SuperCities and SuperGrids:

Teratechnology Energy Societies for an Exajoule World

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ZallenFest
18 August 2006
Virginia Polytechnic Institute
Blacksburg, VA

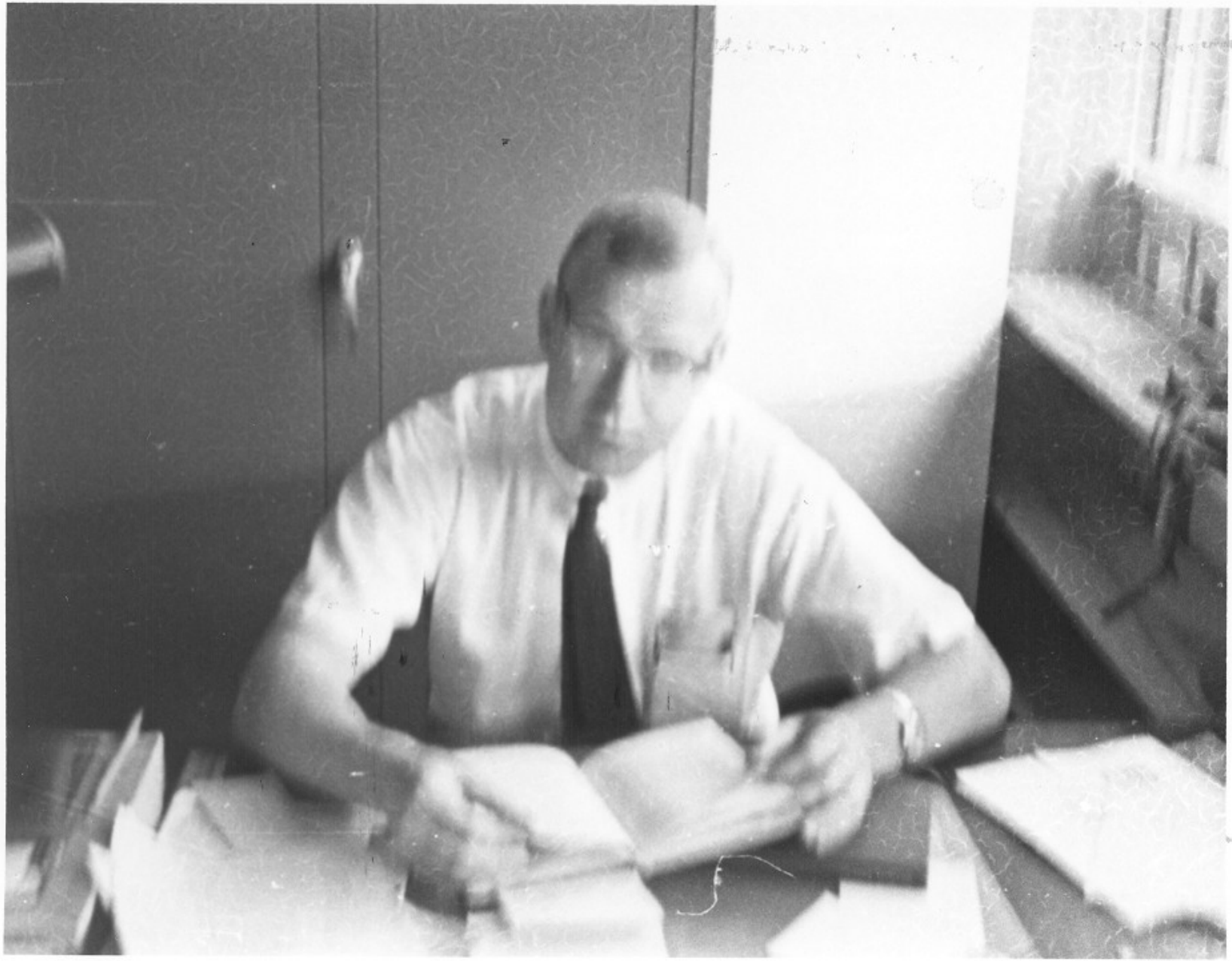
http://www.w2agz.com/zallenfest.htm
(Includes Ballads in Celebration of Irish Freedom !)

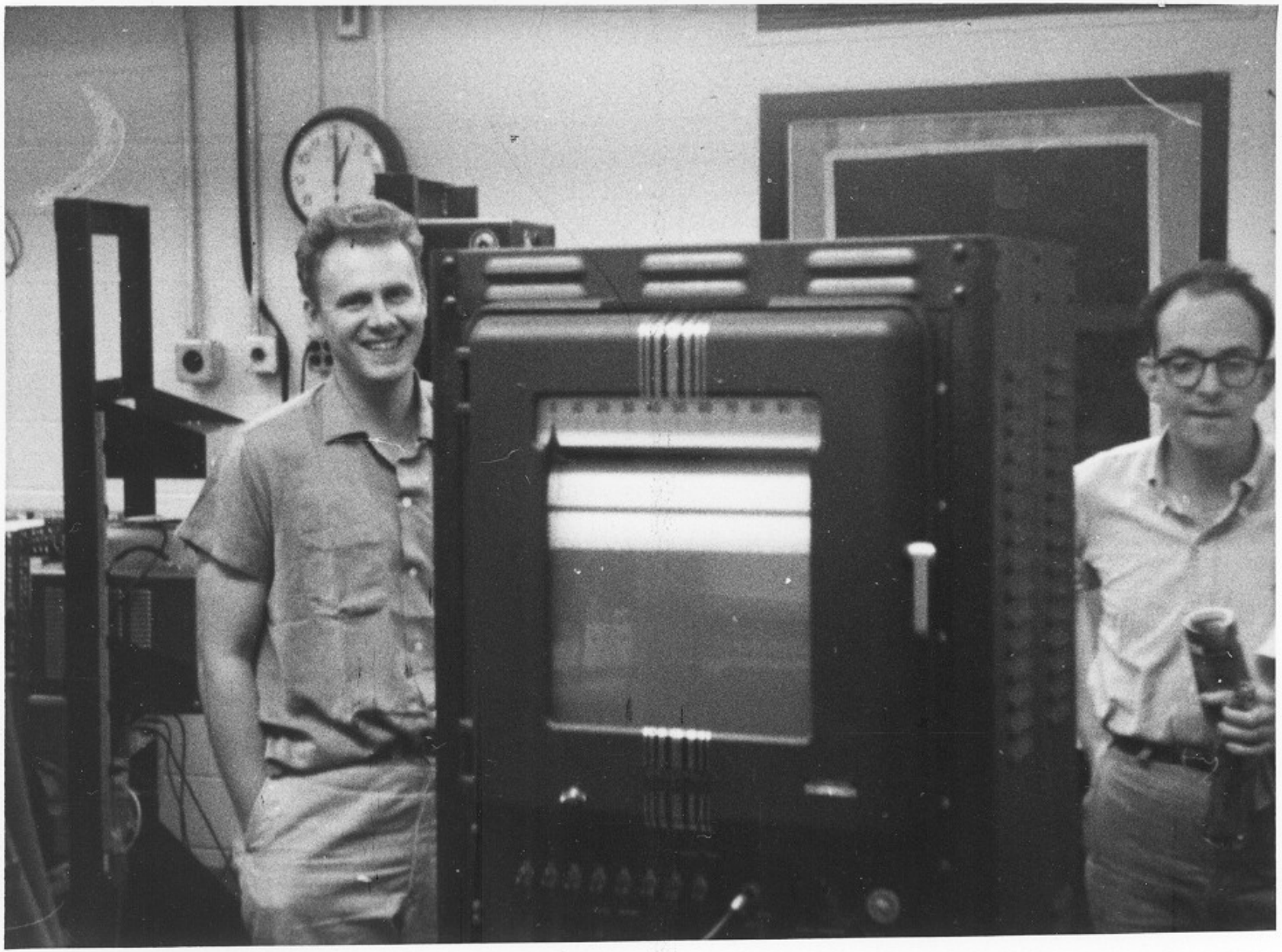
Harvard Daze

Friends of Dick

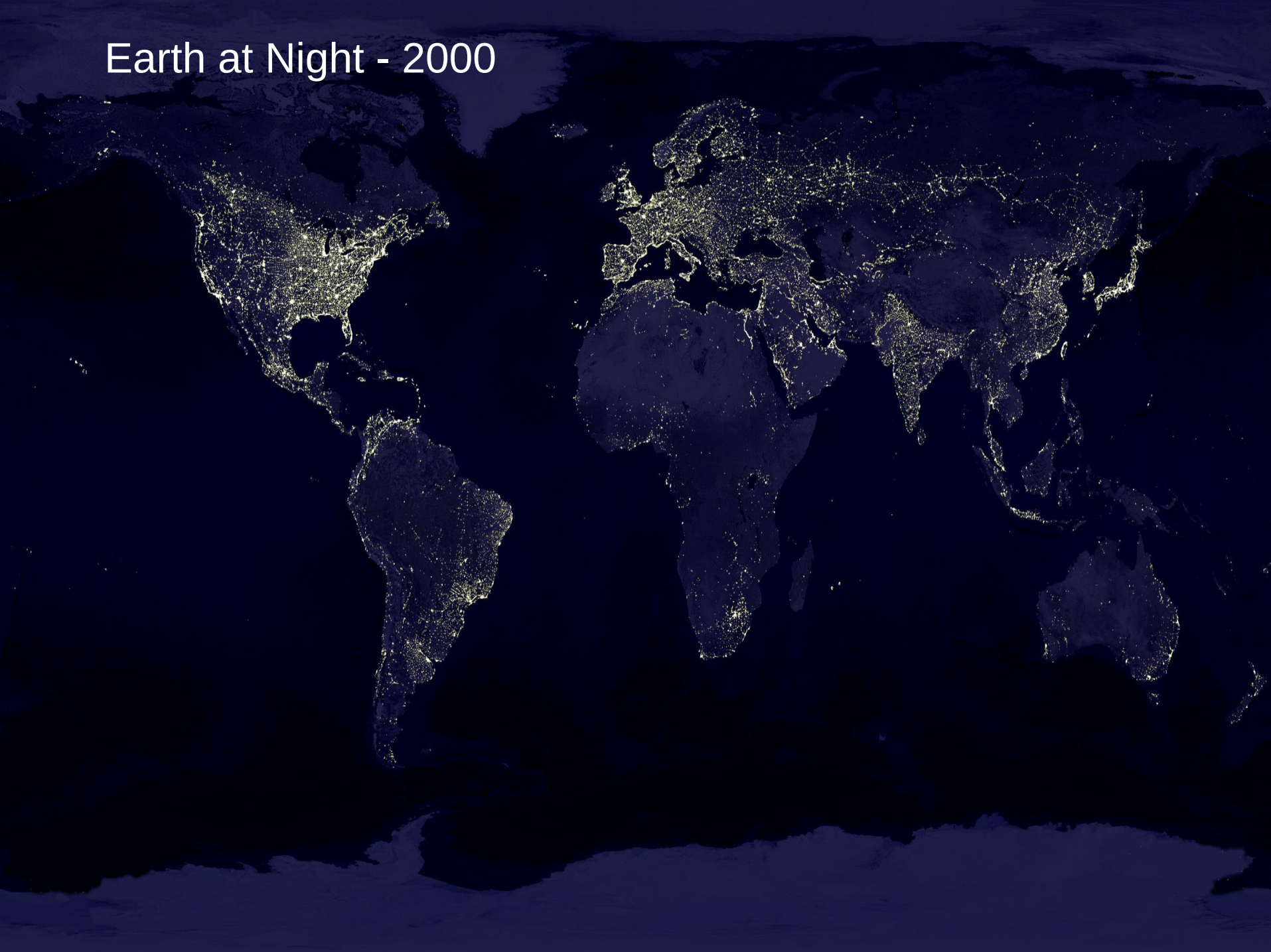
(when we were young)


MONROE

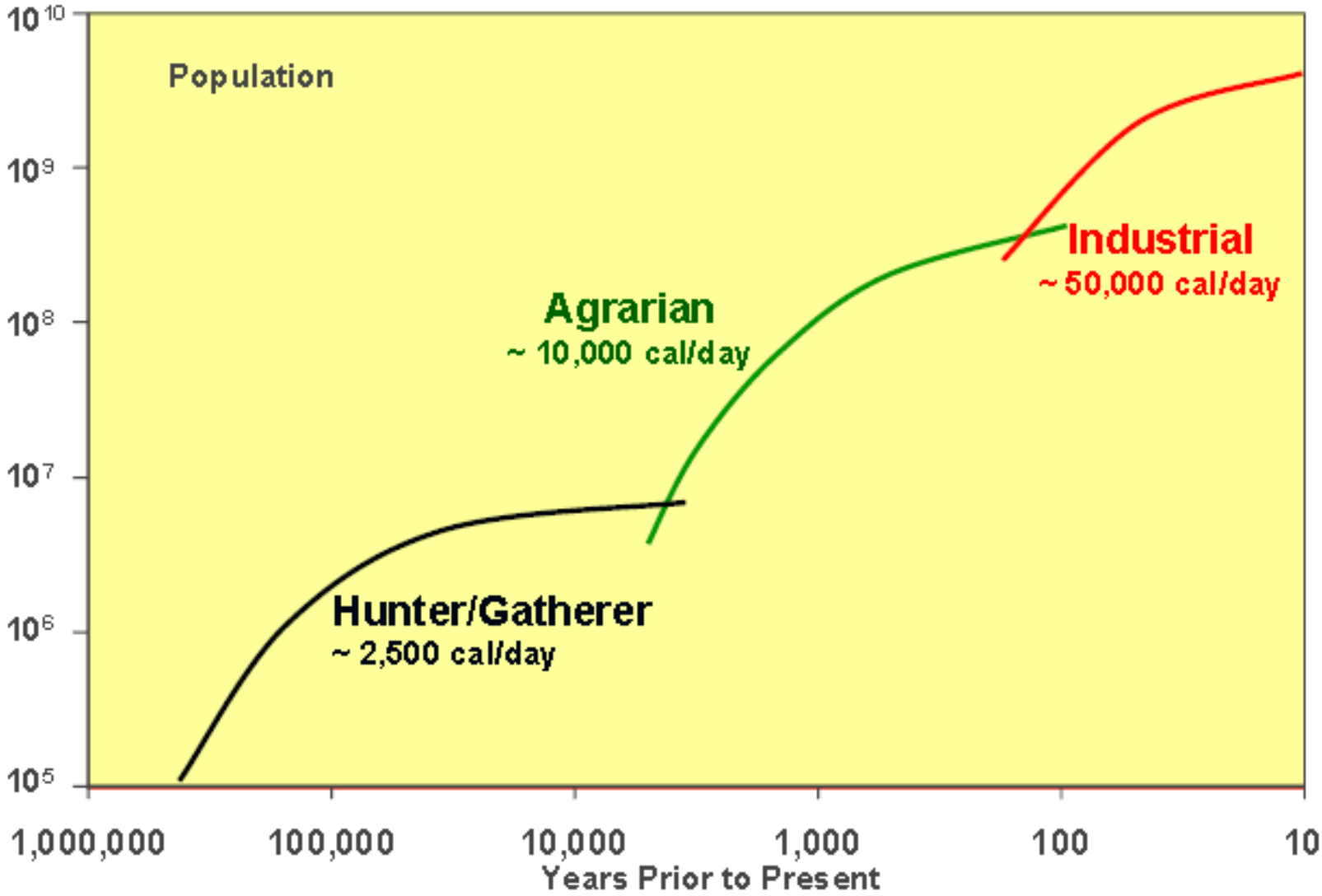




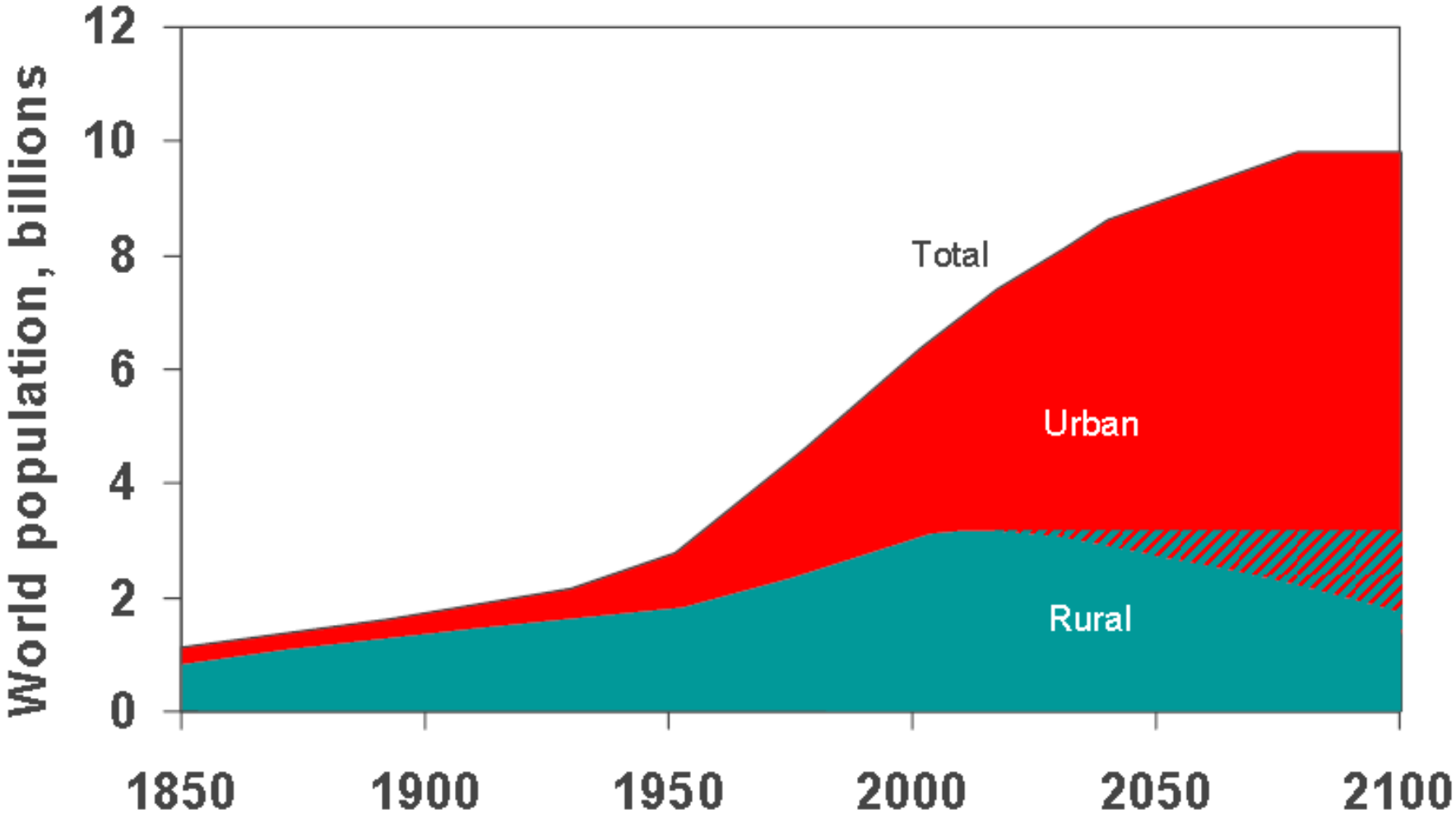
Earth at Night - 2000



Energy/Demographics Timeline



World Population: 1850 - 2100



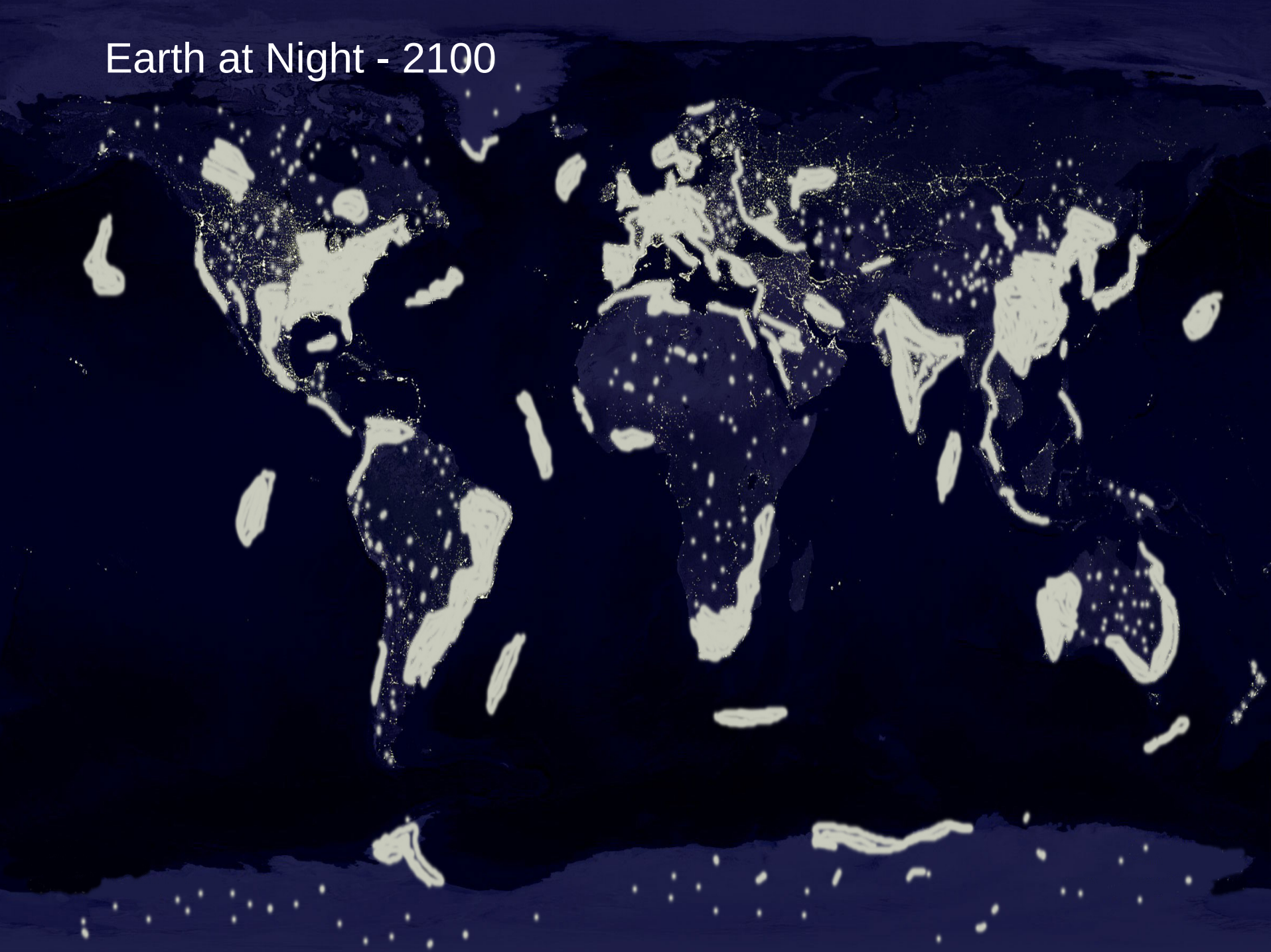
Enfranchisement of Women

China “Factoid”

- Current Population: 1.3 Billion Souls
- All want to live like Americans
- Chinese Family Priorities:
  - (1) TV, (2) Washer, (3) Fridge…
  - Next an Air Conditioner (200 USD, 1 kW)
- Assume an average family size of three, then…

An extra 500 GW of generation capacity must be added just to keep them cool!

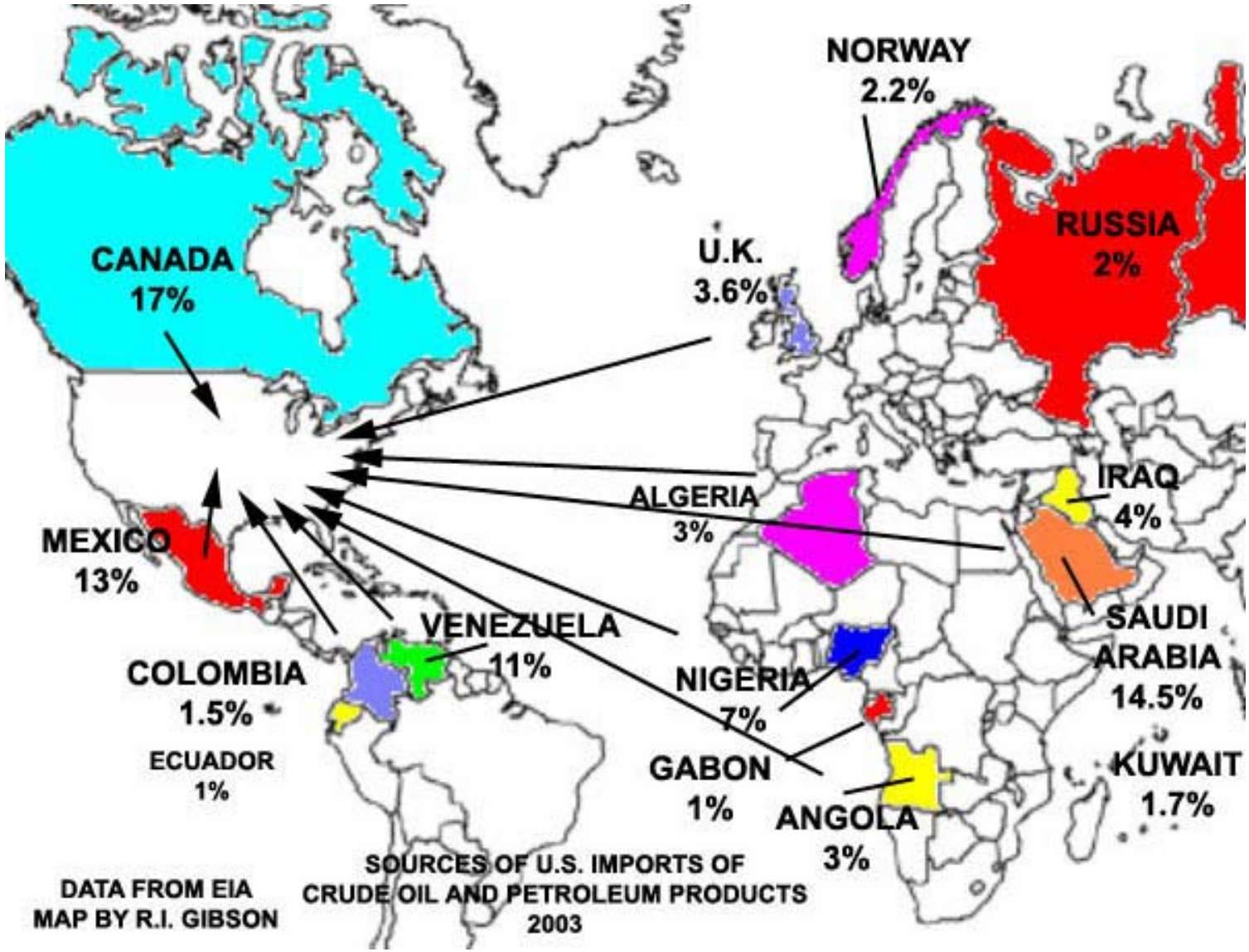
Earth at Night - 2100



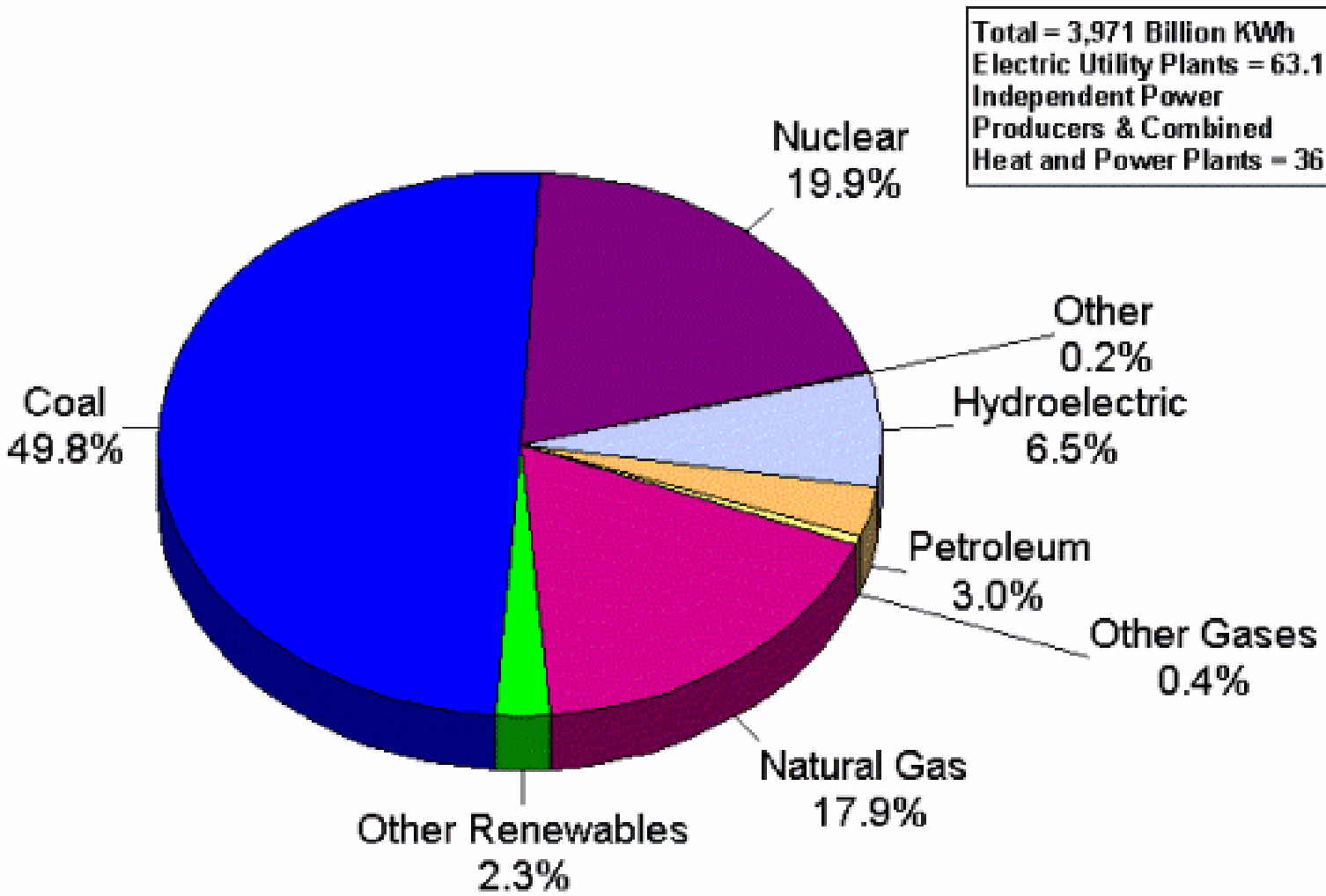
US Energy Consumption (2001)

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)



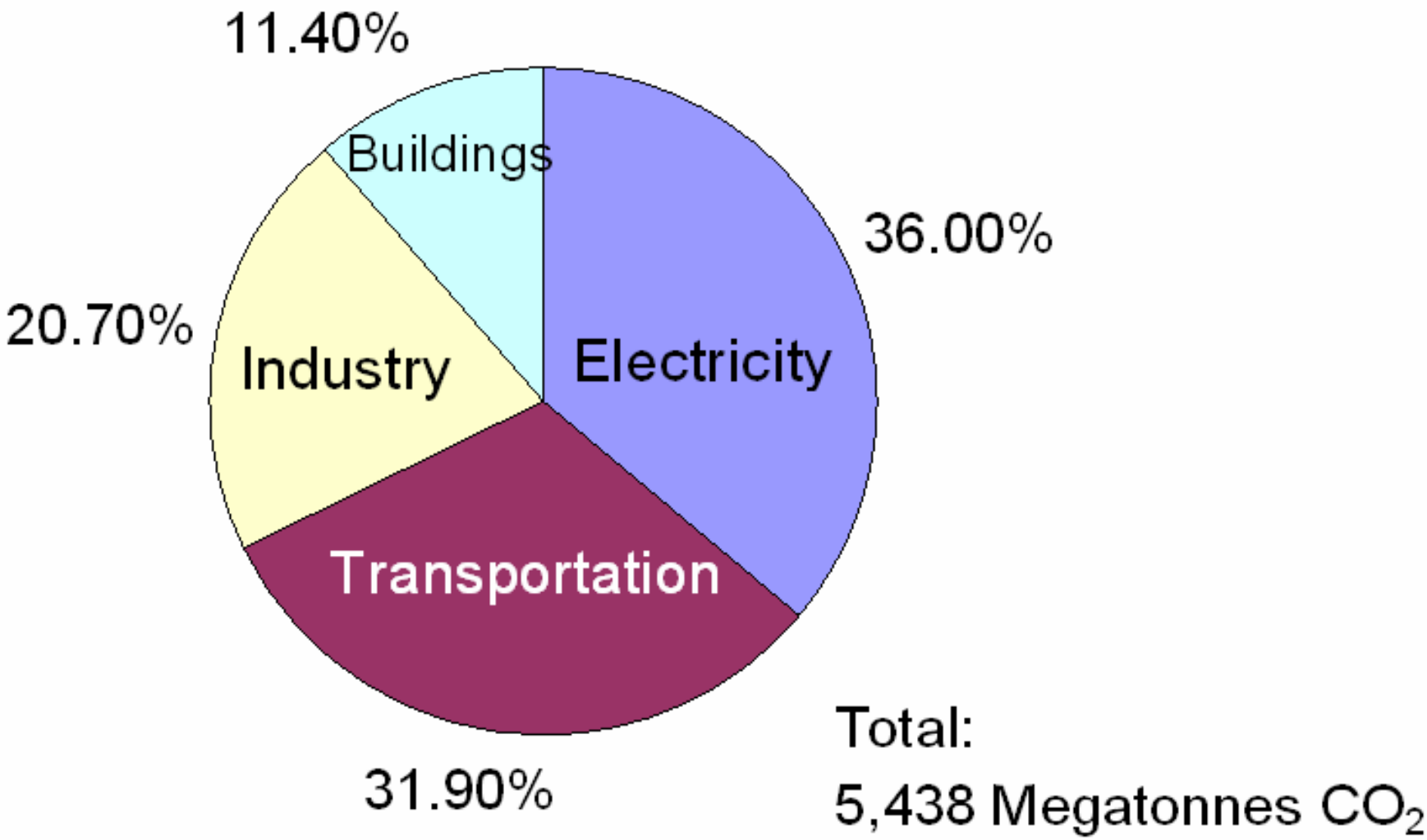
US Electricity Generation - 2005



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

“Greenhouse Gases”

CO_2 Emission Sources



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!

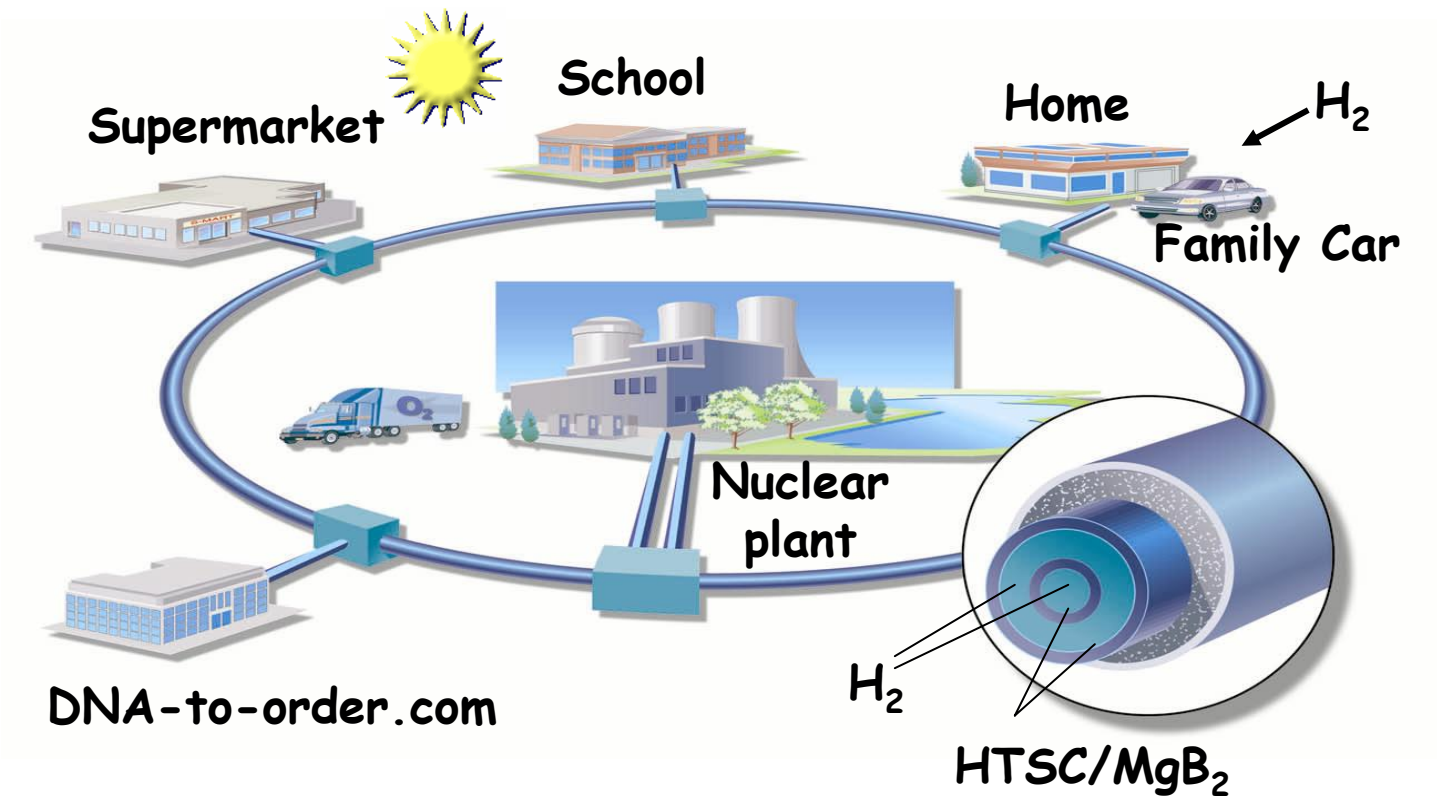
Its Solution

A Symbiosis of

Nuclear/Hydrogen/Superconductivity

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

SuperCity



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

Hydrogen for US Surface Transportation

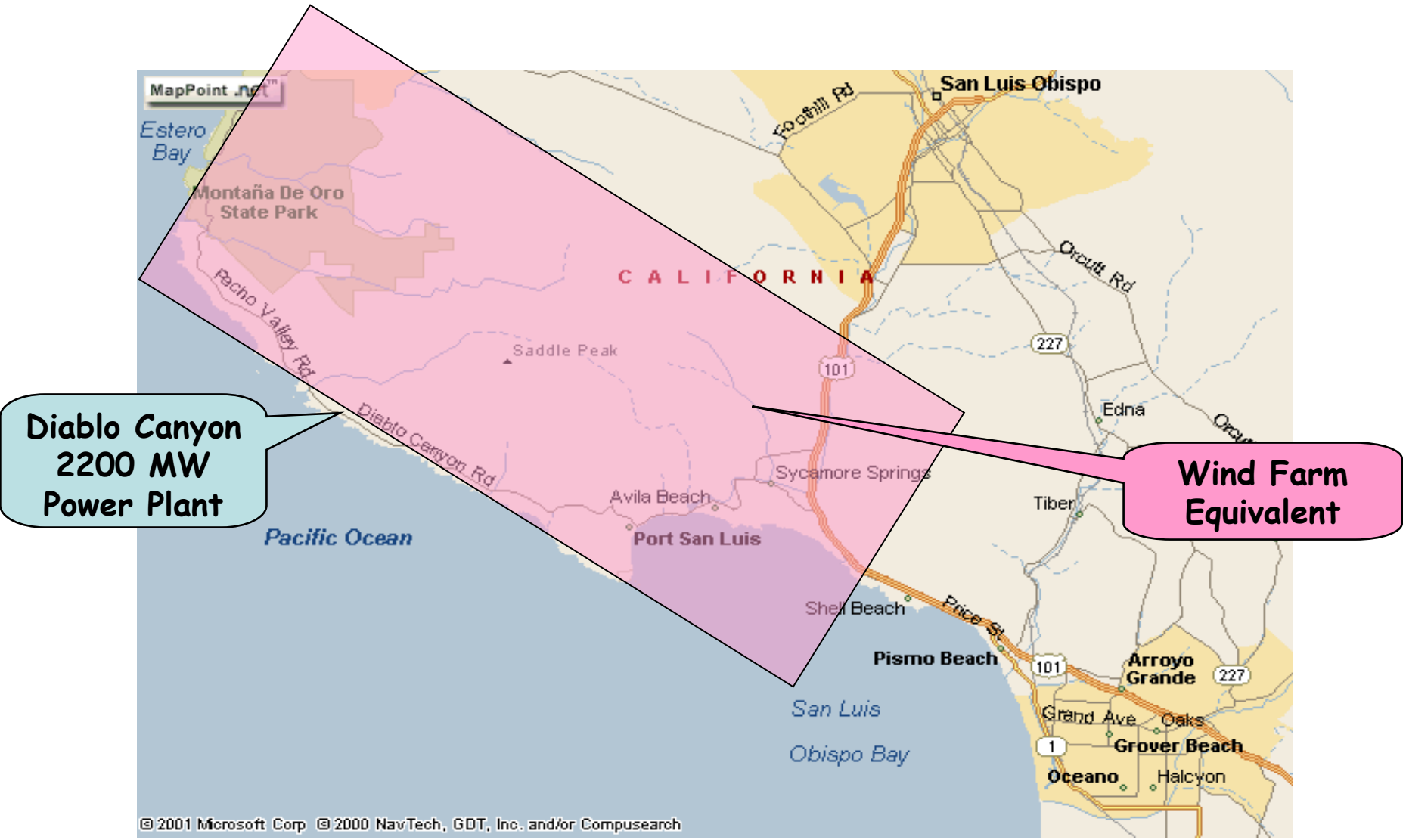
The "25% 80-80-80 400 GW" Scenario

http://www.w2agz.com

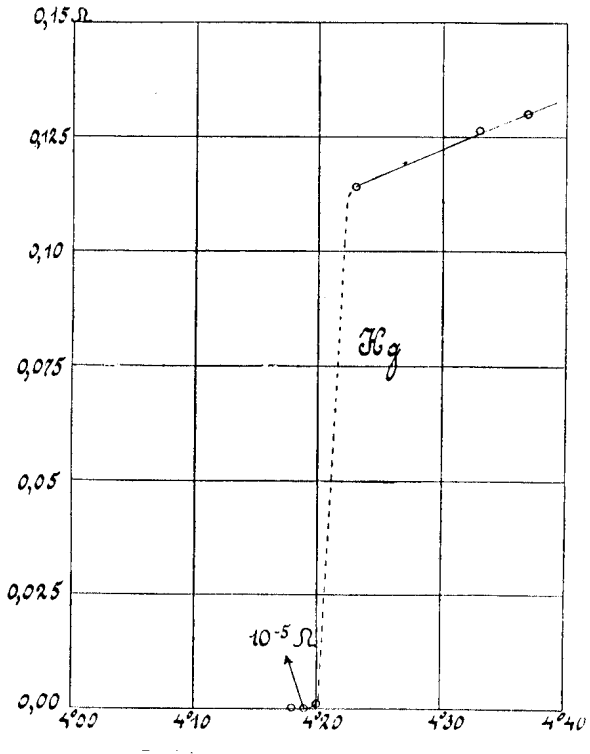
Renewable Land Area Requirements		
Technology	Area (km^2)	Equivalent
Wind	130,000	New York State
Solar	20,000	50% Denmark Death Valley + Mojave
Biomass	271,915	3% USA State of Nevada

Diablo Canyon

California Coast Power



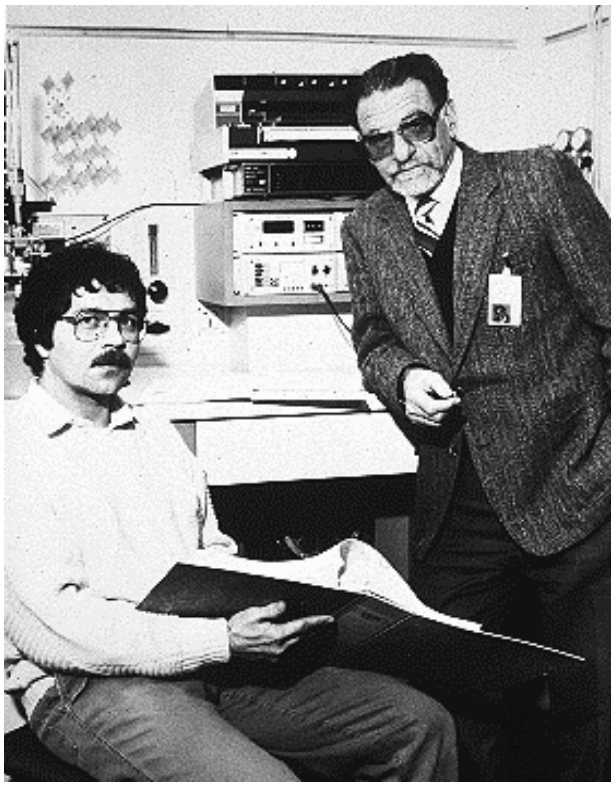
1911: A Big Surprise!



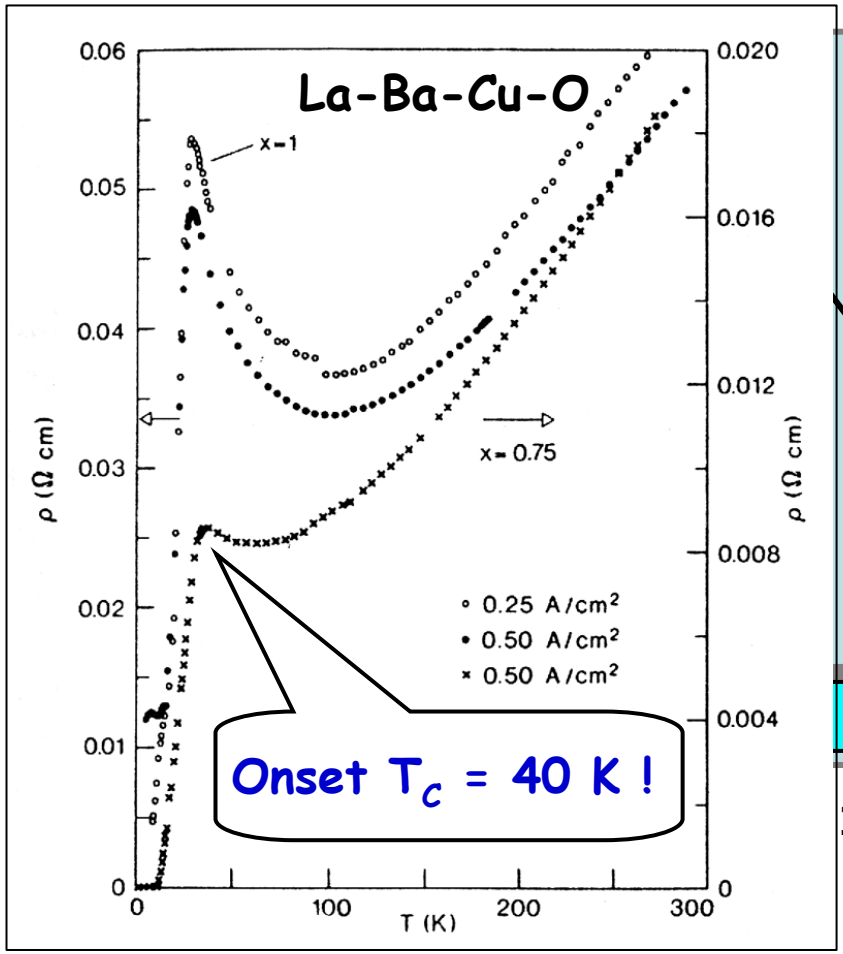
Thus the mercury at 4.2 K has entered a new state, which, owing to its particular electrical properties, can be called the state of *superconductivity*

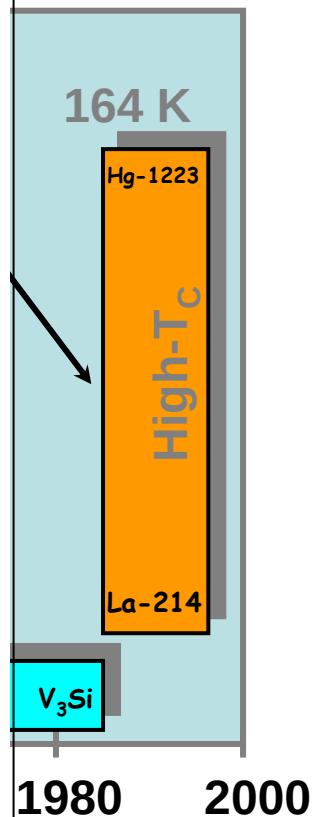
H. Kamerlingh-Onnes (1911)

1986: Another Big Surprise!



Bednorz and Mueller
IBM Zuerich, 1986





1987: "The Prize!"

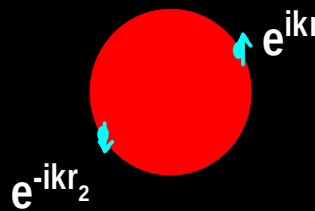
Associated Press

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

Superconductivity 101

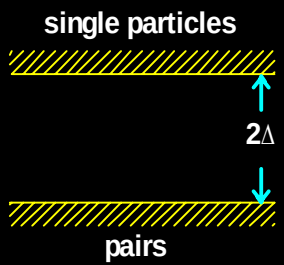
Cooper Problem



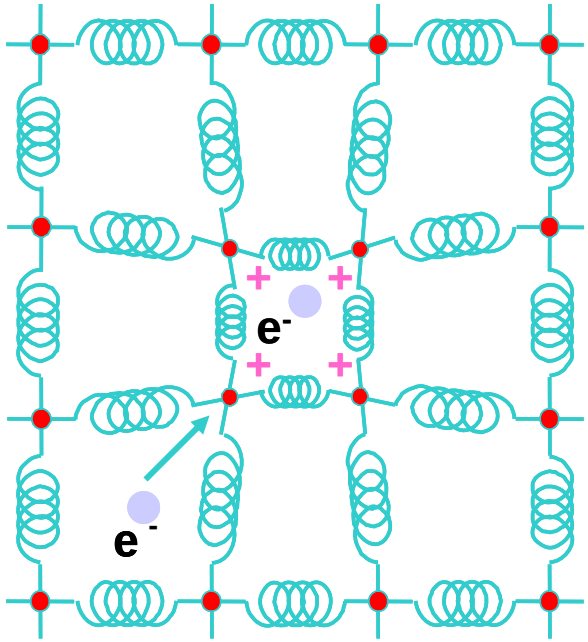
$H(k) + H(-k) + V(k)$

$V(k) = -V_0 \int_0^{k_f} dk\, e^{ik(r_1 - r_2)}$

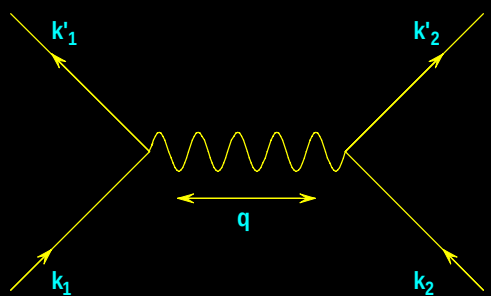
$\psi(r_1-r_2) = \phi(r_1-r_2)\chi(s_1,s_2)$



$2\Delta \sim e^{-2/N(E_f)V_0}$



Fermion-Boson Feynman Diagram



$$T_C = 1.14\,\theta_D \exp(-1/\lambda)$$

$\theta_D = 275\ \text{K}$,

$\lambda = 0.28$,

$\therefore\ T_C = \underline{9.5\ \text{K}}$ (Niobium)

GLAG

$$G[\phi] \approx \int d^3 r [\frac{1}{2m^*}(-i\hbar\nabla + e^* A)\phi^*(i\hbar\nabla + e^* A)\phi + a\phi\phi^* + \tfrac{1}{2} b\phi\phi^*\phi\phi^*]$$

$$-(i\partial\nabla - A)^2 f + f(1 - f^2) = 0$$

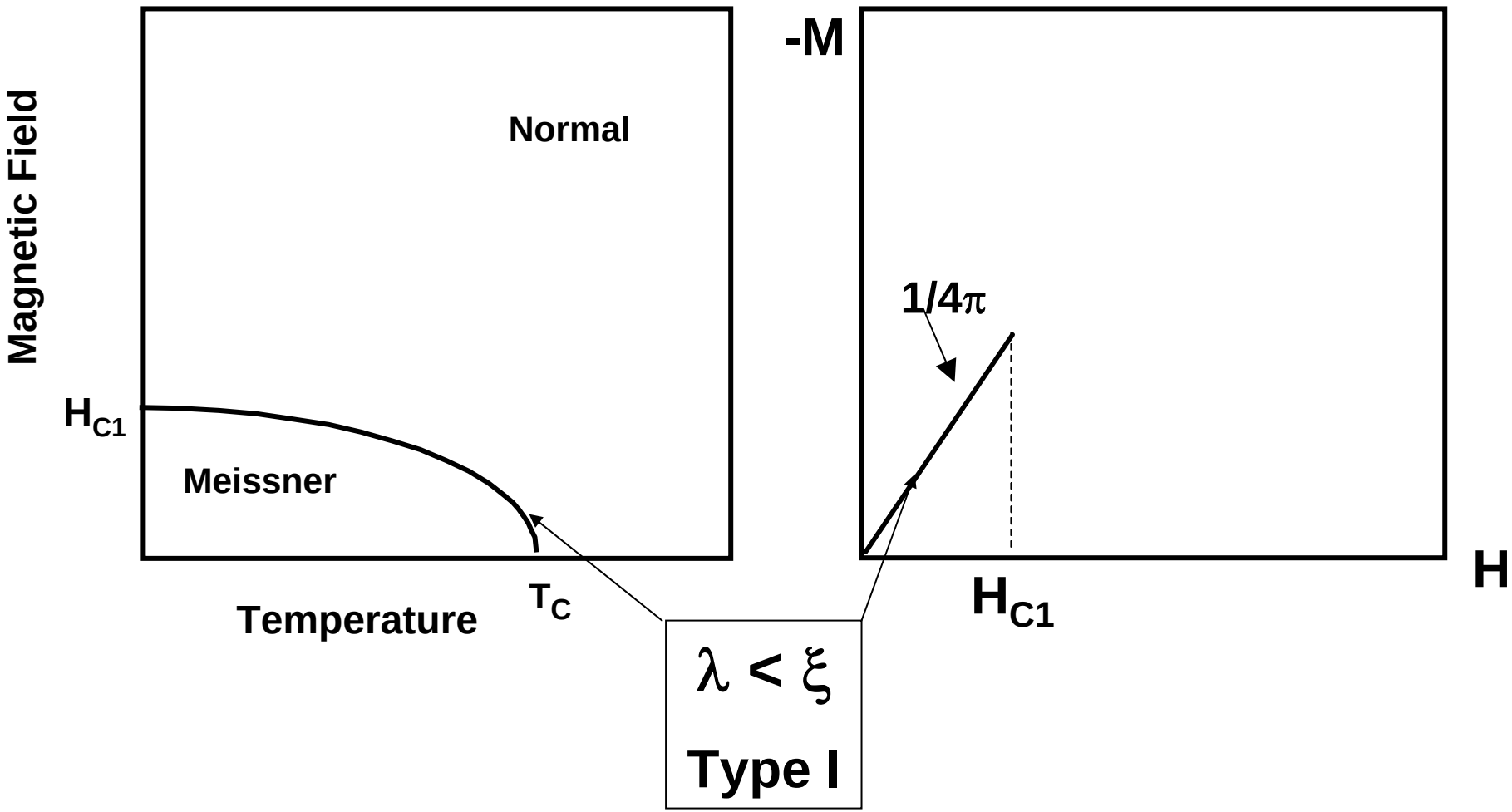
$$\kappa^2 \nabla \times (\nabla \times A) + \tfrac{1}{2} i(f^* \nabla f - f\nabla f^*) + Af^2 = 0$$

$$\phi = (|a|/b)^{1/2} f$$

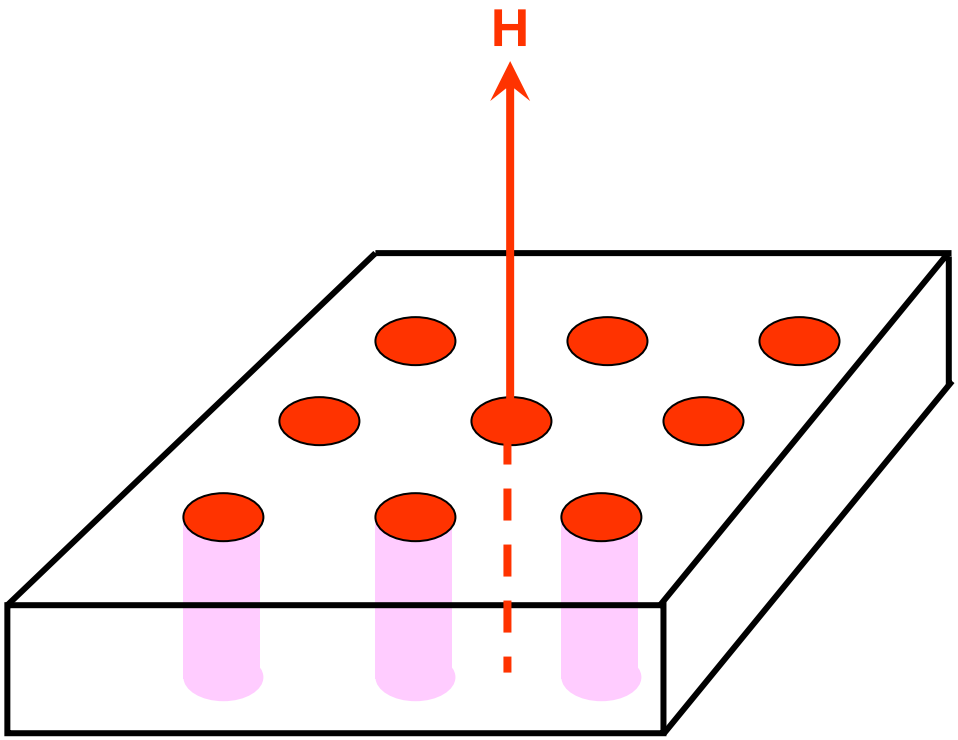
$$A = (\Phi_0 / 2\pi\xi) A$$

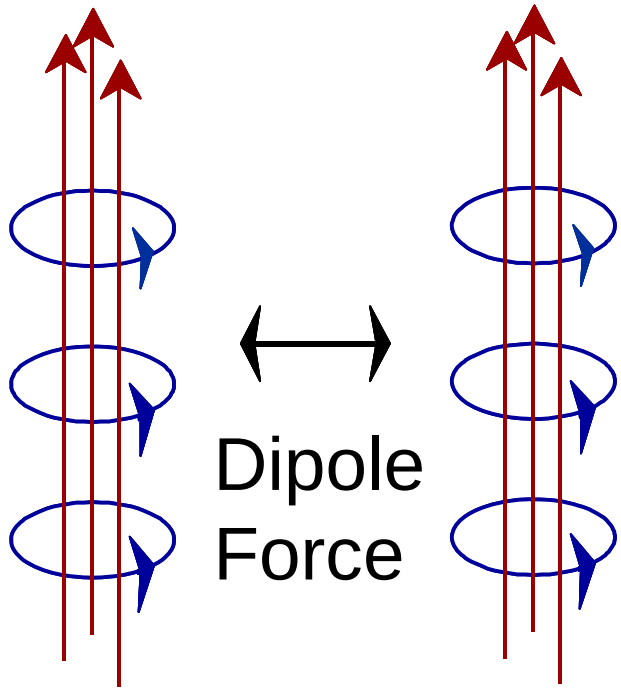
$$\kappa = \lambda_L / \xi$$

The Flavors of Superconductivity

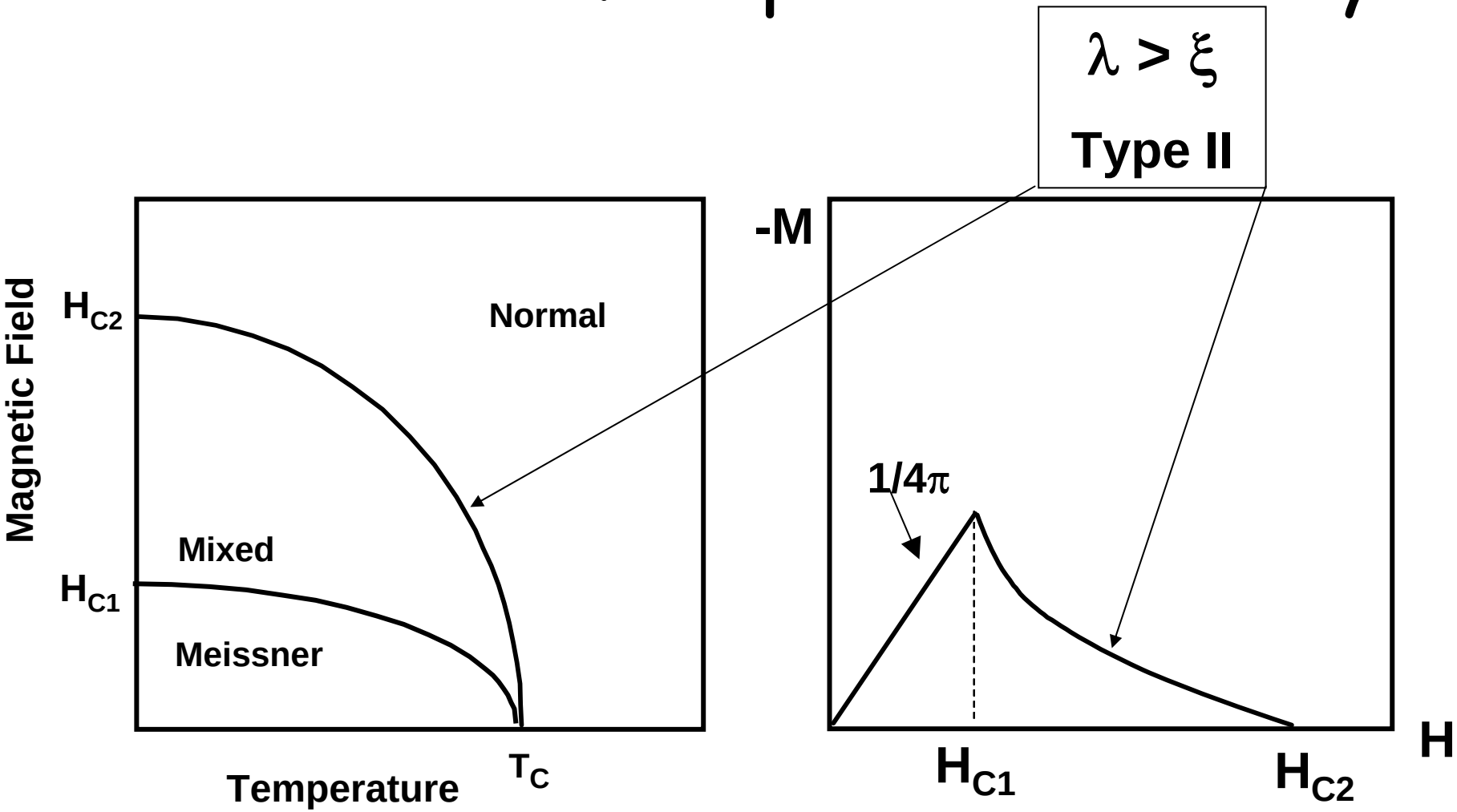


Abrikosov Vortex Lattice

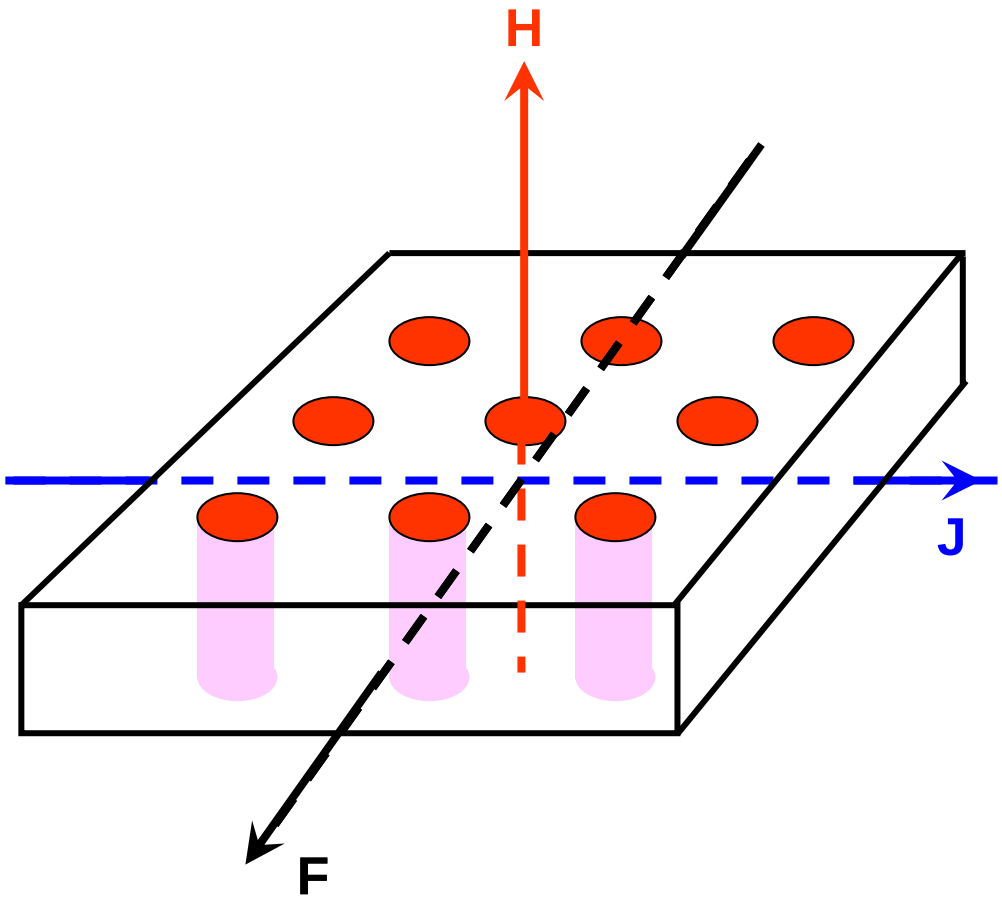


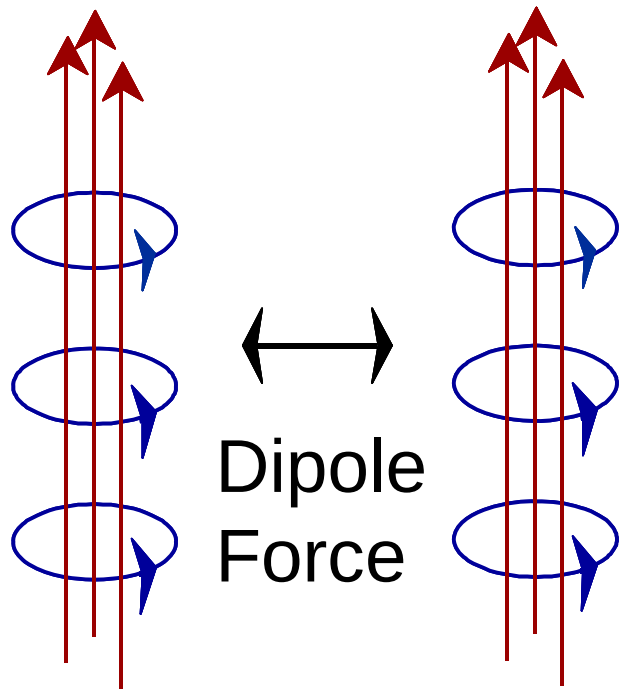


The Flavors of Superconductivity



Abrikosov Vortex Lattice





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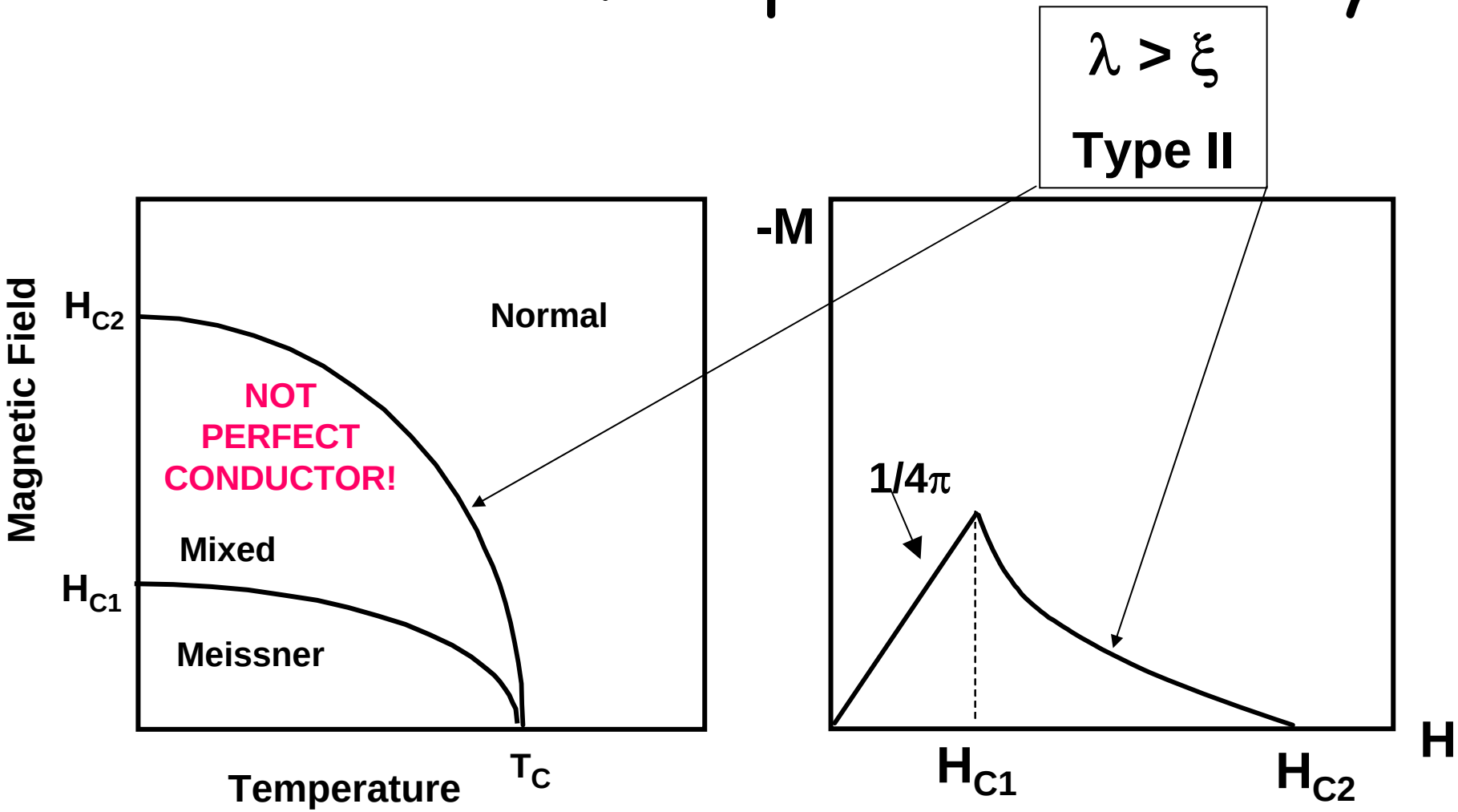

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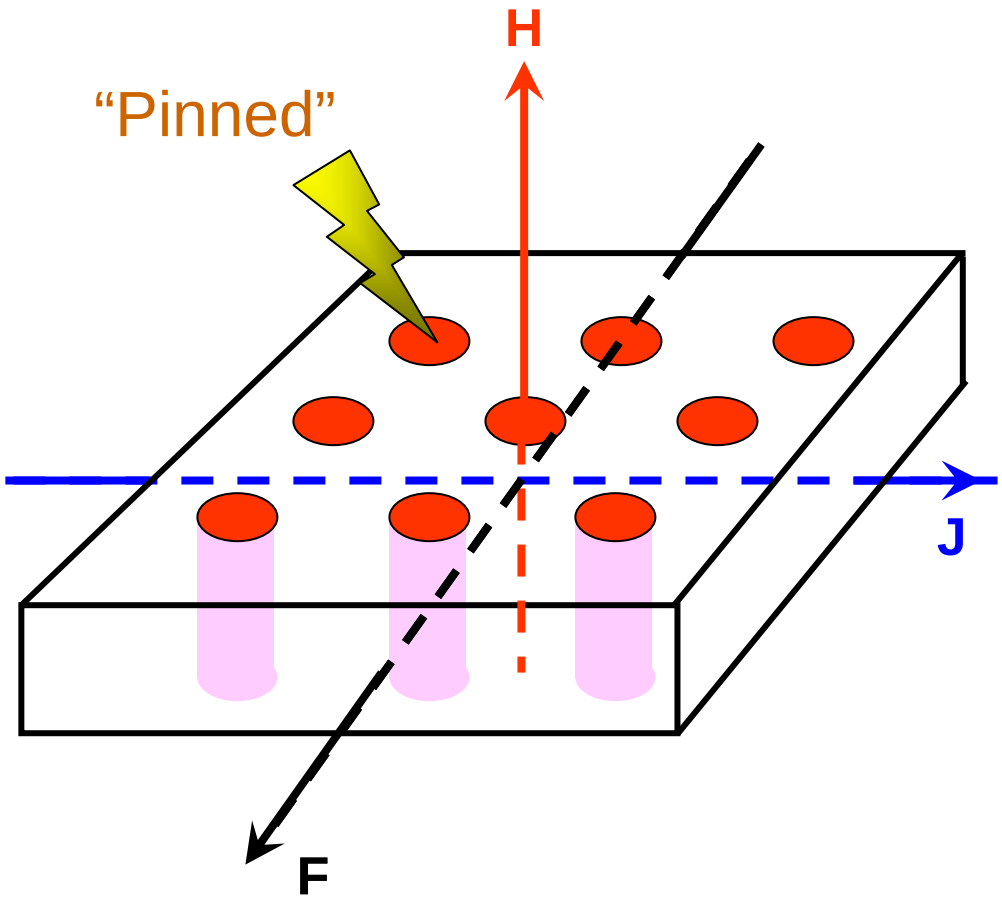
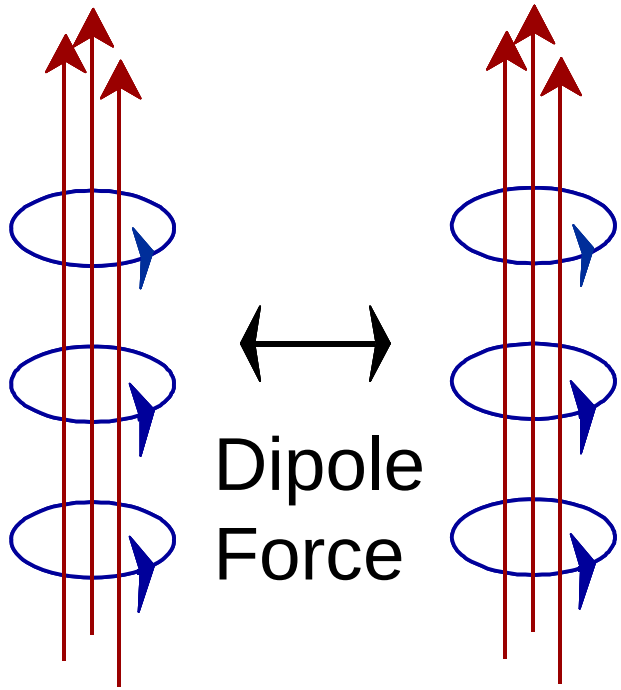
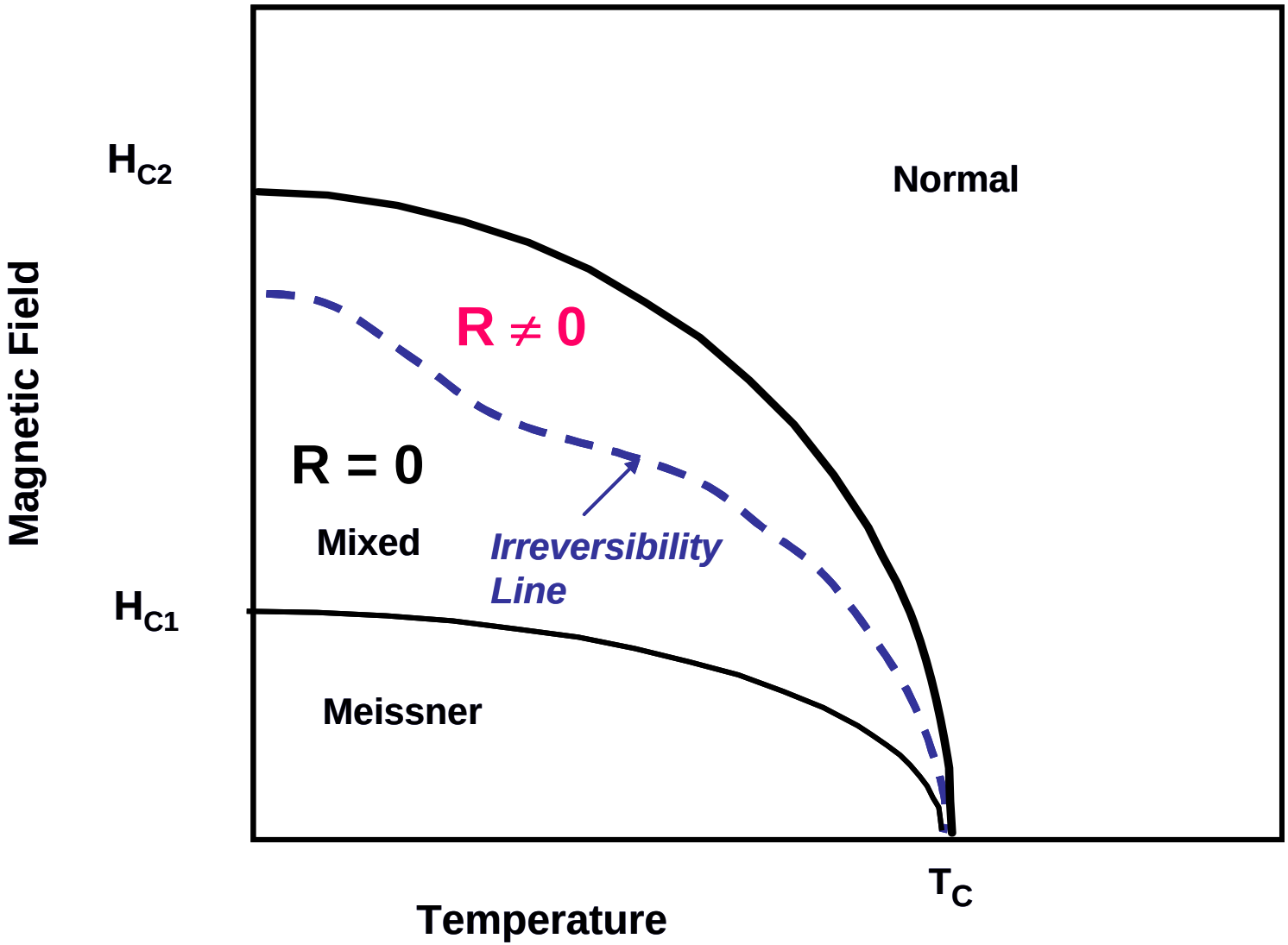
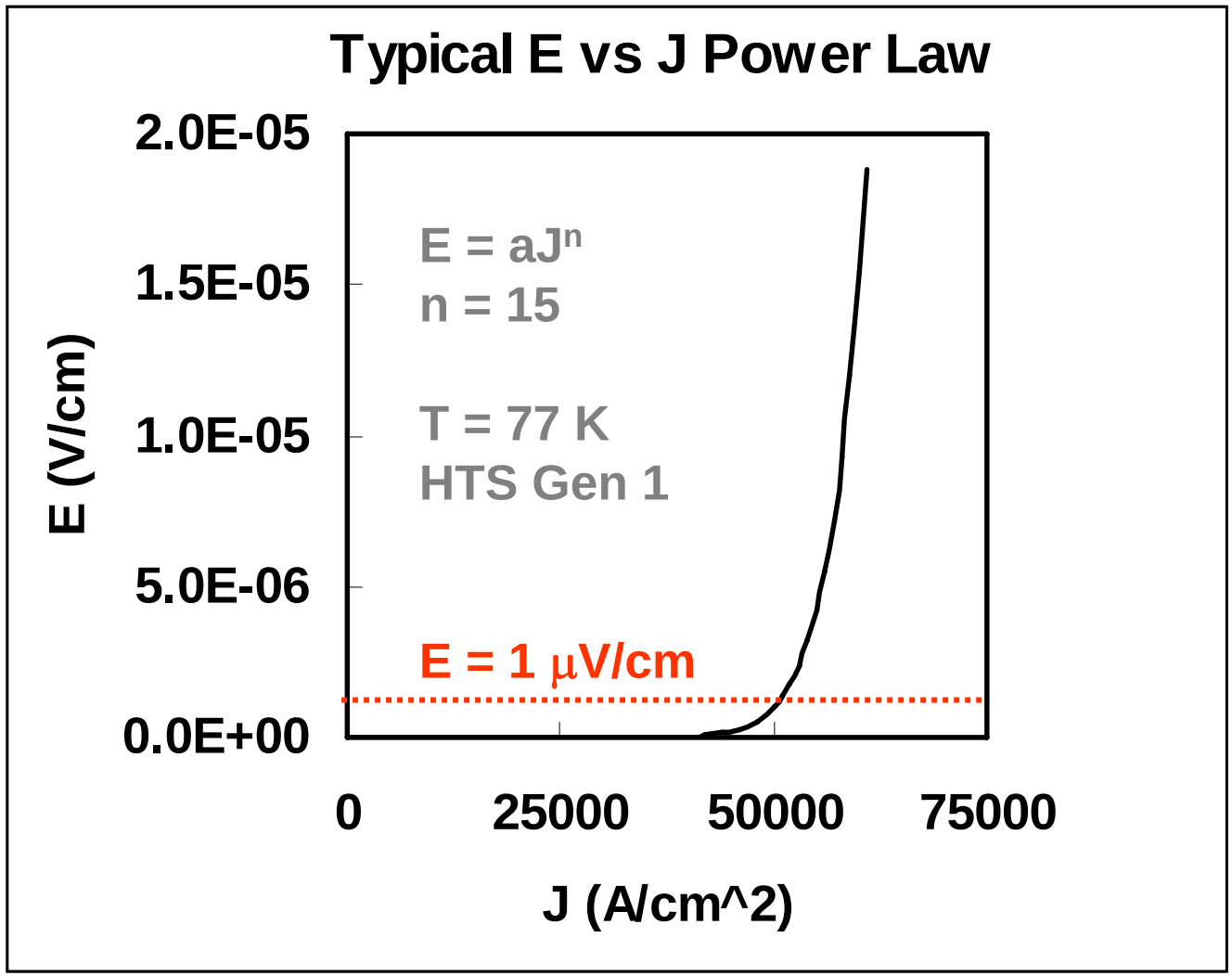




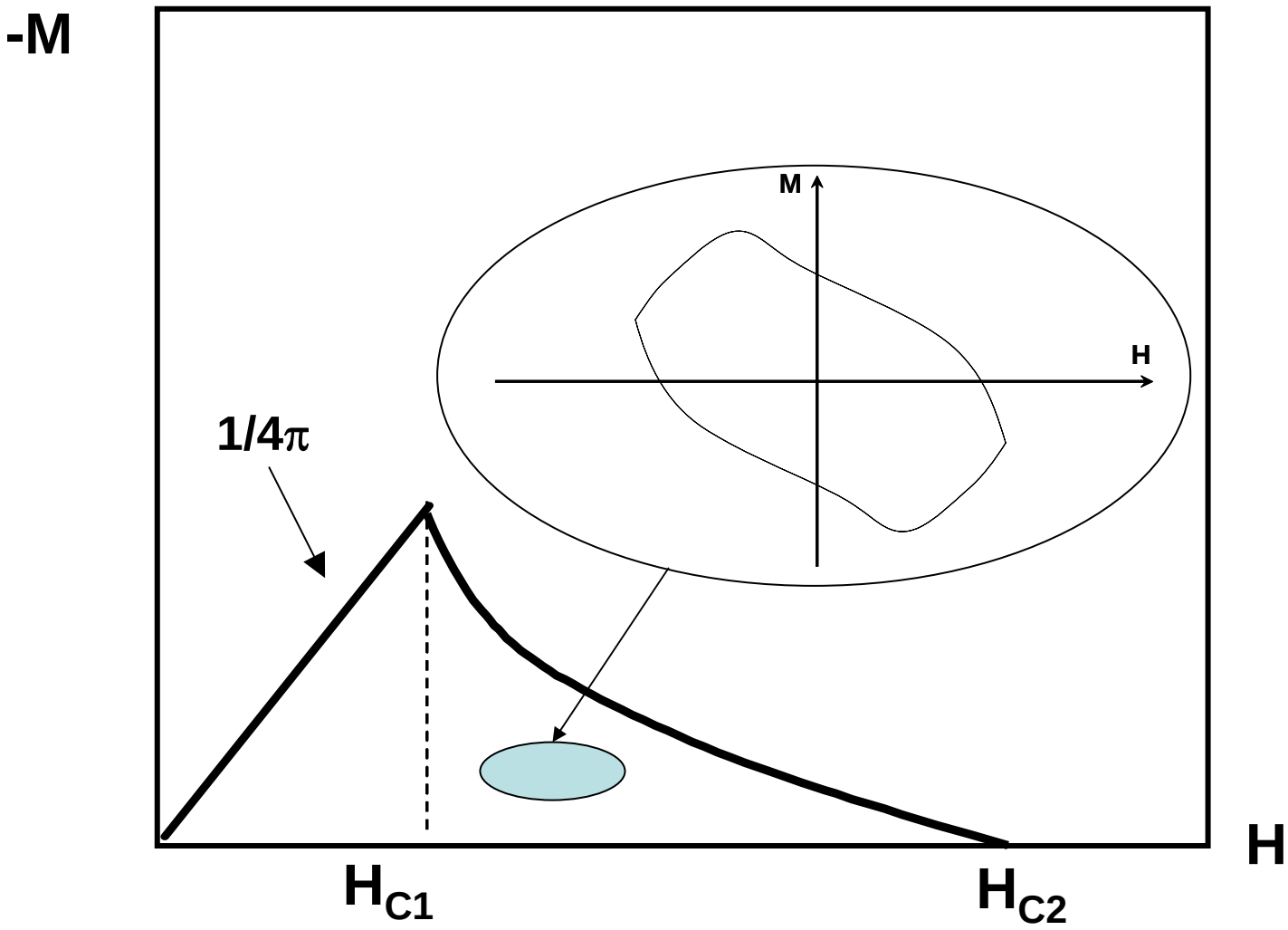
The Flavors of Superconductivity



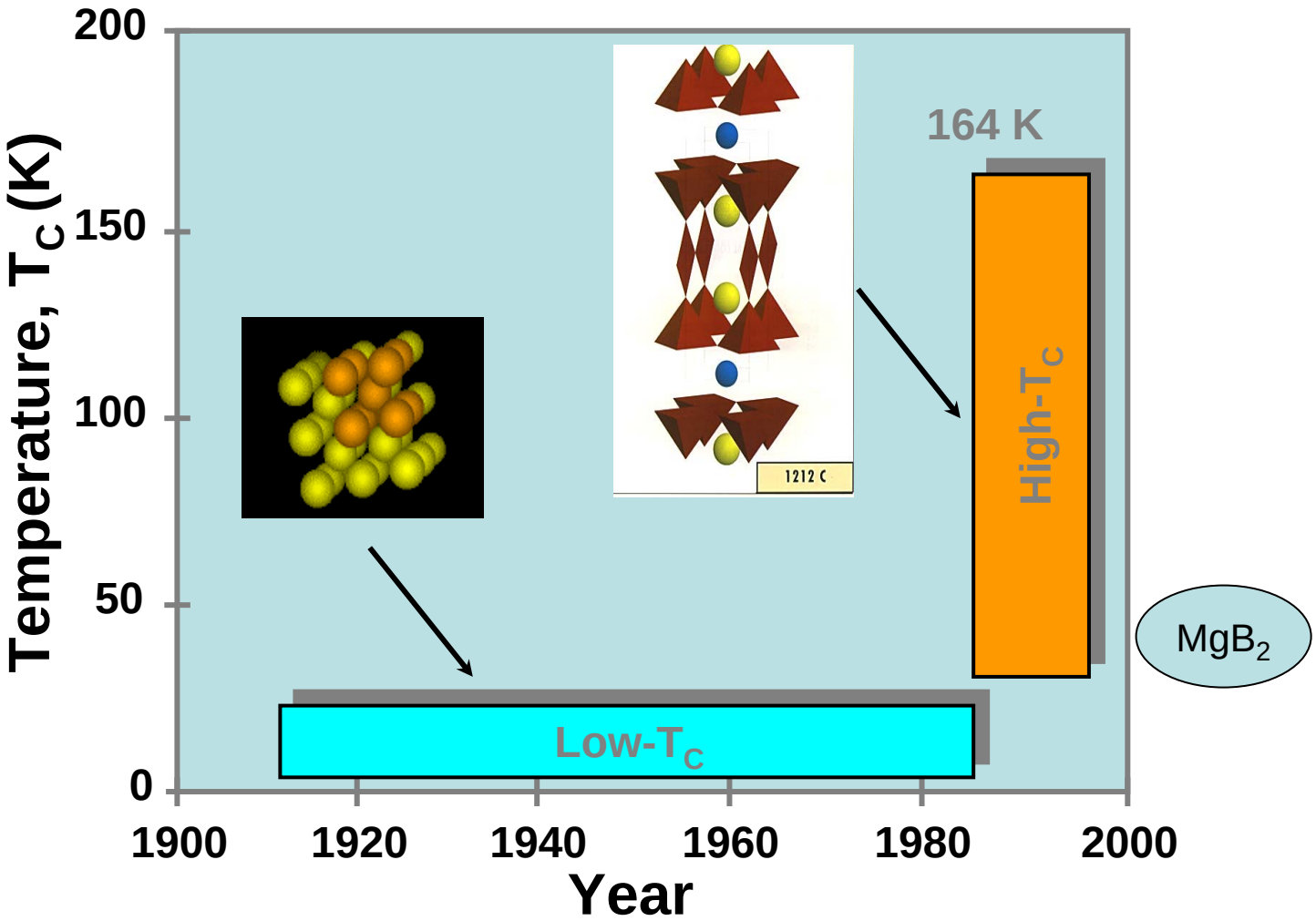
No More Ohm's Law



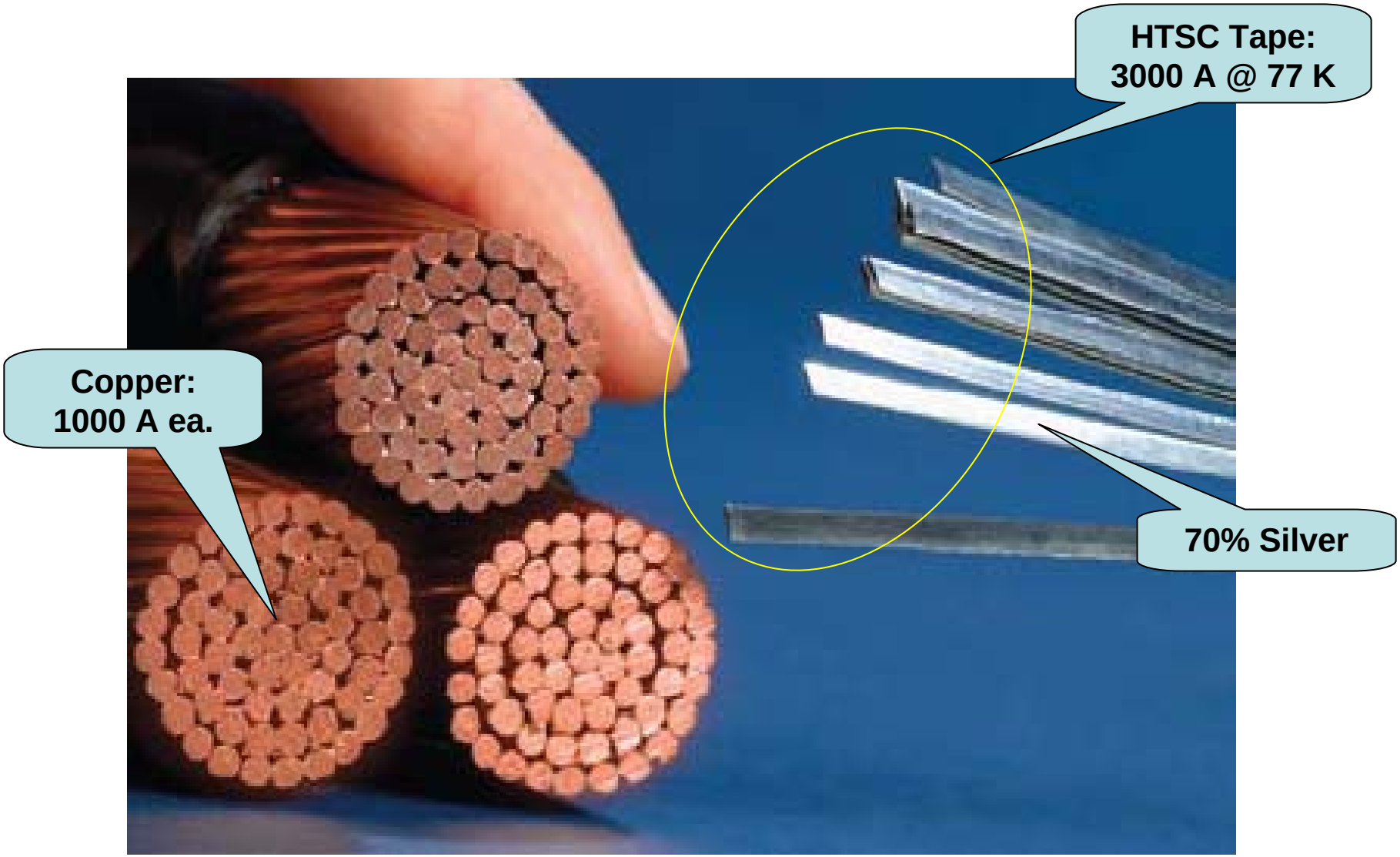
ac Hysteresis



T_c vs Year: 1991 - 2001

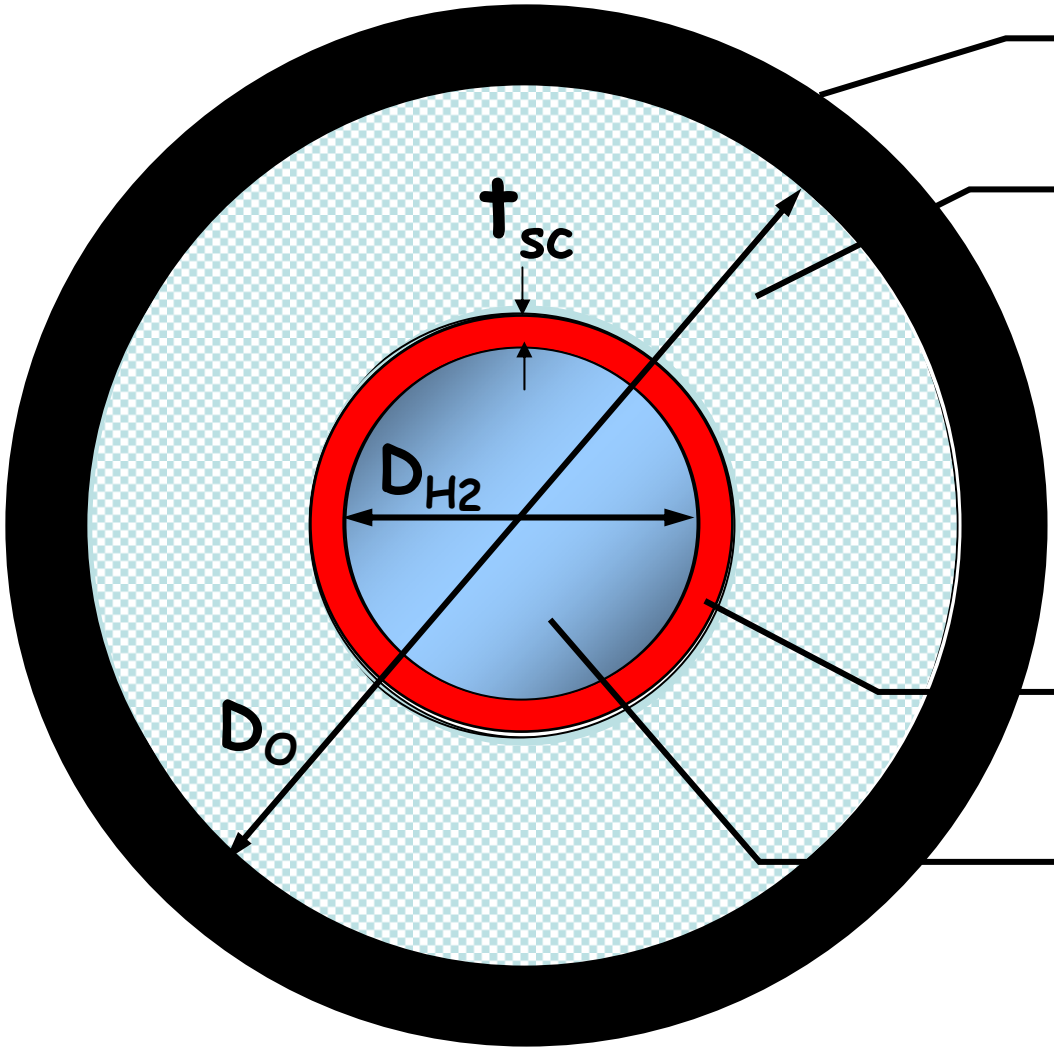


HTSC Tape (AMSC)



Finished Cable

LH_2 SuperCable



HV Insulation

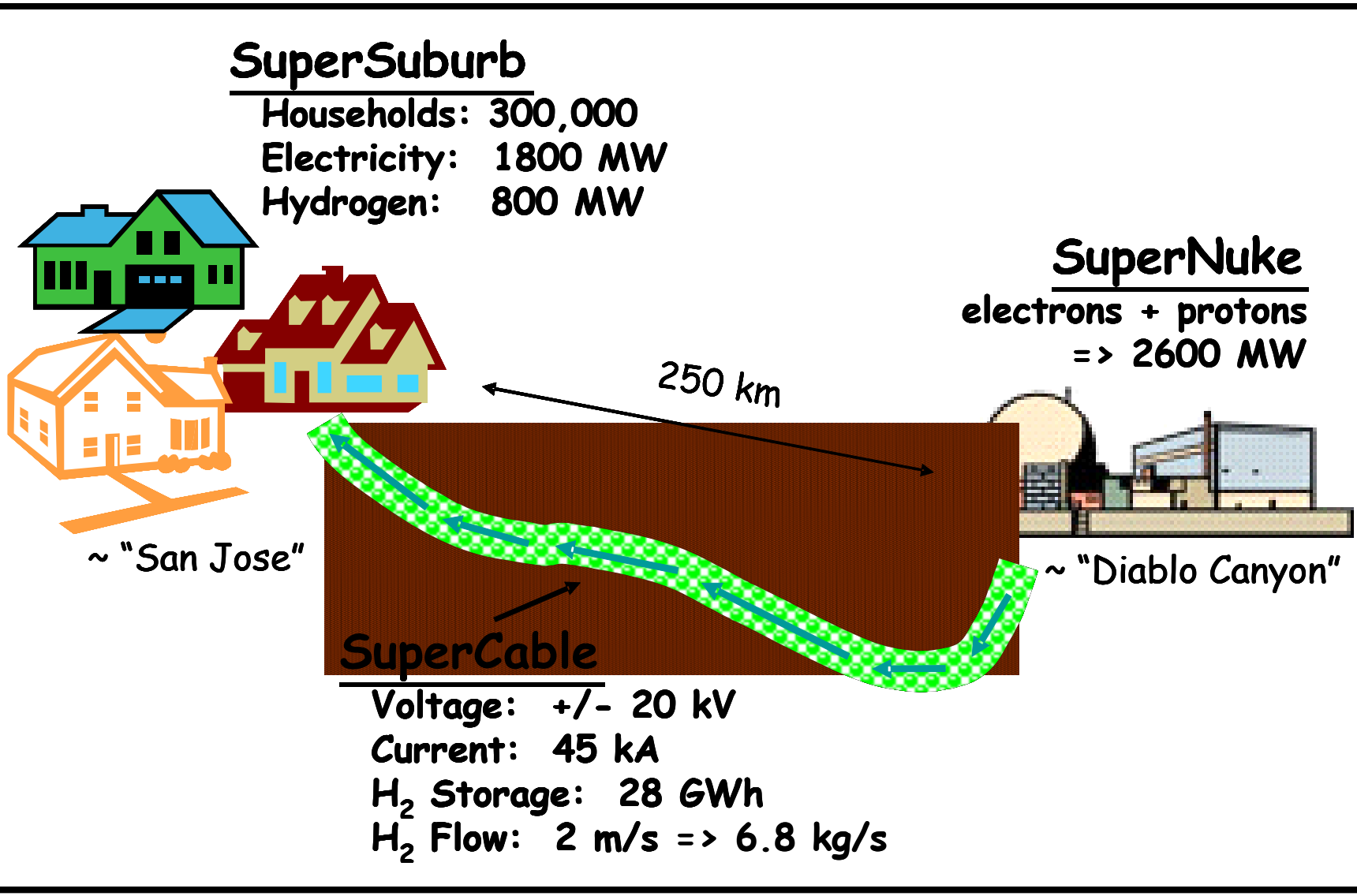
"Super-Insulation"

Roughly to Scale:
- Overall 30 cm Diameter

Superconductor

Hydrogen

SuperSuburb



A Canadian's View of the World

The Mackenzie Valley Pipeline

http://www.mackenziegasproject.com

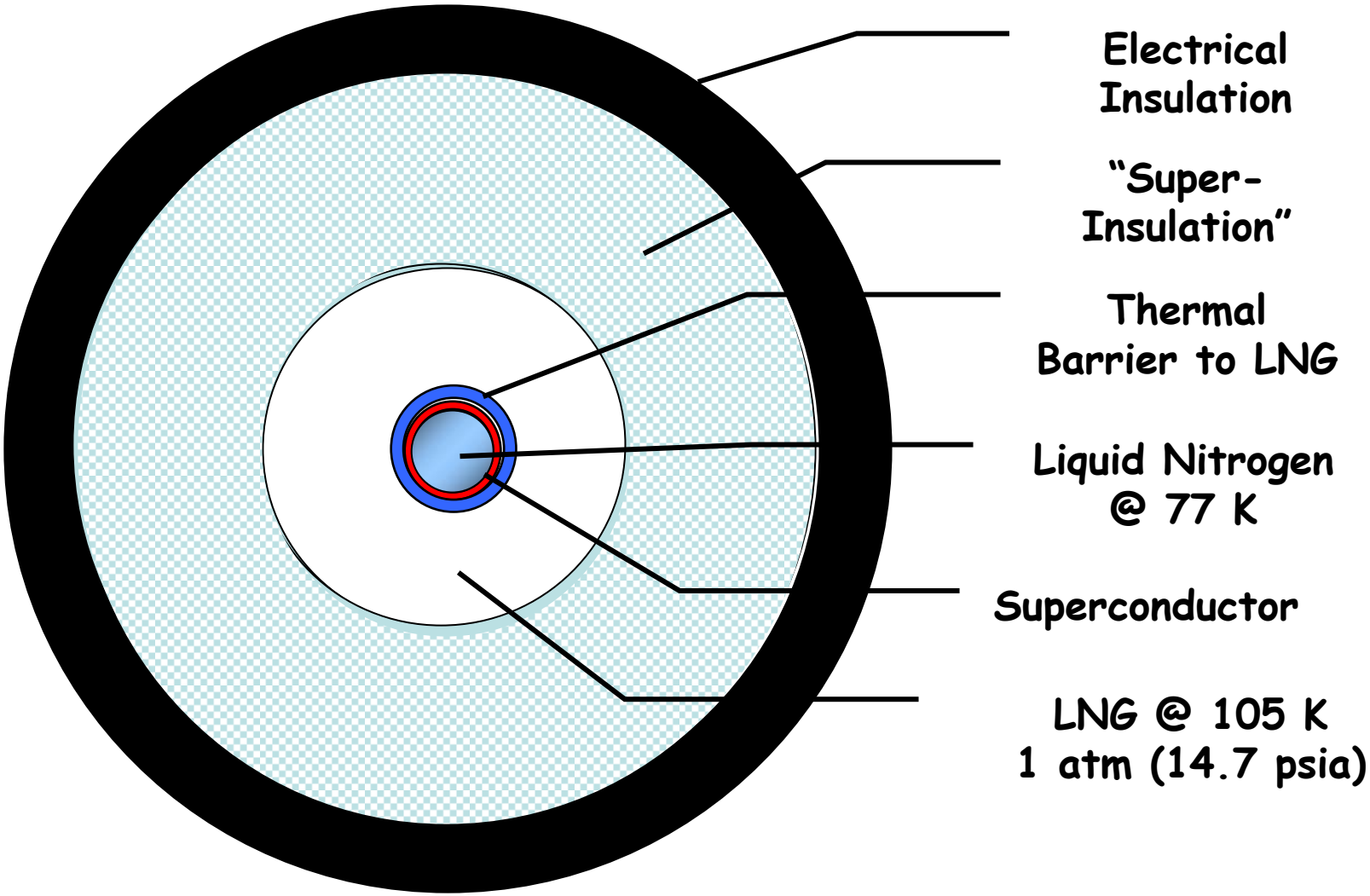
1220 km

18 GW-thermal

2006 - 2009

Design for eventual conversion to high pressure cold or liquid H_2

LNG SuperCable



It’s 2050!

- *The Gas runs out!*
- Build HTCGR Nukes on the well sites in the Mackenzie Delta (some of the generator infrastructure already in place)
- Use existing LNG SuperCable infrastructure to transport protons and electrons

Where there is no vision, the people perish…

Proverbs 29:18

“You can’t always get what you want…”

“…you get what you need!”