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The **Energy**-**Environment** Problem and Superconductivity Technology

Paul M. Grant

EPRI

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P. M. Grant

17 November 1998

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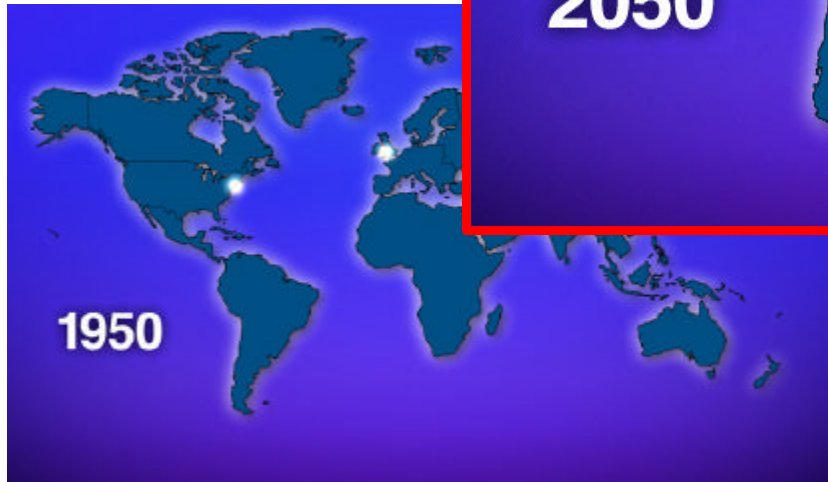


Mega-Cities

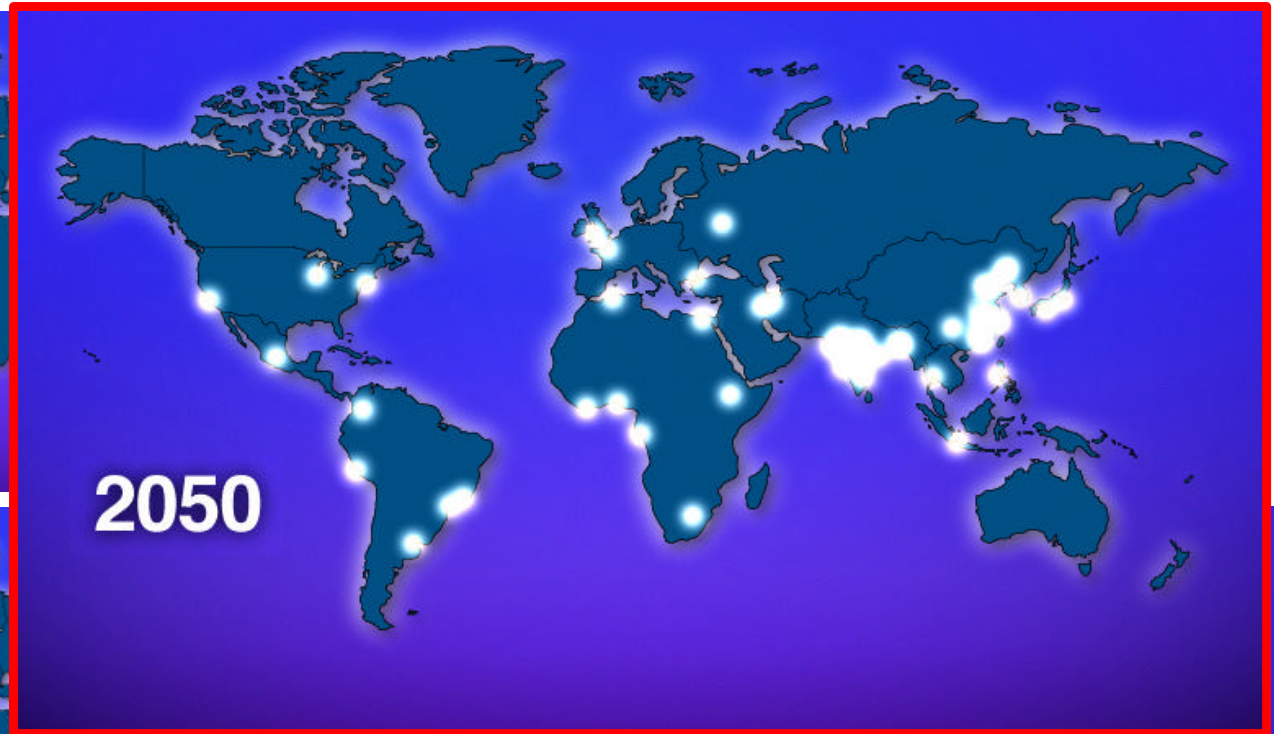
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1900



1950



2050



2020

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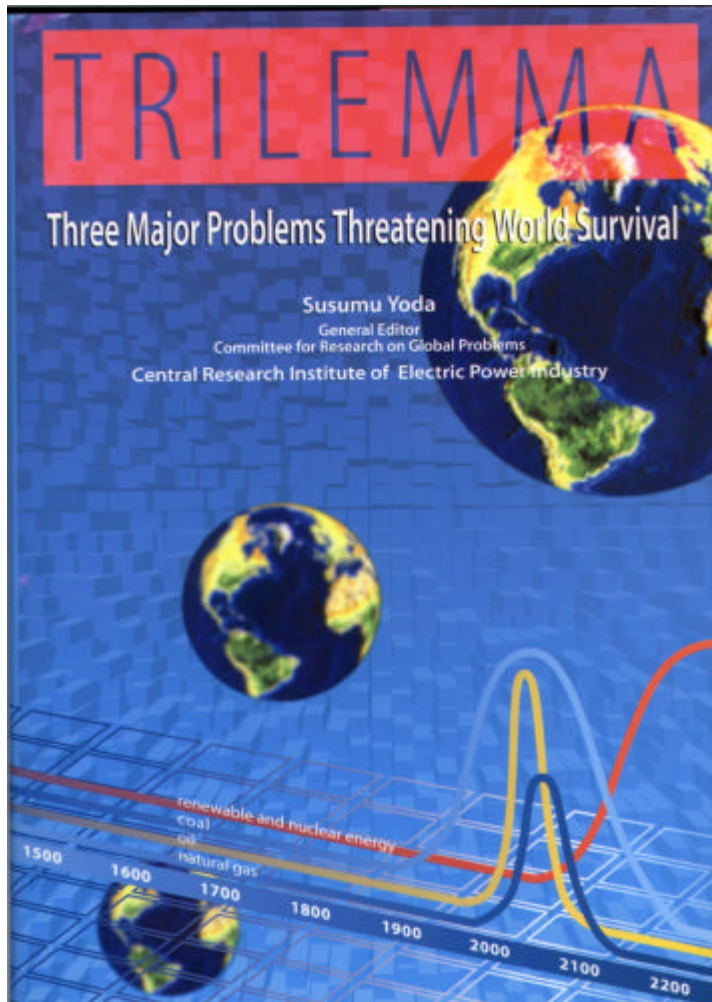
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The “Trilemma”

- Economic Growth
- Energy Consumption
- Conservative & Environment



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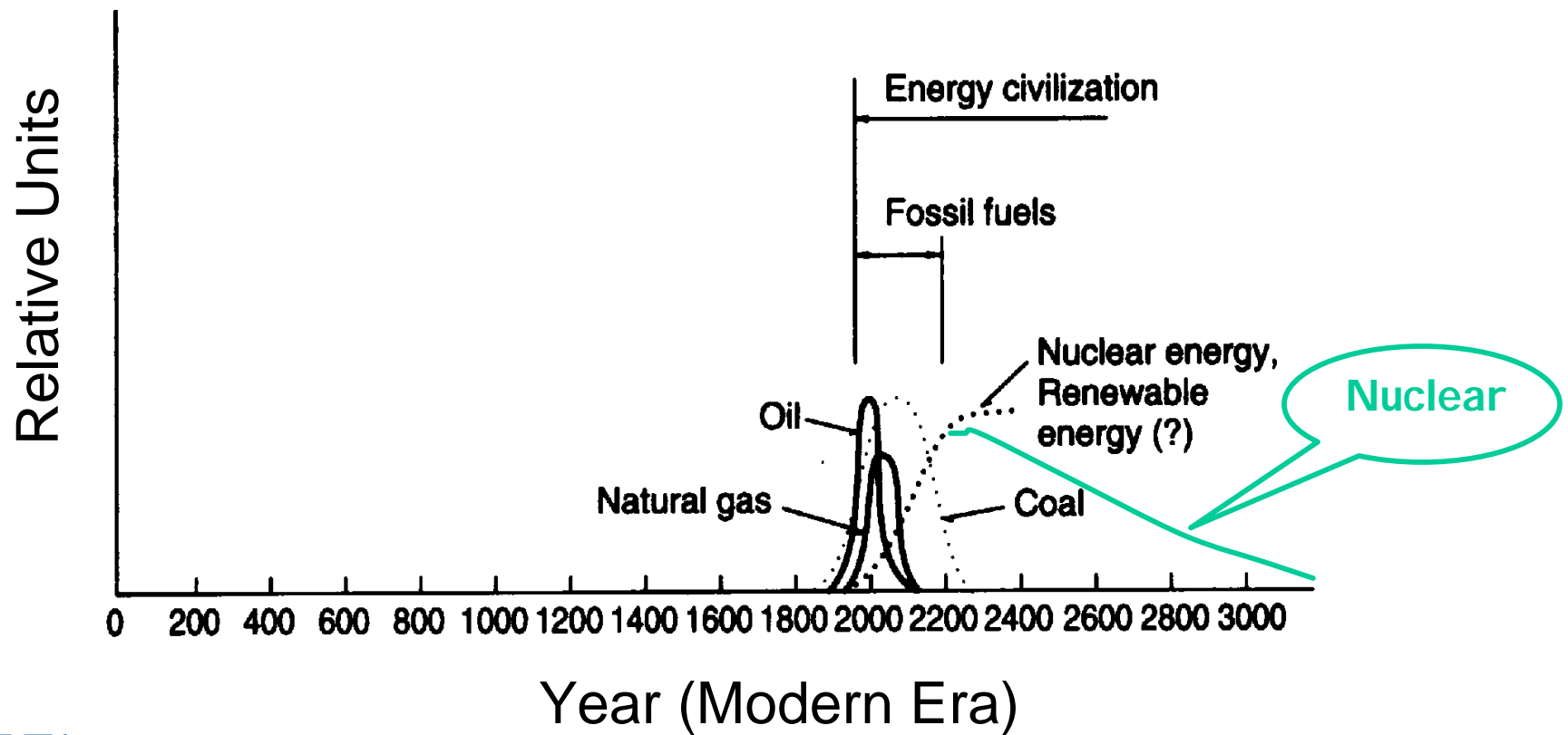
“... to save the earth and assure the survival of humanity.”



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Energy Civilization

Fig. 1 Production Volume of Energy Resources



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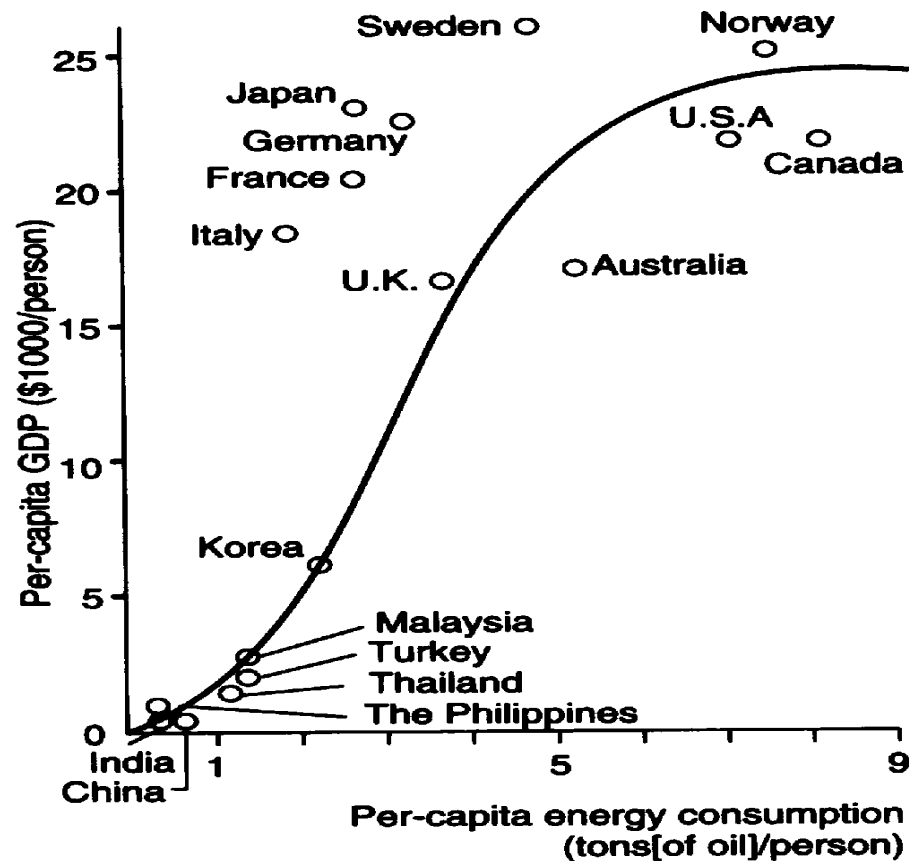
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Economic Growth & Energy Consumption

Fig. 2 Economic Growth and Energy Consumption (1990)





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Global Energy Consumption

Figure 2. World Energy Consumption, 1970-2020

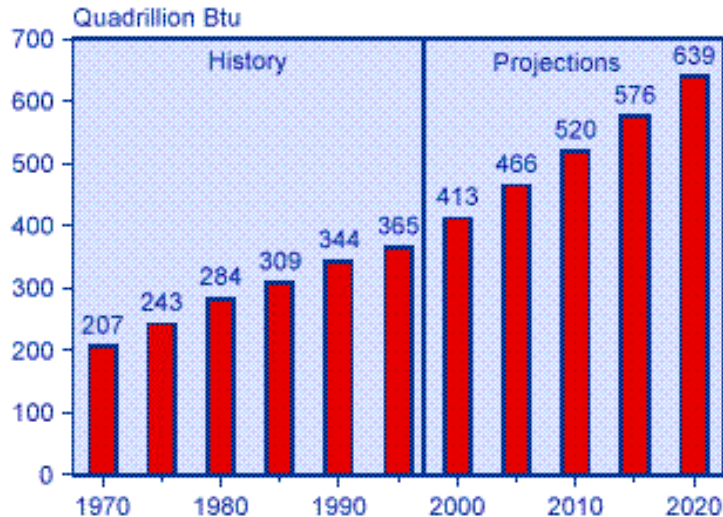
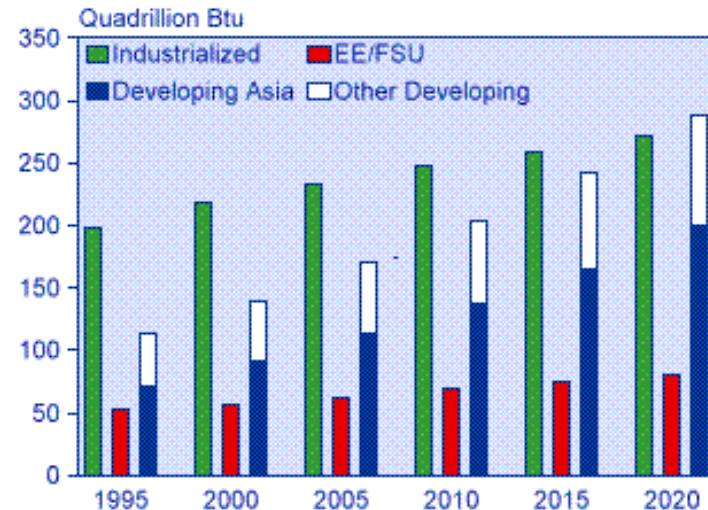


Figure 3. World Energy Consumption by Region, 1995-2020



Source: International Energy Outlook: 1998

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US Energy Information Agency



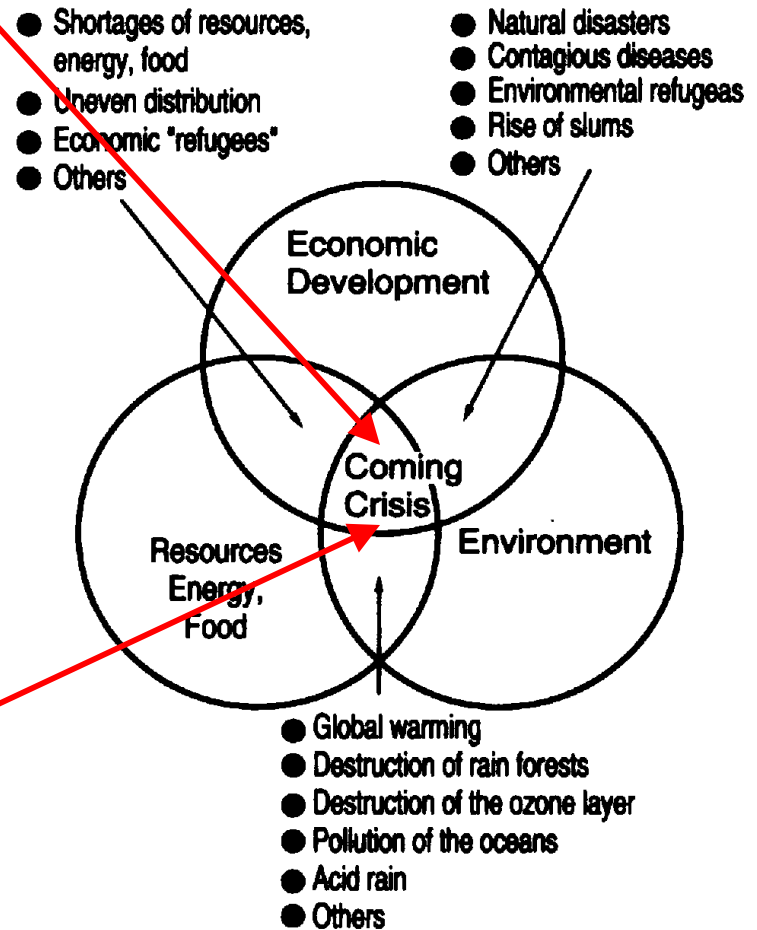
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Four Horsemen of the Apocalypse...Albrecht Duerer

Elements of the Trilemma

Fig. 7 The Structure of the Trilemma





North American Grid

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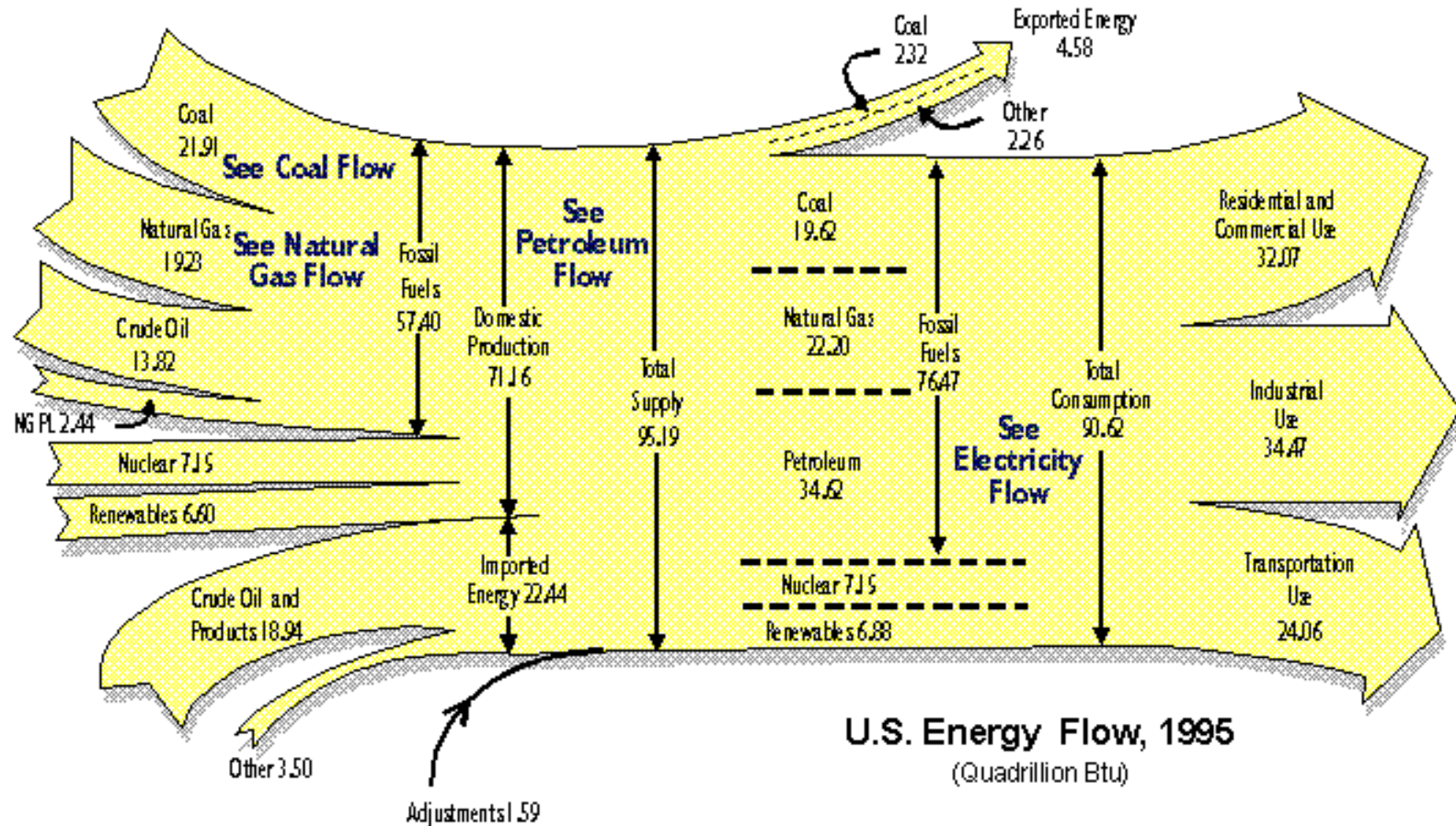
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US Energy Flow - 1995



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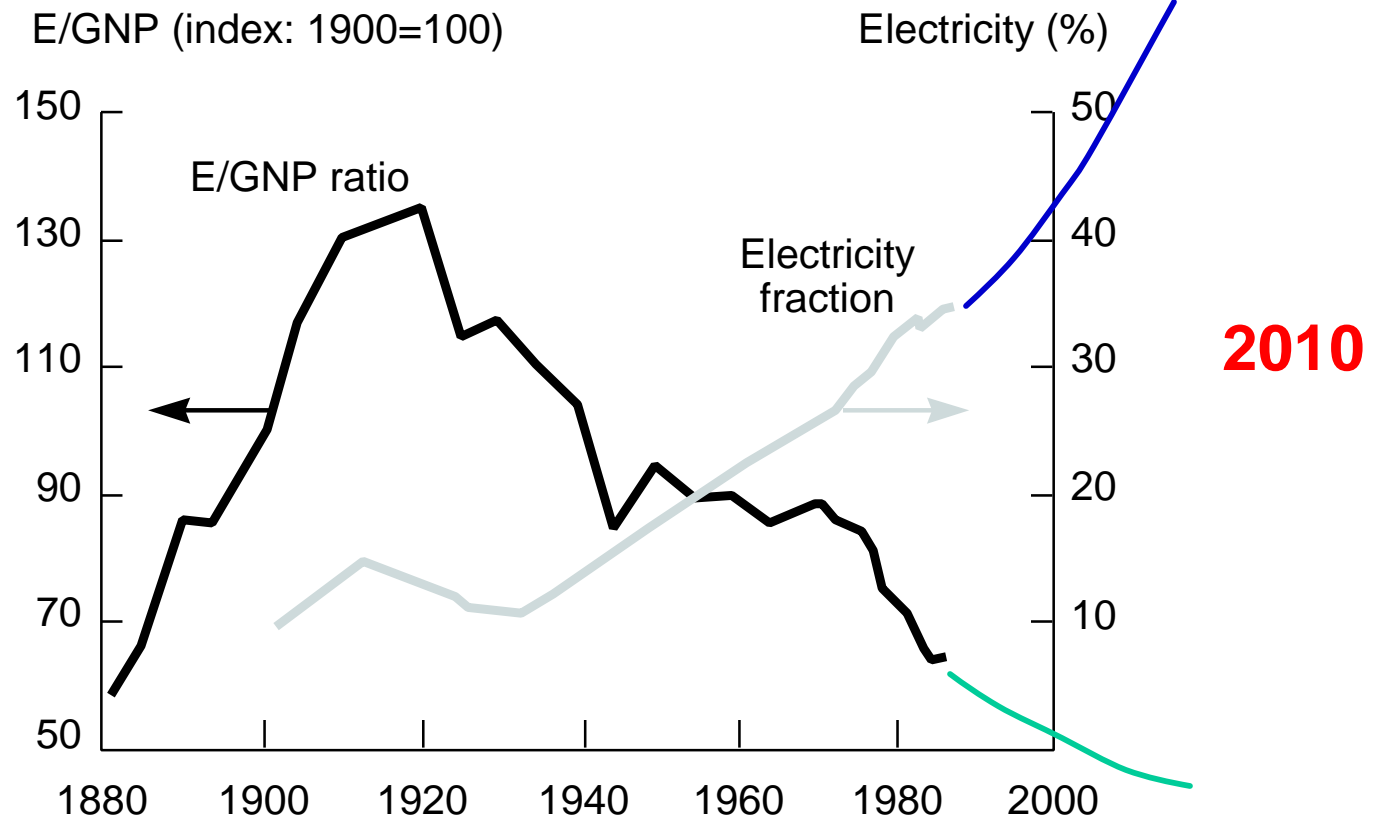
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Electricity & Energy Conservation

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Source: Electricity in the American Economy, Sam H. Schurr, et al., 1990



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0.15 TkWh

0.28 TkWh

3.24 TkWh

U.S. Electricity Flow, 1994

(Quadrillion Btu)



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Electricity Paradigm and Superconductivity

- Generation/Storage
 - Generators, SMES, Flywheels
- Transmission/Distribution
 - Cables, Transformers, FCLs
- Delivery/End Use
 - Motors, Electromagnets



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Electricity- Transportation Analogy

Electricity

- Fuel
- Generation
- Transmission
Electrons
- Distribution
- End Uses
 - Lighting
 - Rotating Machinery
 - Appliances

Transportation

- Natural Resources
- Manufacturing/Agriculture
- Interstate Highways
Trucks
- Regional Freeways
- Retail Sales
 - Home Depot
 - Sears
 - Safeway



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U.S. Electricity Production/Loss Summary

	TkWh	% in T&D Loss and In-Plant Use	Revenue @ \$0.10/kWh (B\$)	No. of 500 MW Plant Equivalents	Capital Cost @ \$800/kW (B\$)
Total	3.24		324	740	296
T&D Losses	0.28	8%	28	63	25
In-Plant Used	0.15	5%	15	35	14



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Superconductivity and Efficiency

	1994	2014 @ 2%/yr	2014 Plants Saved 0.2% Penetration 4× Efficiency
Total	740	360	
T&D Losses	63	31	11
In-House Use	35	17	6