So Now We Have a Room Temperature Superconductor… So What?

(Will We Be Able to Use It?)

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EPRI Science Fellow (Retired)

Principal, W2AGZ Technologies

The Road to Room Temperature Superconductivity

Loen, Norway

17-22 June 2007

http://www.w2agz.com/rtsc06.htm

“From Rags to Riches”

The Road to Room-Temperature Superconductivity

For Fame:

- T_c = 300 K
- no layered cuprate

Thanks, Jochen !

For Fortune:

- T_c > 500 K
- J_e (350 K) > 10^4 A/cm^2 in 5 T
- ductile, robust, good thermal properties
- good Josephson junctions
- environmentally friendly compound
- available in large quantities
- < 20 € kA/m


The Big Blackout
Northeast 8/14
States affected
Major metropolitan areas affected
CANADA
VERMONT
Brief power failures in northern counties
Ottawa
Lake Michigan
Lake Huron
MAINE
MICHIGAN
Toronto
Lake Ontario
NEW YORK
N.H.
Rochester
Syracuse
Lansing
Buffalo
Albany
MASS.
Detroit
Lake Erie
Binghamton
Kalamazoo
CONN.
R.I.
Erie
Toledo
Cleveland
Canton
Akron
PENNSYLVANIA
New York City
IND.
OHIO
NEW JERSEY
Bergen, Essex and Hudson counties
MD.
DEL.
W. VA.
KY.
VA.
Atlantic Ocean
TENN.
N.C.
0 Miles 100

The Party Begins…

…and Continues…

As Night Falls…

It Gets Better…

and Better…

and Finally, Really Good!

The Morning After

Viva New York!

“You can’t always get what you want…”

“…you get what you need!”

Two IBM Physicists (1967)

Superconducting Lines for the Transmission of Large Amounts of Electrical Power over Great Distances

R. L. GARWIN AND J. MATISOO

- Nb_3Sn (T_C = 18 K) @ 4.2 K
- 100 GW (+/- 100 kV, 500 kA)
- 1000 km
- Cost: $800 M ($8/kW) (1967)

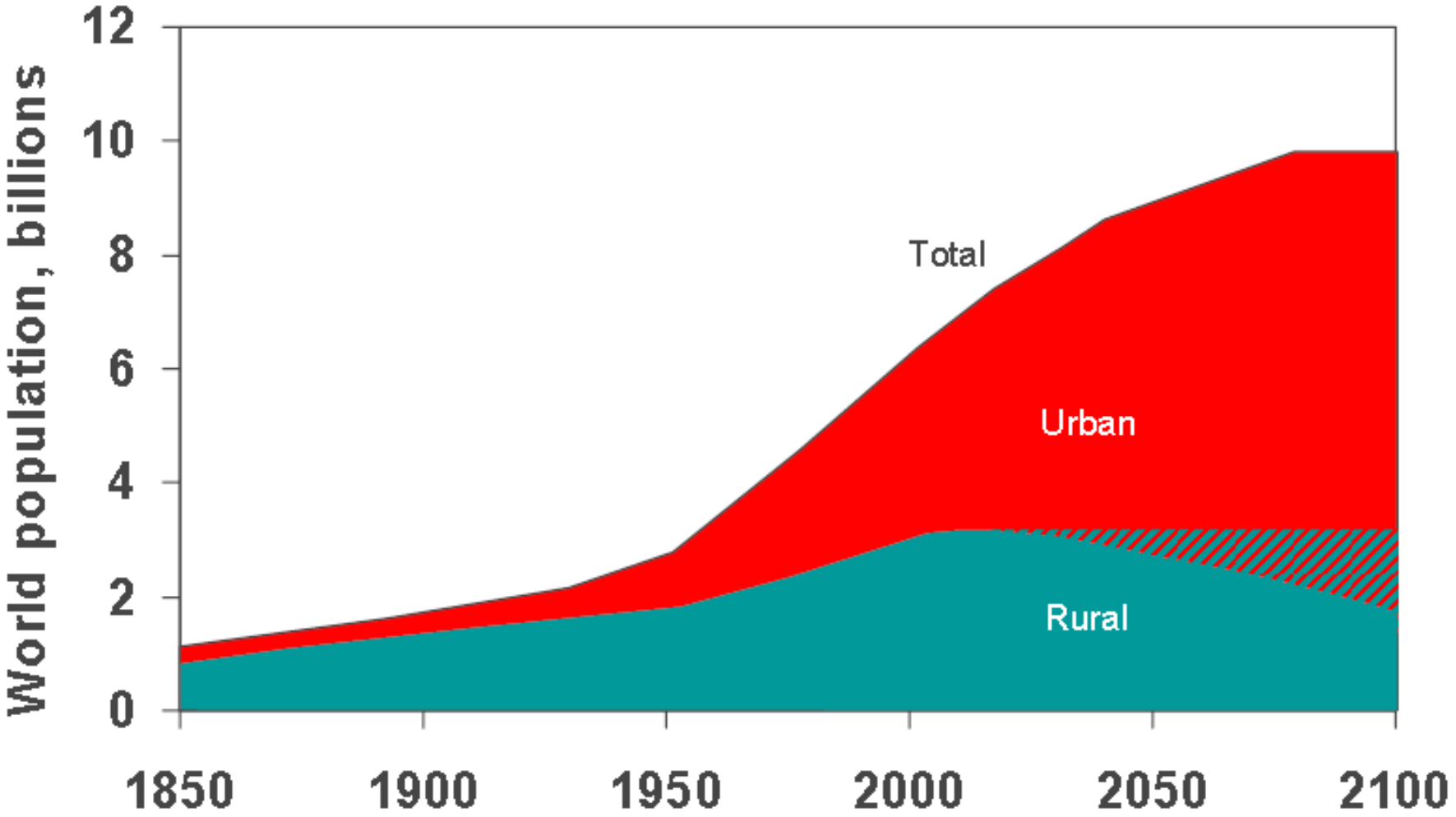
$4.7 B Today!

Where there is no vision,
the people perish…

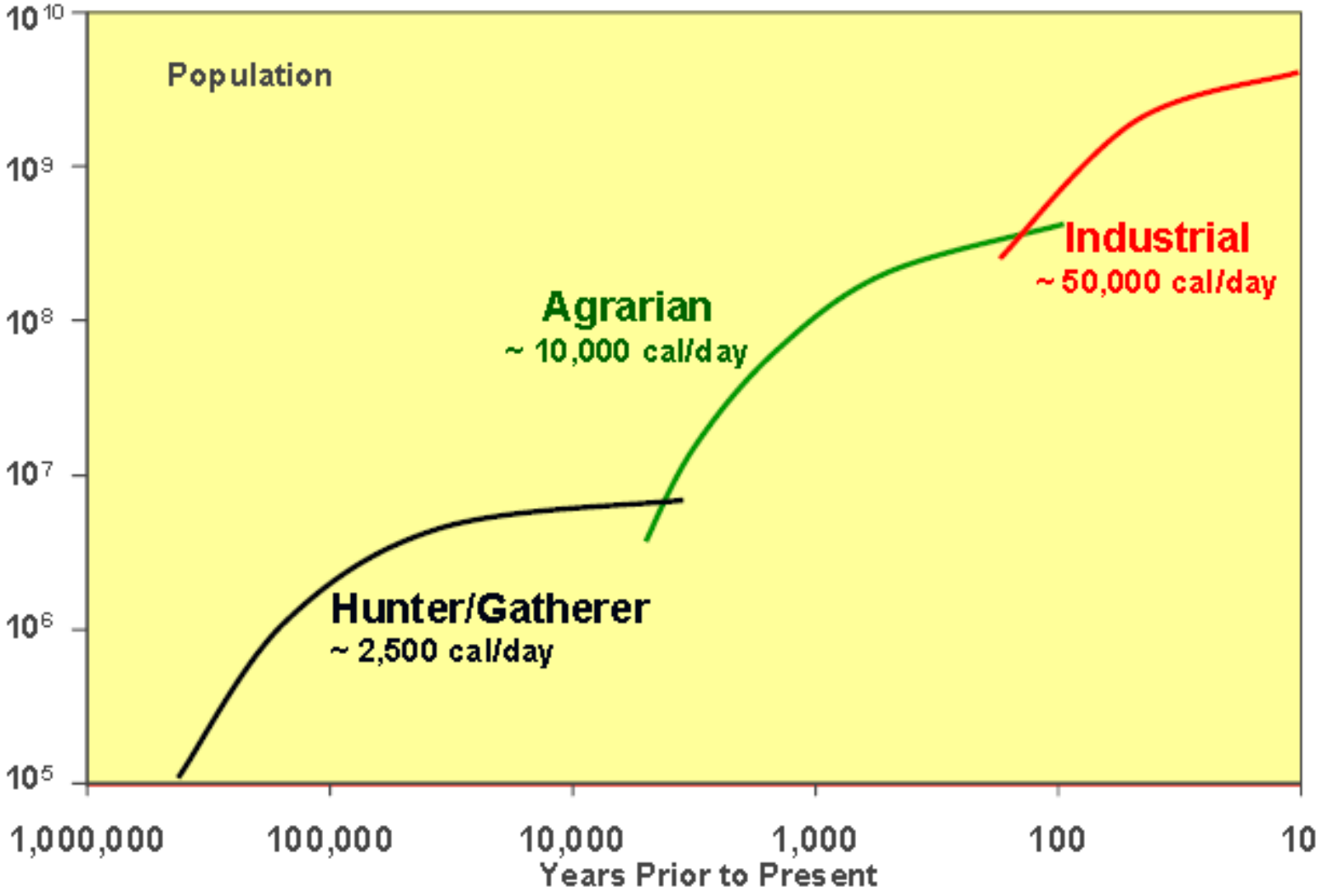
Proverbs 29:18

Earth at Night - 2000

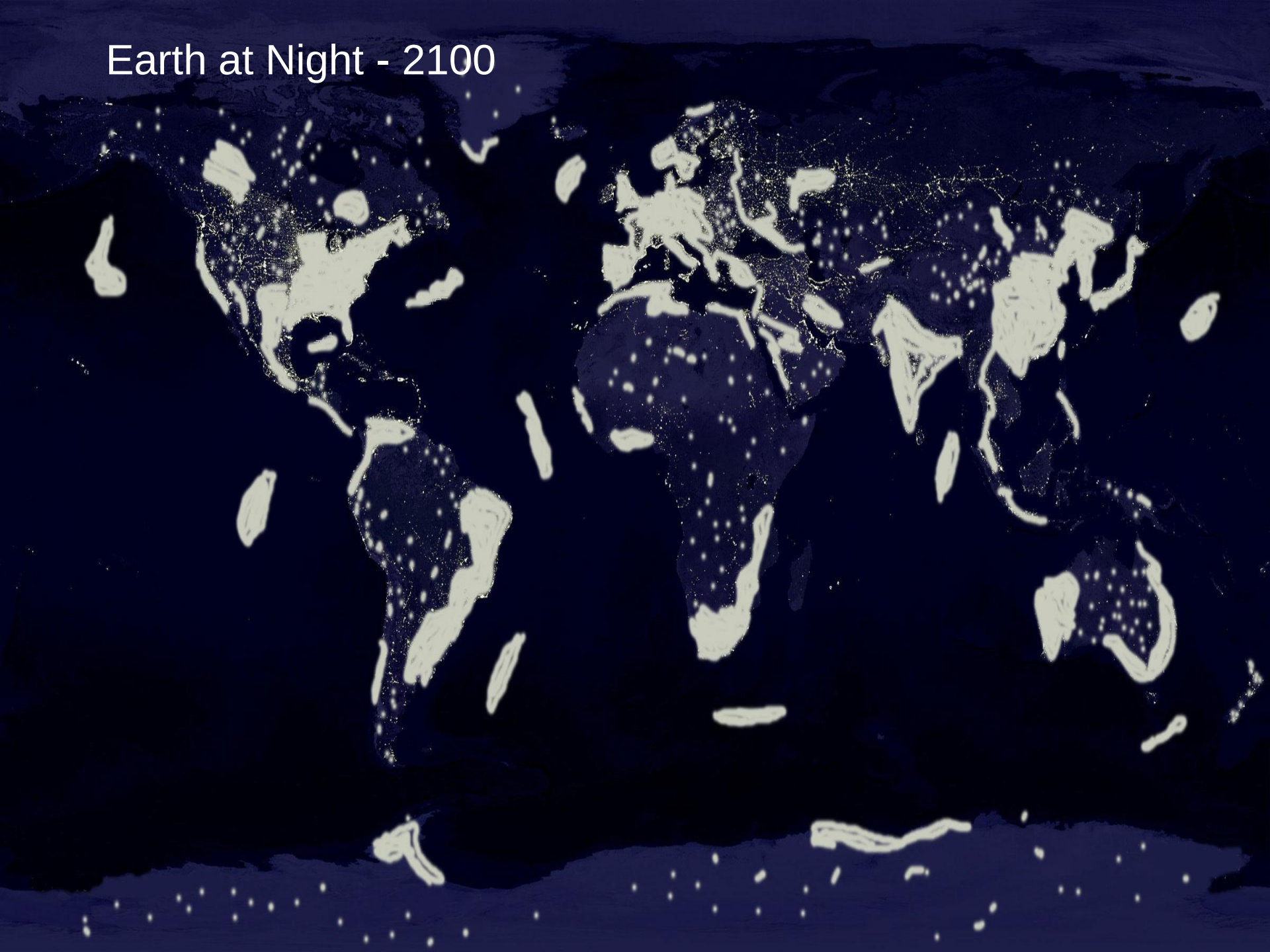
World Population: 1850 - 2100



Energy/Demographics Timeline

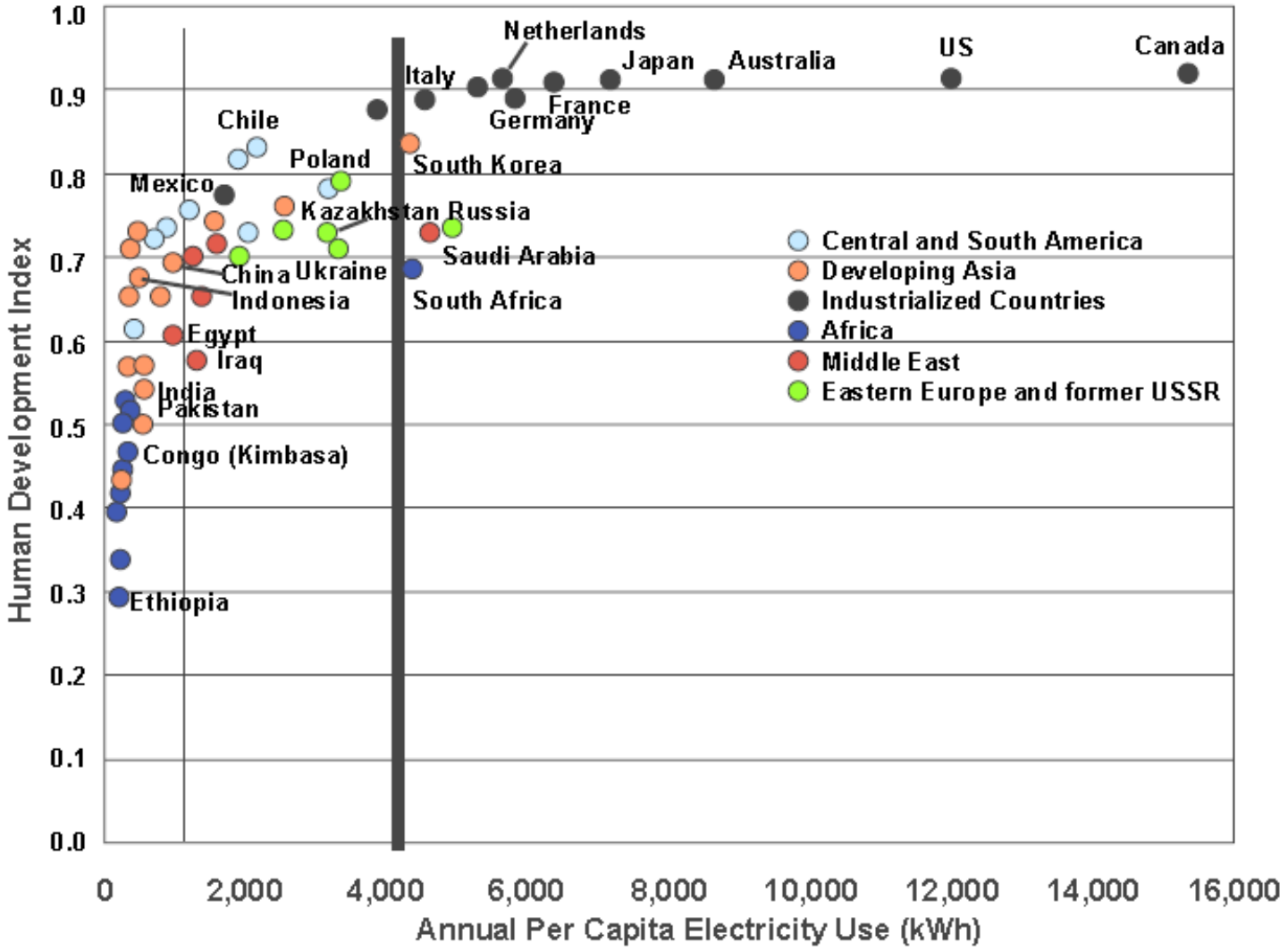


Earth at Night - 2100

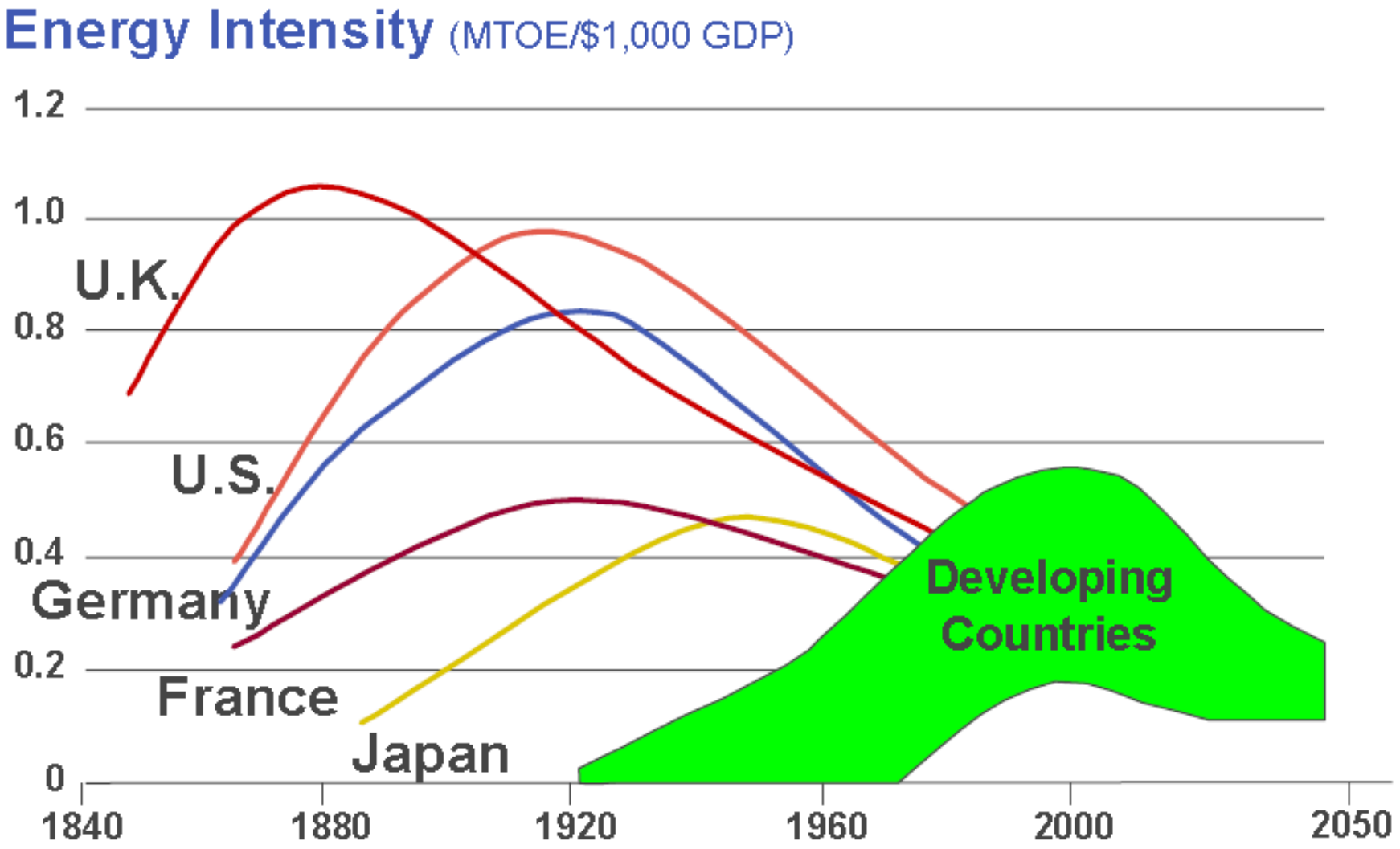


Enfranchisement of Women

HDI vs per capita Electricity



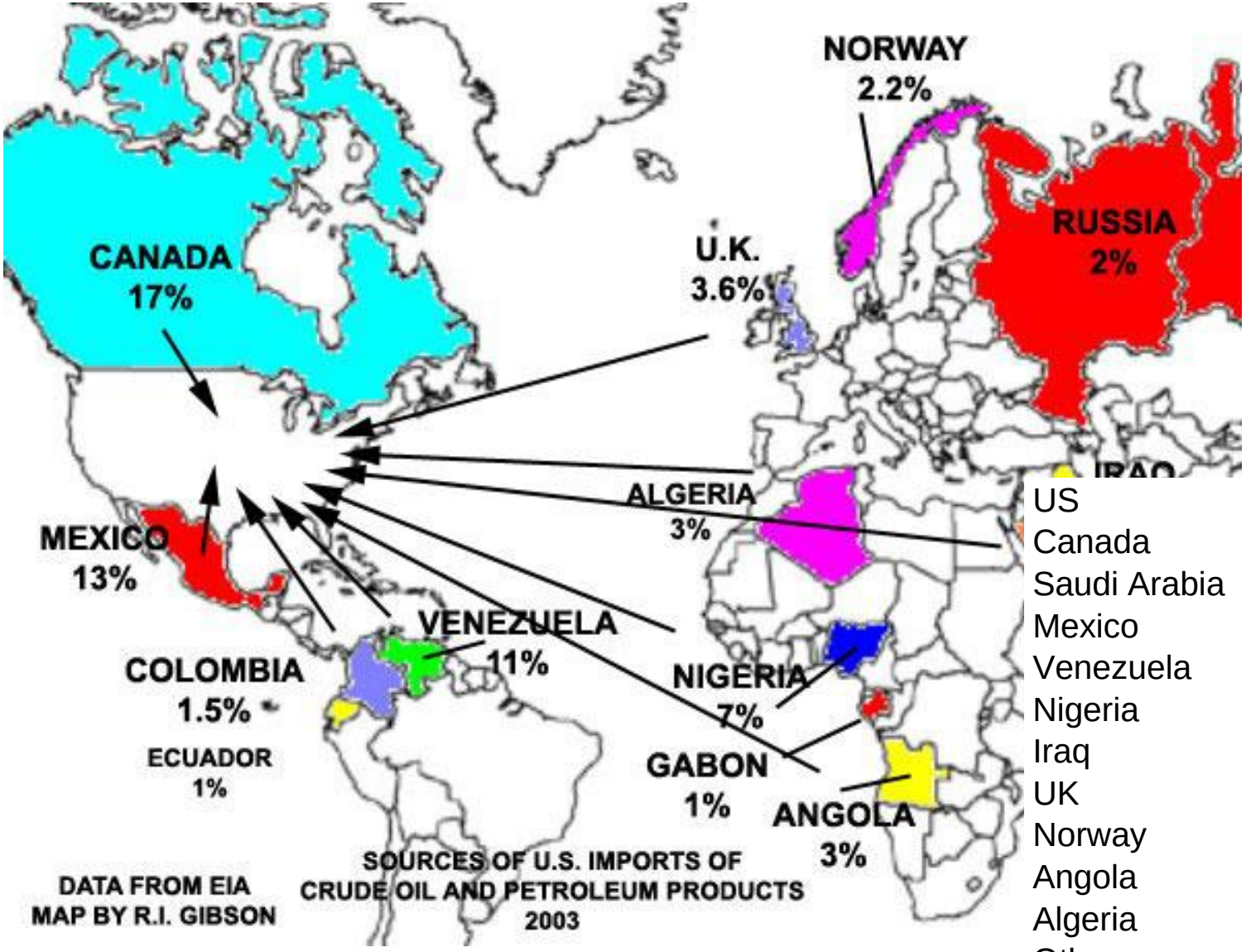
Industrialization Helps Bring Energy Efficiency



US Energy Consumption (2001)

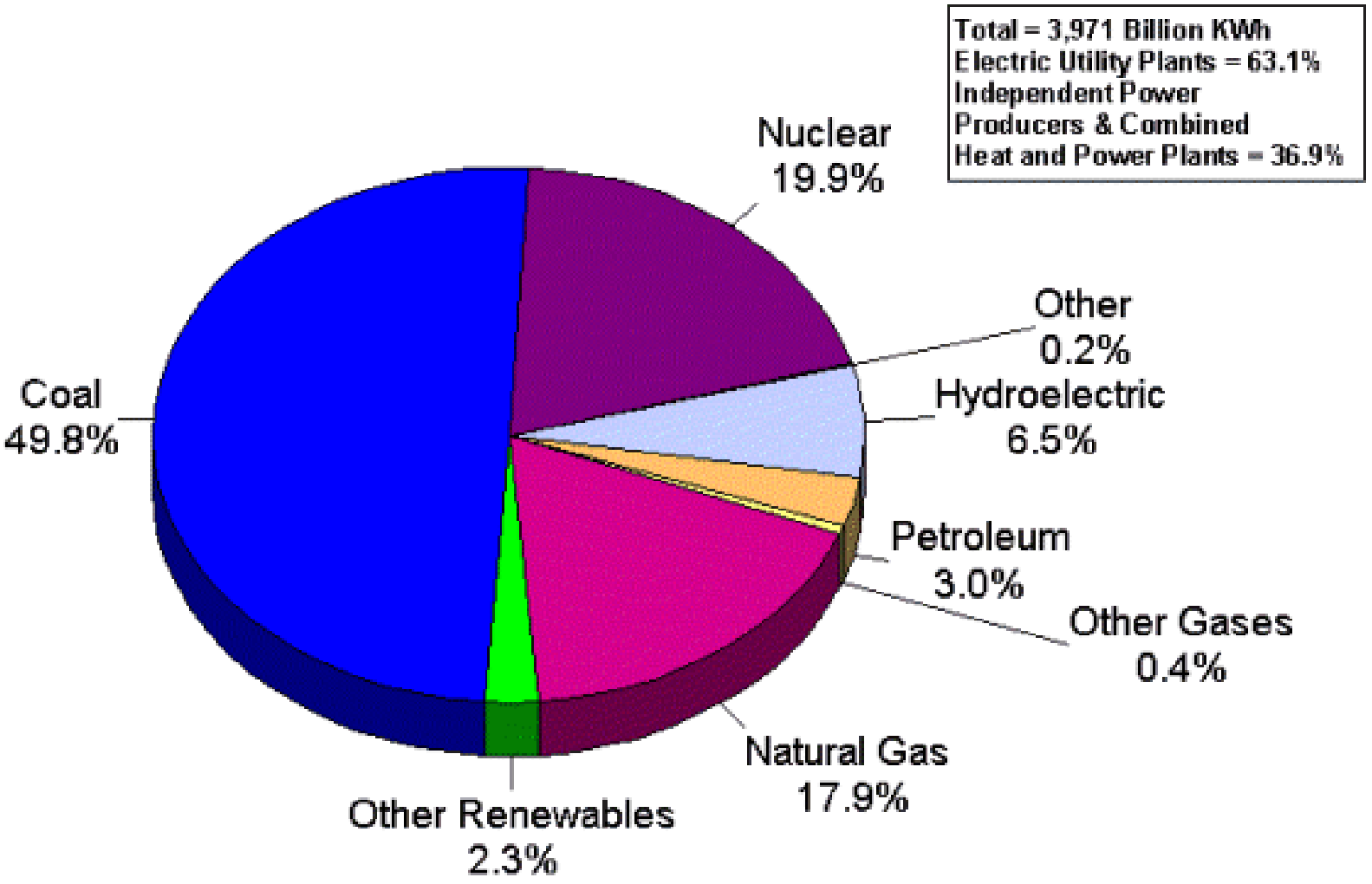
Energy Source	Percentage of total
Petroleum	42%
Coal	24%
Natural Gas	20%
Nuclear	8%
Hydro power	2%
Solar, Wind, etc.	2%

US Oil Imports (2003)



US	39%
Canada	13%
Saudi Arabia	10%
Mexico	10%
Venezuela	9%
Nigeria	4%
Iraq	4%
UK	3%
Norway	3%
Angola	2%
Algeria	2%
Other	2%

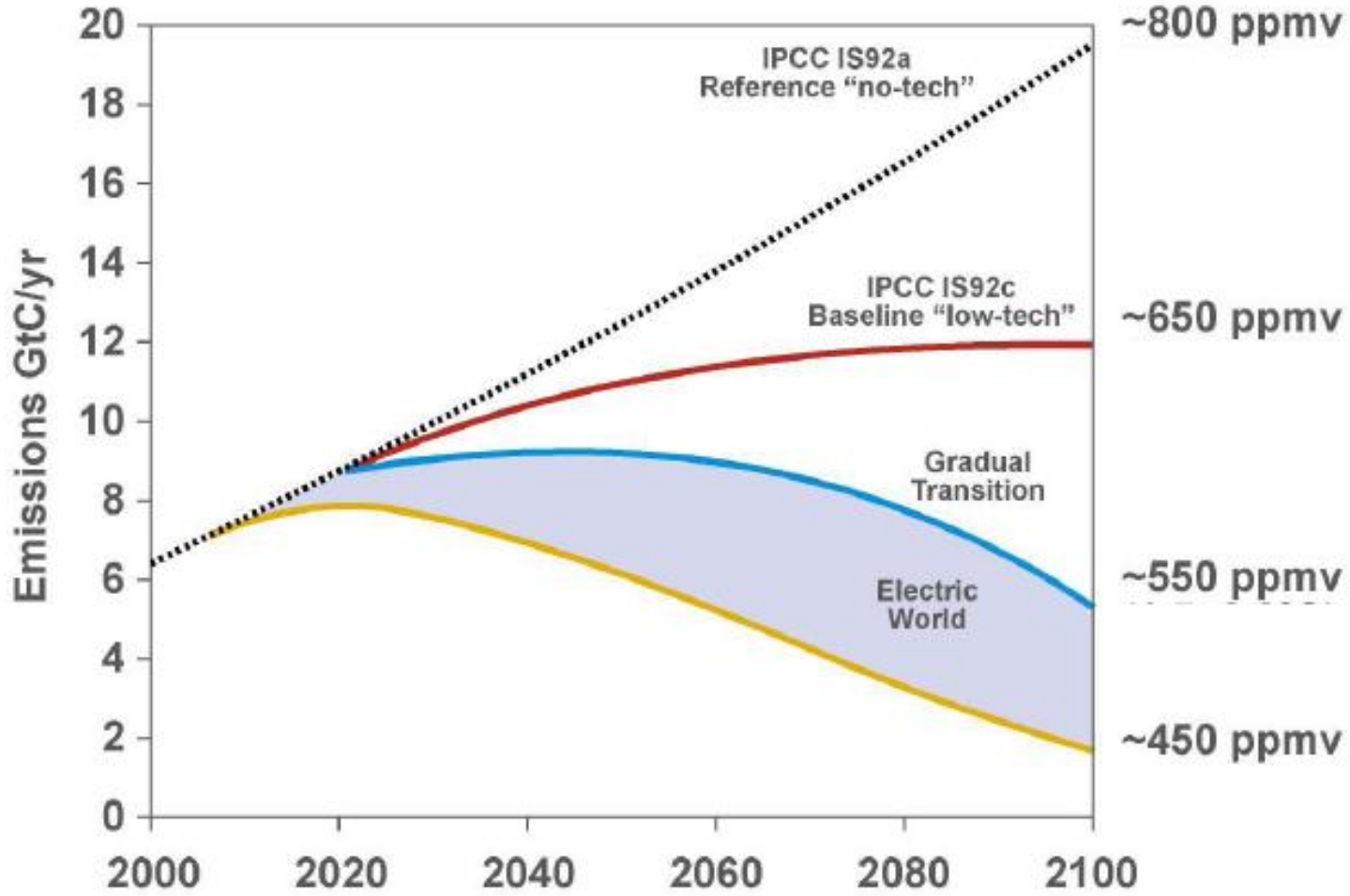
US Electricity Generation - 2005



Note: Conventional hydroelectric power and hydroelectric pumped storage facility production minus energy used for pumping.

“Greenhouse Gases”

CO_2 Emission Scenarios



60 million years ago, the CO_2 concentration in the atmosphere was 7,000 ppmv!

The 21st Century Energy Challenge

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

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

…without requiring any new scientific discoveries or breakthroughs!

But it sure would help to have a practical RTSC!

The Solution

A Symbiosis of

Nuclear/Hydrogen/Superconductivity

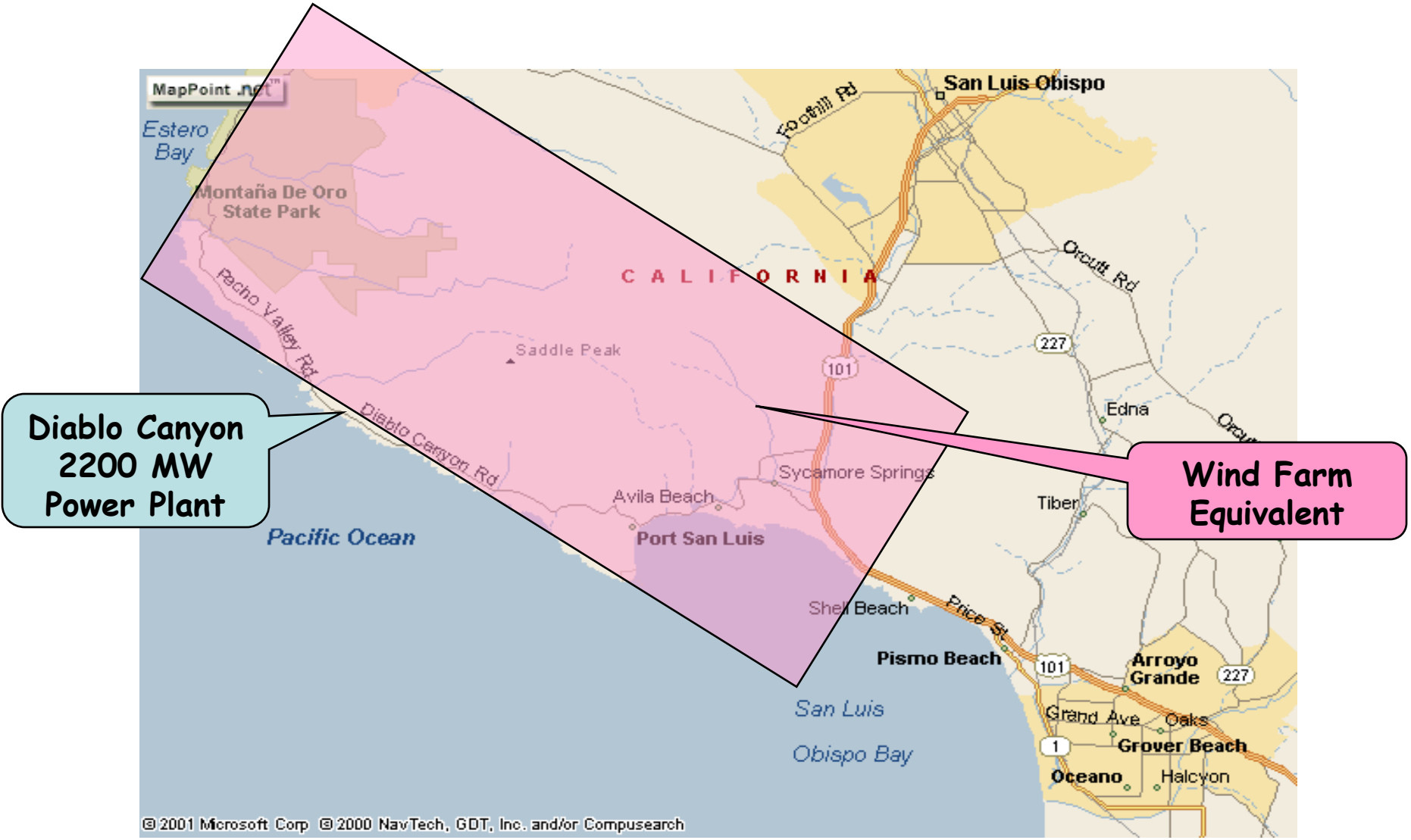
Technologies supplying Carbon-free, Non-Intrusive Energy for all Inhabitants of Planet Earth

Chauncey Starr
1912 - 2007

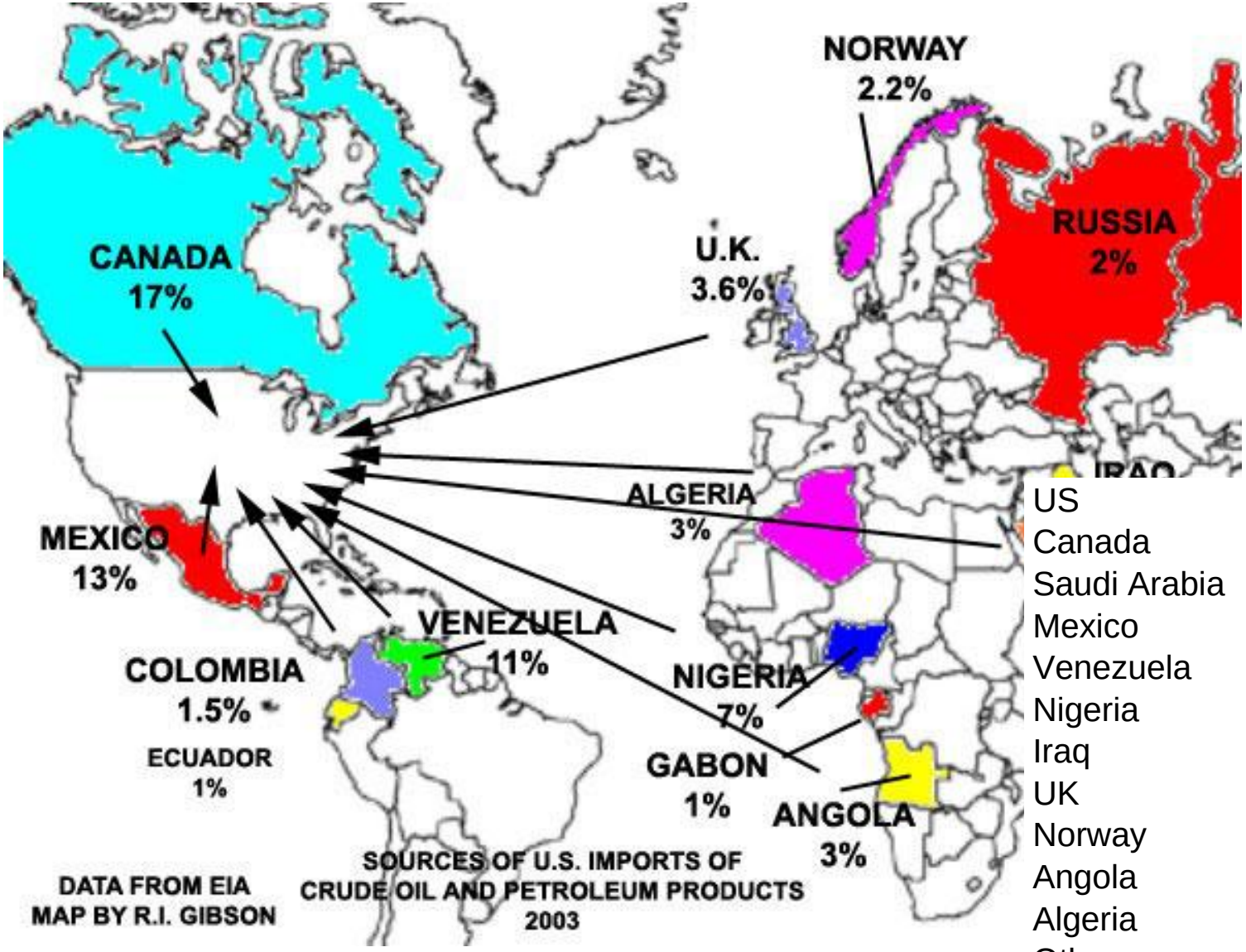
Obituary, Nature, 14 June 2007

Diablo Canyon

California Coast Power



US Oil Imports (2003)



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UK	3%
Norway	3%
Angola	2%
Algeria	2%
Other	2%

The Hydrogen Economy

- 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)

P.M. Grant, "Hydrogen lifts off…with a heavy load," Nature 424, 129 (2003)

Hydrogen for US Surface Transportation

The "25% 80-80-80 400 GW" Scenario

http://www.w2agz.com

Hydrogen per Day	
Tonnes	Shuttles
230,000	2,225

Water per	
Tonnes	Mete
2,055,383	

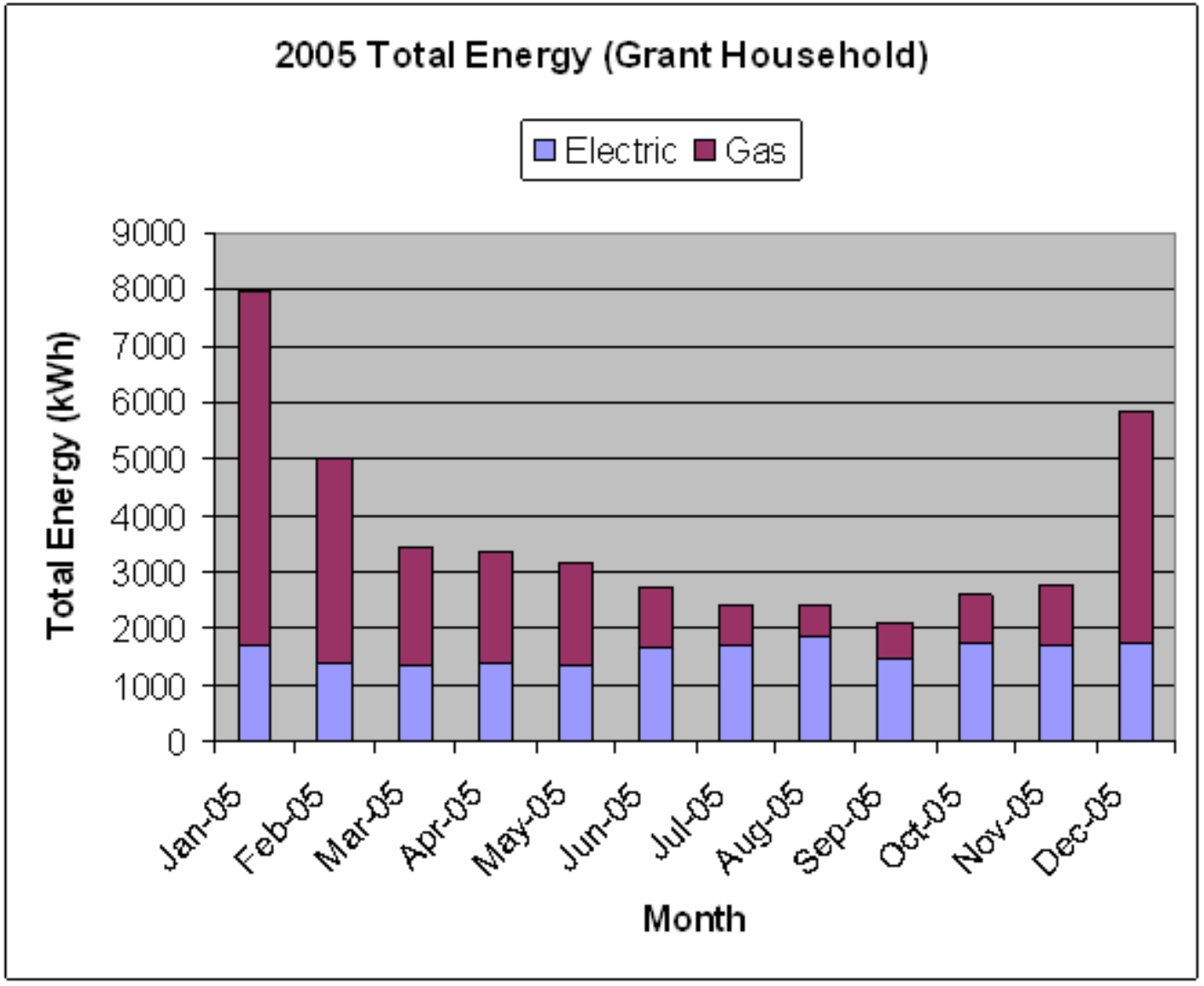
Hydrogen for US Surface Transportation

The "25% 80-80-80 400 GW" Scenario

http://www.w2agz.com

Renewable Land Area Requirements		
Technology	Area (km^2)	Equivalent
Wind	130,000	New York State
Solar	20,000	50% Denmark Death Valley + Mojave
Biomass	271,915	3% USA State of Nevada

Hydrogen Transport (according to DOE OH)


2005 Total Energy (Grant Household)
Electric
Gas
Total Energy (kWh)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Jan-05
Feb-05
Mar-05
Apr-05
May-05
Jun-05
Jul-05
Aug-05
Sep-05
Oct-05
Nov-05
Dec-05
Month

GHE Statistics

Power (kW)	*Electricity*	*Natural Gas*	*Total*
Monthly Mean	2.16	2.84	4.99
Standard Deviation	0.24	2.39	2.39
Mean + STD	2.39	5.23	7.39
Mean - STD	1.92	0.45	2.60

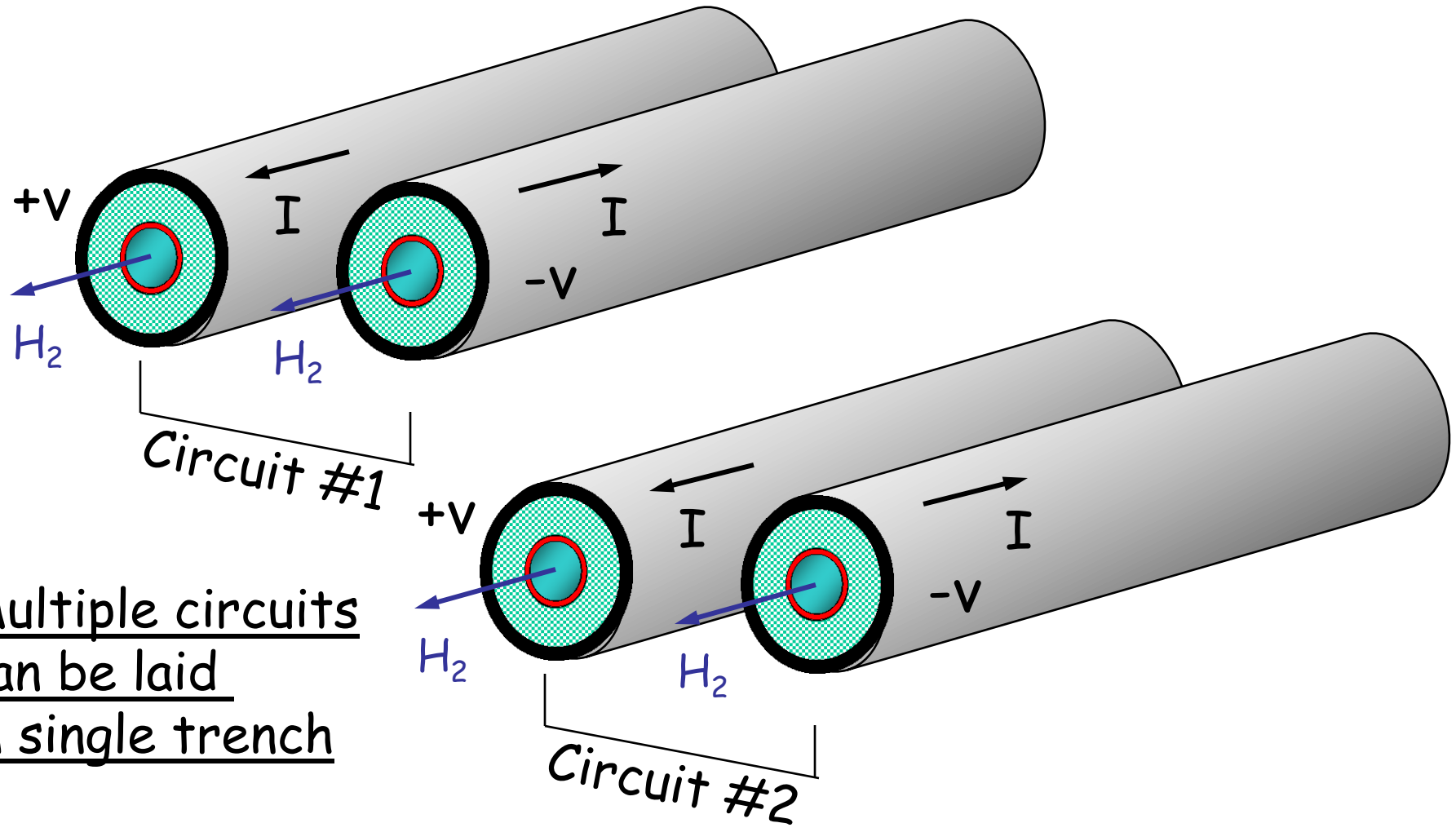
GHE Load Centers

- Motors 40%
  - 12 @ ~ 0.75 hp (80%)
- Lights/Appliances 60%

- Assume Motor Efficiency at 90% for RTSC
- Energy Saving/yr for 50 M USA-HH =

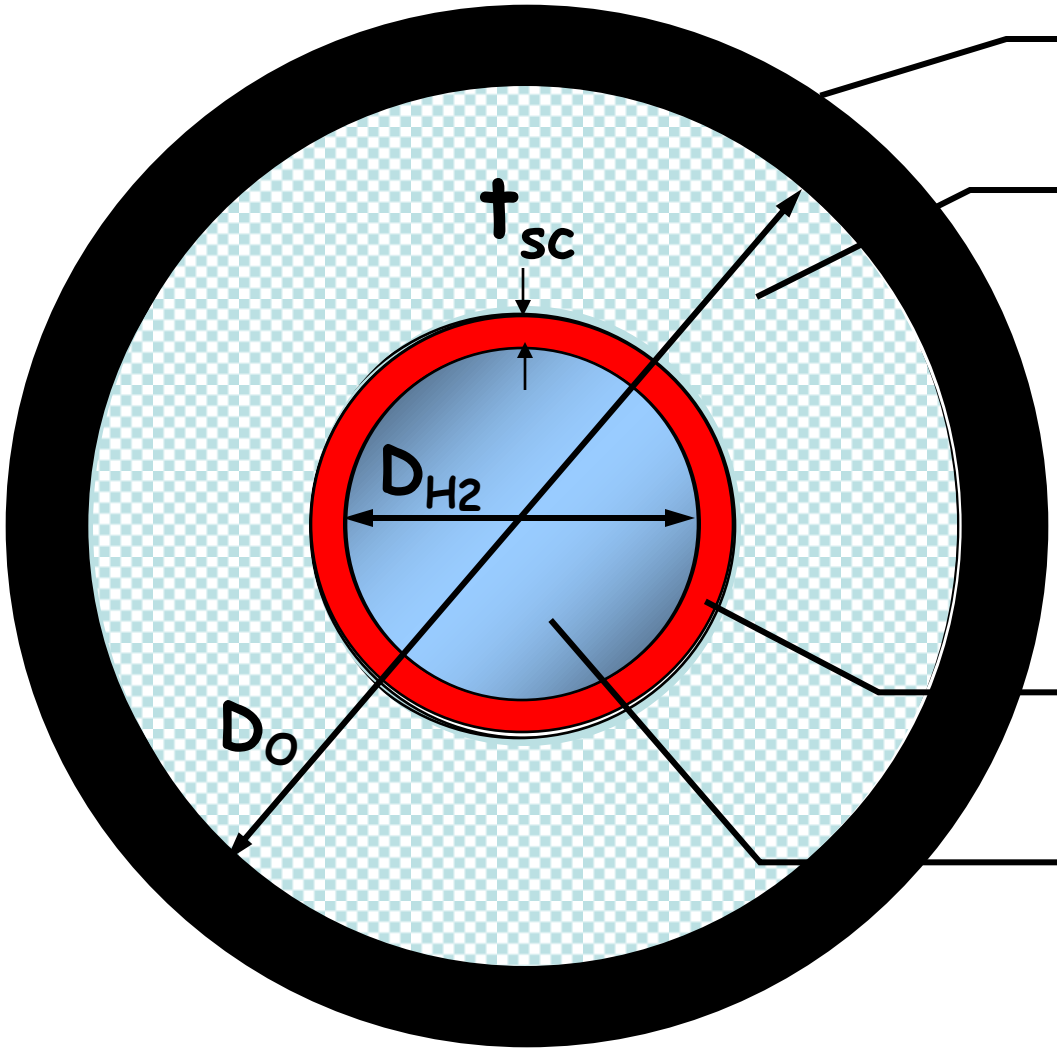
  $3 B/yr

“Hydricity” SuperCables



Multiple circuits
can be laid
in single trench

LH_2 SuperCable



HV Insulation

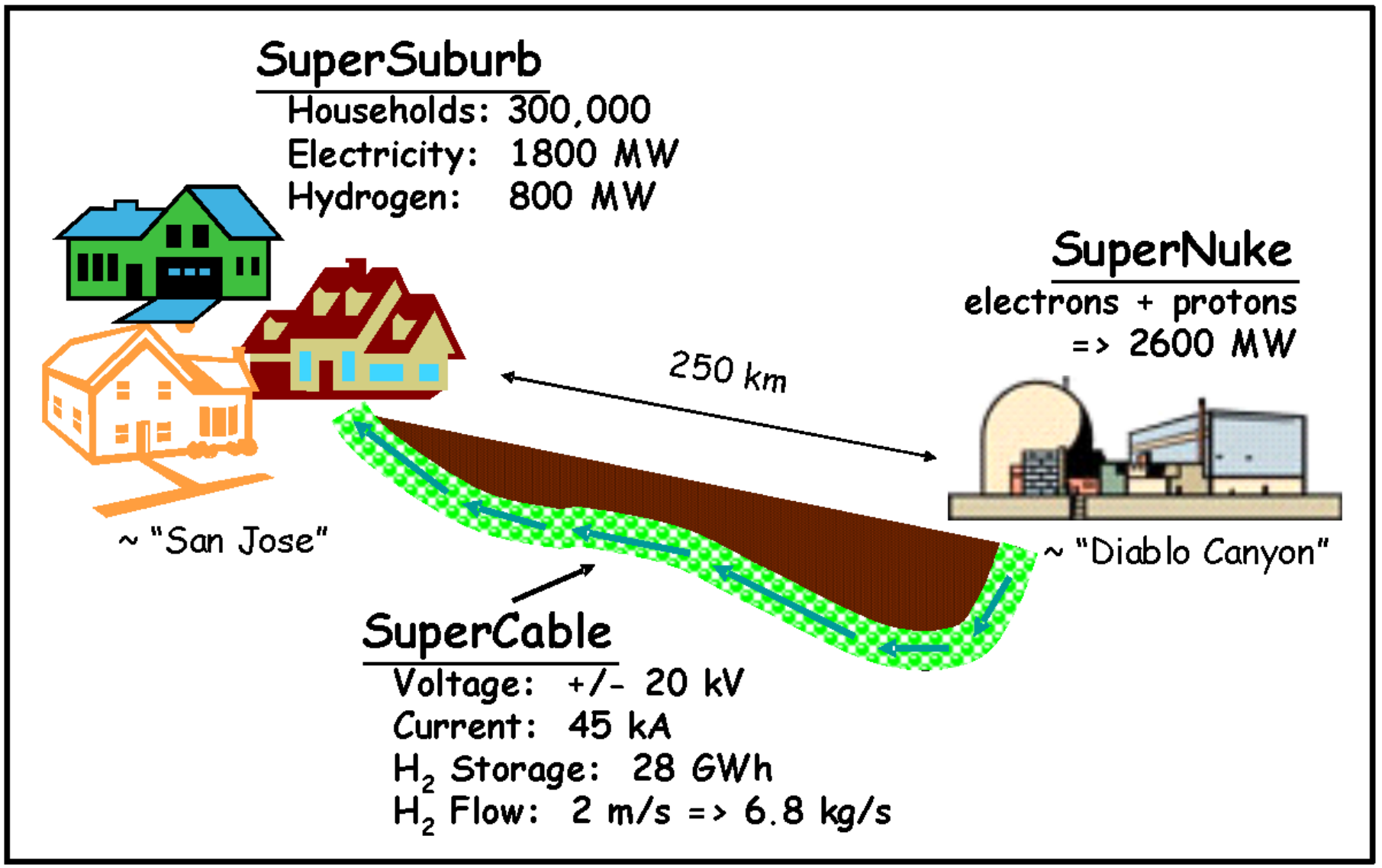
"Super-Insulation"

Roughly to Scale:
- Overall 30 cm Diameter

Superconductor

Hydrogen

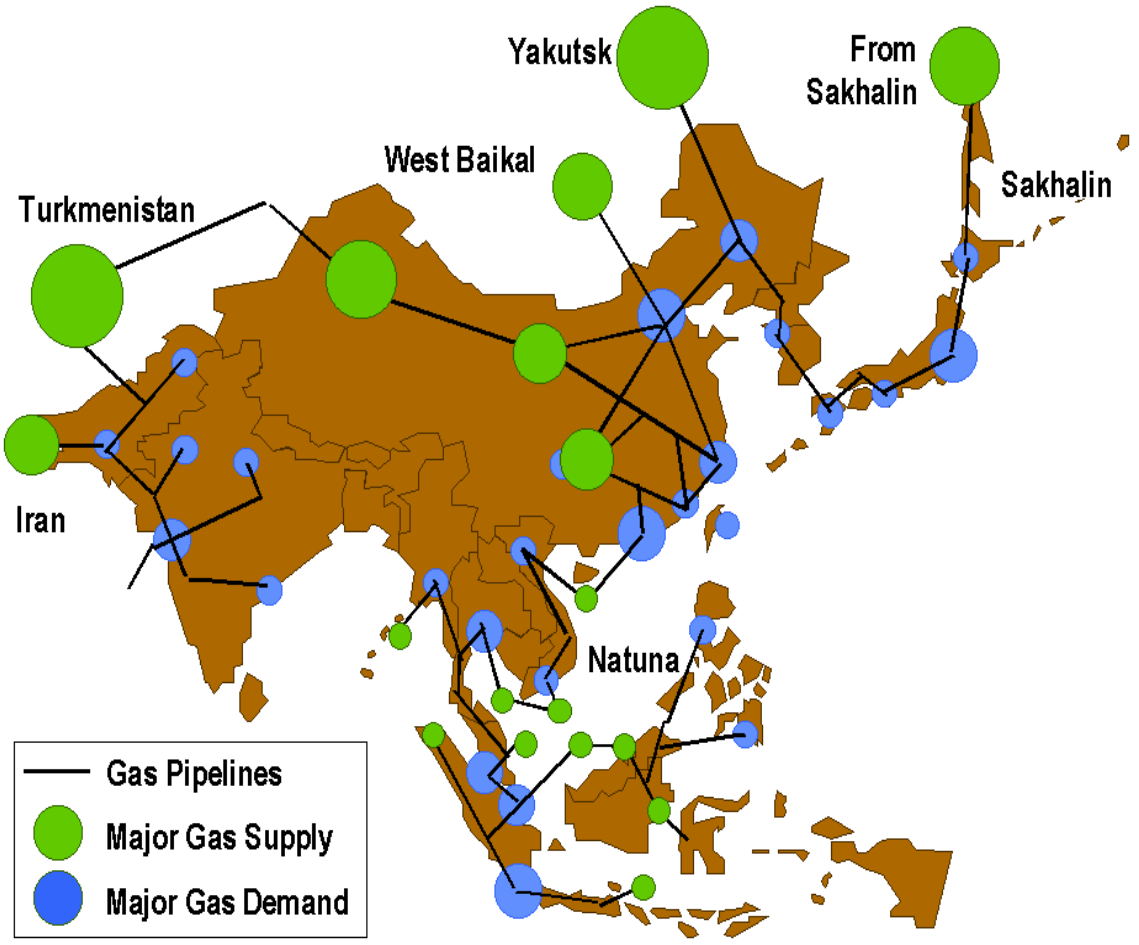
SuperSuburb



Utility Spec for an “RTSC”

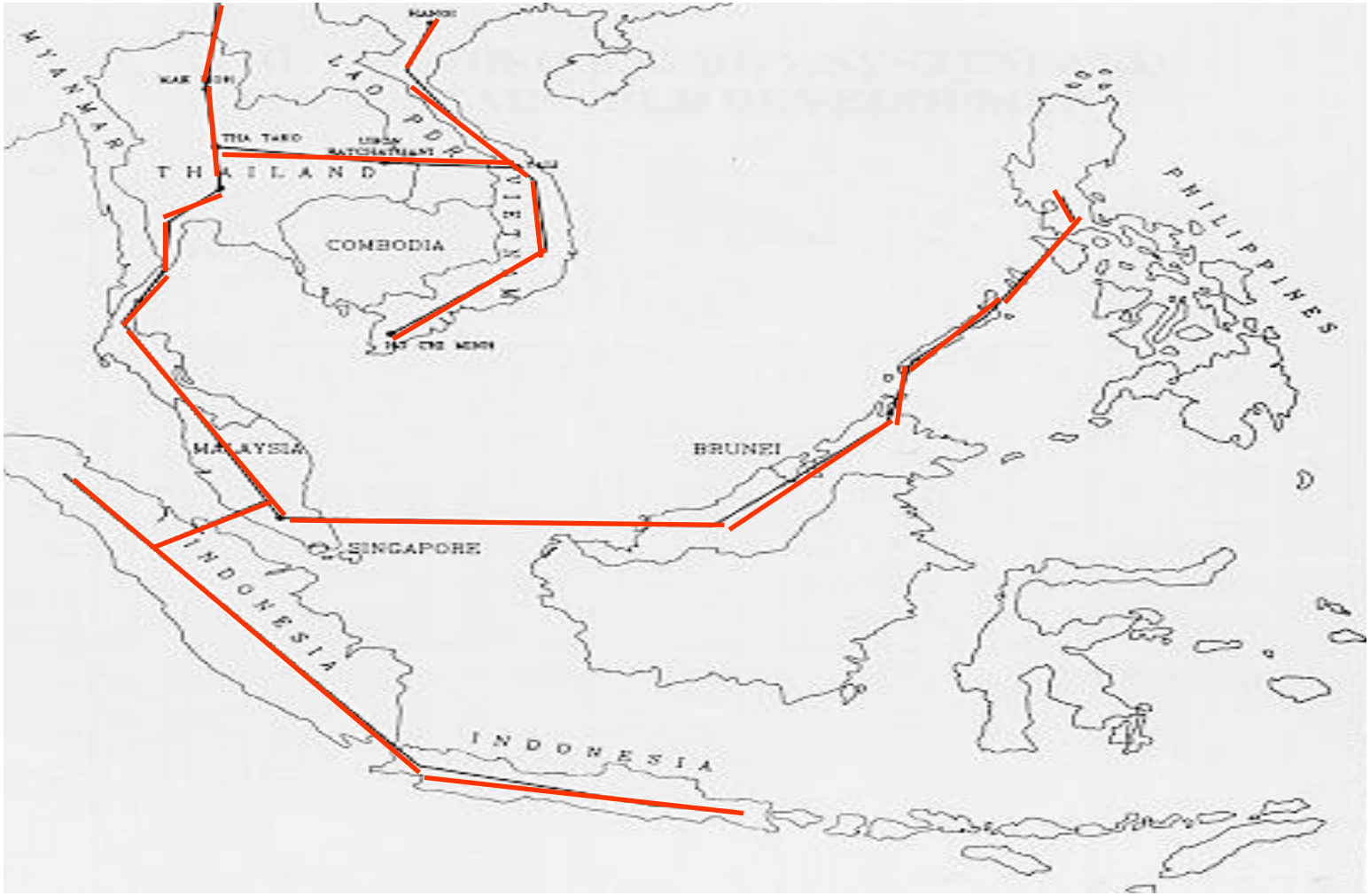
- σ >= 200x Cu @ 300 K @ 20 kA/cm^2 @ 1000 Hz
- ρ_{RTSC}/ρ_{Cu} <= 2
- Tensile Strength ~ CR Al
- Not Obnoxiously Toxic
- Cost <= 5x Cu
  - Related to cost of electricity

Power by HTSC: Asia



Location of Asian Gas Fields and Major Energy Use Centers

Power by HTSC: Southeast Asia



“Superconduct-ress”

Mr. Electric Utility Good Ol' Boy

Miss Same Old Technology

Together Forever?

“Most Loyal”