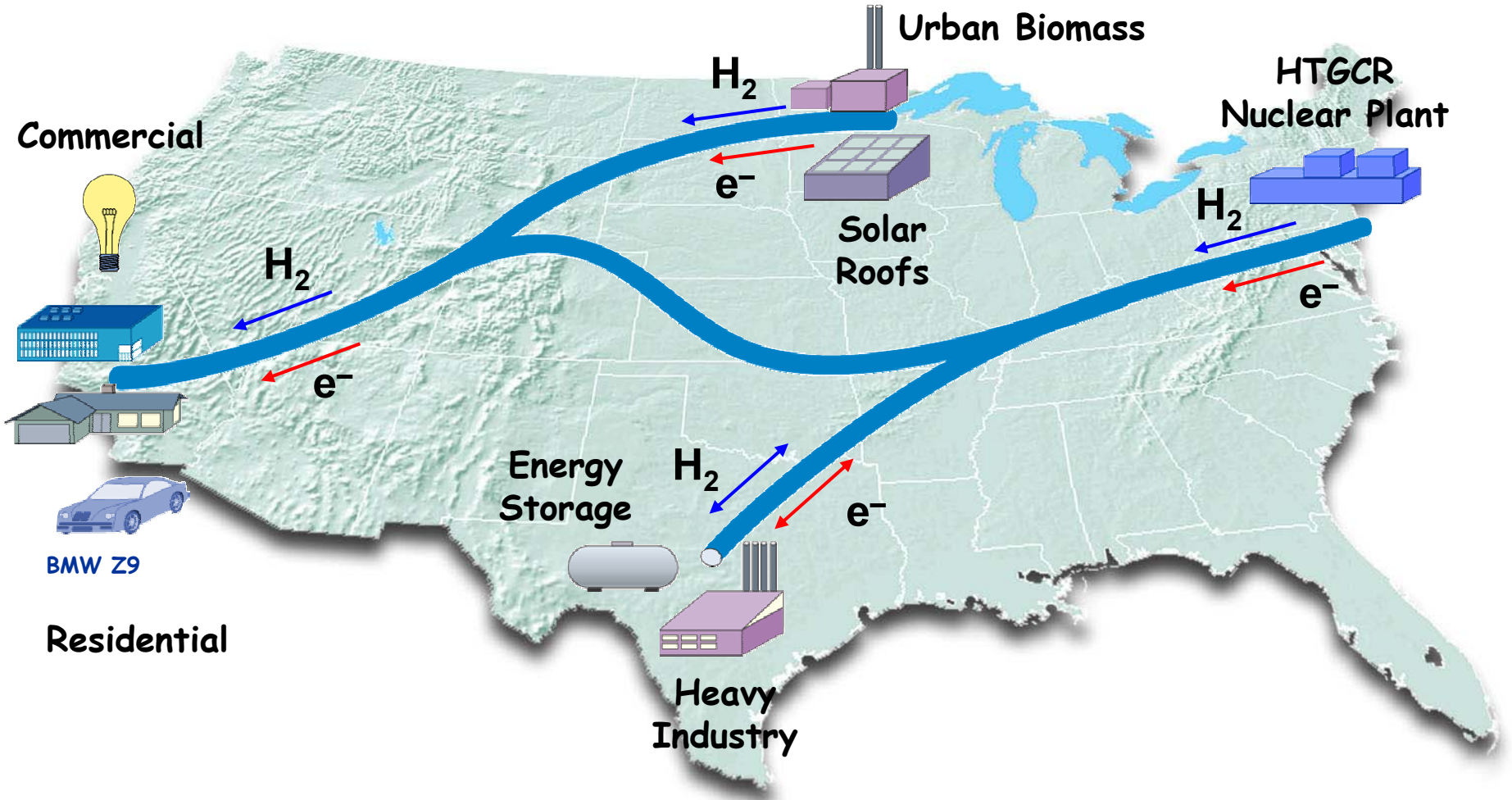
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# North American 21st Century Energy SuperGrid



EPRI

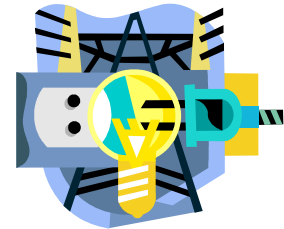
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# Architecture

## Three Dimensions

- **SuperGrid** – A superconducting, H<sub>2</sub>-cooled interstate “backbone” connecting regions coast to coast.
- **RegionGrid** – Two grid operators (East and West) with upgraded high capacity lines to transmit power regionally.
- **CityGrid** – Local mini- and micro-grids with distributed intelligence, energy resources, and demand response



Integrated systems architecture enables  
**NationalGrid** operations across all dimensions.



# Garwin-Matisoo (IBM, 1967)

100 GW dc, 1000 km !

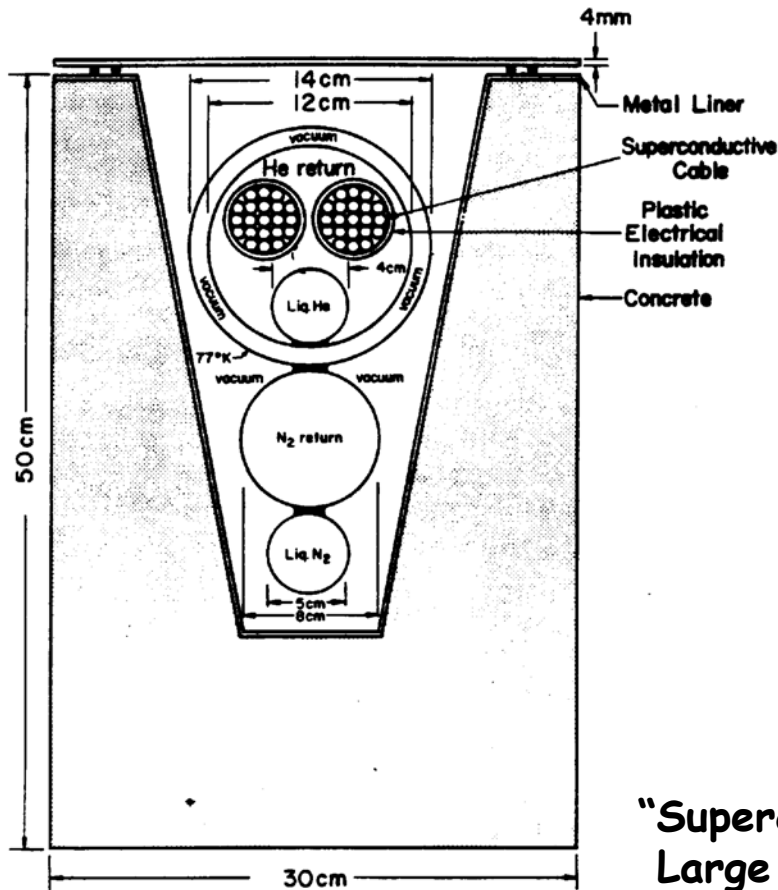


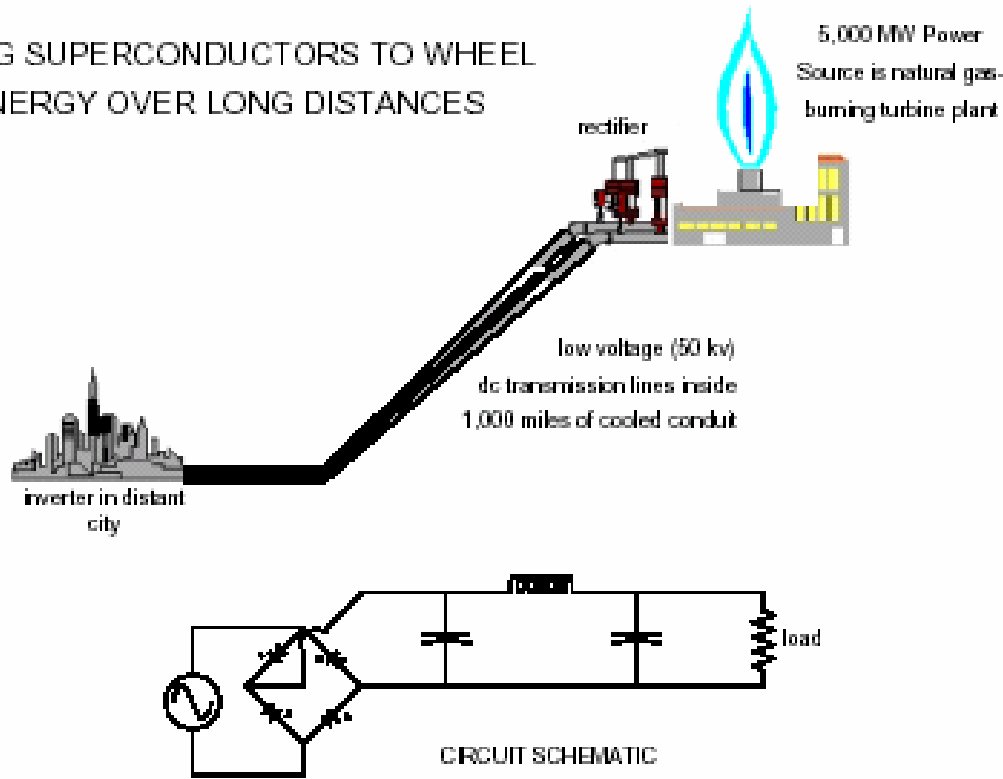
Fig. 1. Cross section of the 100-GW line.

"Superconducting Lines for the Transmission of Large Amounts of Electric Power over Great Distances,"  
R. L. Garwin and J. Matisoo, Proc. IEEE 55, 538 (1967)

- Nb<sub>3</sub>Sn Wire
- T<sub>c</sub> = 9 K
- LHe liquid-vapor cooled
- LN<sub>2</sub> heat shield

# Electricity Pipe

USING SUPERCONDUCTORS TO WHEEL  
ENERGY OVER LONG DISTANCES

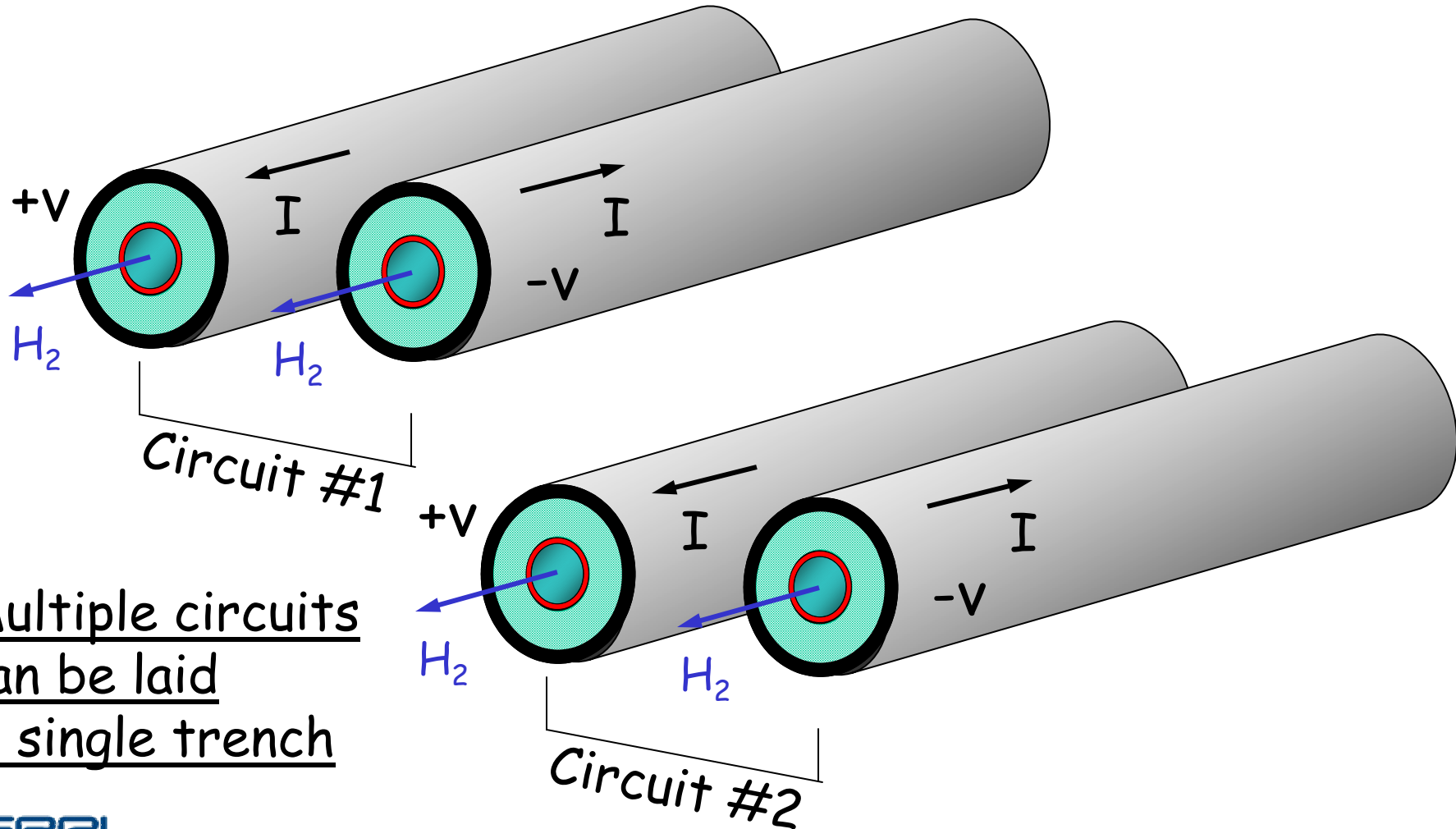


Initial EPRI study on long distance (1000 km) HTSC dc cable cooled by liquid nitrogen -- 1997 --

**P.M. Grant, S. Schoenung, W. Hassenzahl, EPRI Report 8065-12, 1997**

<ftp://grant:marulo@ftp.epri.com/Nat%20Lab%20SuperGrid%20Proposal>

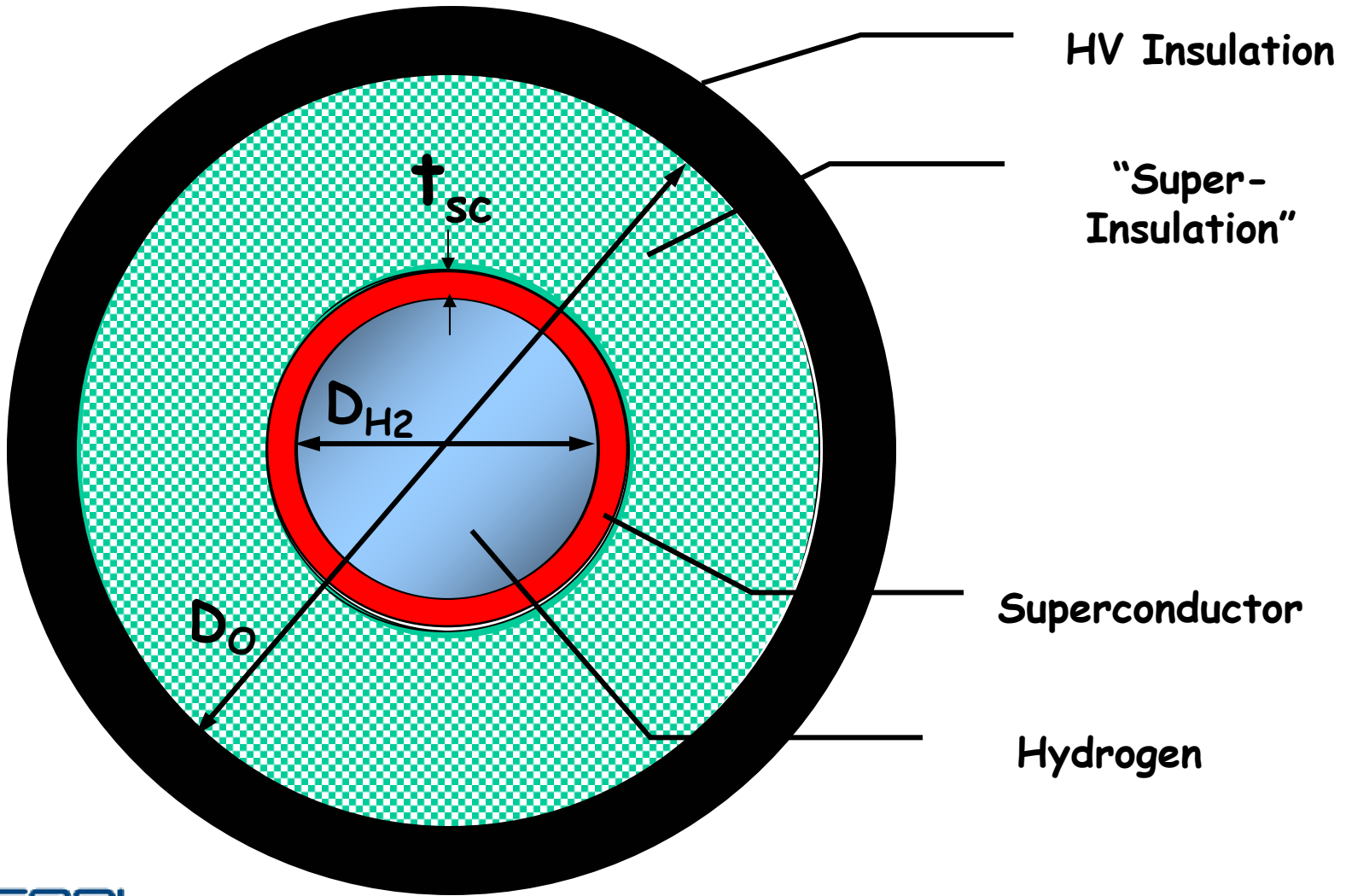
# SuperCables



Multiple circuits  
can be laid  
in single trench



# SuperCable



# Electric & H<sub>2</sub> Power

## Electricity

Power (MW)	Voltage (V)	Current (A)	Critical Current Density (A/cm <sup>2</sup> )	Annular Wall Thickness (cm)
1000	+/- 5000	100,000	25,000	0.125

## Hydrogen (LH<sub>2</sub>, 20 K)

Power (MW)	Inner Pipe Diameter, D <sub>H<sub>2</sub></sub> (cm)	H <sub>2</sub> Flow Rate (m/sec)	"Equivalent" Current Density (A/cm <sup>2</sup> )
500	10	3.81	318

# Remaining Issues

- Current stabilization via voltage control
- Cryogenic power electronics
- Hydrogen gas cooling and transport
- Hydrogen storage
- Prototyping
- Costs
- Initial Demonstration Site

# S.14 Opportunity

- S.14 - Senate Energy Omnibus Bill
  - FY04 \$15 M Authorization For OETD R&D
  - Section 927(e)(C):
    - *"Facilitate commercial transition toward direct current power transmission, storage, and use for high power systems utilizing high temperature superconductivity."*
- FY04 National Lab Study targeting prototype SuperCable by FY05 and beyond (\$10 M ?)