MgB_2

What's It All About?

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Nature, 1 March 2001

How was it ever missed!

Superconductivity at 39 K in magnesium diboride

Jun Nagamatsu*, Norimasa Nakagawa*, Takahiro Muranaka*, Yuji Zenitani* & Jun Akimitsu*†

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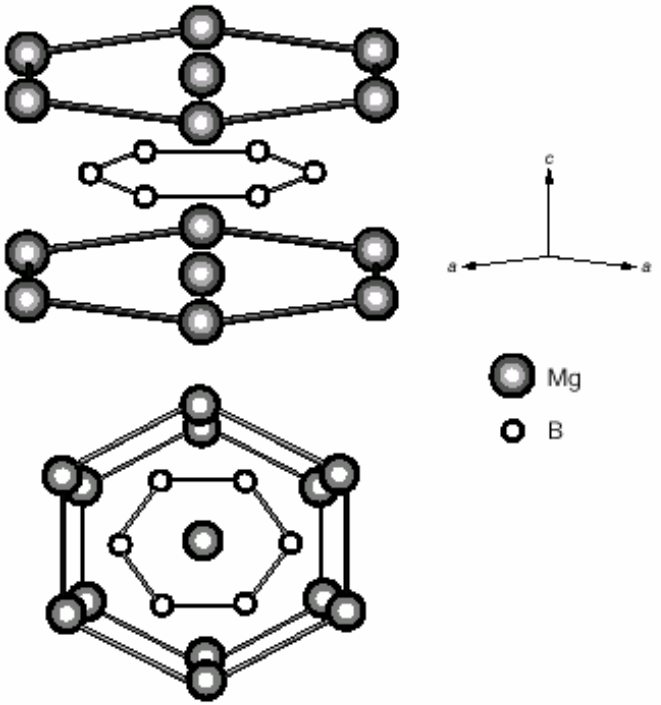

Figure 2 Crystal structure of MgB_2.

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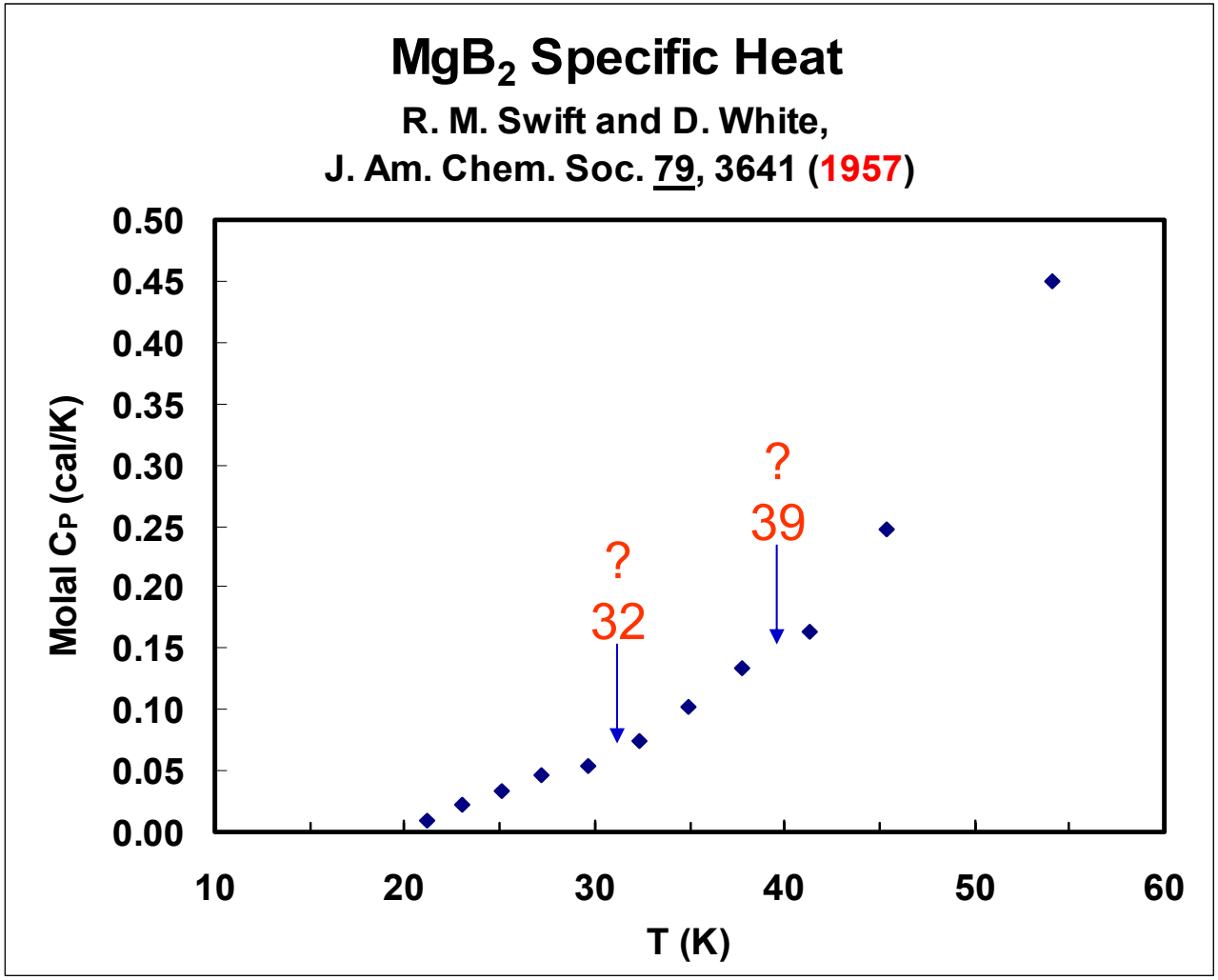
Maybe It Wasn't!



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Nature, 31 May 2001

Superconductivity

Rehearsals for prime time

Paul Grant

Superconductivity seems to have been forever waiting in the wings. Although superconducting power cables are about to go live, will the newest material, magnesium diboride, become the class act of the future?

High critical currents in iron-clad superconducting MgB_2 wires

S. Jin, H. Mavoori, C. Bower & R. B. van Dover

Agere Systems/Lucent Technologies, Murray Hill, New Jersey 07974, USA

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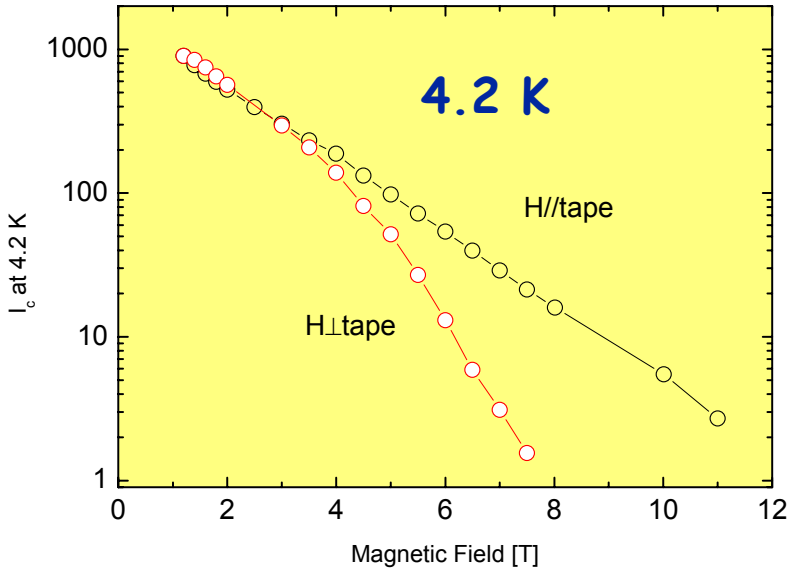
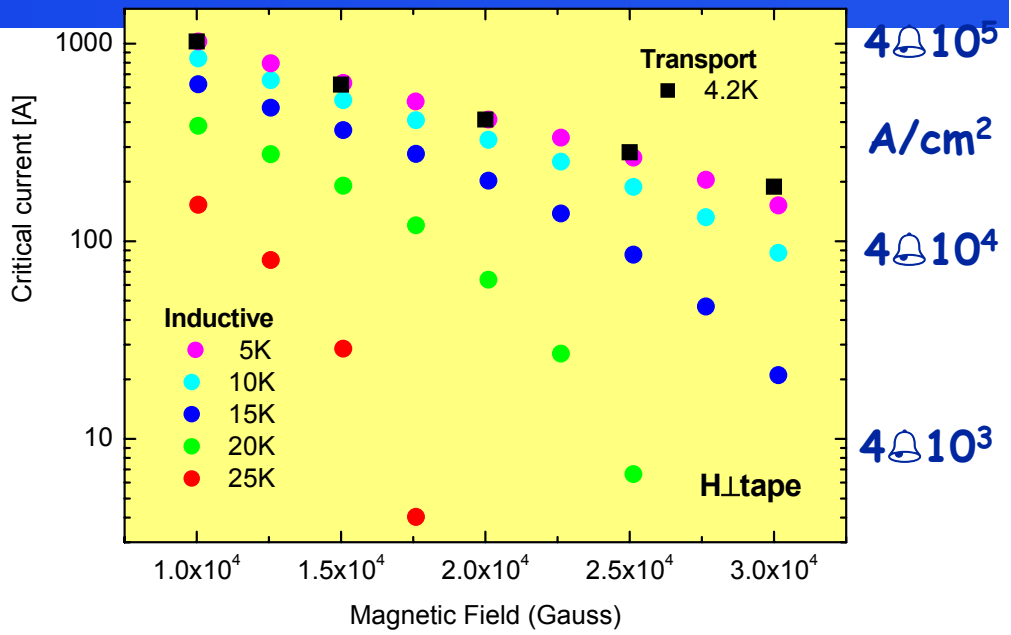
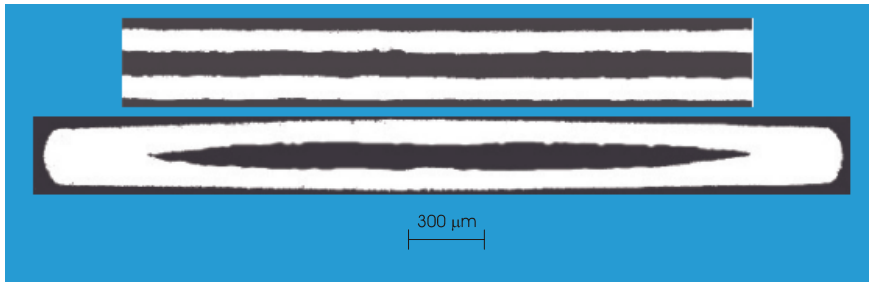
INFM-Genova
Ni-Sheathed MgB_2 Tape







Ex-Situ Sintered

Tape dimensions: 3.5 mm x 0.35 mm

Filling factor 20% $A_{sc} = 2.5 \times 10^{-3}$ cm^2

Treated at 900°C for 2 hours in Ar

INFM-Genova, G. Grasso, A. Malagoli, V. Braccini, S. Roncallo, and A.S. Siri, Italy

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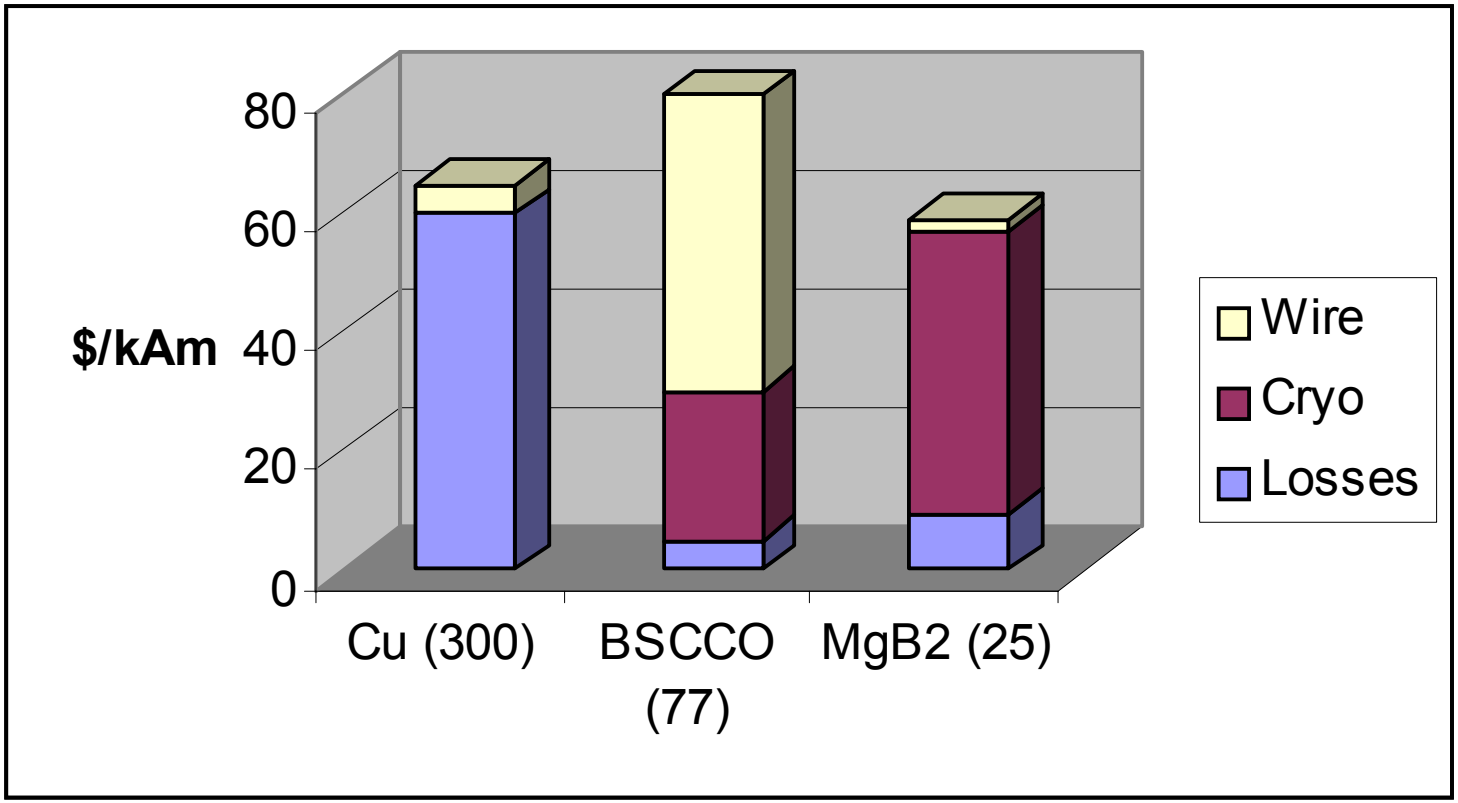
Transformer Cost of Ownership

Following ABB SPI I Analysis



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Prologue: The 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

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One Likely Future Scenario

By 2025:

- Global Accord is Achieved
  - *Materials for WOMD controlled; terrorism contained*
- World's Population Aspires to an American SOL
  - *400 -> 600 quads per year*
- GHG-driven GCC a Major Concern
  - *Either accepted scientifically, or "no regrets" policy applied*
- Society Demands Green, Sustainable Energy Supply
  - *Many hundred years, minimal environmental impact*
- Plus Safe, Robust, Non-intrusive Energy Delivery
  - *Invisible, > 50 year life, 4-9s reliability*

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Constrained Energy Technology Choice

- Zero GHG emissions for energy production and personal transportation
  - *No combustion/reforming of fossil fuels – nada!*
- Optimal (minimal) utilization of land area for energy production and delivery
  - *No Wind Farms!*
  - *No Solar Farms!*
  - *No Biomass Farms!*
- Optimal (maximal) physical safety and security
  - *Almost everything underground!*

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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 Solution

- Generation
  - *Nuclear-hydrogen, solar roofs*
- Transmission
  - *Underground (lvdcsc electricity and hydrogen)*
- Distribution
  - *Reversible fuel cell substations + H_2 storage*
  - *Local H_2 and electricity distribution for end use*
- End Use
  - *Appliances, Space Conditioning, Transportation*

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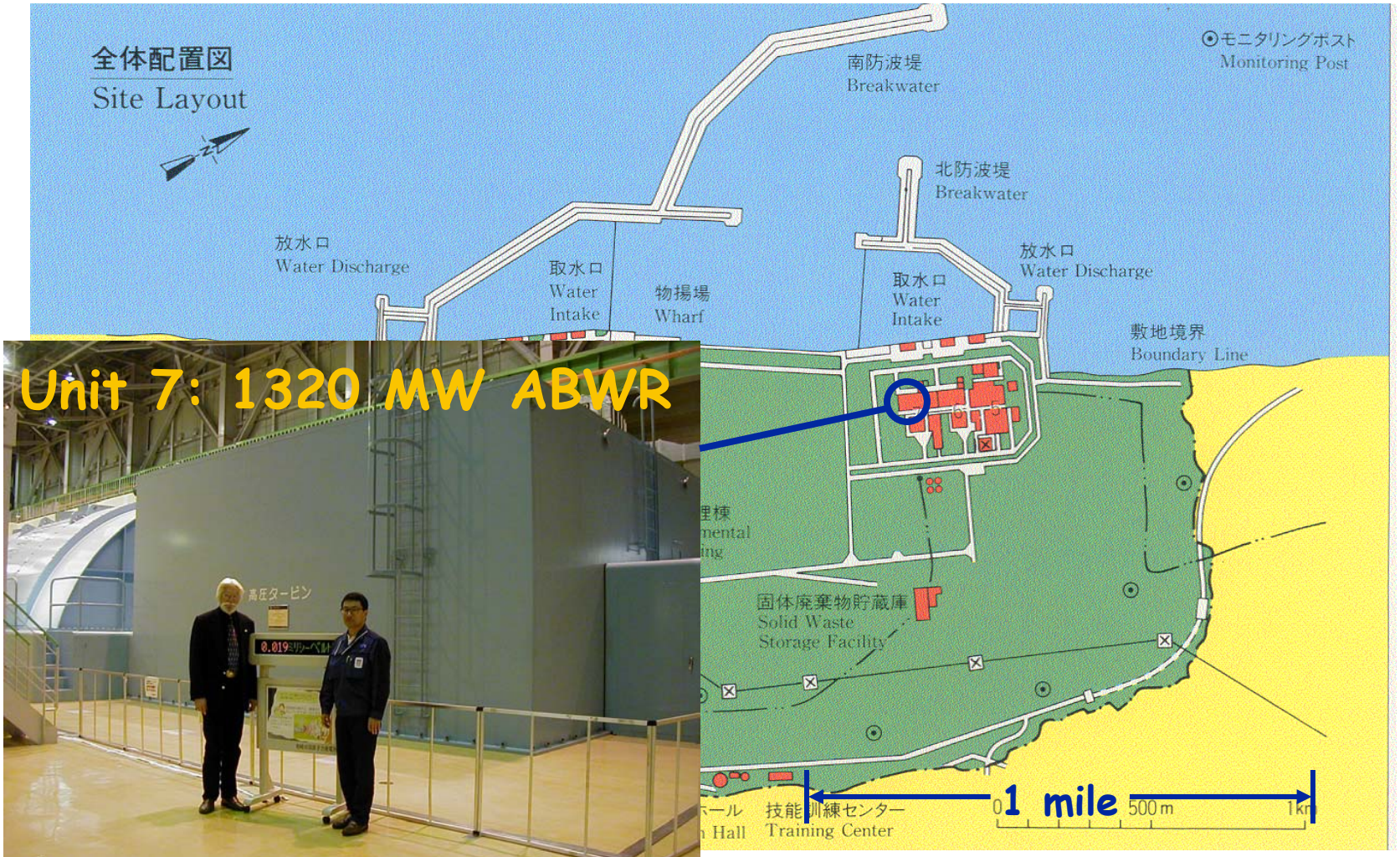
Kashiwazaki Kariwa: 8000 MW



Diablo Canyon

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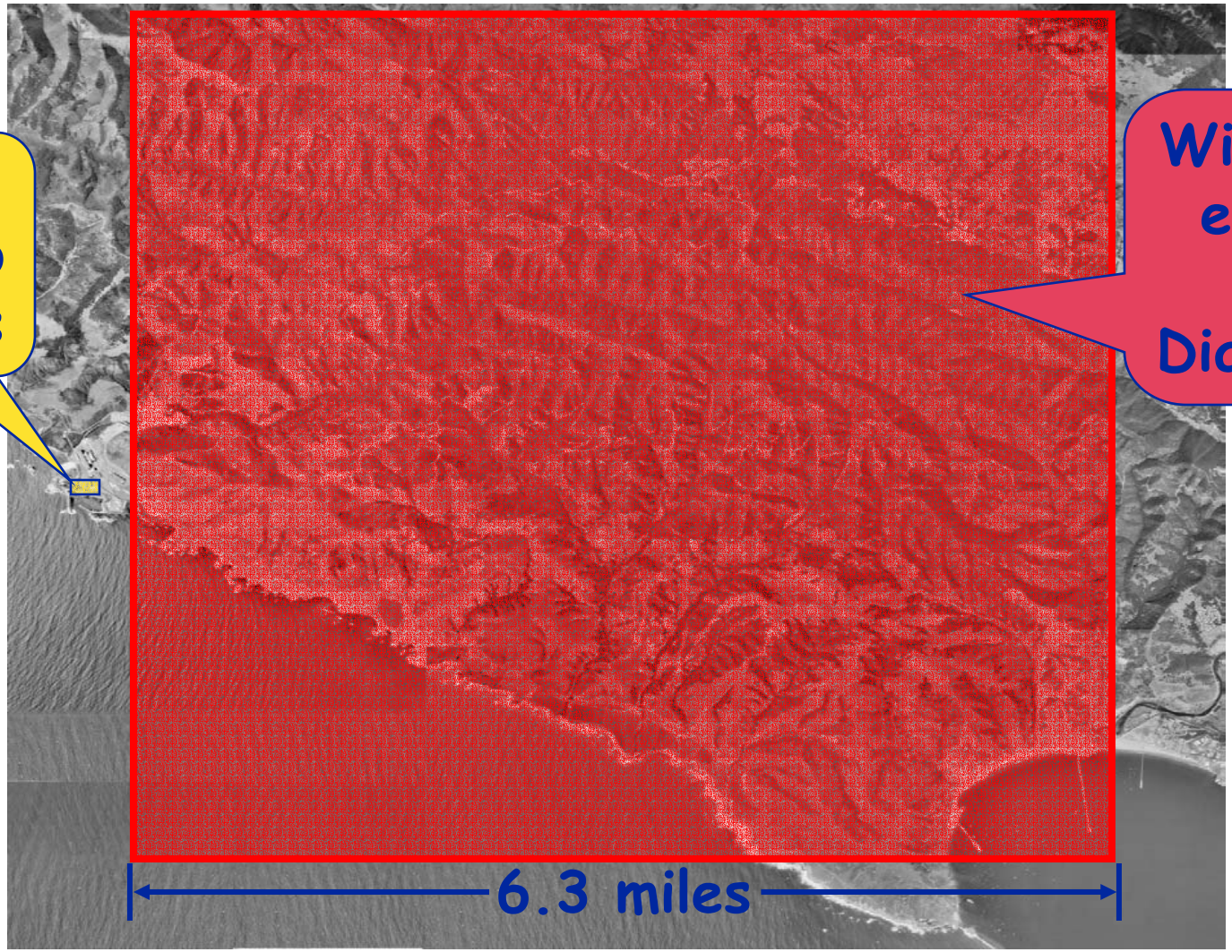
Diablo Canyon



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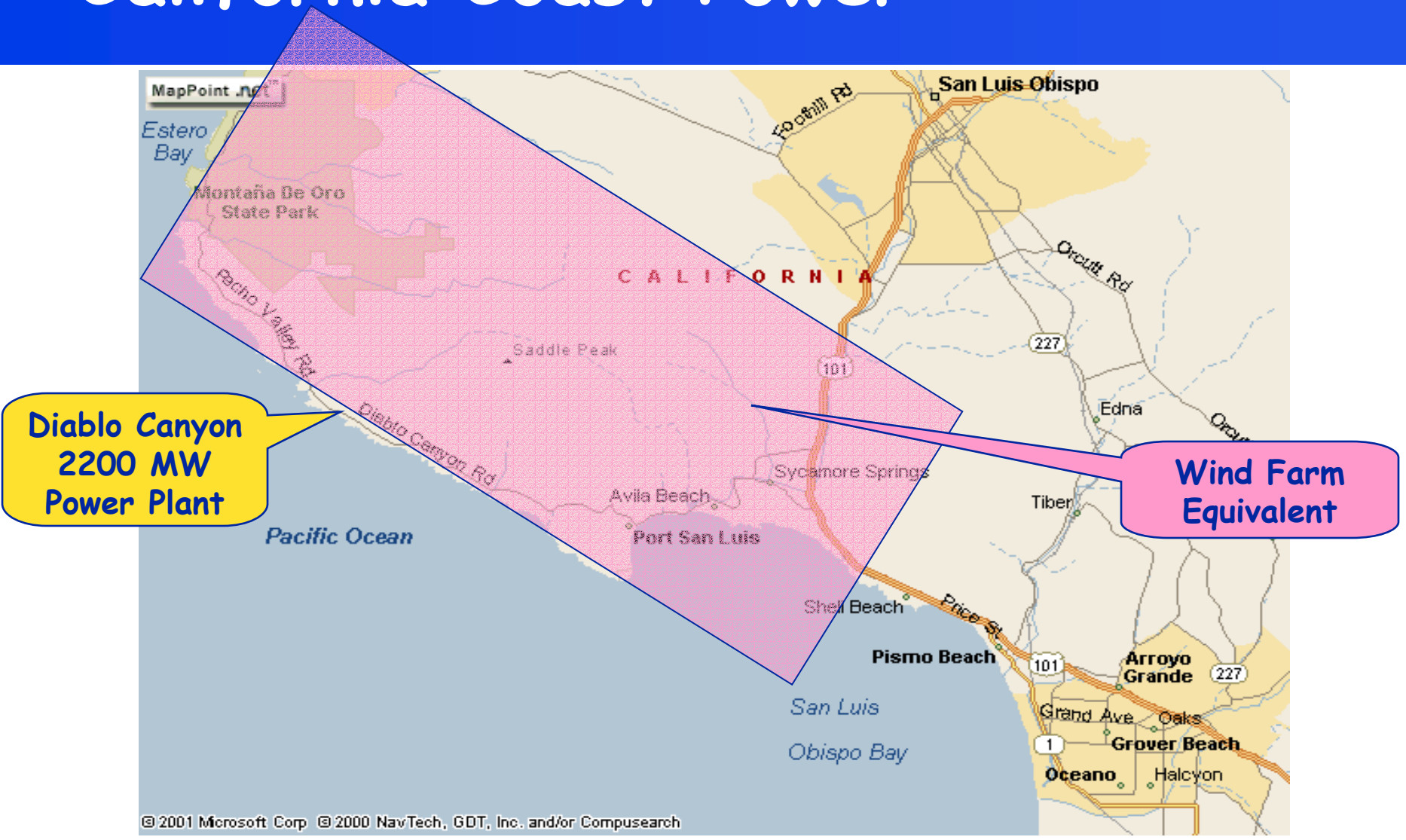
California Coast Power



Hydrogen Production

Stuart Industries

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Hindenburg Hysteria

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Solar Roofs
PV shingle roofing

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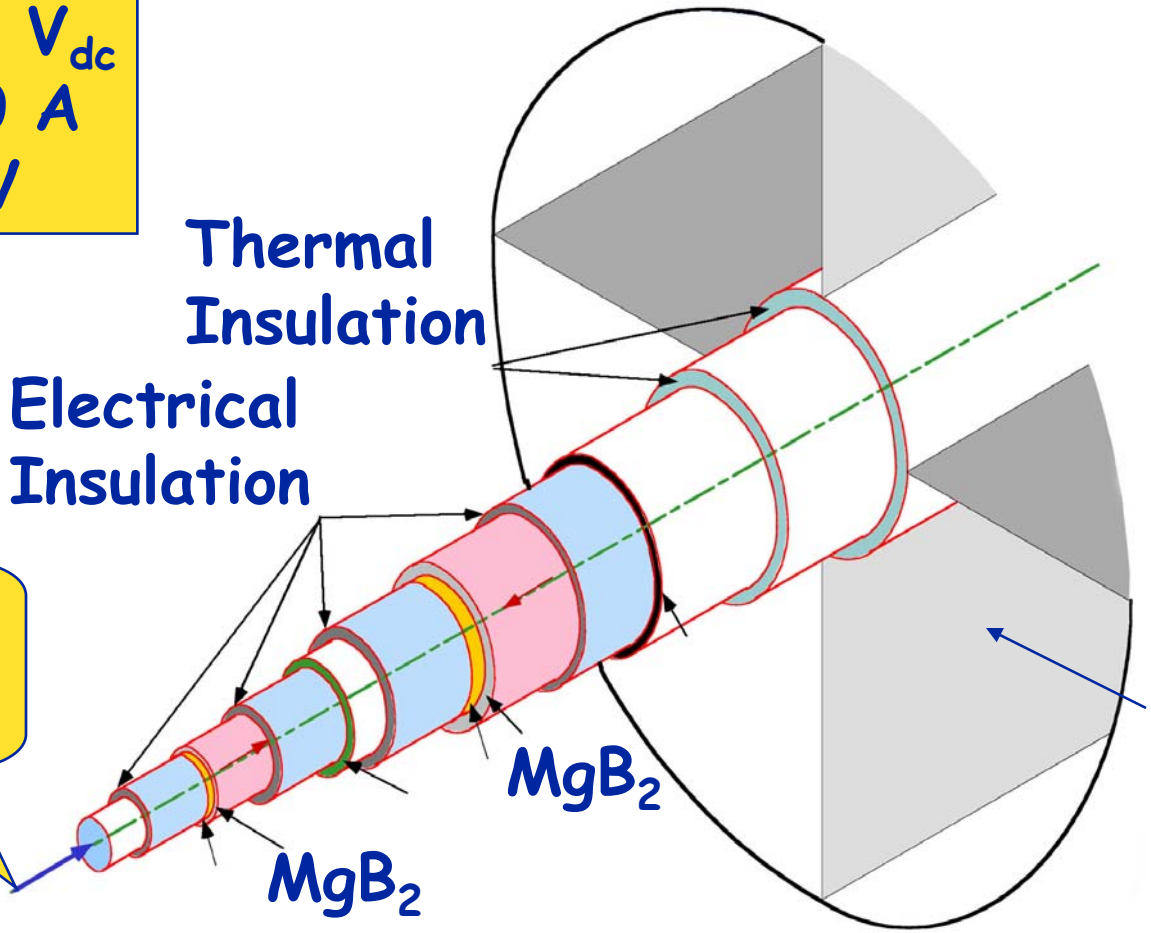
Urban Biomass

- Average U.S. adult produces 0.7 kg (1.5 lbs) of combustible biowaste daily
  - *Unconsumed food*
  - *Paper products*
- Assume an energy content of 10 MJ/kg (40% of coal)
- 50 MW/day potential recovery from biowaste for population of 600,000

"The Energy Pipeline"

± 50,000 V_{dc}
100,000 *A*
10 *GW*



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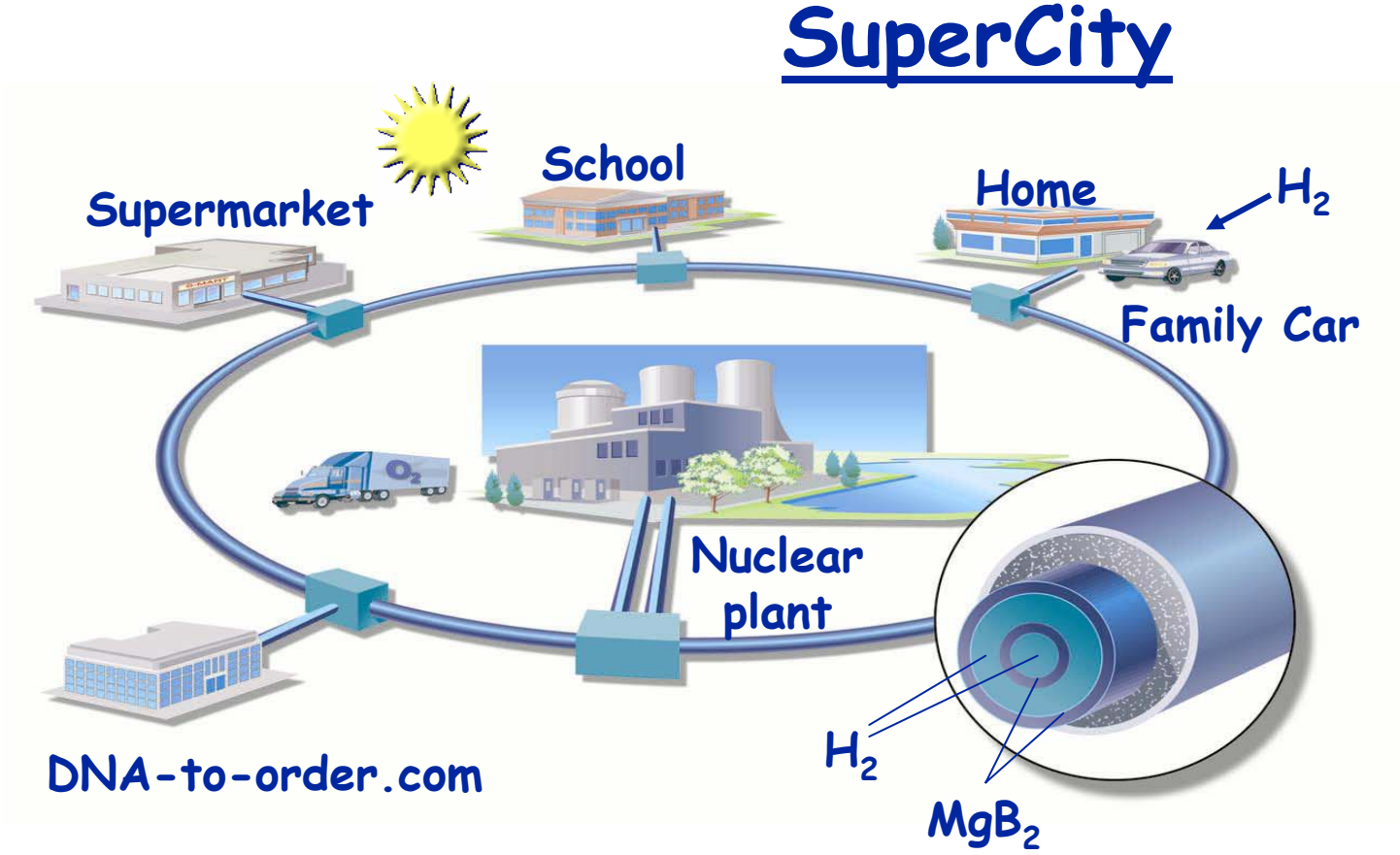
An American Vision for the World: "SuperCities & SuperGrids"



National Climate Change Technology Initiative (NCCTI – "Necktie")

"Absolutely Zero GHG Emissions by 2050" -- George W. Bush

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

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SuperCity

- Population: 600,000 (e.g., Seattle)
  - *40% Commercial*
  - *20% Light Industrial*
  - *40% Residential*
- Energy Load
  - *1000 MWe*
  - *450 MWt*
  - *50 MWe (for cryogenics & pumping)*

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SuperCities & SuperGrids
A New EPRI SS&T Project

- $150,000 2002 SS&T "Innovative Circle"
  - *Internally Funded Direct Cost*
  - *Utilize EPRI staff competence*
  - *Network with interested parties in government and industry*
- $100,000 Foundation-funded Workshop
  - *Organized through Jesse Ausebel, Rockefeller U.*
  - *To be held, Summer 2002*
- Deliverables
  - *Feasibility and cost report*
  - *"Energy Pipeline" scoping design*
  - *Find a Federal Champion!*

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Where there is no vision, the people perish…

Proverbs 29:18

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