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

(Will We Be Able to Use It?)

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The Road to Room Temperature Superconductivity

Loen, Norway

17-22 June 2007

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

Road2RTS

Abstract for Road to RTSC, Loen, Norway
17 June 2007

So Now We Have a Room Temperature Superconductor… So What? (Will We Be Able to Use It?)

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An ancient Chinese proverb advises, "Be careful what you wish for…you might get it!" Such would apply if we were to accomplish our dream of room temperature superconductivity only to find it overwhelmingly difficult to use. Barriers can arise from many sources…micro-macro-structural complexity, scalability, cost, eco-enviro-invasion…as well as raw performance. We will consider only performance factors relating to large scale power applications such as electric transmission cables and rotating machinery, noting that these systems seldom, if ever, require persistent current operation. That is, superconductors…low, high and room temperature…need not necessarily be perfect conductors for power purposes, simply "ultra-conductors." For purposes of discussion, we will set as a benchmark that our "RTSC" must possess 200 times the conductivity of copper at 300 K, whether that be embodied in a material in a Cooper-paired type-II superconducting state undergoing thermally activated flux flow, or ballistic transport down a bundle of nanotubes, or through a graphene sandwich, or as charge density waves a la Froehlich, or low mass charged solitons, or something we can't imagine at the moment. Realization of deployable "SuperCopper" wire could yield massive savings in electric energy and enable novel energy delivery systems. As an example of the former, we will study the potential savings accruable for a typical middle class American home summed over the nation, and of the latter, an infrastructure for a hydrogen economy where the protons are "manufactured at the end of a wire" rather than delivered by pipeline or truck.

“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

Northeast 8/14

The Party Begins…

…and Continues…

Mary Altaffer / AP

As Night Falls…

It Gets Better…

David Friedman / MSNBC.com

and Better…

George Widman / AP

and Finally, Really Good!

David Friedman / MSNBC.com

The Morning After

Gregory Bull / AP

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

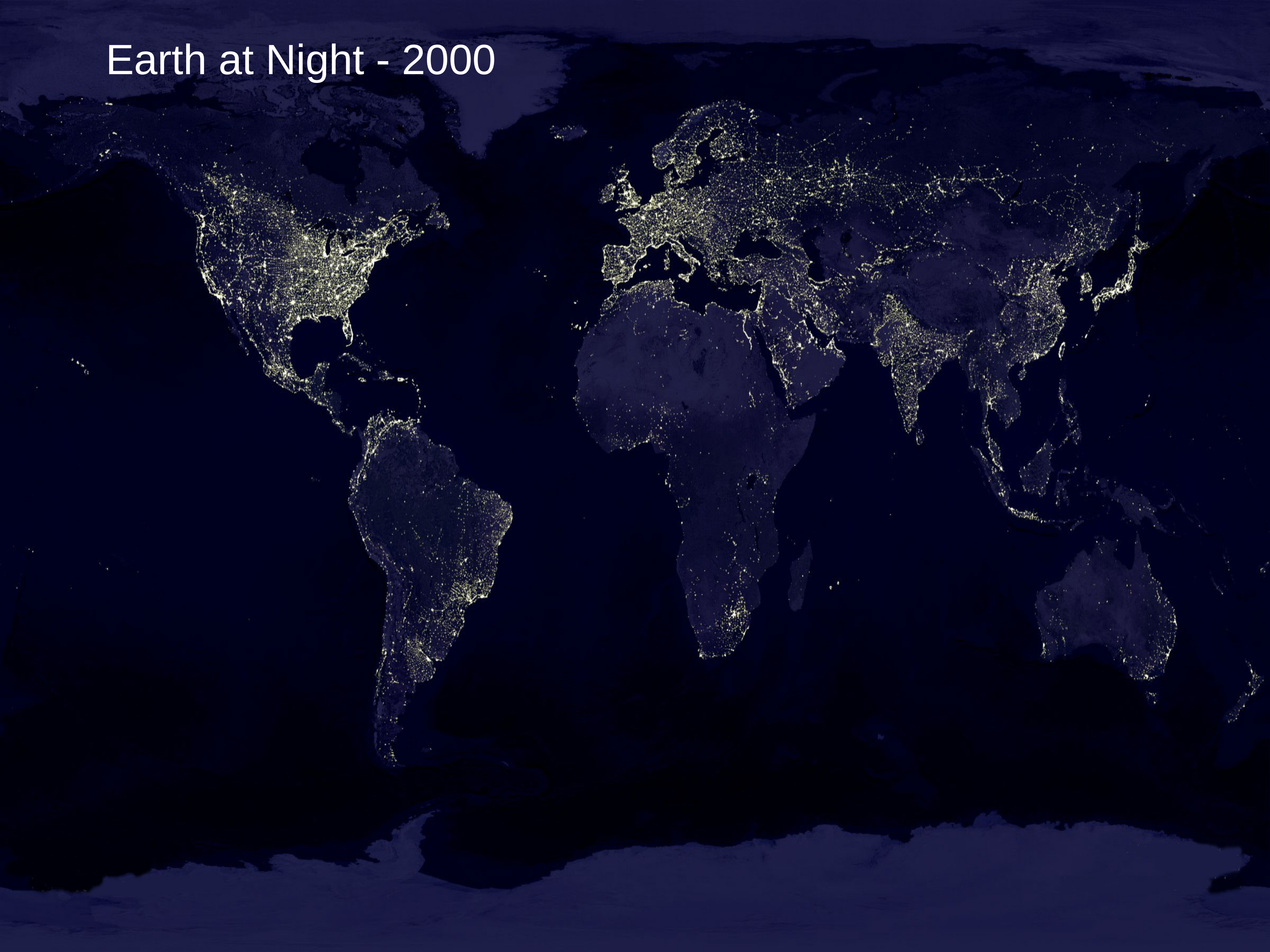
- Nb_3Sn (T_C = 18 K) @ 4.2 K
- 100 GW (+/- 100 kV, 500 kA)
- 1000 km
- Cost: $800 M ($8/kW) (1967)

$4.7 B Today!

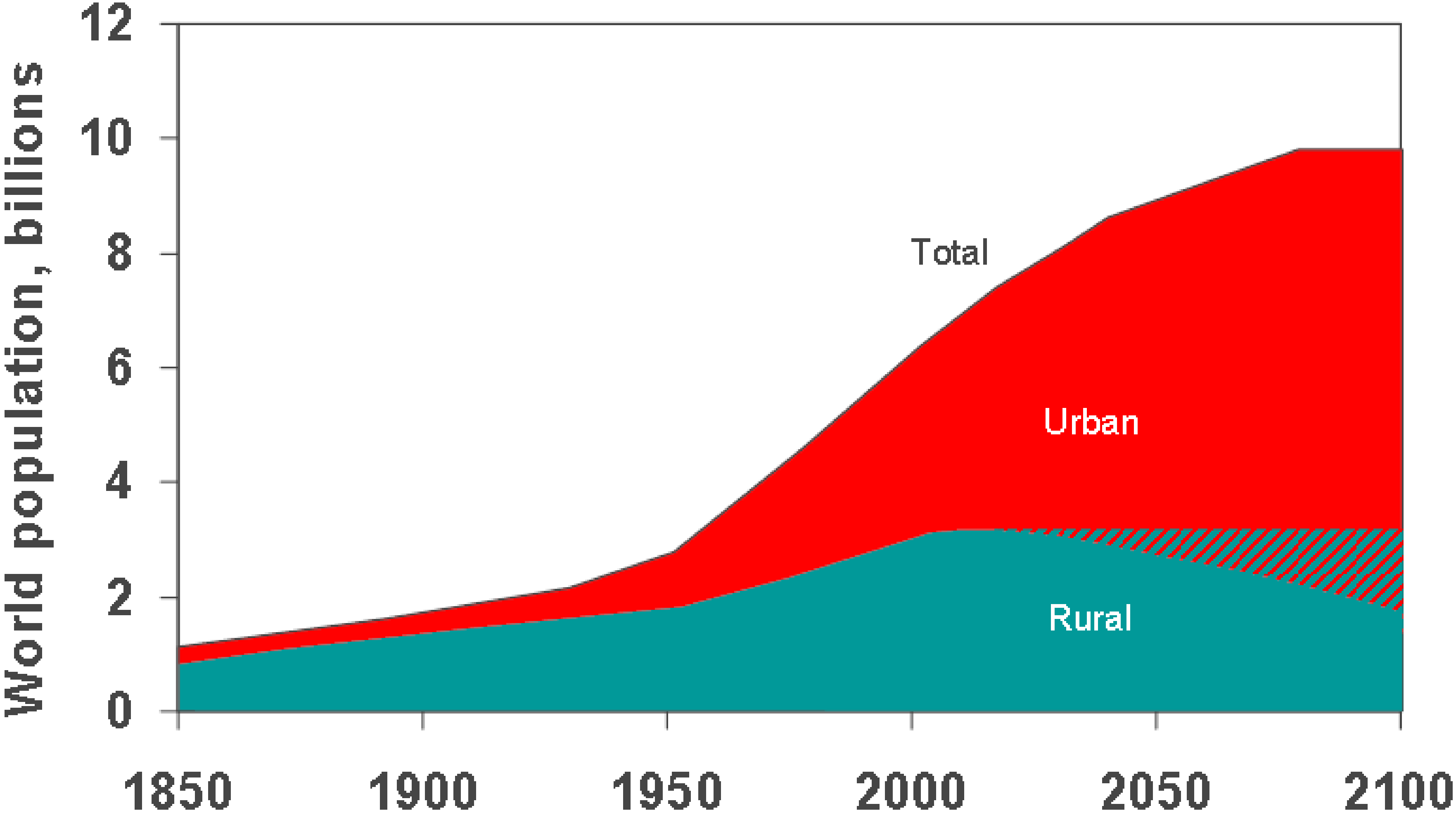
Where there is no vision,
the people perish…

Proverbs 29:18

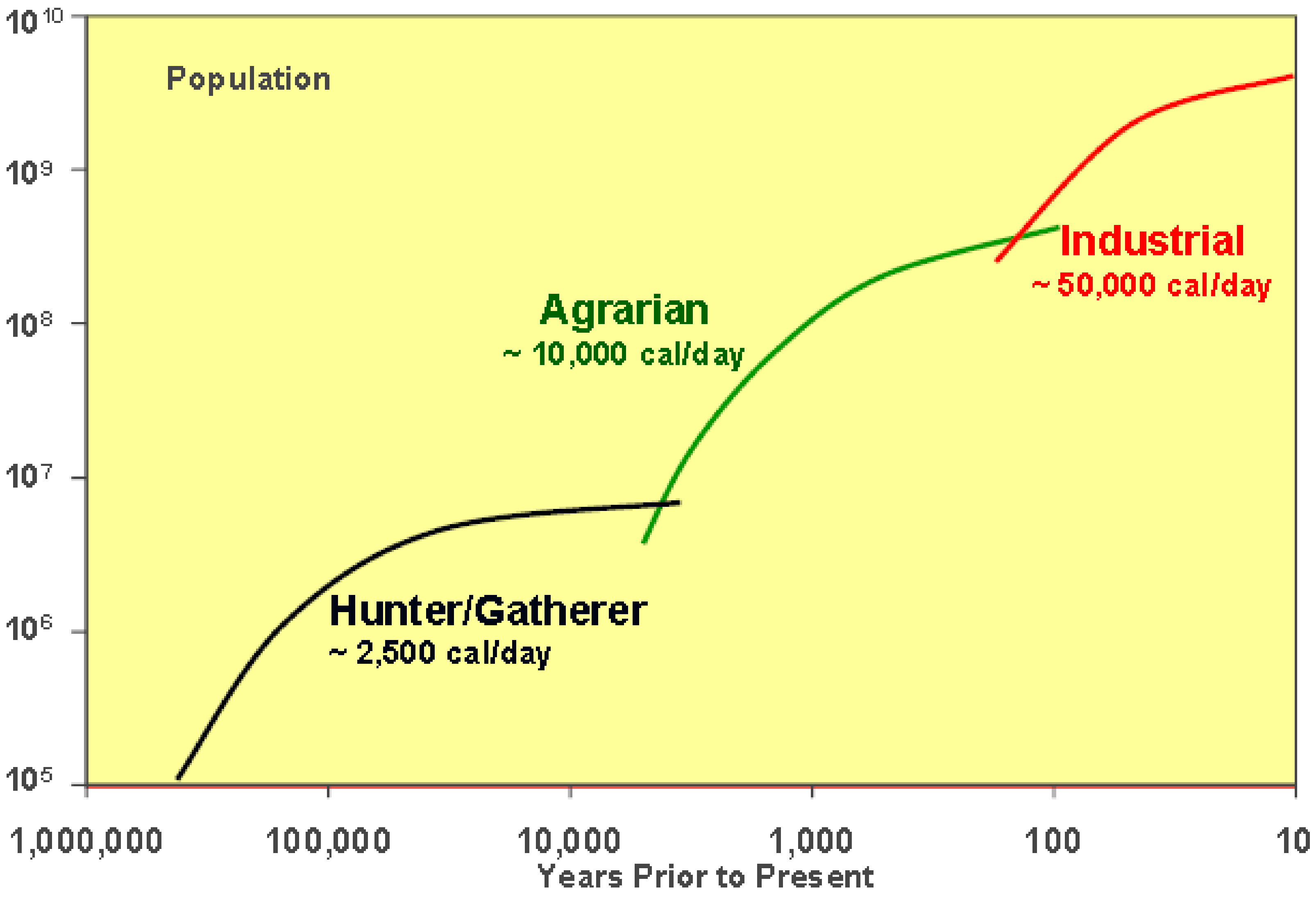
Earth at Night - 2000



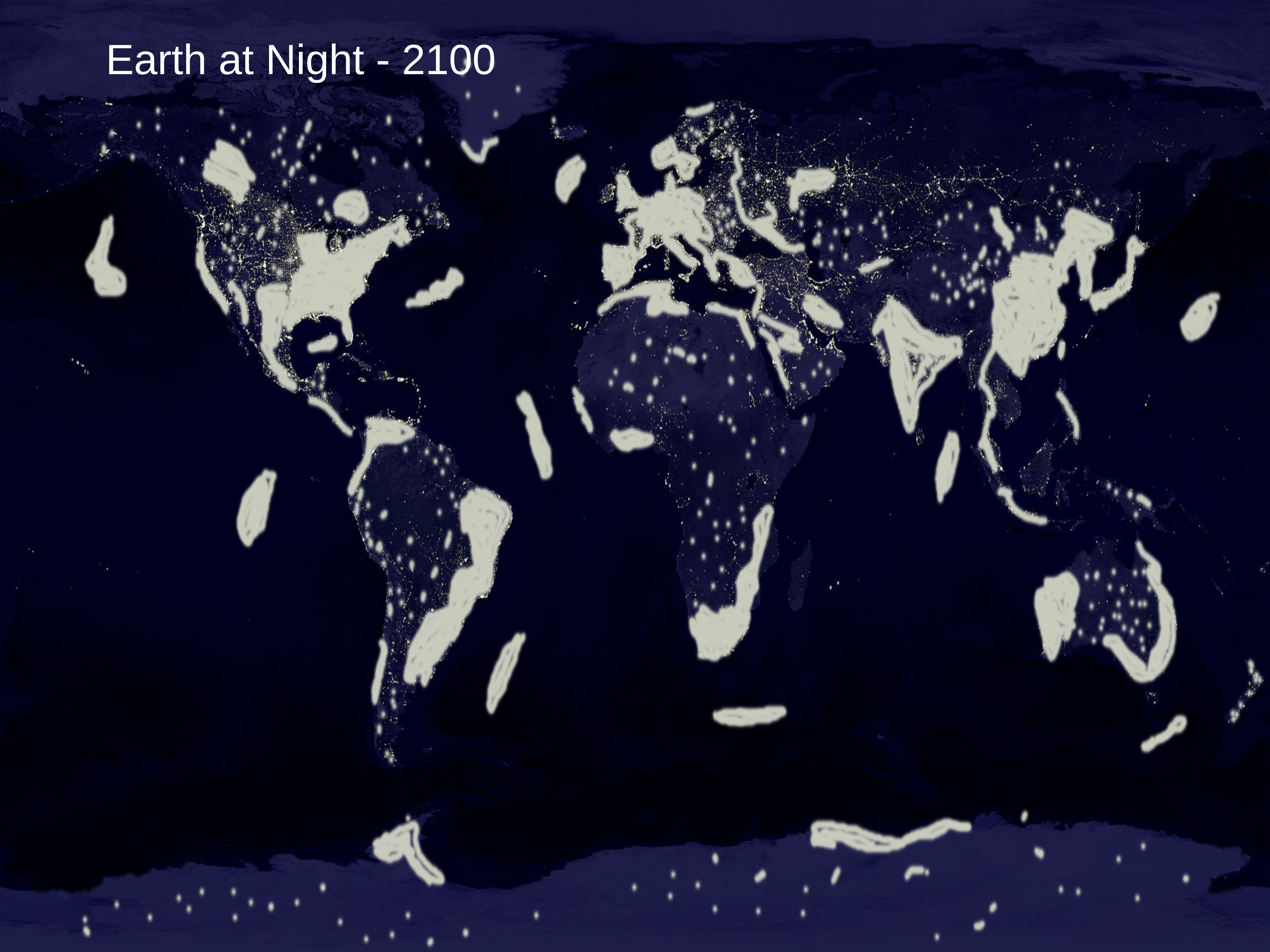
World Population: 1850 - 2100



Energy/Demographics Timeline

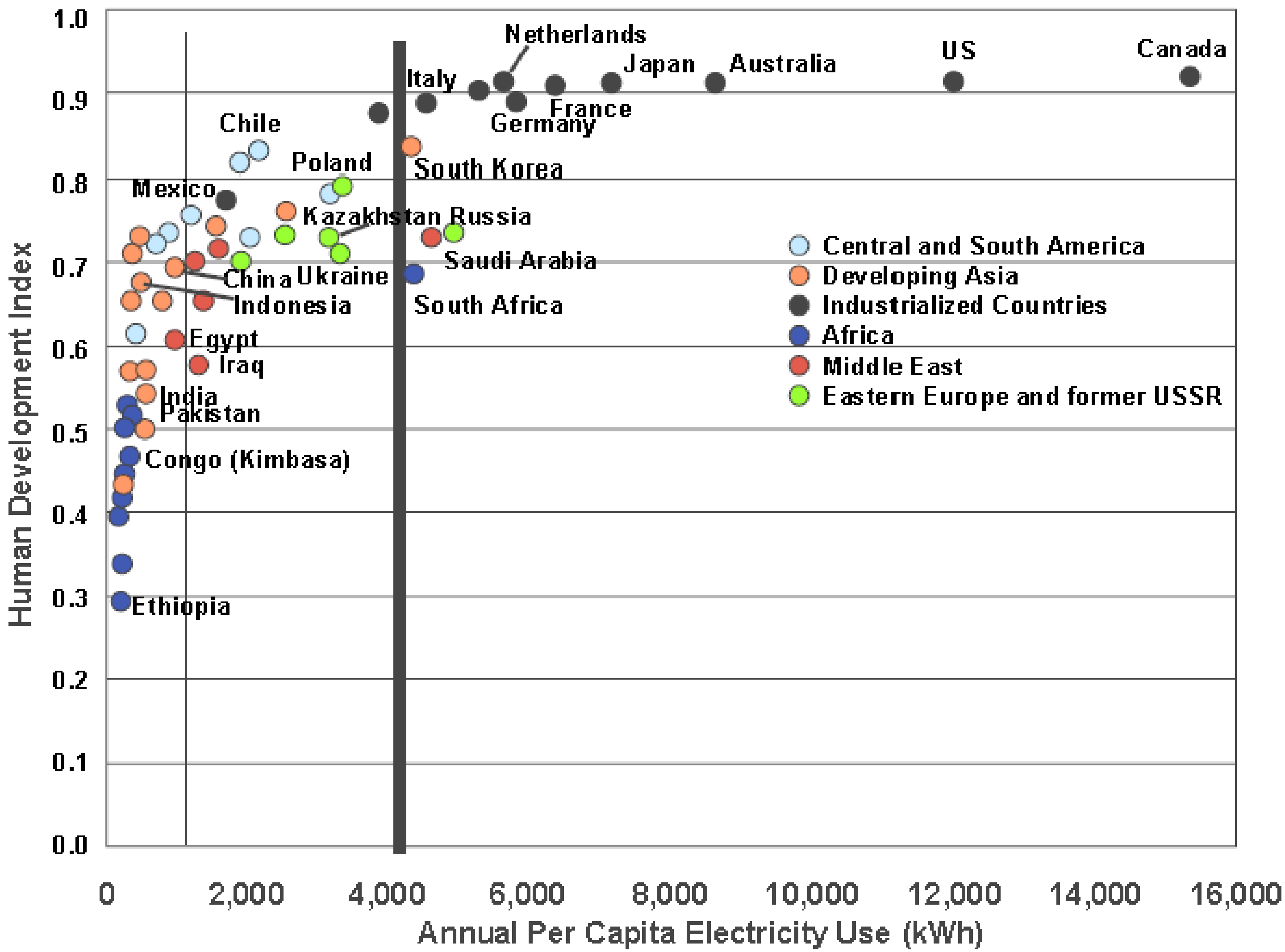


Earth at Night - 2100

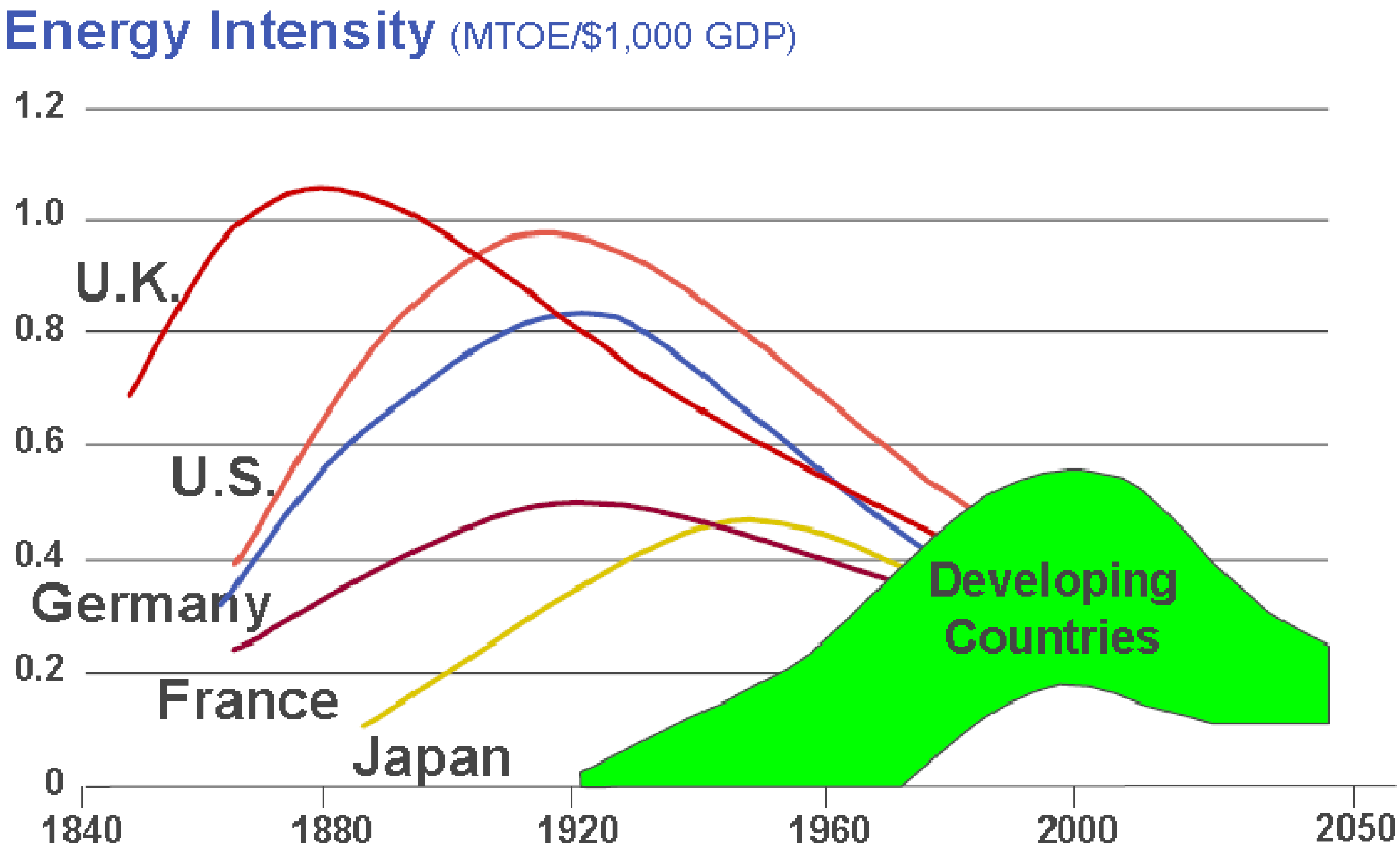


Enfranchisement of Women

HDI vs per capita Electricity



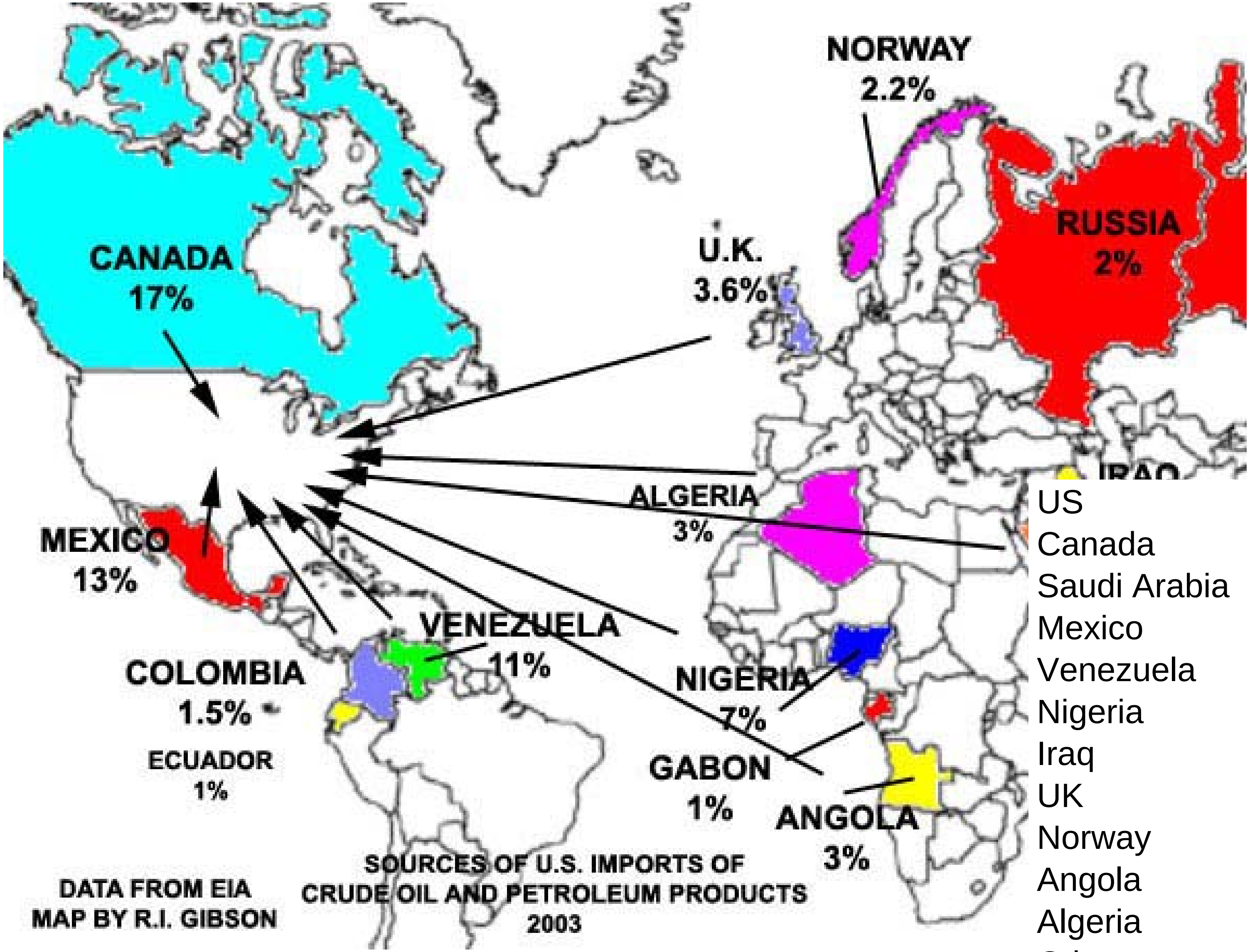
Industrialization Helps Bring Energy Efficiency



US Energy Consumption (2001)

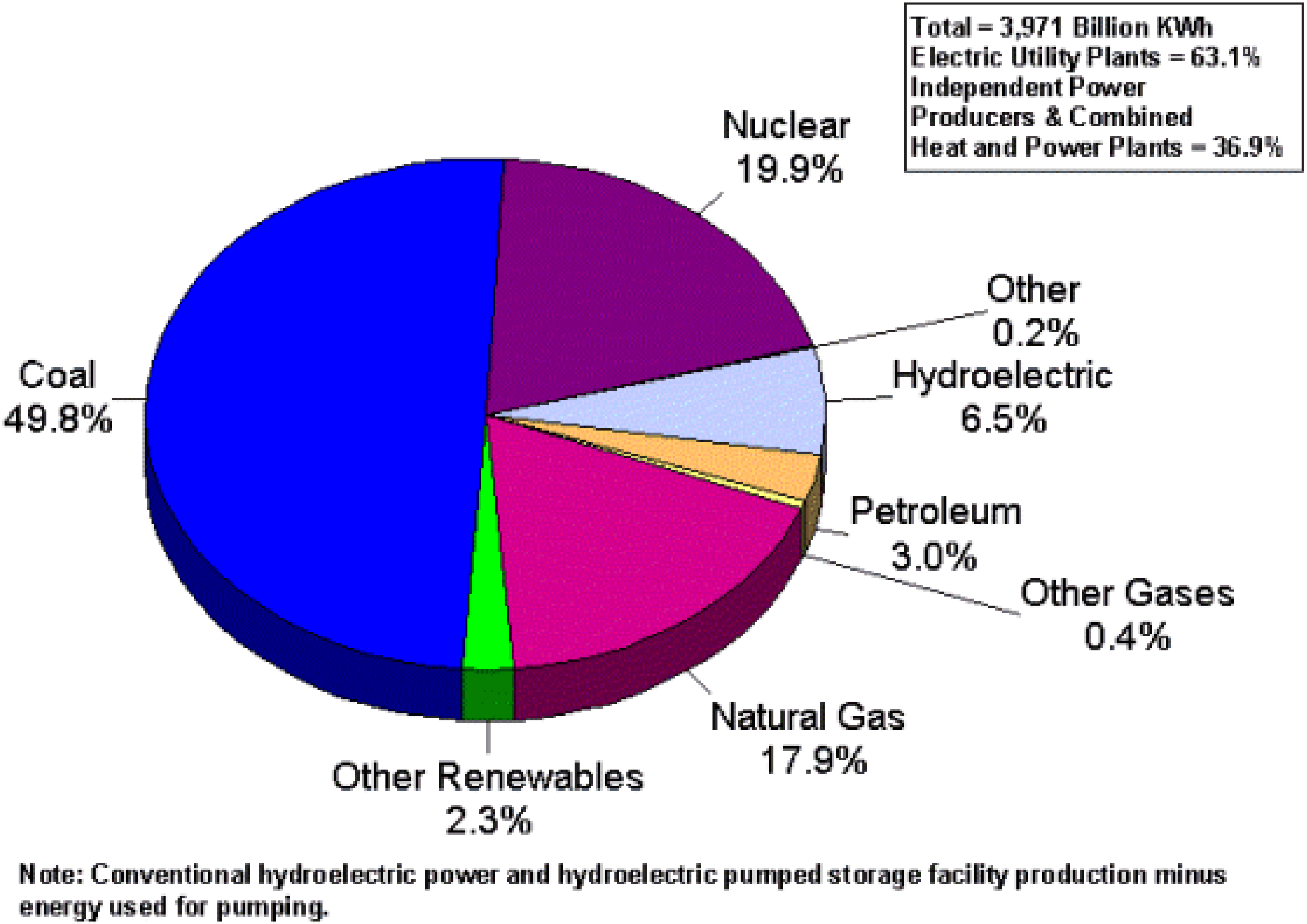
Energy Source	Percentage of total
Petroleum	42%
Coal	24%
Natural Gas	20%
Nuclear	8%
Hydro power	2%
Solar, Wind, etc.	2%

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%

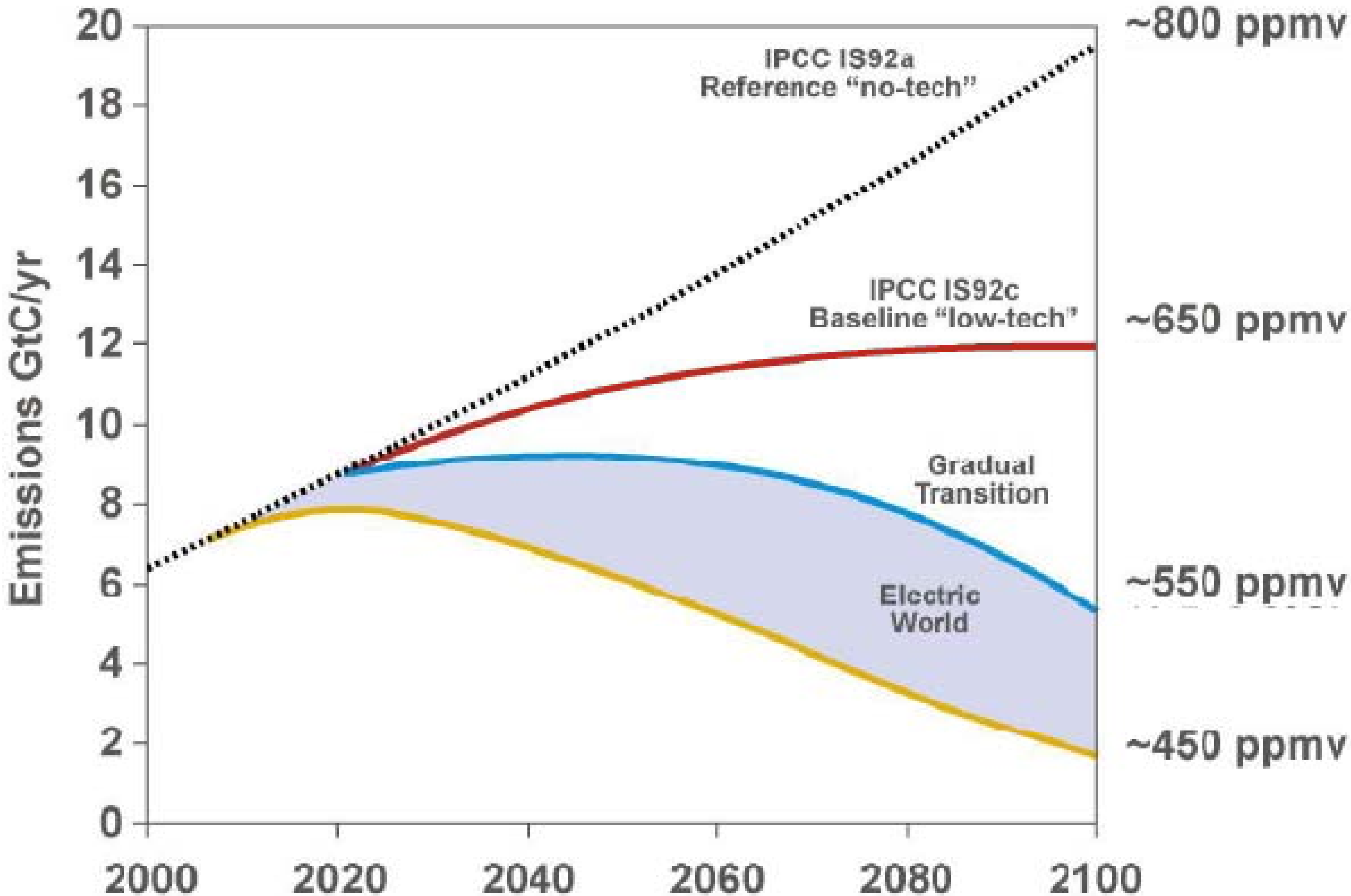
US Electricity Generation - 2005



“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

<u>Nuclear/Hydrogen/Superconductivity</u>

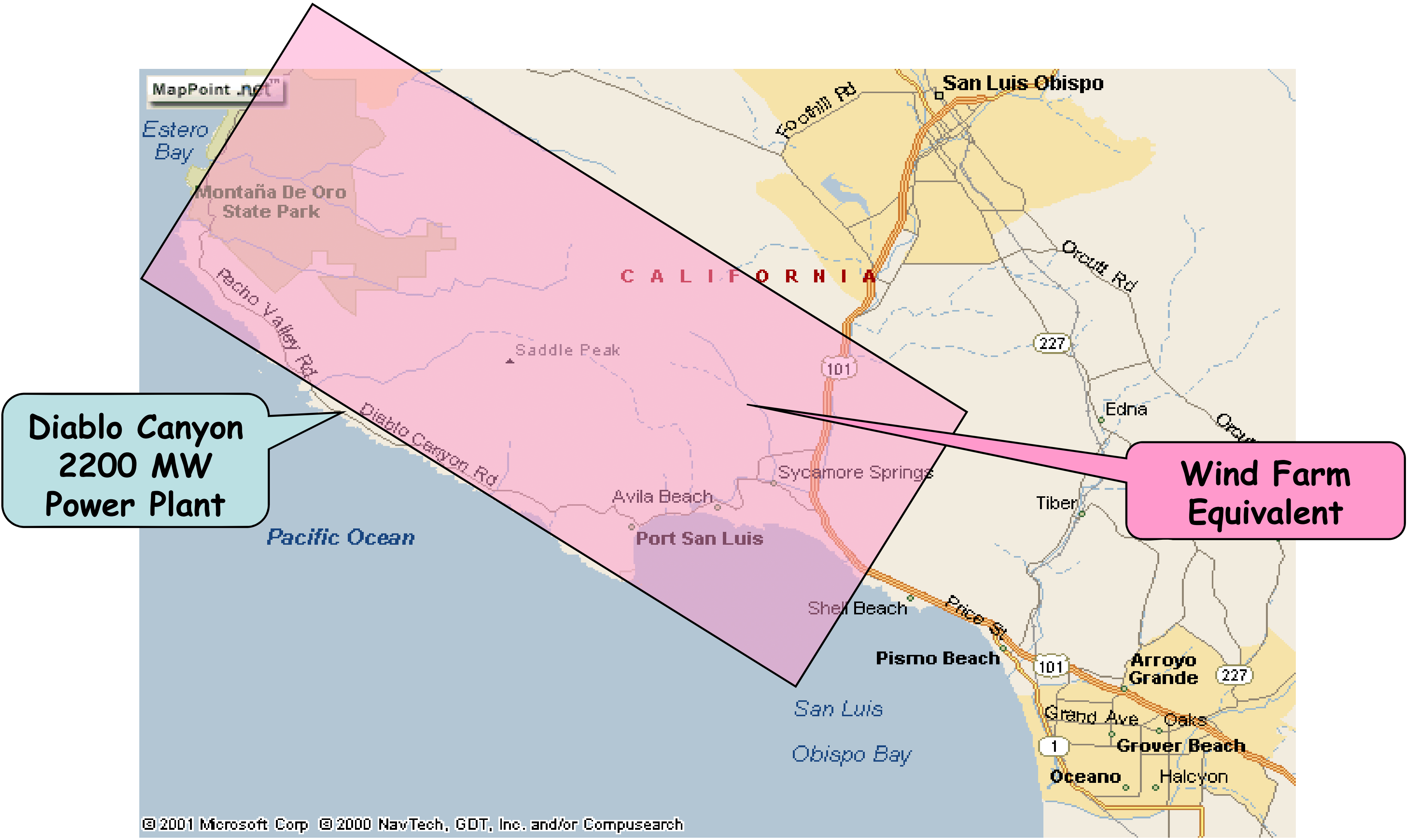
Technologies supplying Carbon-free, Non-Intrusive Energy for all Inhabitants of Planet Earth

Chauncey Starr
1912 - 2007

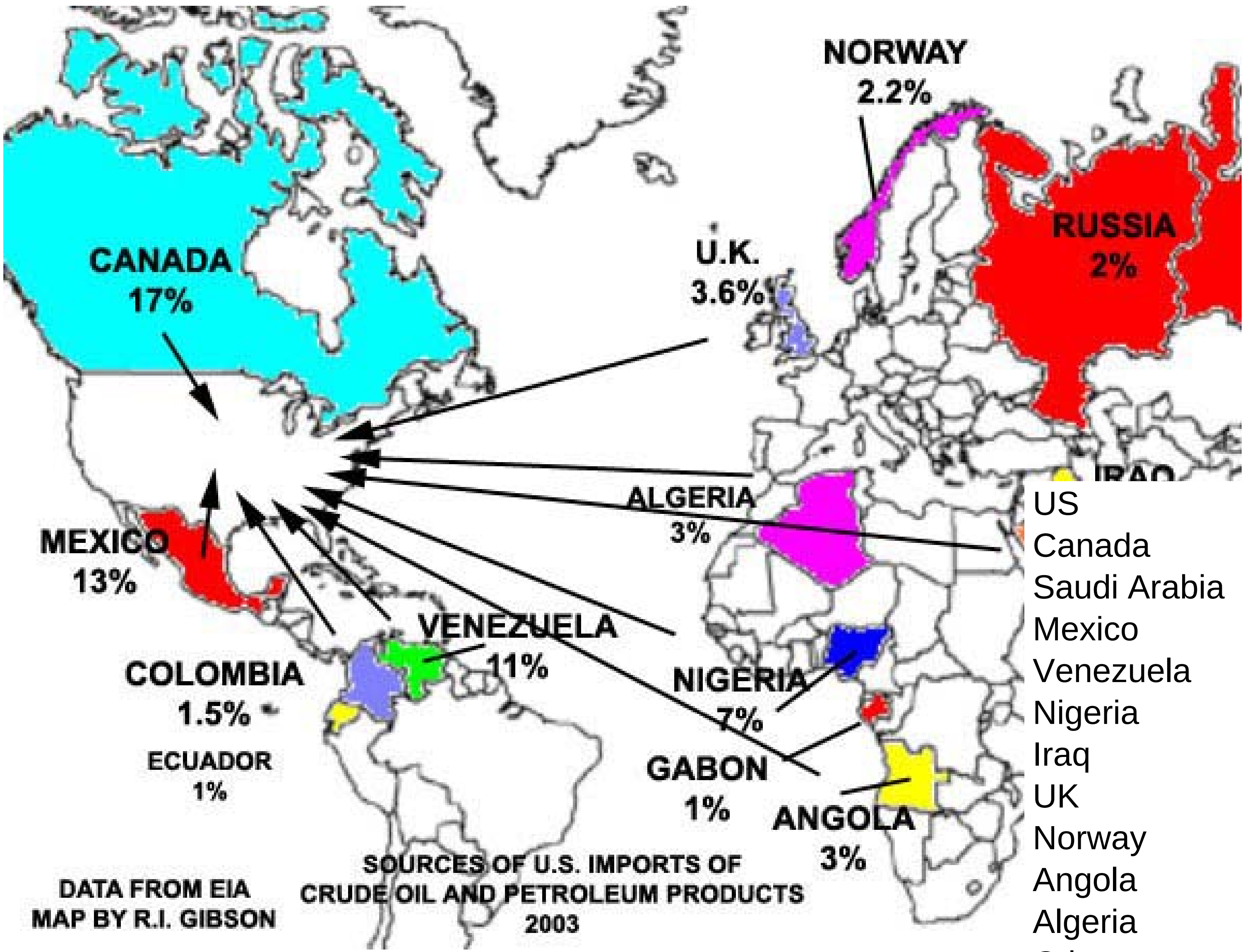
Obituary, Nature, 14 June 2007

Diablo Canyon

California Coast Power



US Oil Imports (2003)



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%

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)

http://www.w2agz.com

Hydrogen per Day	
Tonnes	Shuttle
230,000	2,225

Water per	
Tonnes	Mete
2,055,383	

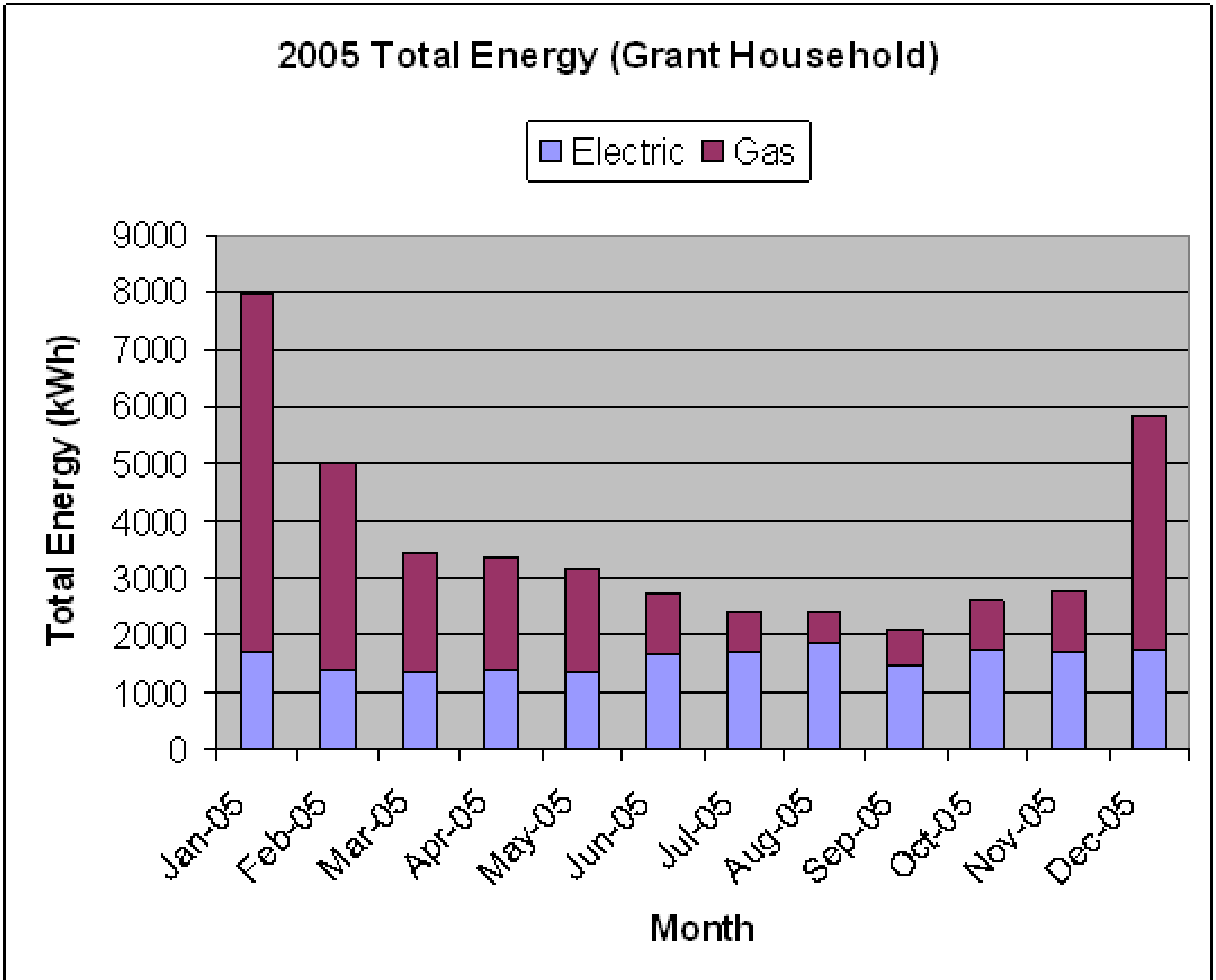
Hydrogen for US Surface Transportation

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

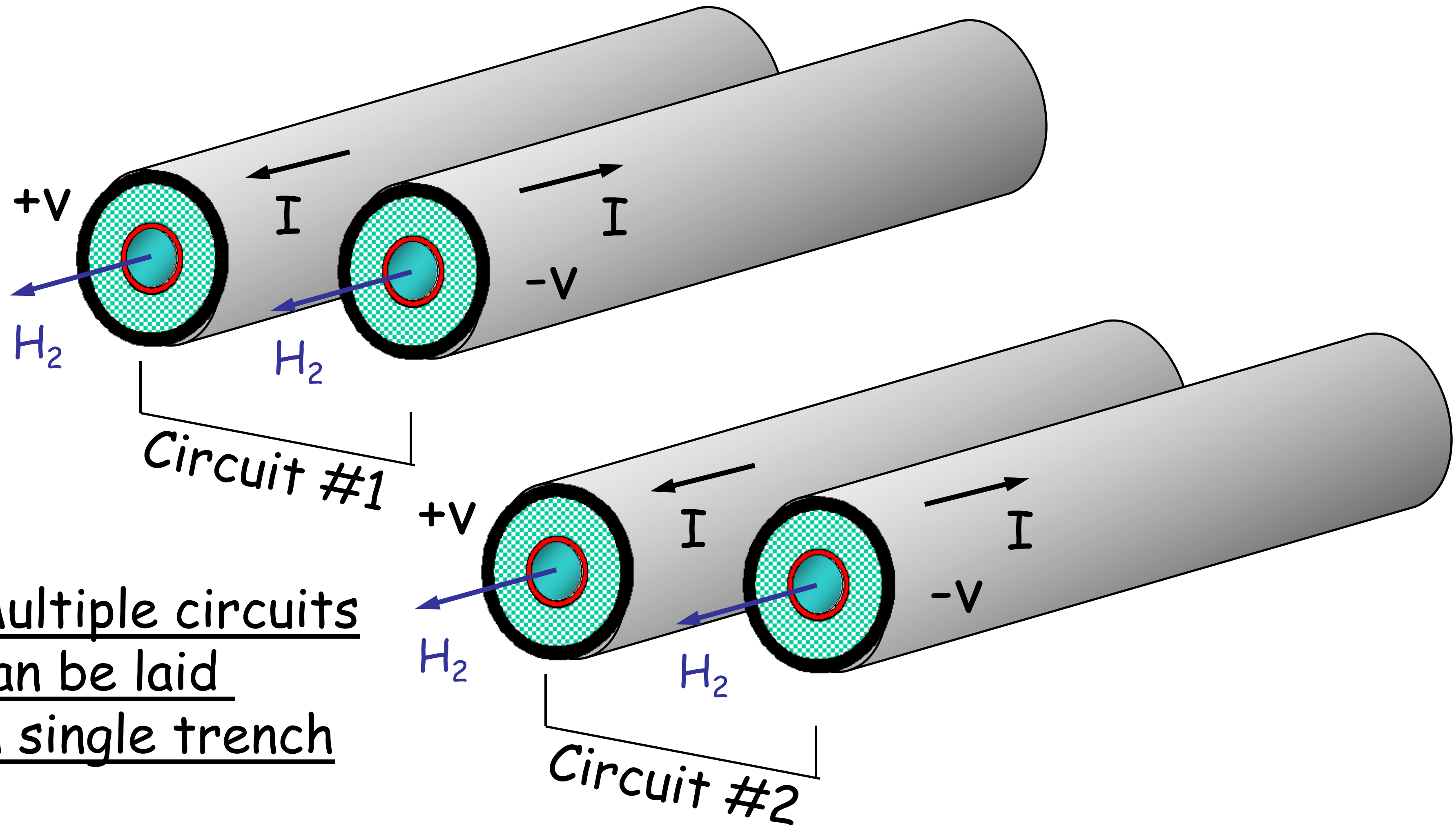
GHE Load Centers

- 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 =

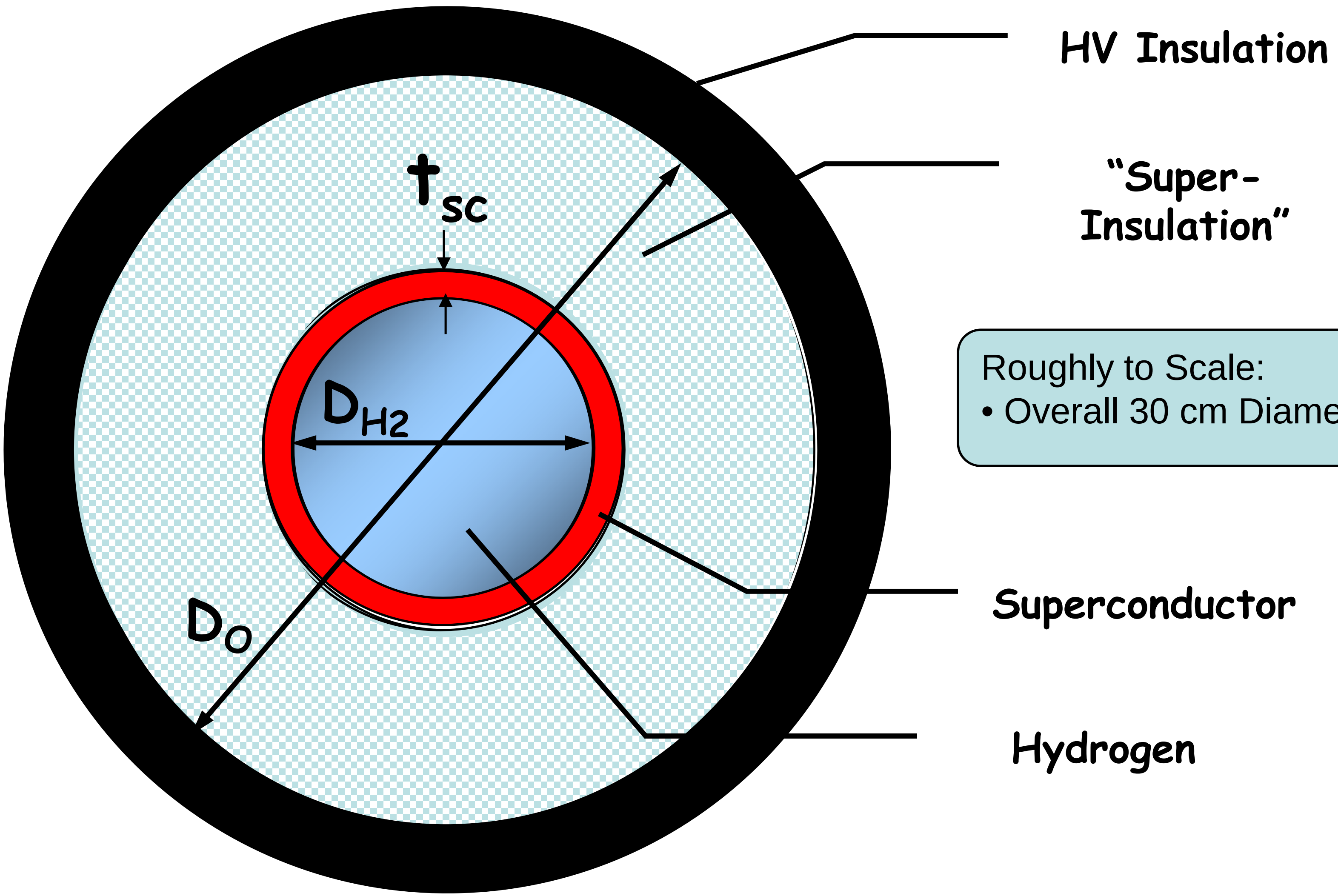
$3 B/yr

"Hydricity" SuperCables



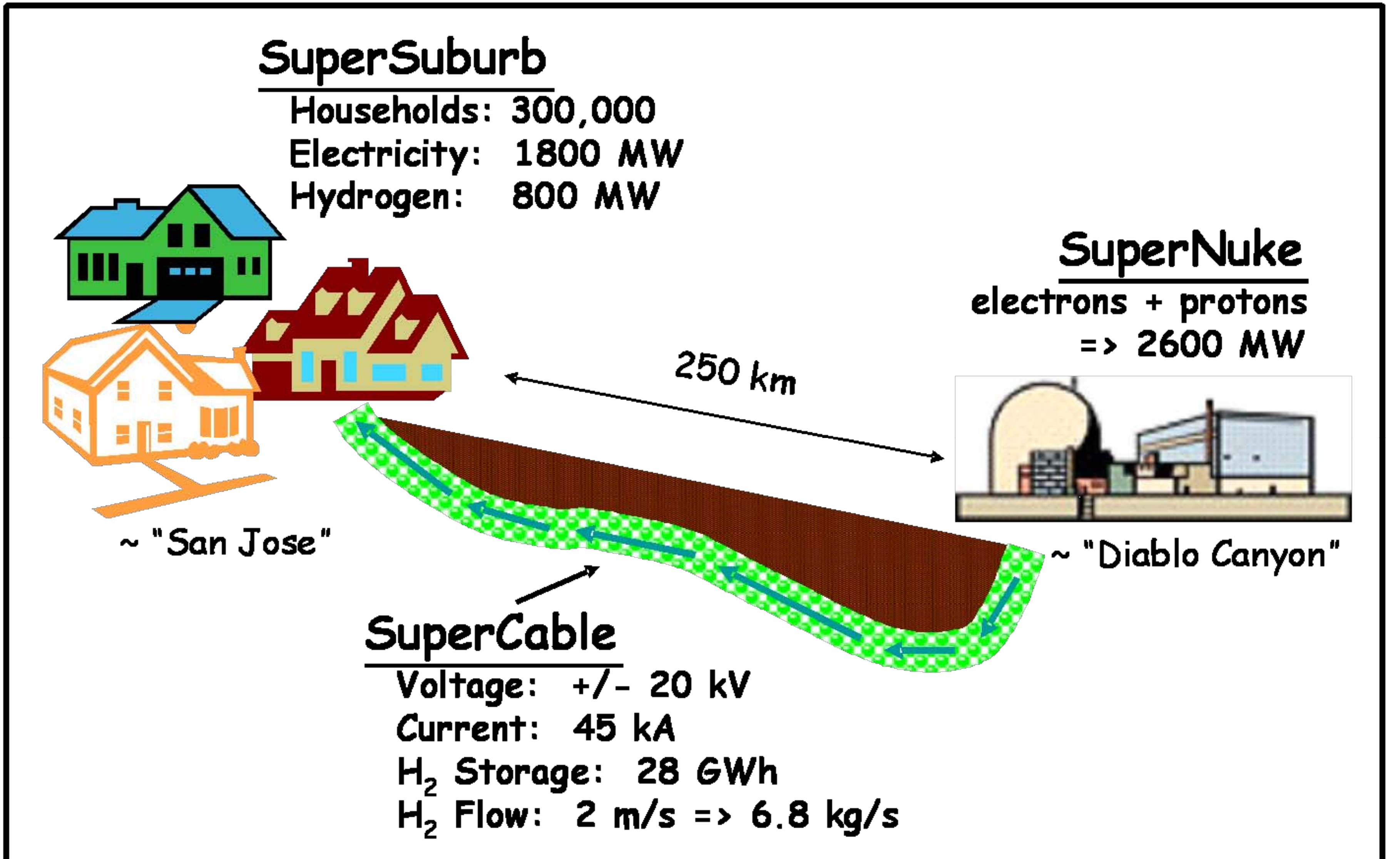
Multiple circuits
can be laid
in single trench

LH_2 SuperCable



Roughly to Scale:
- Overall 30 cm Diameter

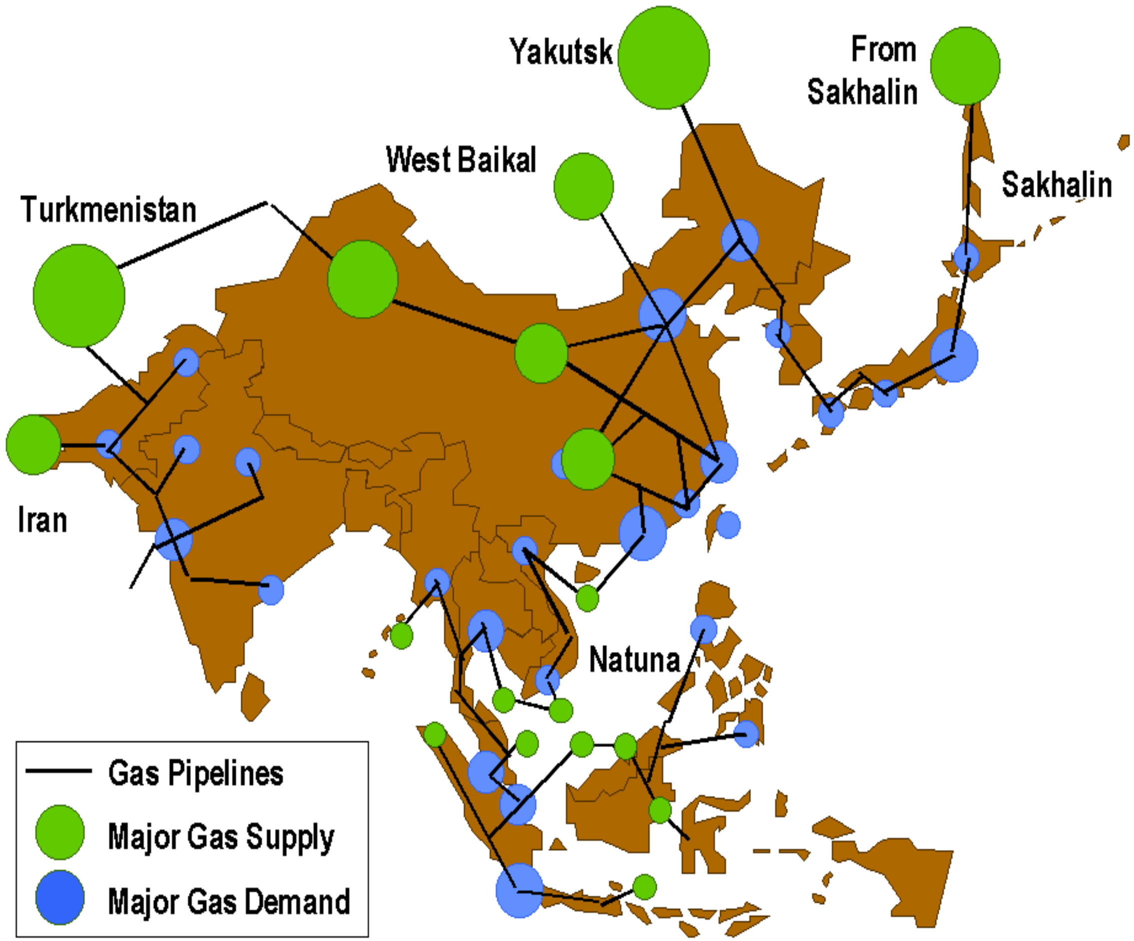
SuperSuburb



Utility Spec for an “RTSC”

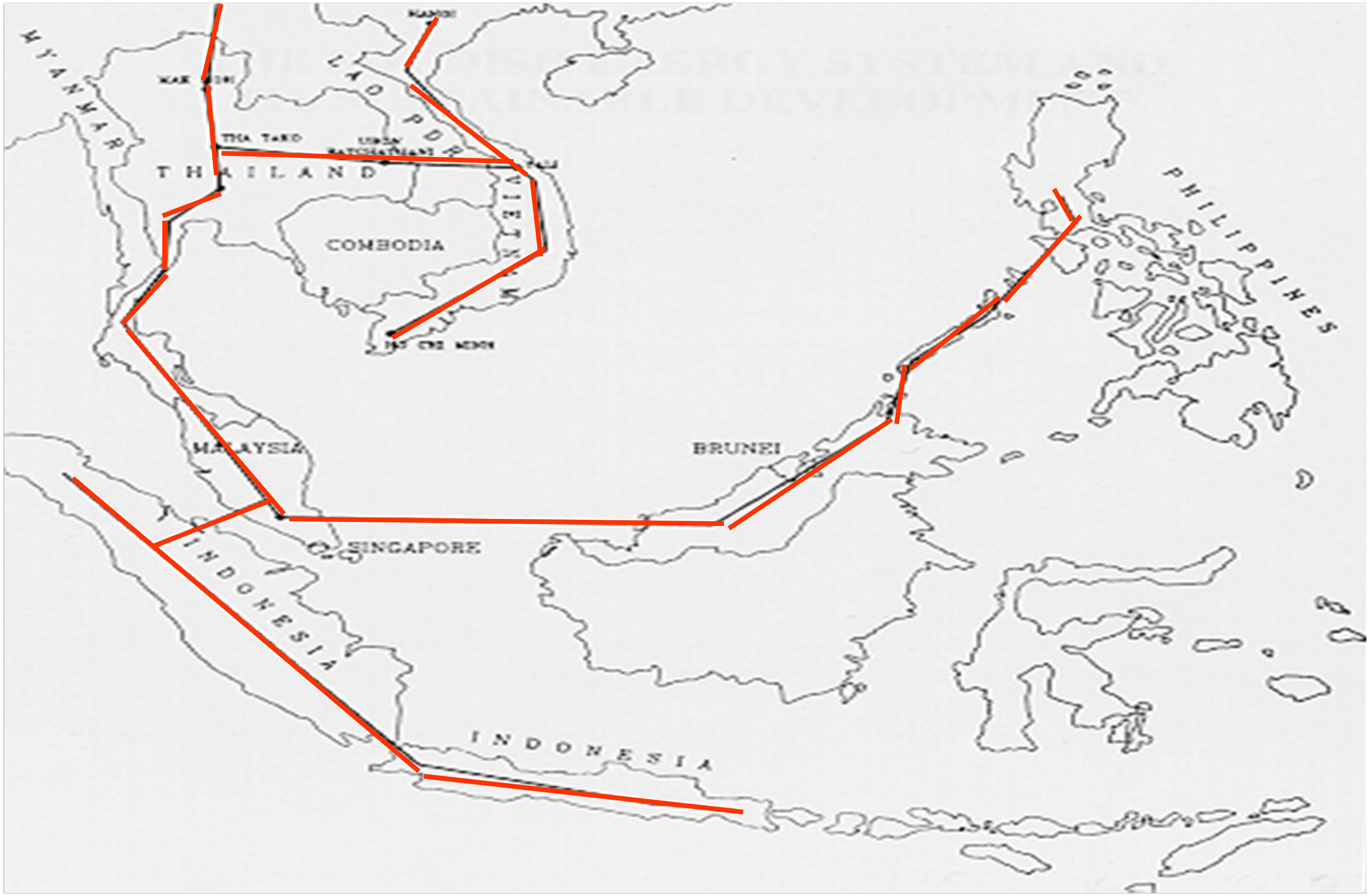
- σ >= 200x Cu @ 300 K @ 20 kA/cm^2 @ 1000 Hz
- ρ_{RTSC}/ρ_{Cu} <= 2
- Tensile Strength ~ CR Al
- Not Obnoxiously Toxic
- Cost <= 5x Cu
  - Related to cost of electricity

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”