





Tulsa, OK 10/20/2003

# The Energy SuperGrid

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# Power Outage



**"We are sick  
and tired of  
them, and they  
had better  
change!"**

*Chicago Mayor  
Richard Daley on  
the August 1999  
Blackout*



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# NYC 14 August 2003



The Energy SuperGrid - Paul M. Grant, 20 September 2003

EPRI



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Brothers and sisters!  
I want to tell you this.

The greatest thing on earth is to have the love of  
God in your heart...

*and the next greatest thing is to have electricity in  
your house!*



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# Prologue: Two Energy Lemmas

- I. Any discussion of the application of energy technology must involve, from the very start, an explicit social and political scenario
  
- II. The unique aspect of energy as a life-sustaining necessity separates it from the jurisdiction of many of the usual "laws" of economics

# The Challenge

*Design a communal energy economy to meet the needs of a densely populated industrialized world that reaches all corners of Planet Earth.*

*Accomplish all this within the highest levels of environmental, esthetic, safe, reliable, efficient and secure engineering practice possible.*

*...without requiring any new scientific discoveries or breakthroughs*



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# The Vision

***A Symbiosis of  
Nuclear/Hydrogen/Superconductivity  
Technologies yielding Carbon-free,  
Non-Intrusive Energy for an  
Industrialized Planet Earth***



# Diablo Canyon



# Diablo Canyon

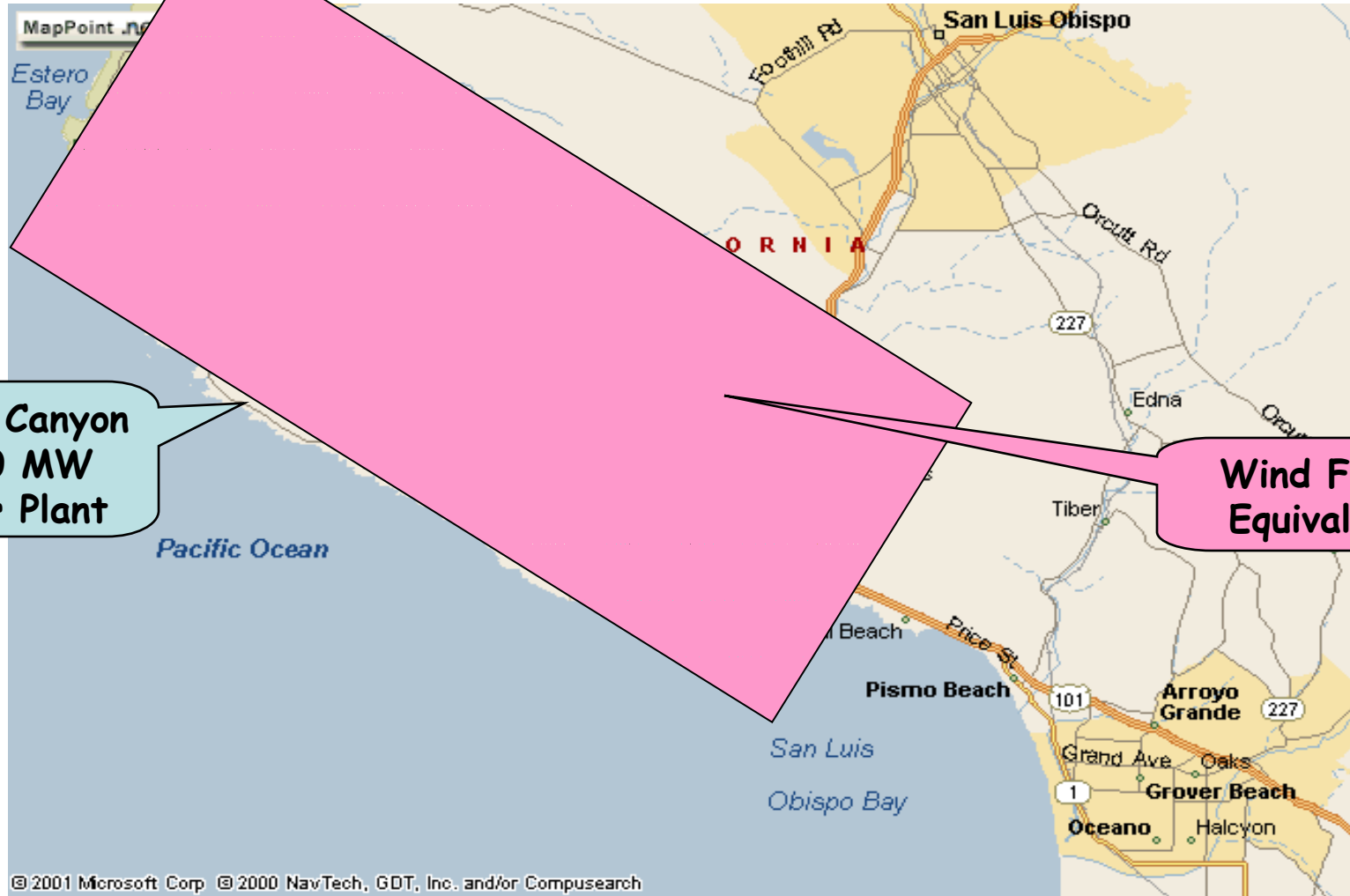
Two  
Diablo  
Nukes

Wind Farm  
equal to  
ONE  
Diablo Unit

1100  
1 MW  
Towers,  
1000 ft  
apart

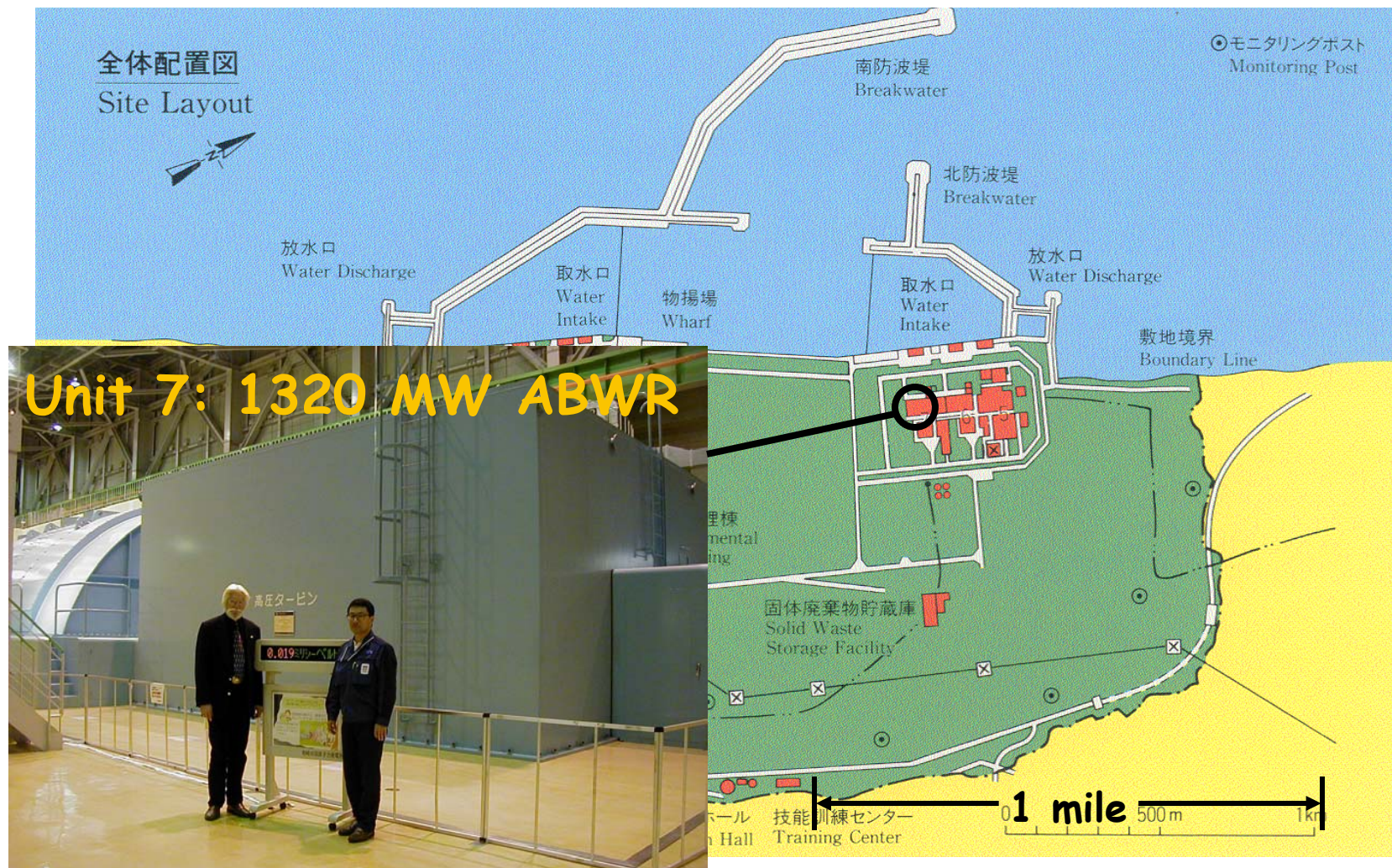
6.3 miles

# California Coast Power



© 2001 Microsoft Corp © 2000 NavTech, GDT, Inc. and/or Compusearch

# Kashiwazaki Kariwa: 8000 MW

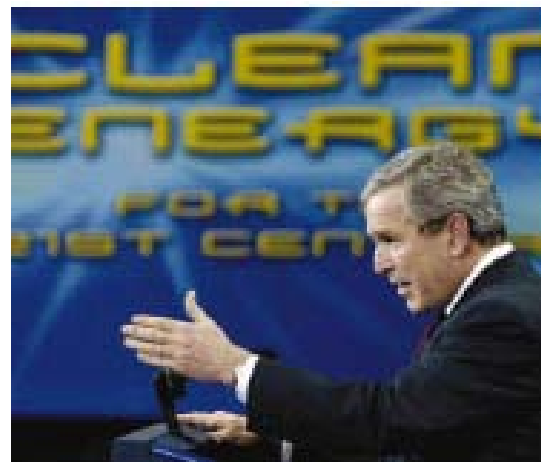


# Hindenburg Hysteria

*The Hindenburg did not crash  
Because of a hydrogen leak!*



# Hydrogen



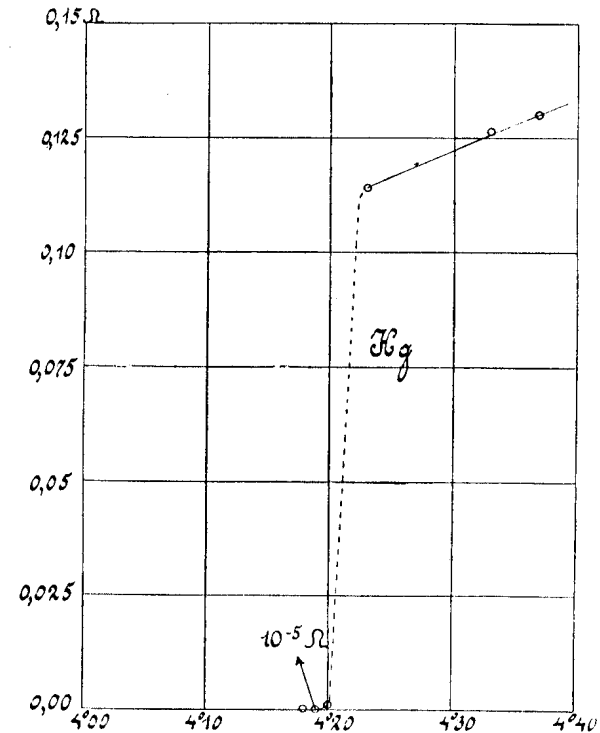
- You have to make it, just like electricity
- Electricity can make  $H_2$ , and  $H_2$  can make electricity ( $2H_2O \leftrightarrow 2H_2 + O_2$ )
- You have to make a lot of it
- You can make it cold, - 419 F (21 K)

# 1911: A Big Surprise!

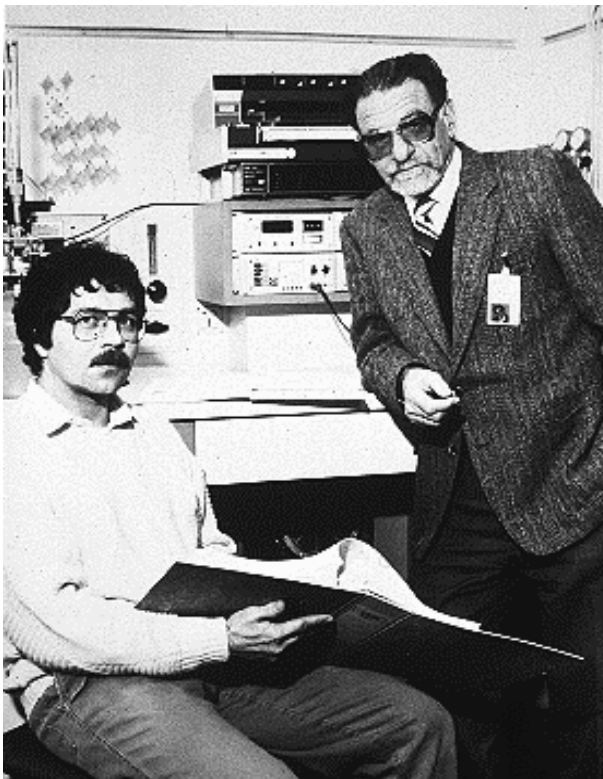


Thus the mercury at 4.2 K has entered a new state, which, owing to its particular electrical properties, can be called the state of *superconductivity*

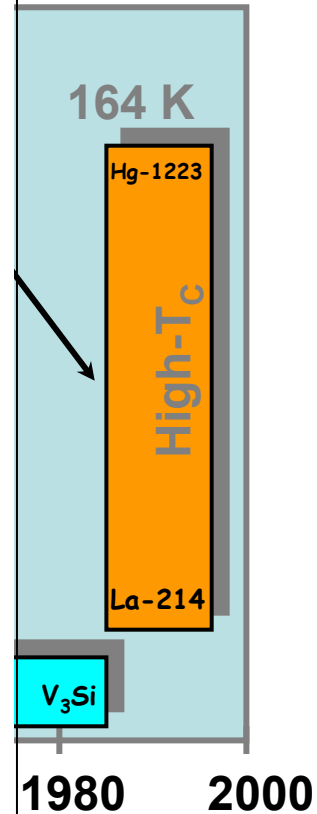
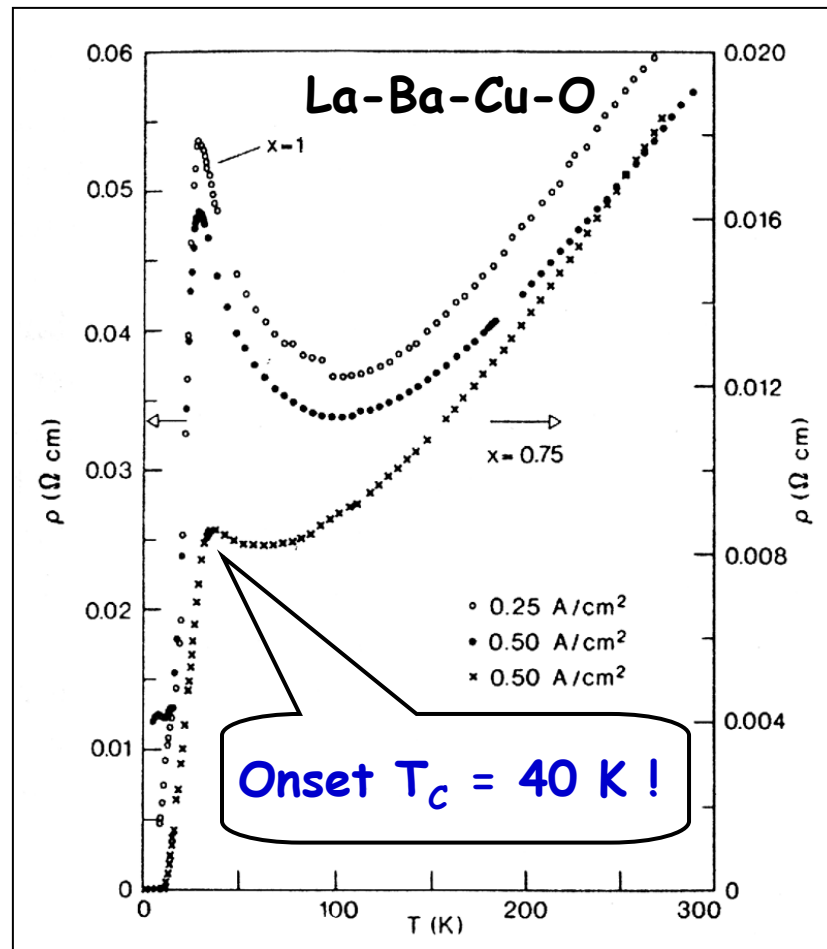
H. Kamerlingh-Onnes (1911)



# 1986: Another Big Surprise!



**Bednorz and Mueller**  
**IBM Zuerich, 1986**







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# 1987: "The Prize!"



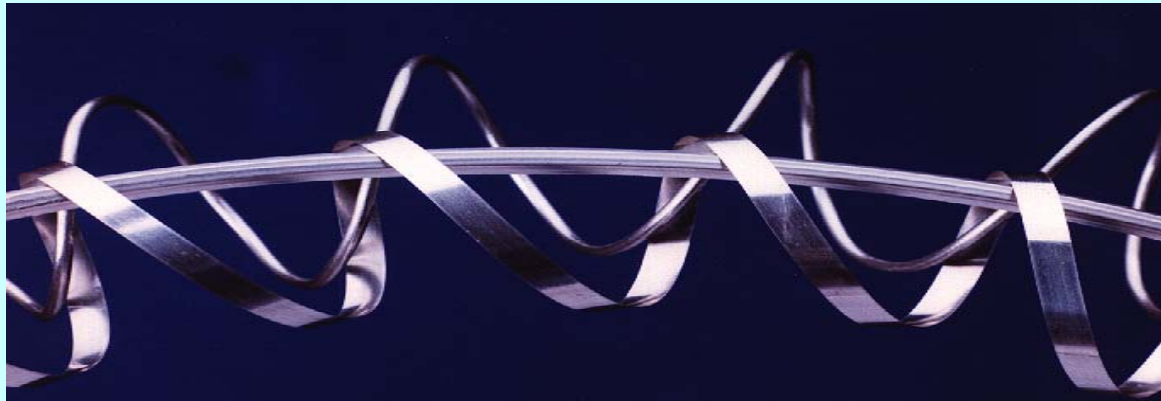
Associated Press

J. Georg Bednorz, left, and K. Alex Müller after learning they had won the Nobel Prize in physics.

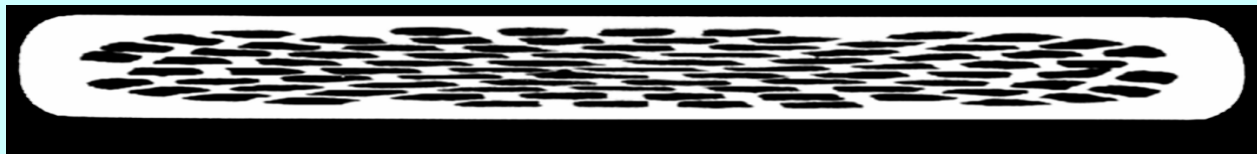
*2 Get Nobel for Unlocking Superconductor Secret*

# HTSC Wire Can Be Made!

**“The Miracle of 1989”**

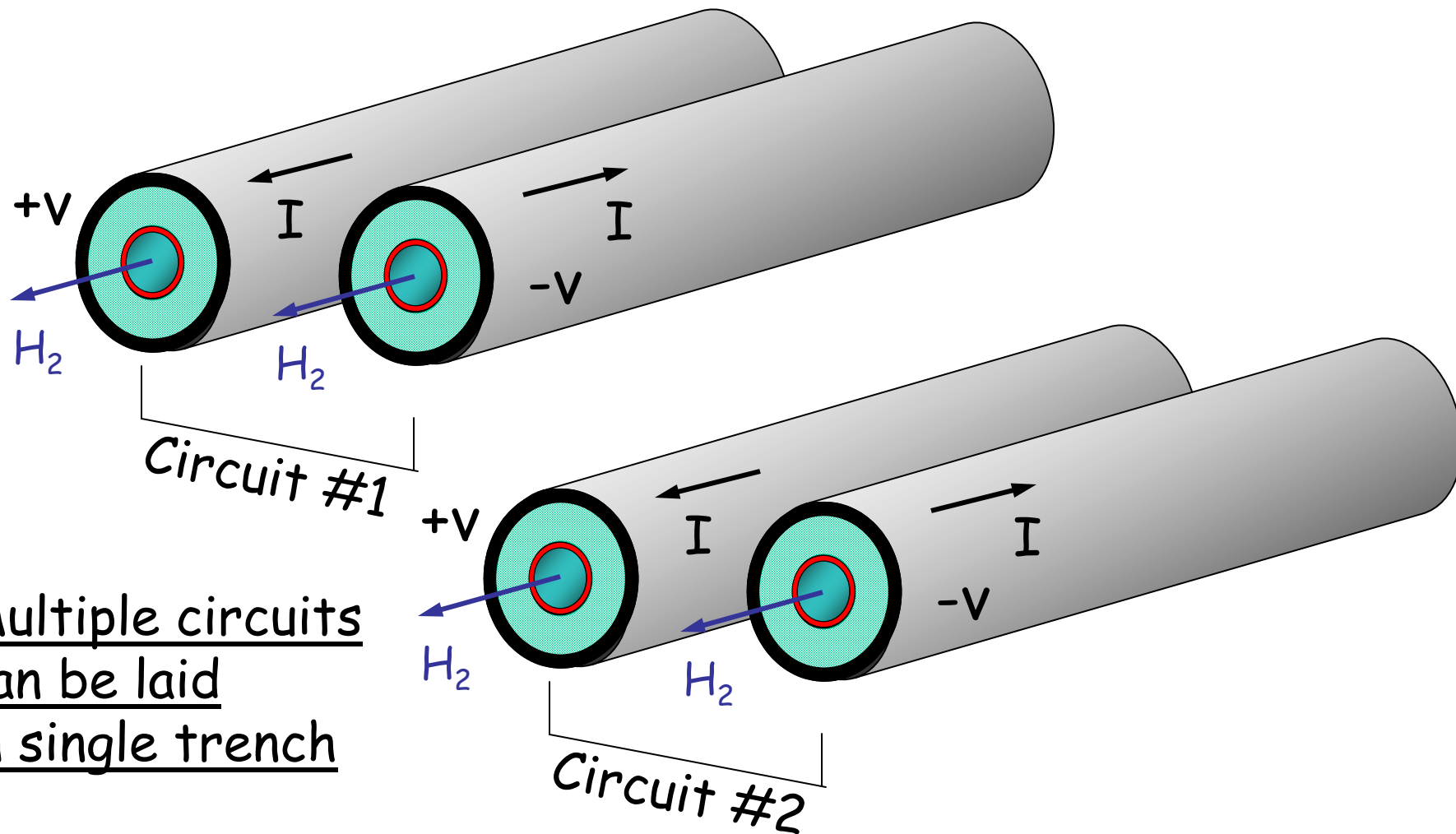


*But it's 70% silver!*



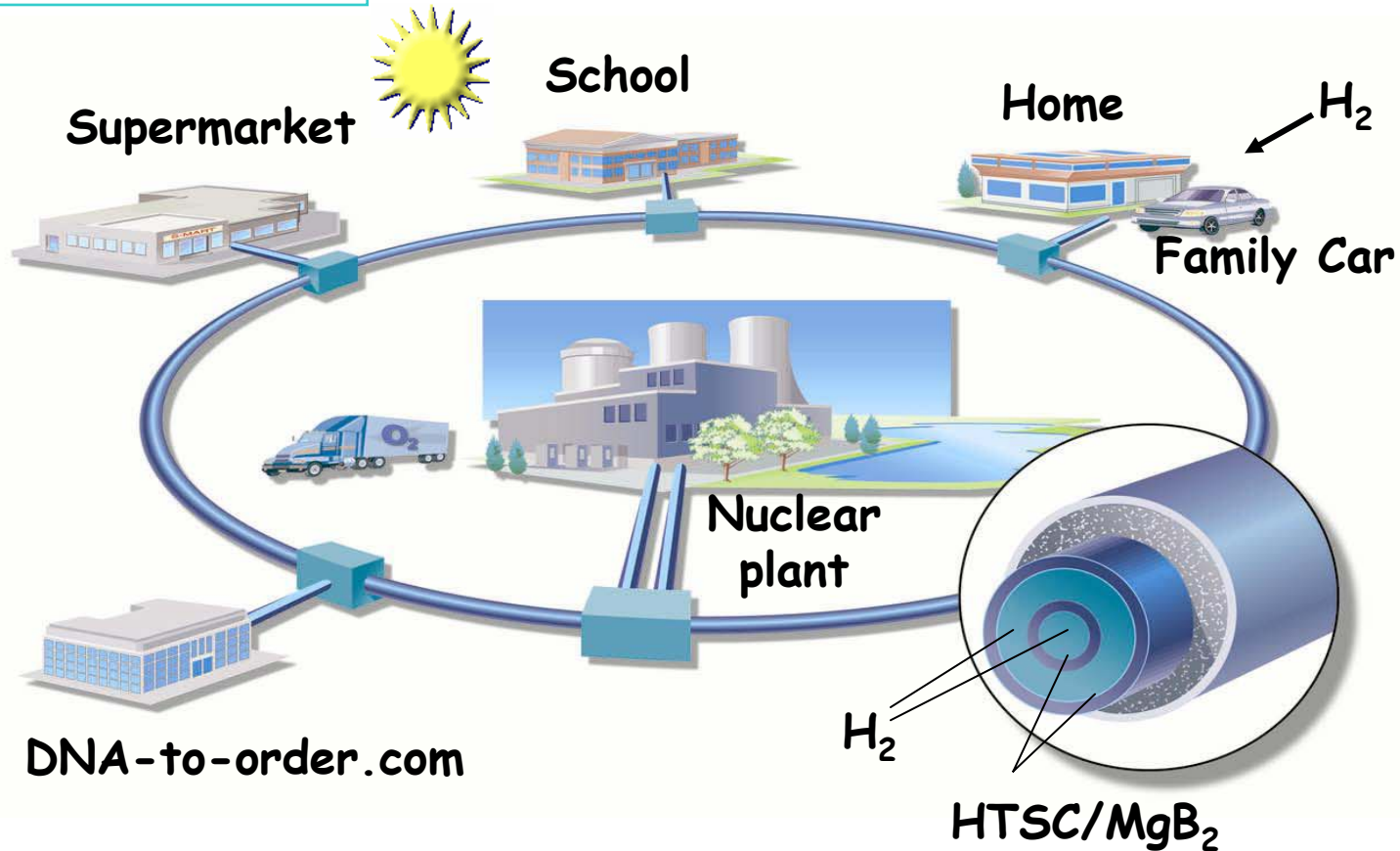
# SuperCables:

## Superconductors Cooled by Liquid Hydrogen



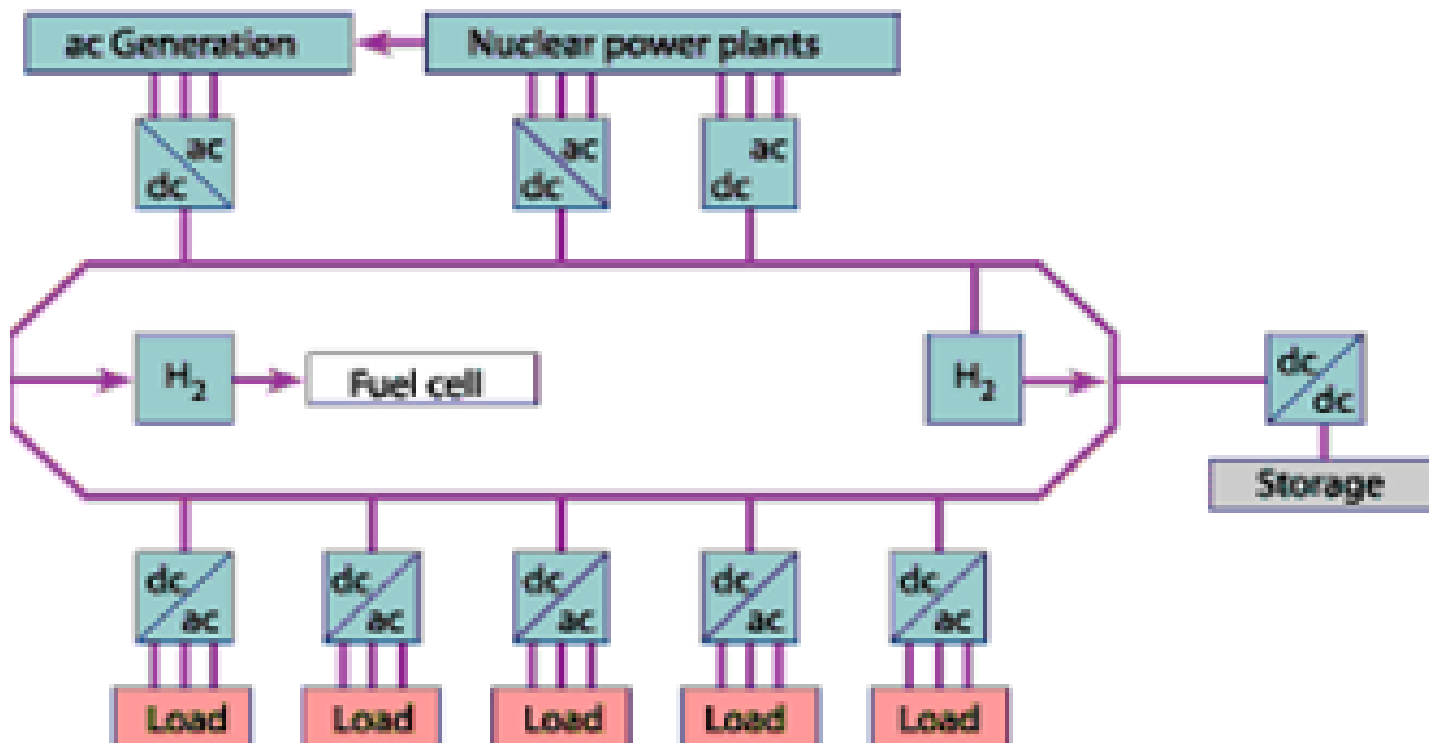
Multiple circuits  
can be laid  
in single trench

# SuperCity



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

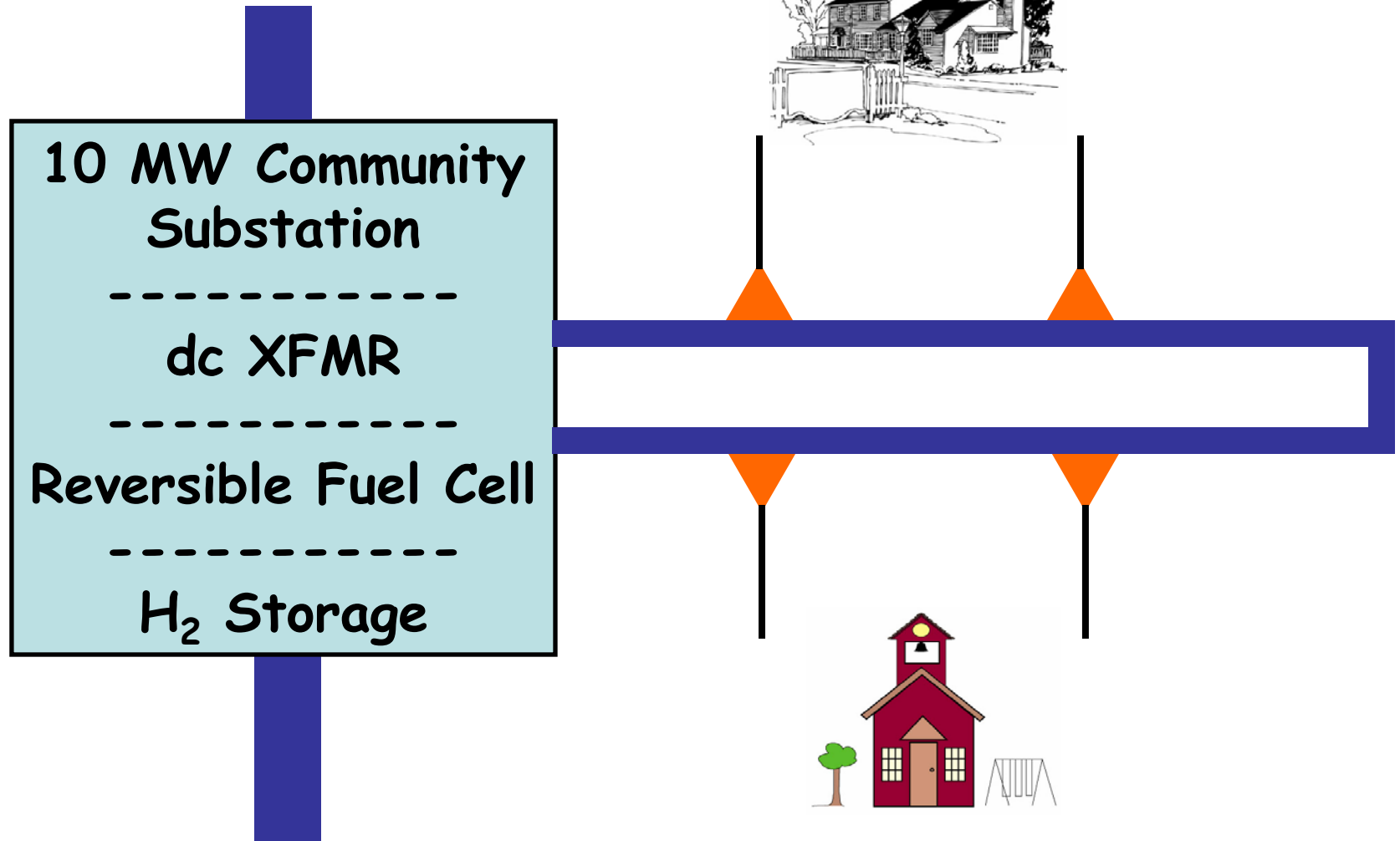
# SuperGrid



## Continental SuperGrid

C. S. Starr, "Continental SuperGrid," Nuclear News, Spring Issue, 2002

# Distribution



# End Use



**Streetside Service**

-----  
100 A @ +/- 25 Vdc

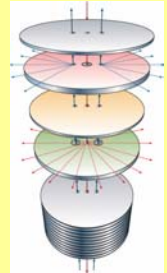
-----  
H<sub>2</sub> @ 200 K, 100 psi

-----  
PLC @ 5 MHz

H<sub>2</sub> Heat Exchanger for AC

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H<sub>2</sub> for Heat/Hot H<sub>2</sub>O

-----  
Household Fuel Cell



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Inv/Conv for Electricity

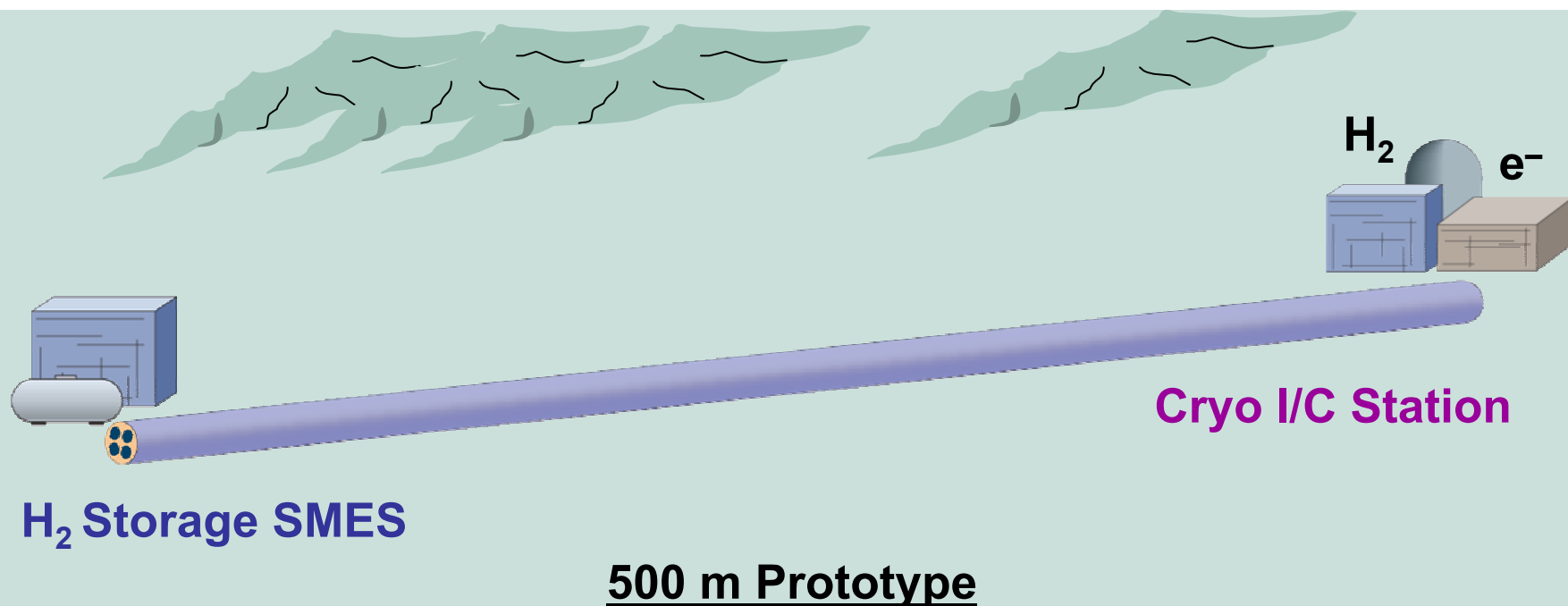
-----  
H<sub>2</sub> Storage for Auto





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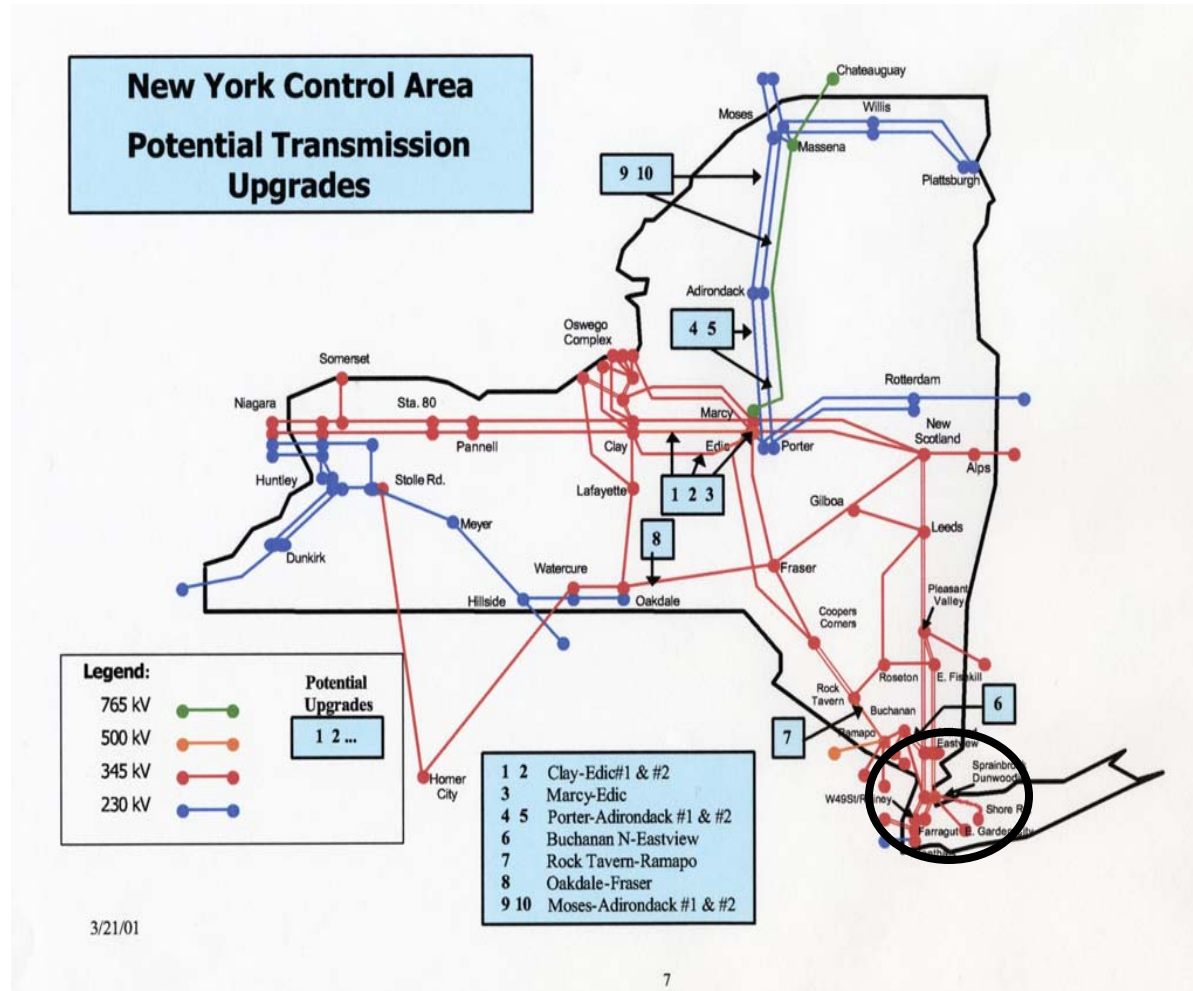
# SuperCable Prototype Project



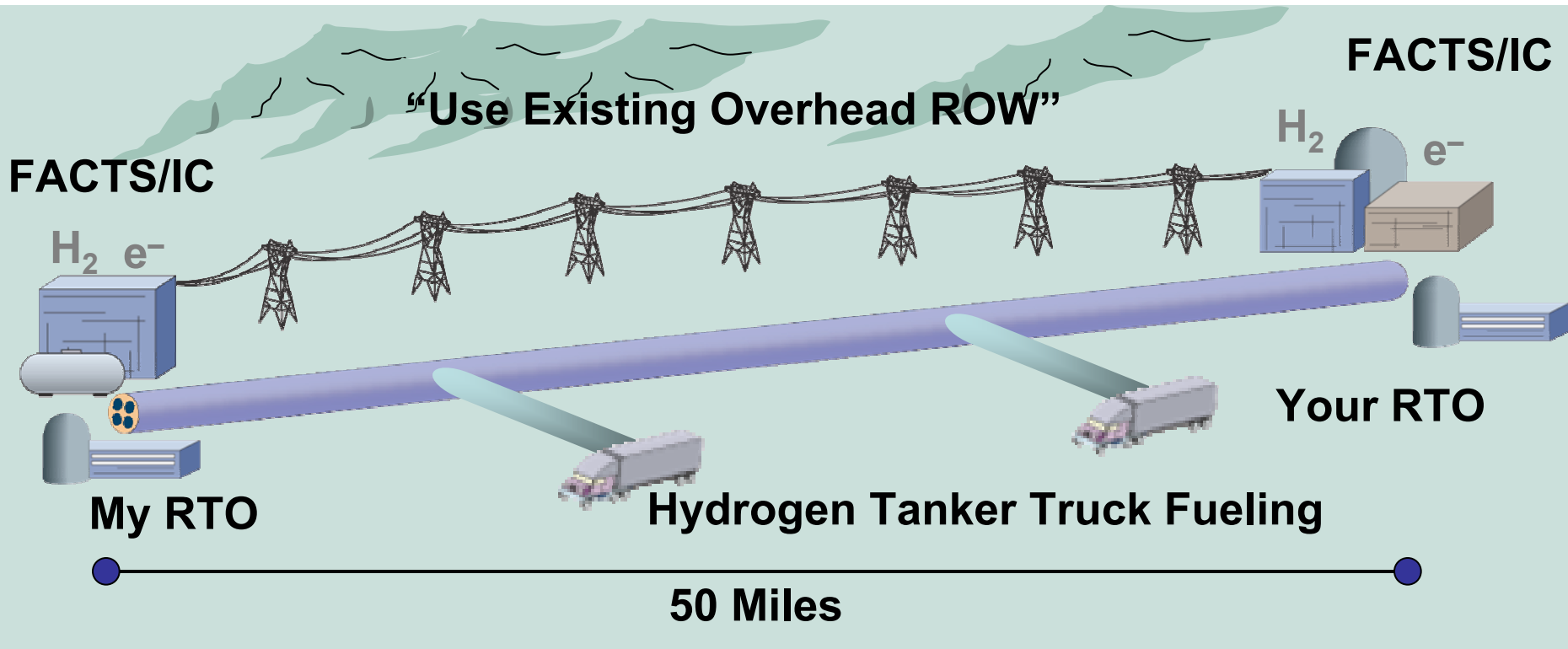
**“Appropriate National Laboratory”  
2005-09**



# Regional System Interconnections



# RegionGrid Interconnection



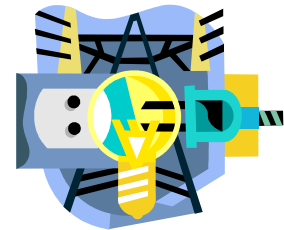
## Hydrogen can store electricity

# Grid Architecture

*Thanks, Jimmy!*

## 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

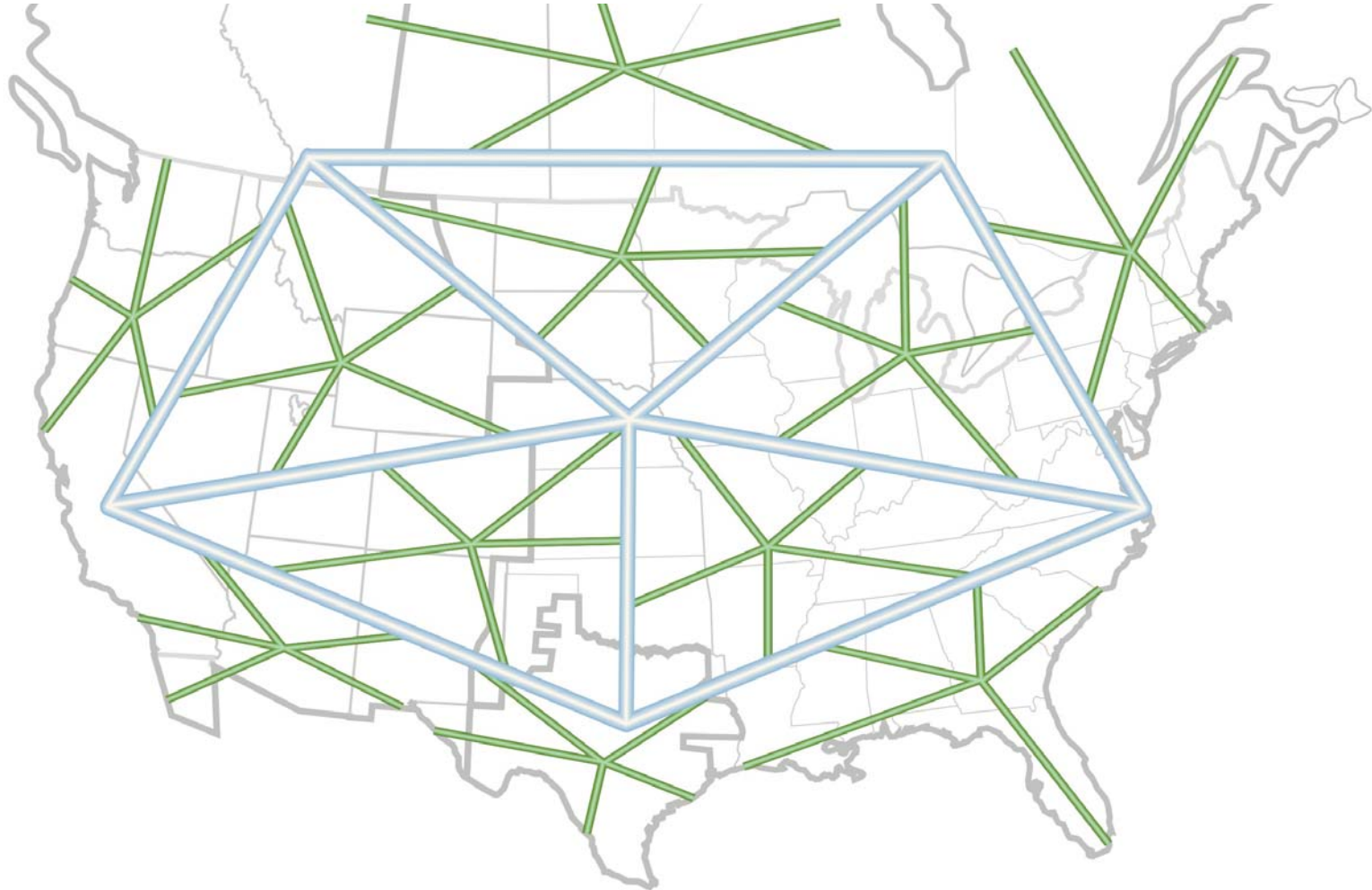


Integrated systems architecture enables  
NationalGrid operations across all dimensions.

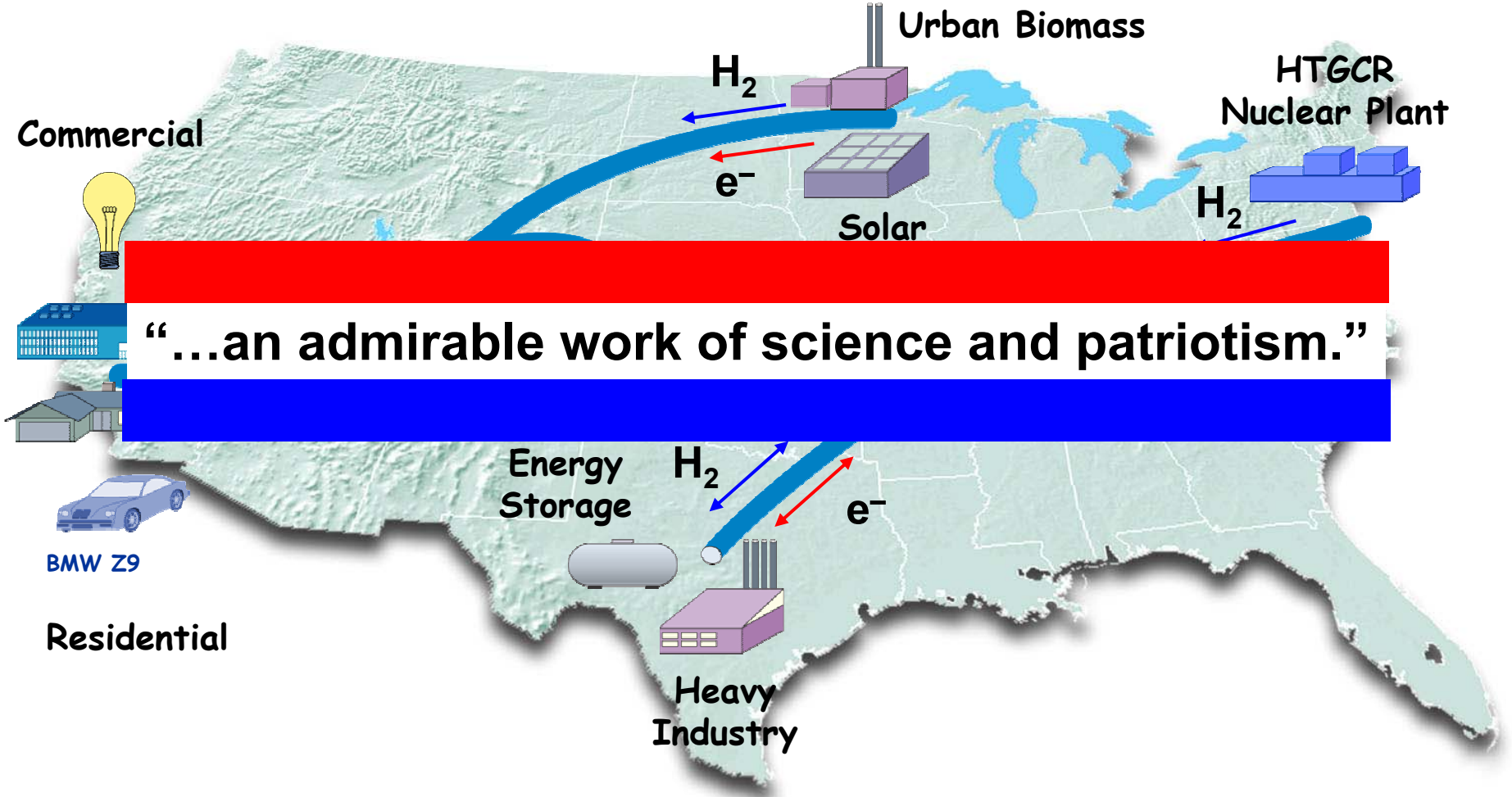


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# SuperGrid + RegionGrid



# 2050: The Energy SuperGrid



“...an admirable work of science and patriotism.”