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Energy: A Global Challenge

Dr. William Fisher

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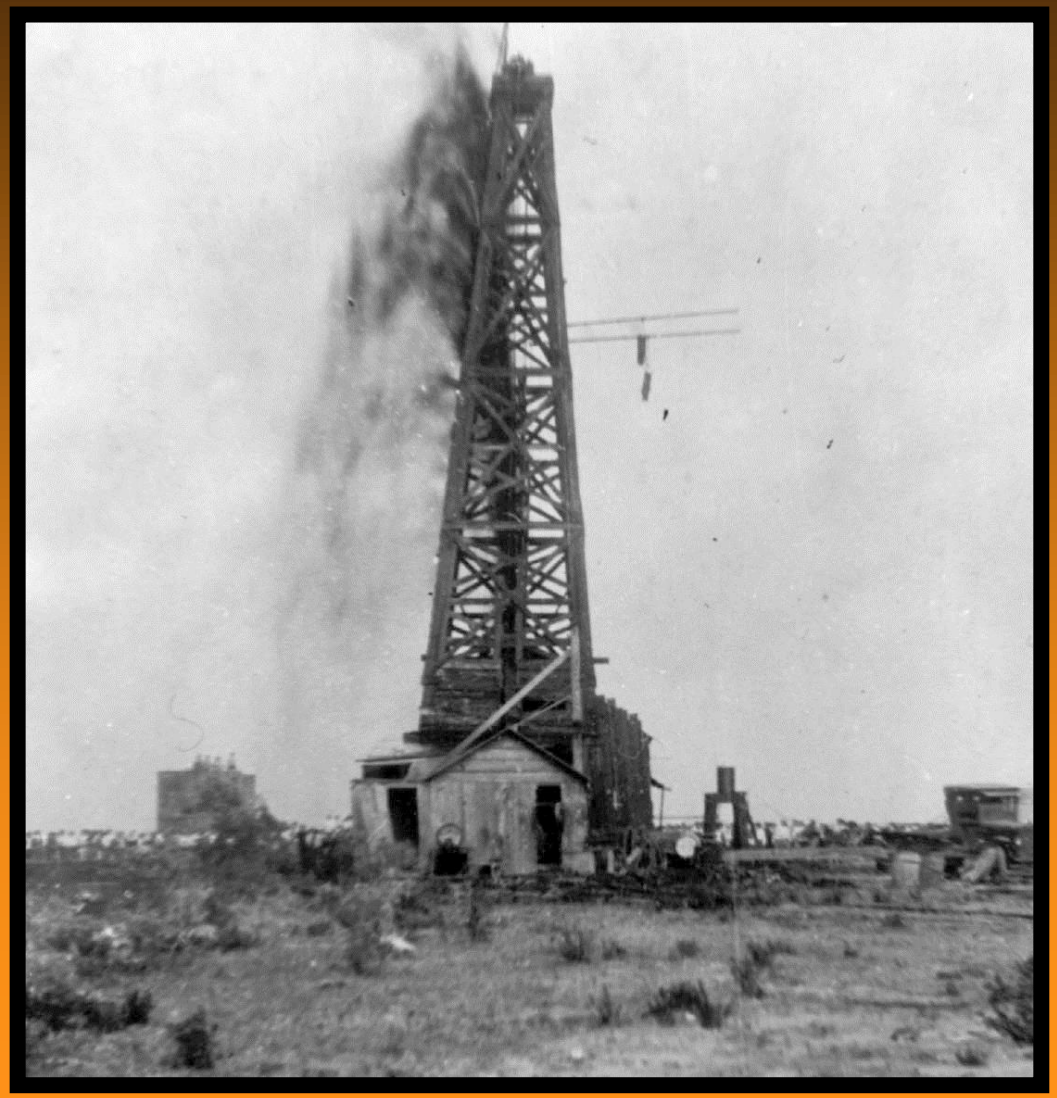
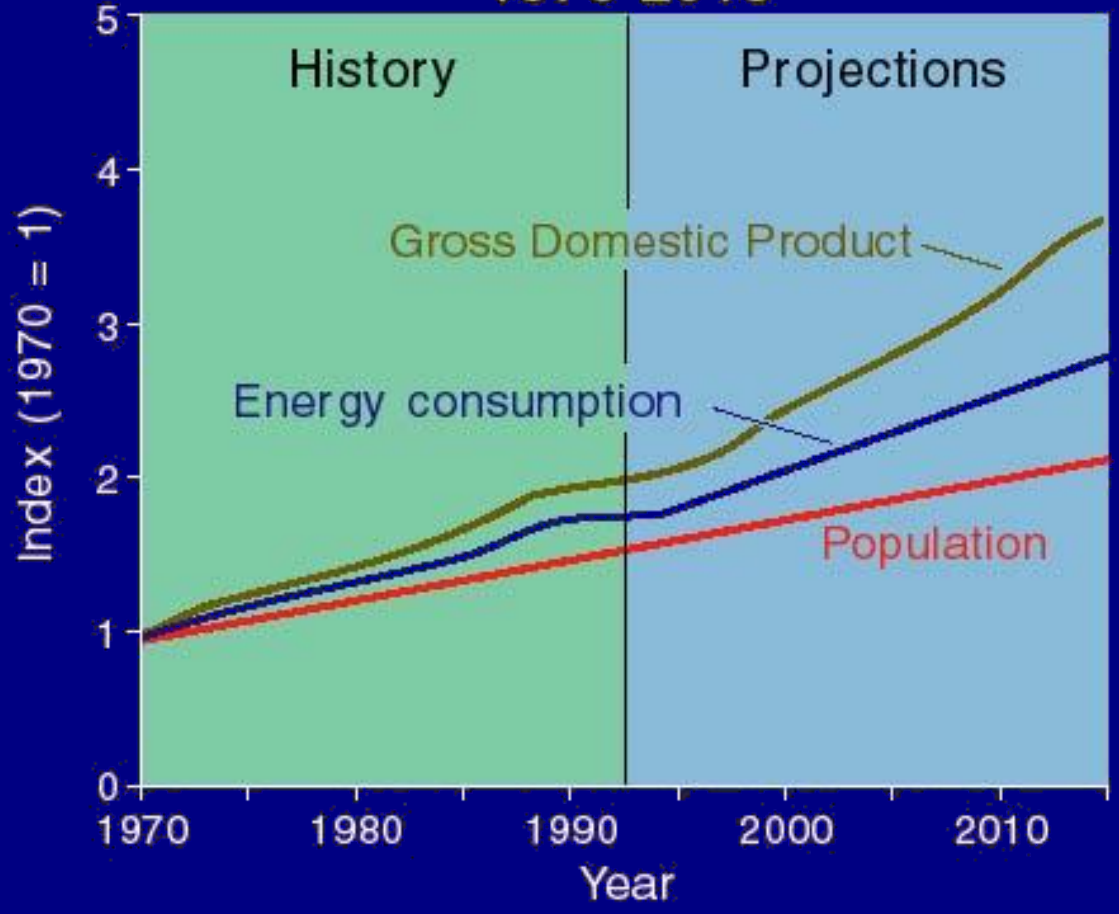
Energy: A Global Challenge

by Dr. William Fisher



WORLD ENERGY, GROSS DOMESTIC PRODUCT, POPULATION TRENDS 1970-2015



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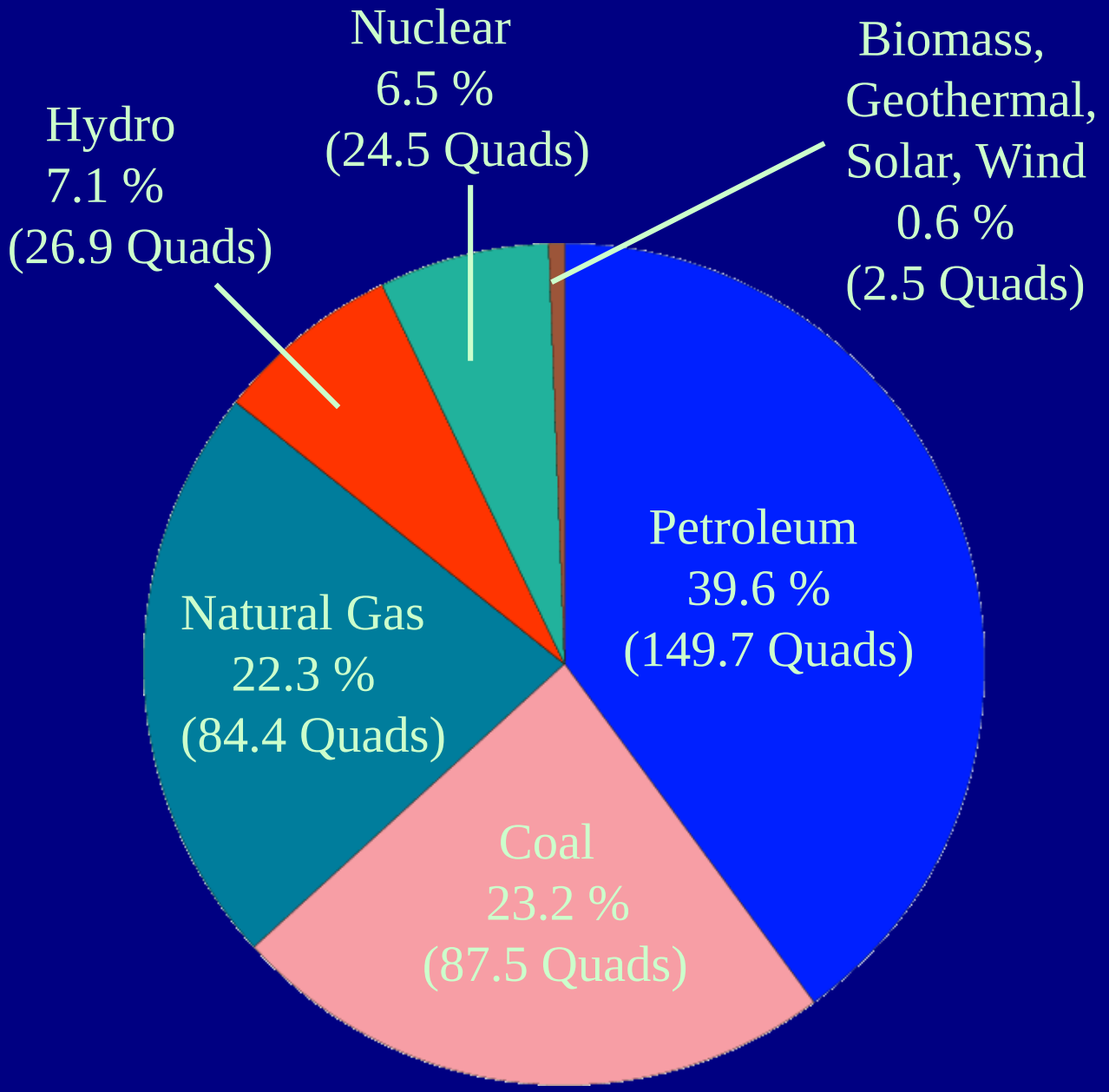
Source EIA (Energy Information Administration)

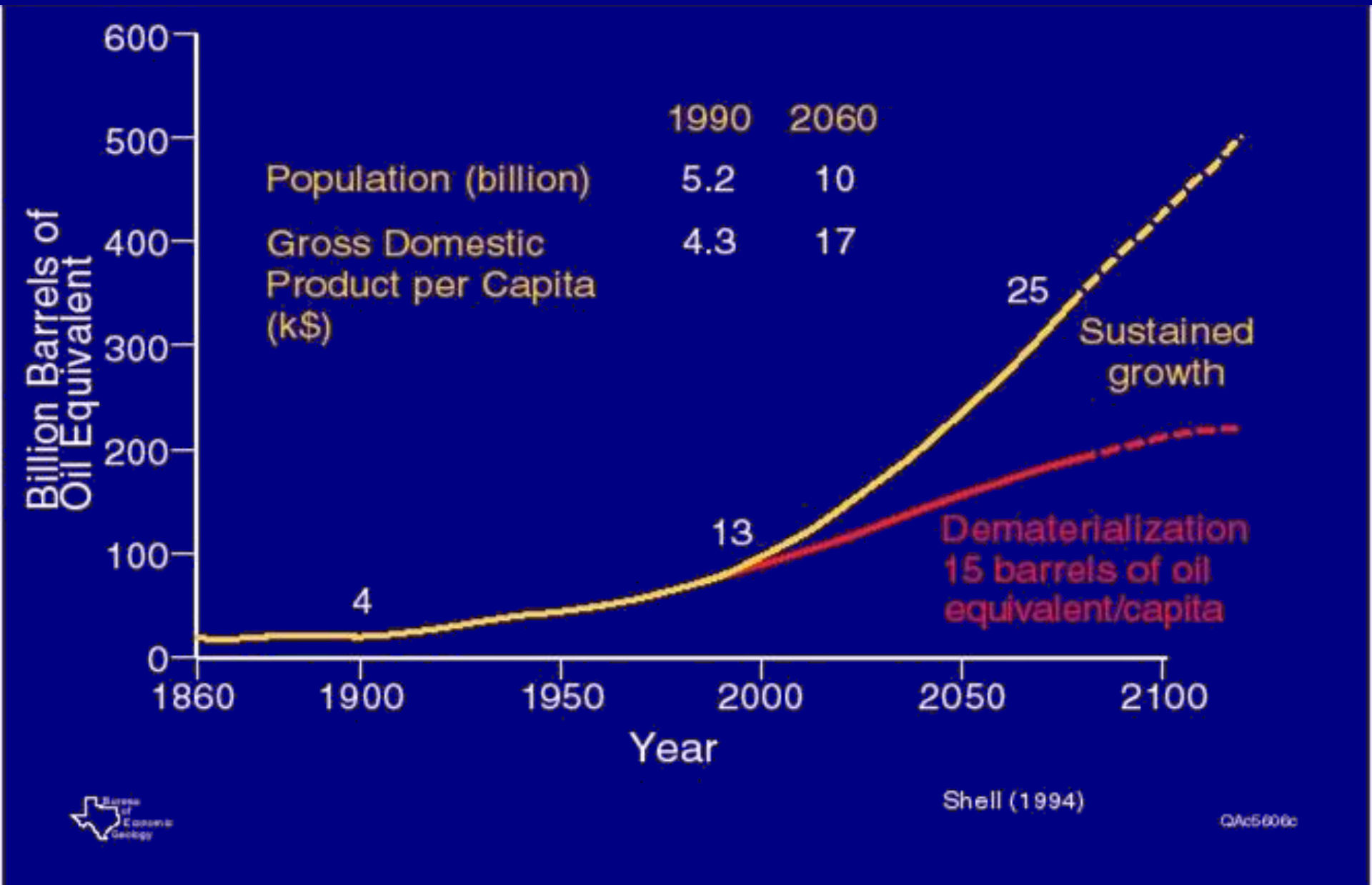
World Primary Energy Consumption



Energy Units for Different Sources

FUEL TYPE	STANDARD MEASURE
PETROLEUM	73.6 MMB/D (million barrels per day)
NATURAL GAS	82.7 TCF (trillion cubic feet)
COAL	5013 MSTs (million short tons)
HYDRO	2584 BKwh (billion kilowatthours)
BIOMASS, GEOTHERMAL, SOLAR, WIND	196 BKwh (billion kilowatthours)

Future Scenarios



Energy Requirements of the 21st Century

Shell Scenarios:

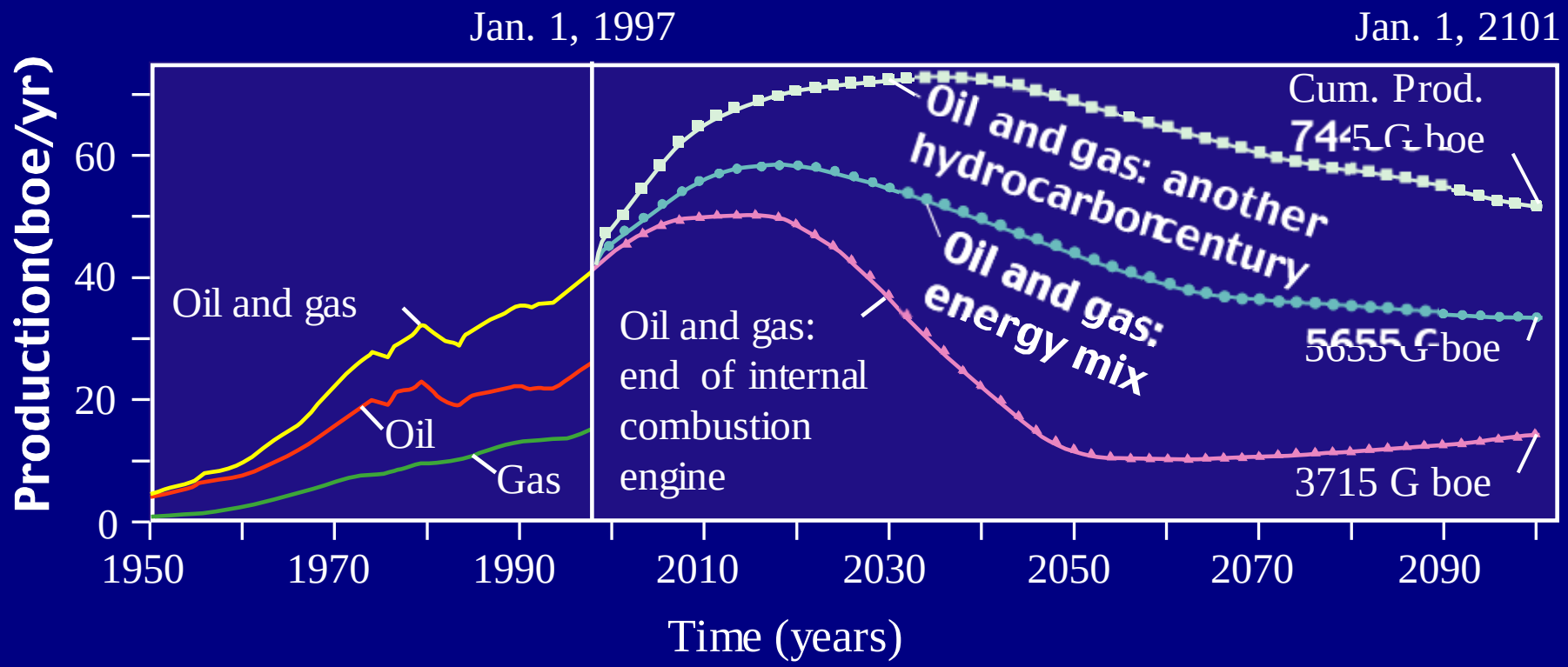
- Sustained Growth - 25 Tboe
- Dematerializtion - 15 Tboe

Available Fossil Fuel Base:

- Oil - 3 Tboe
- Natural Gas - 4.3 Tboe
- Coal - 23.5 Tboe

(Tboe - Trillion barrels of oil)

WORLDWIDE PRODUCTION OF OIL AND NATURAL GAS

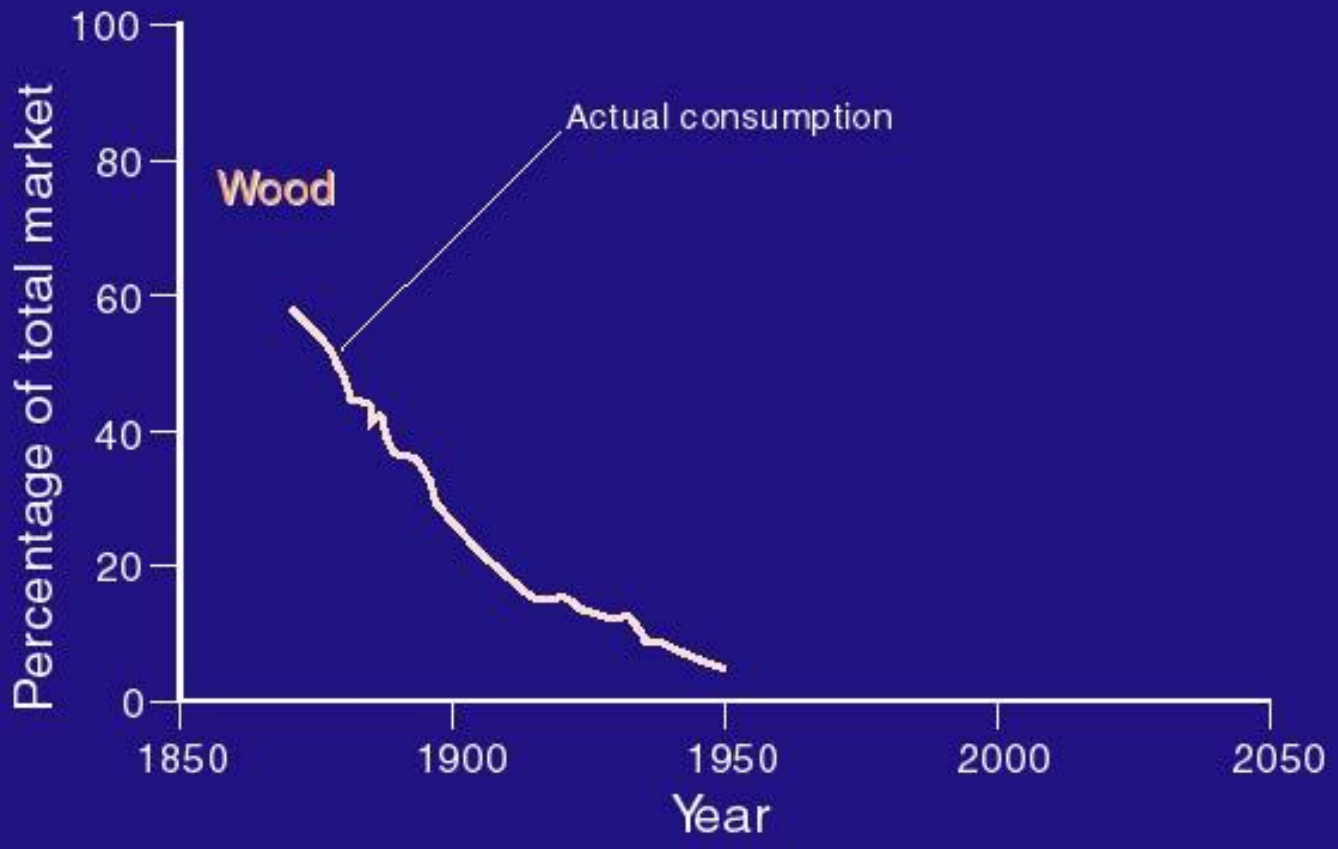


(boe = barrels of oil equivalent)

Bureau of Economic Geology

Schollnberger (1998)

WORLD PRIMARY ENERGY SUBSTITUTION



Marchetti and Nakicenovic (1994)

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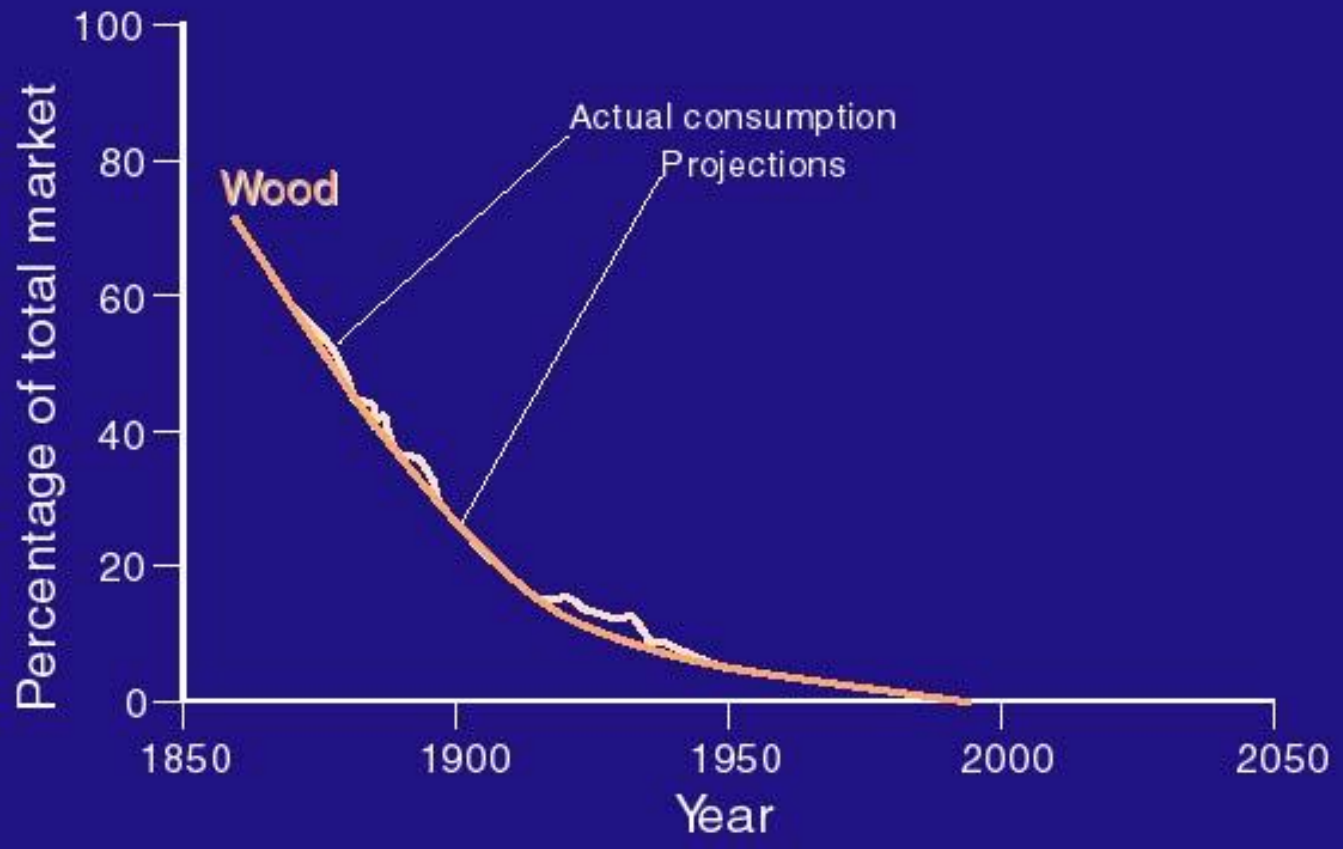
WORLD PRIMARY ENERGY SUBSTITUTION



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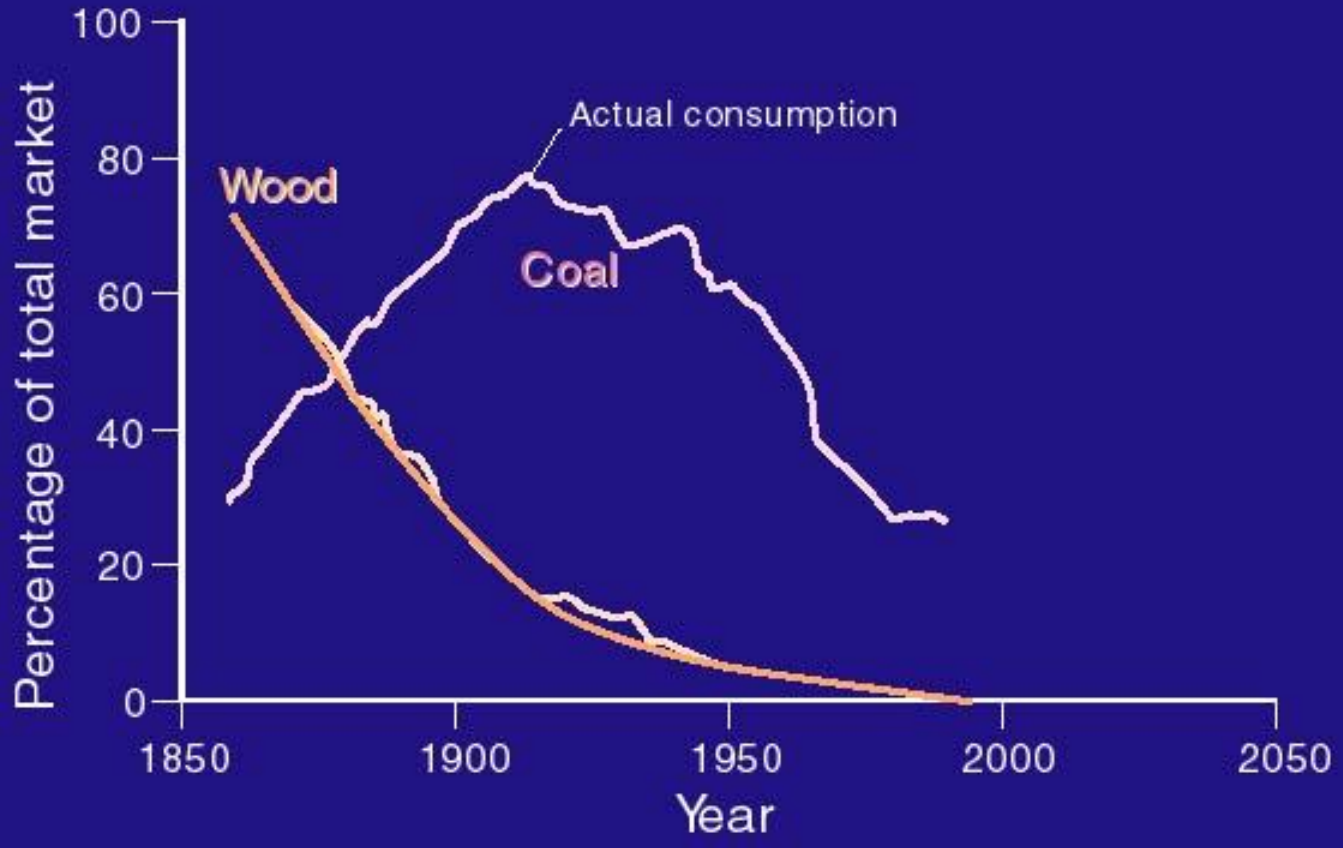

Marchetti and Nakicenovic (1994)

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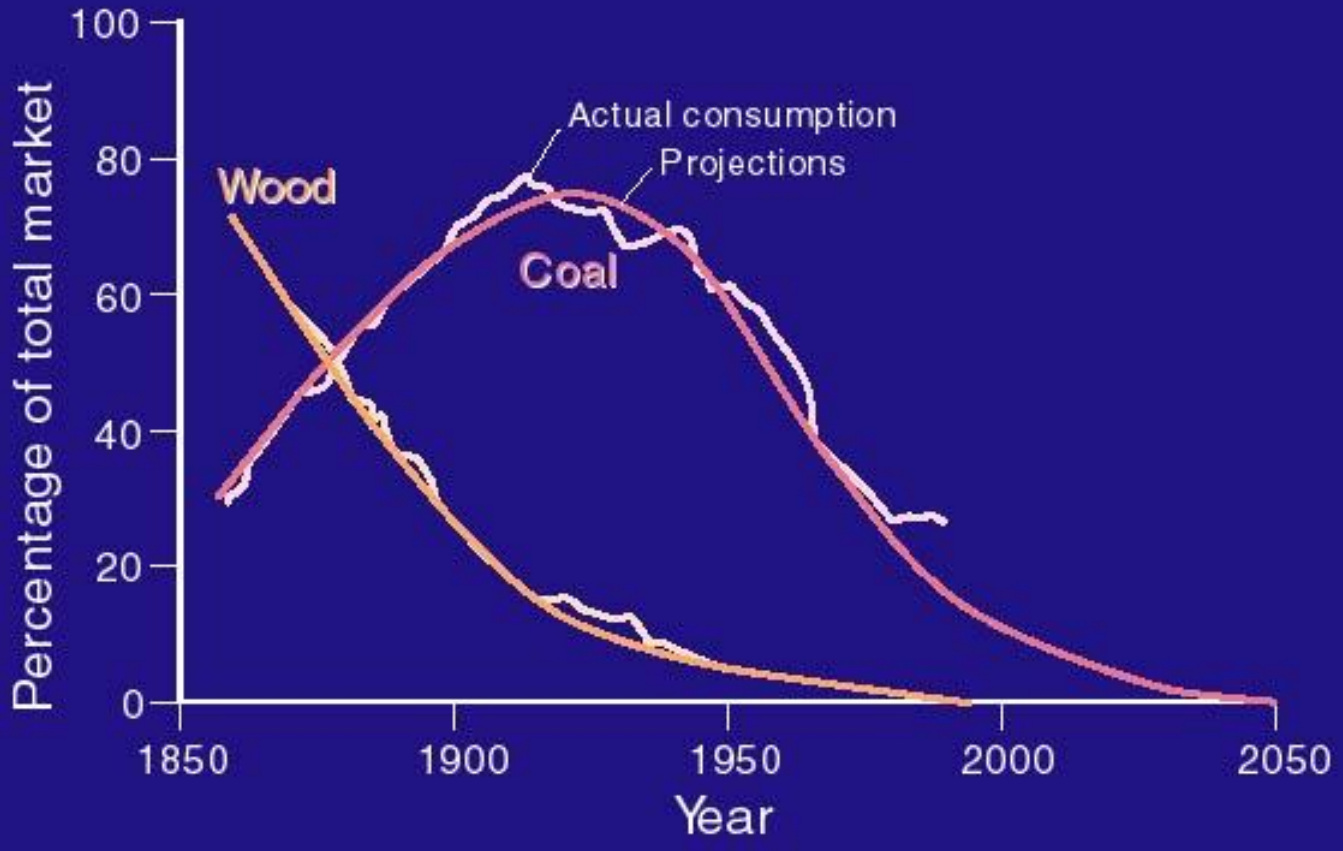

Marchetti and Nakicenovic (1994)

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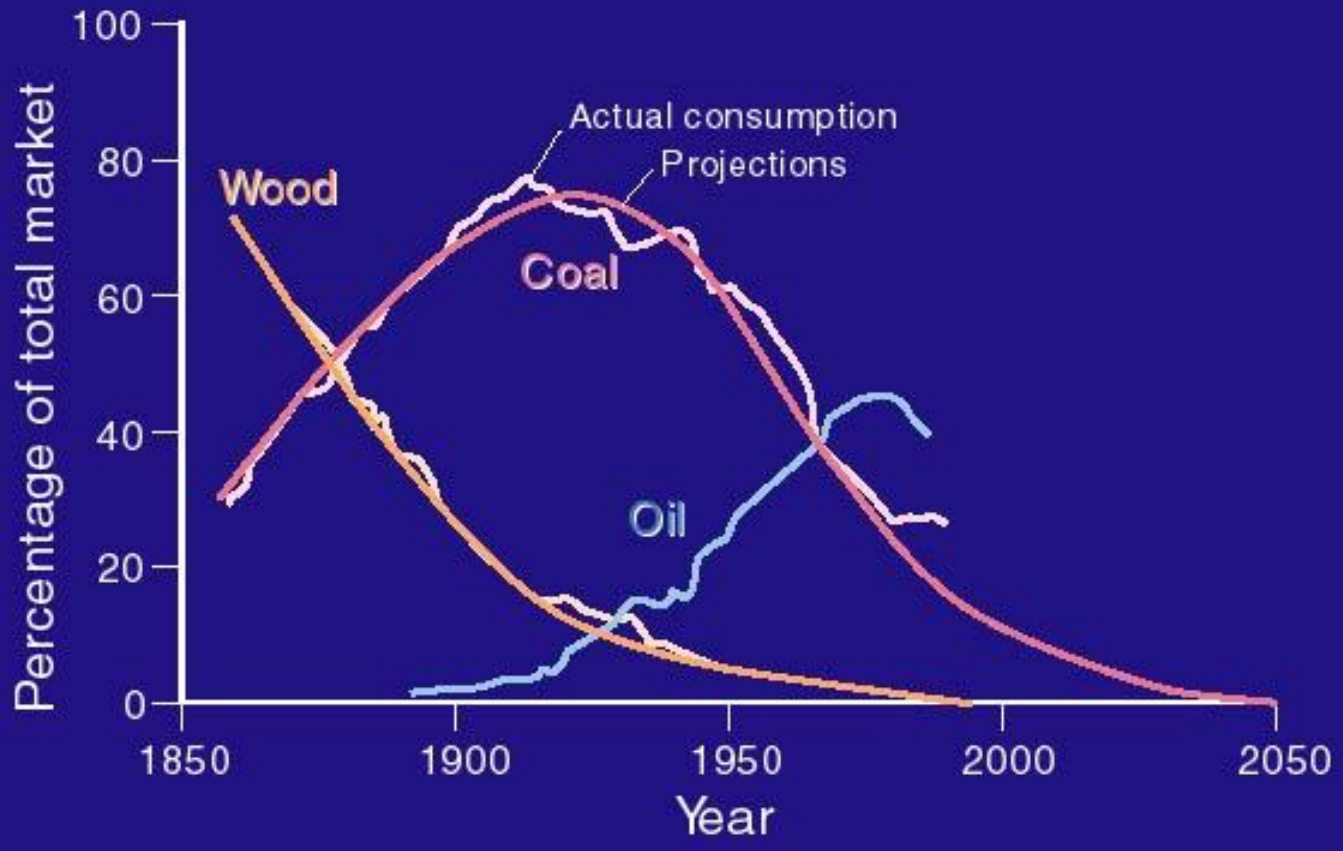

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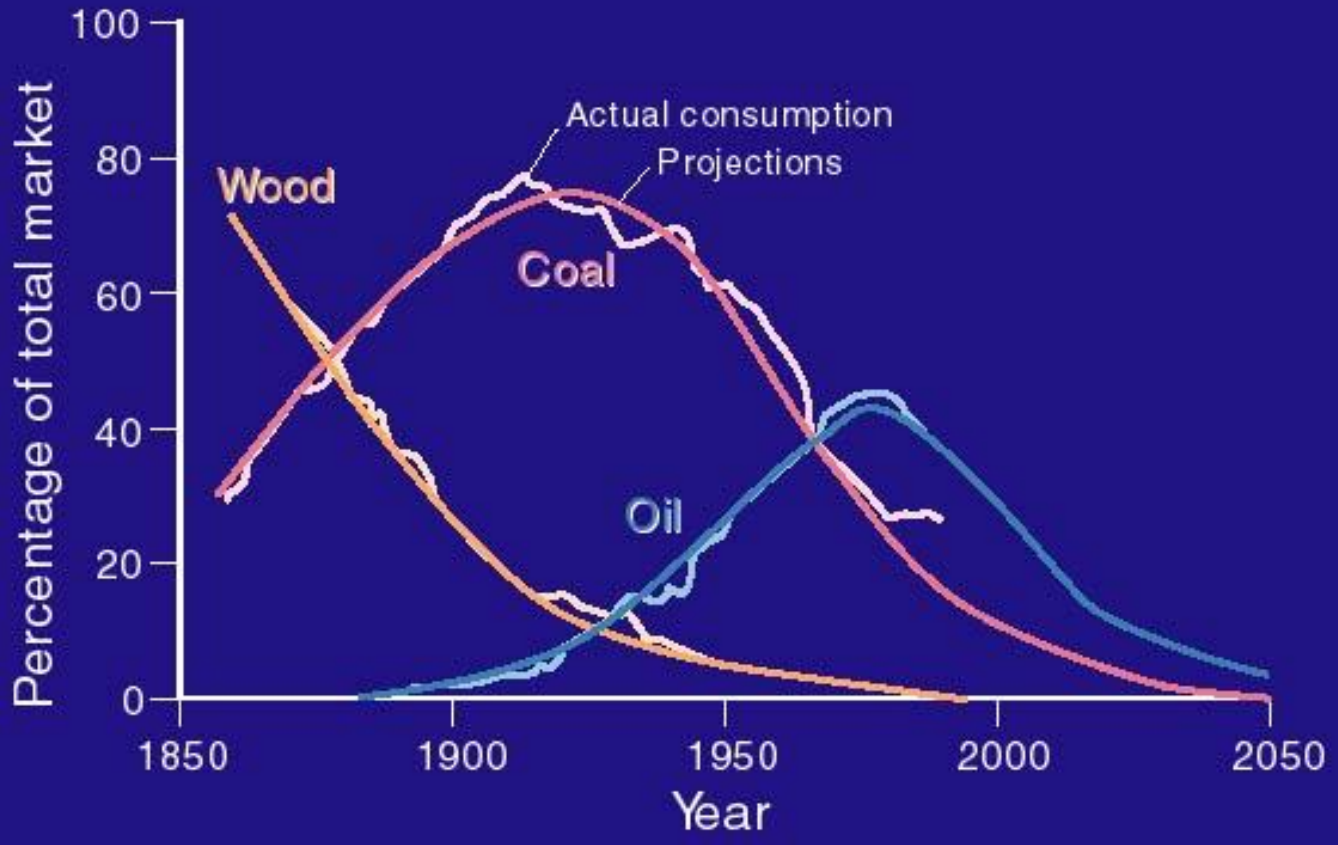

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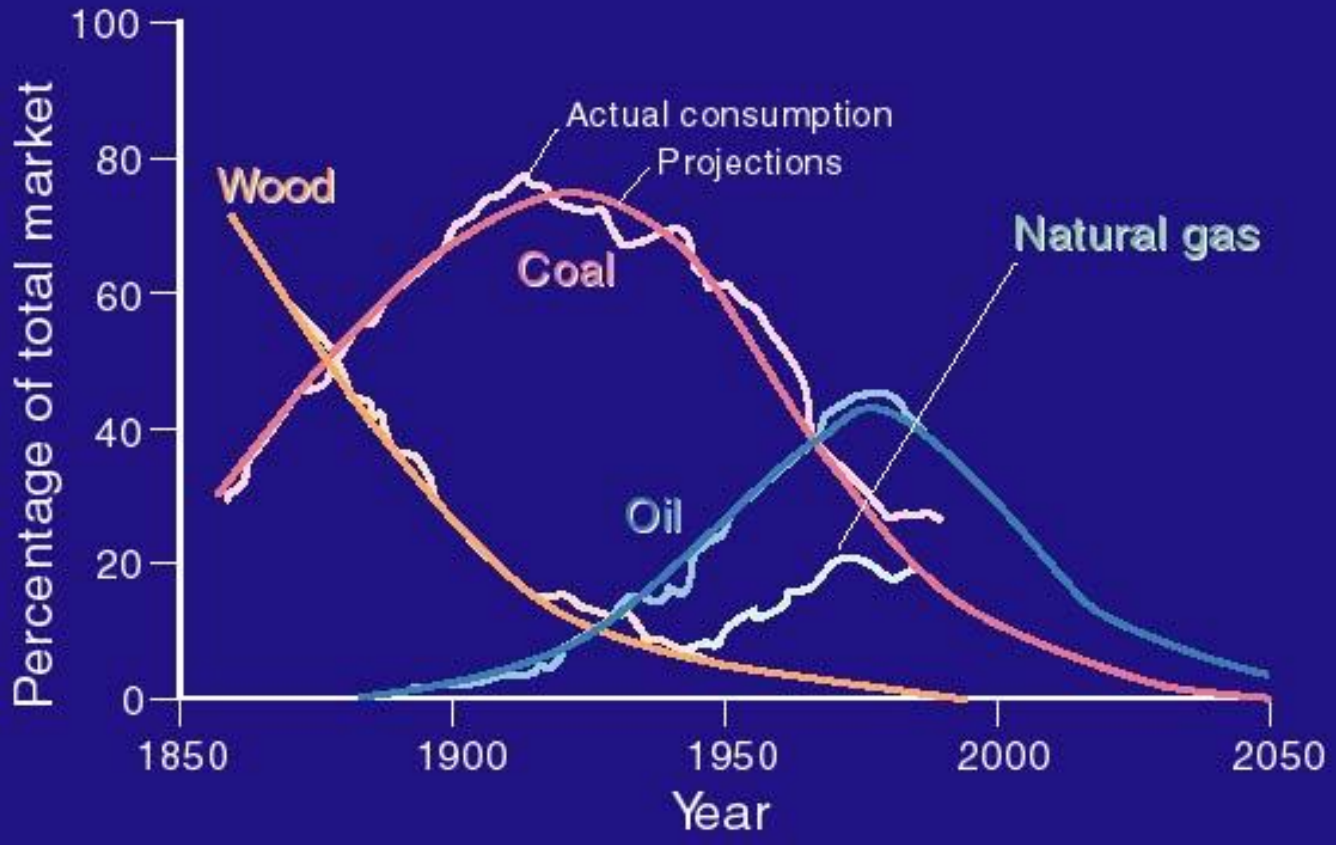

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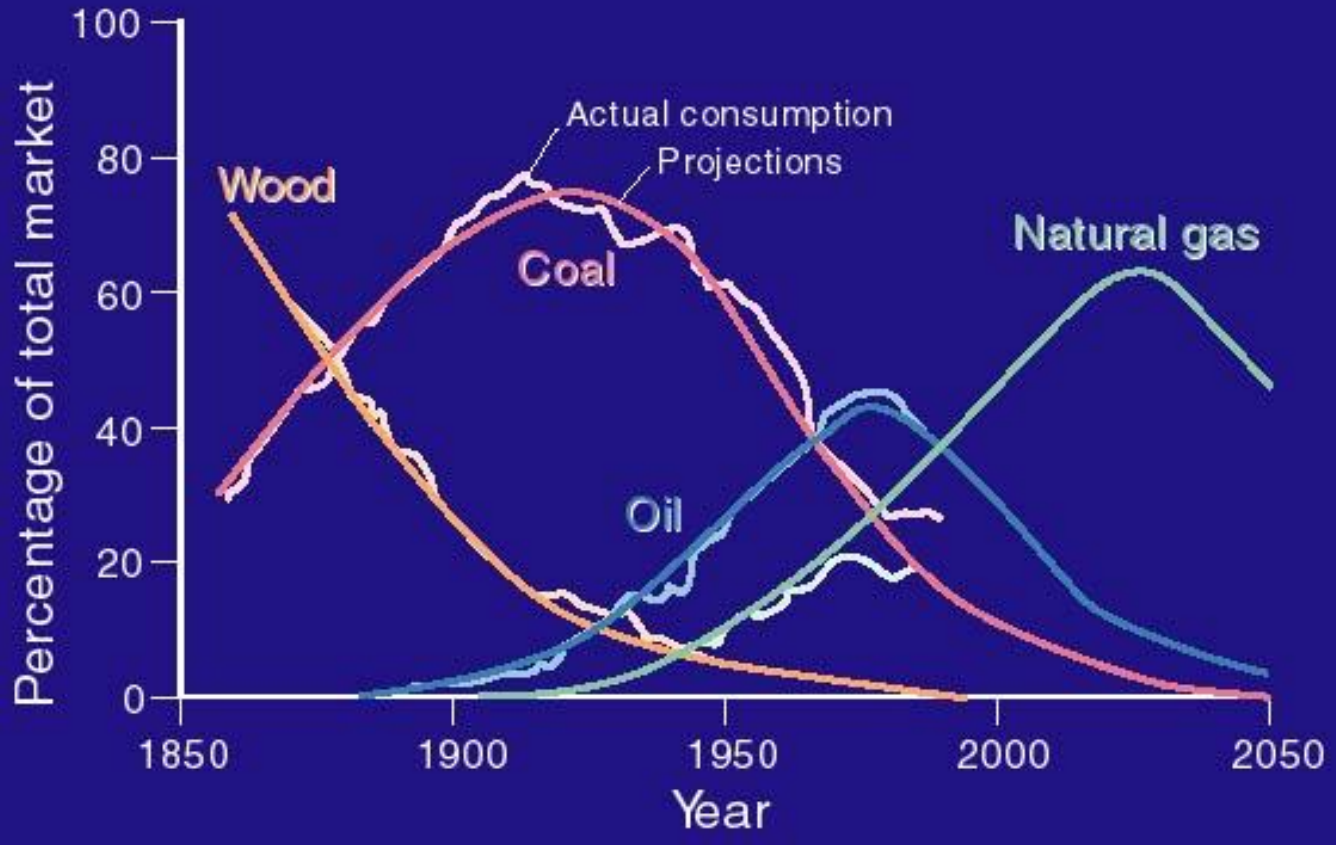

Marchetti and Nakicenovic (1994)

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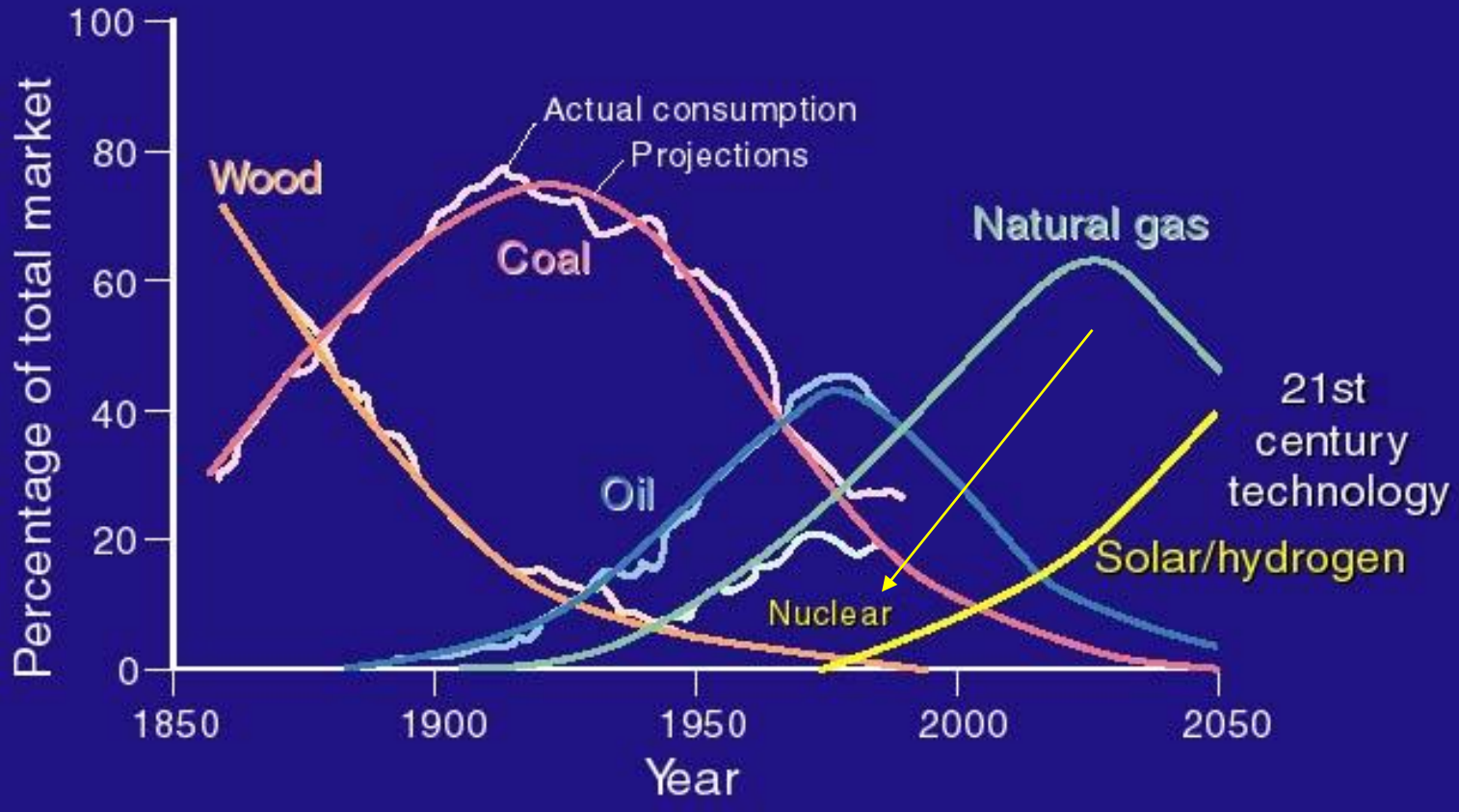

Marchetti and Nakicenovic (1994)

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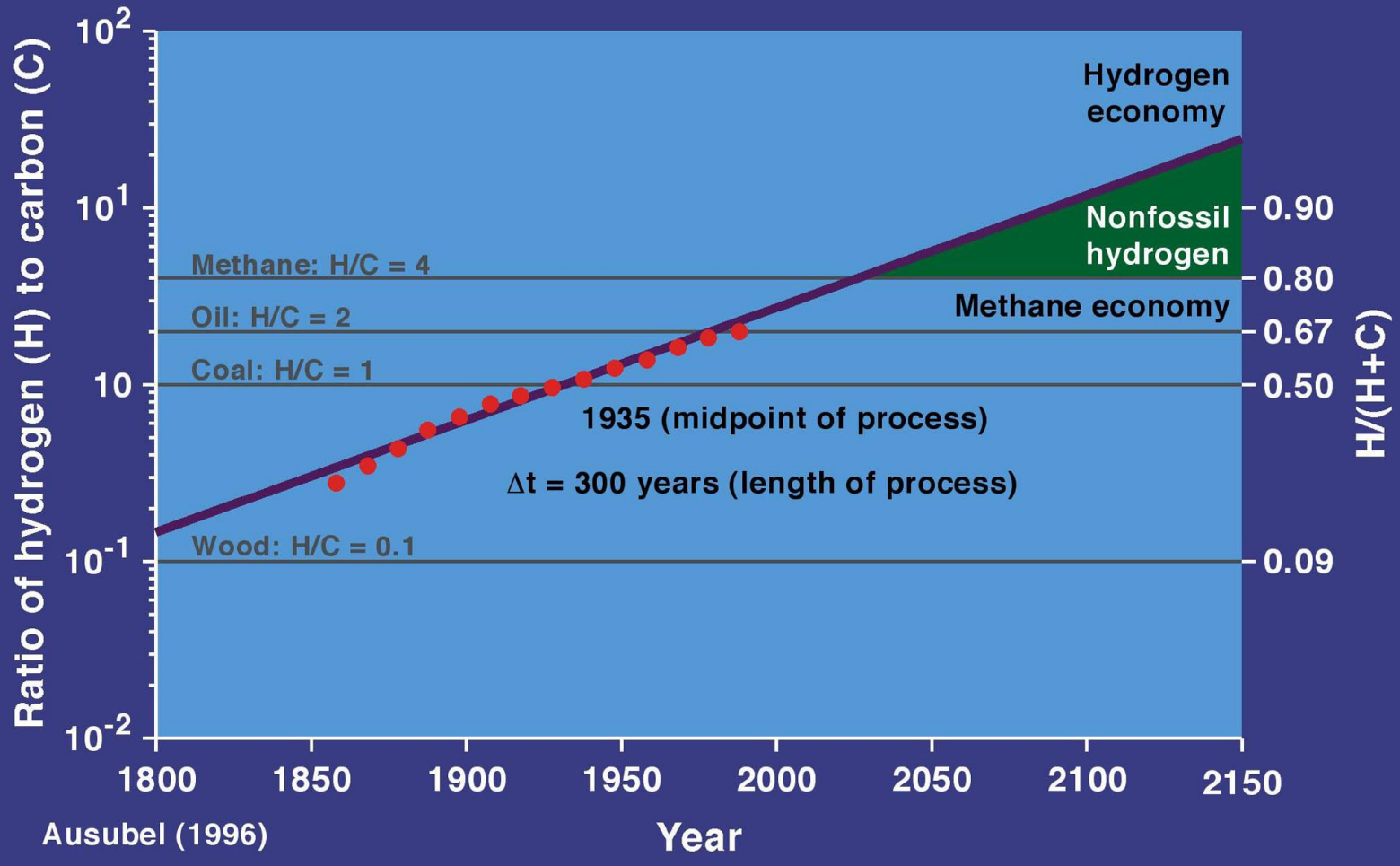
THE RATIO OF HYDROGEN TO CARBON IN OUR FUELS IS CHANGING.

- Fuels with more carbon release more carbon dioxide.
- Fuels with more hydrogen burn more cleanly.

RATIO OF HYDROGEN (H) TO CARBON (C) FOR GLOBAL PRIMARY ENERGY CONSUMPTION SINCE 1860 & PROJECTIONS FOR THE FUTURE



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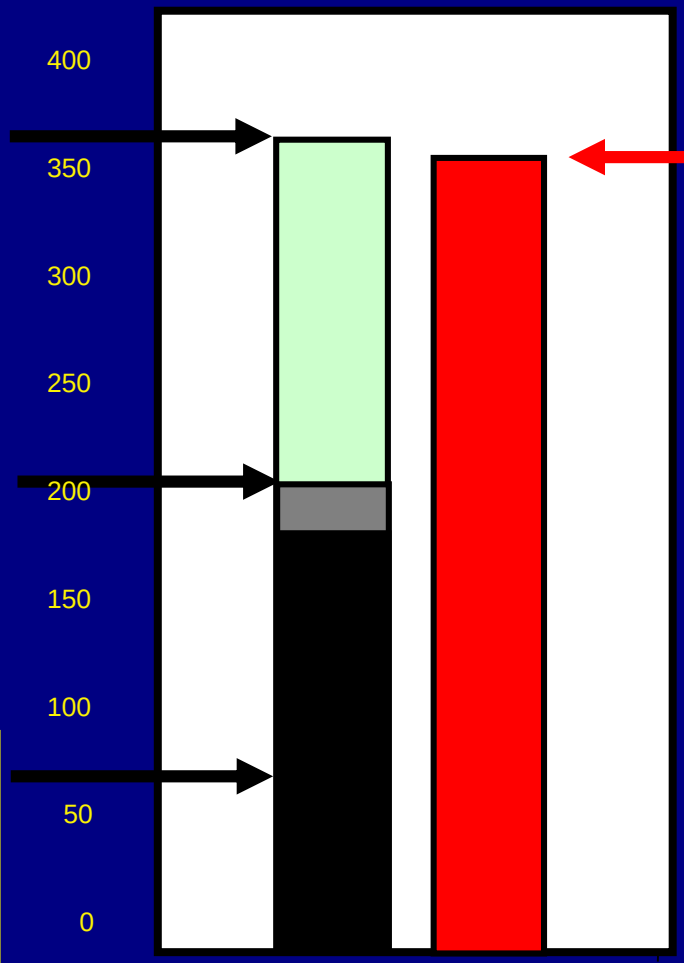
Estimate of U.S. Oil Reserves and Future Needs

Estimate of additional U.S. oil resources.

Estimate of future U.S. oil needs.



Estimate of the U.S. oil reserves.

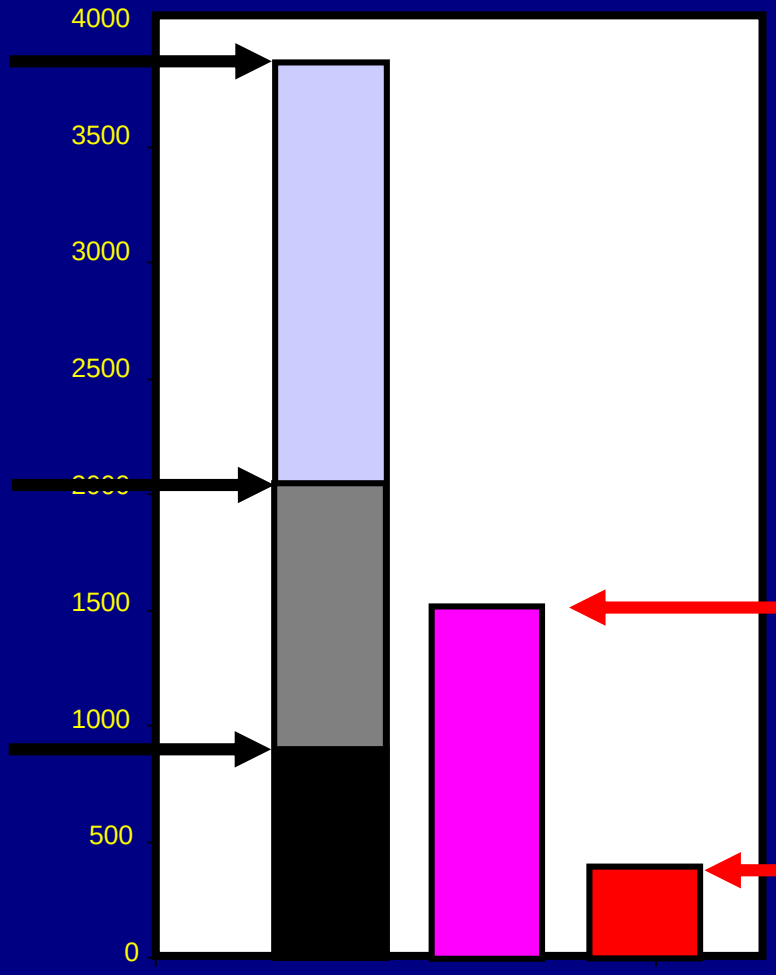
Amount of U.S oil reserves already used.

Estimate of World Oil Reserves and Future Needs

Estimate of world oil resources.

Estimate of world oil reserves.

Amount of oil that has already been used.



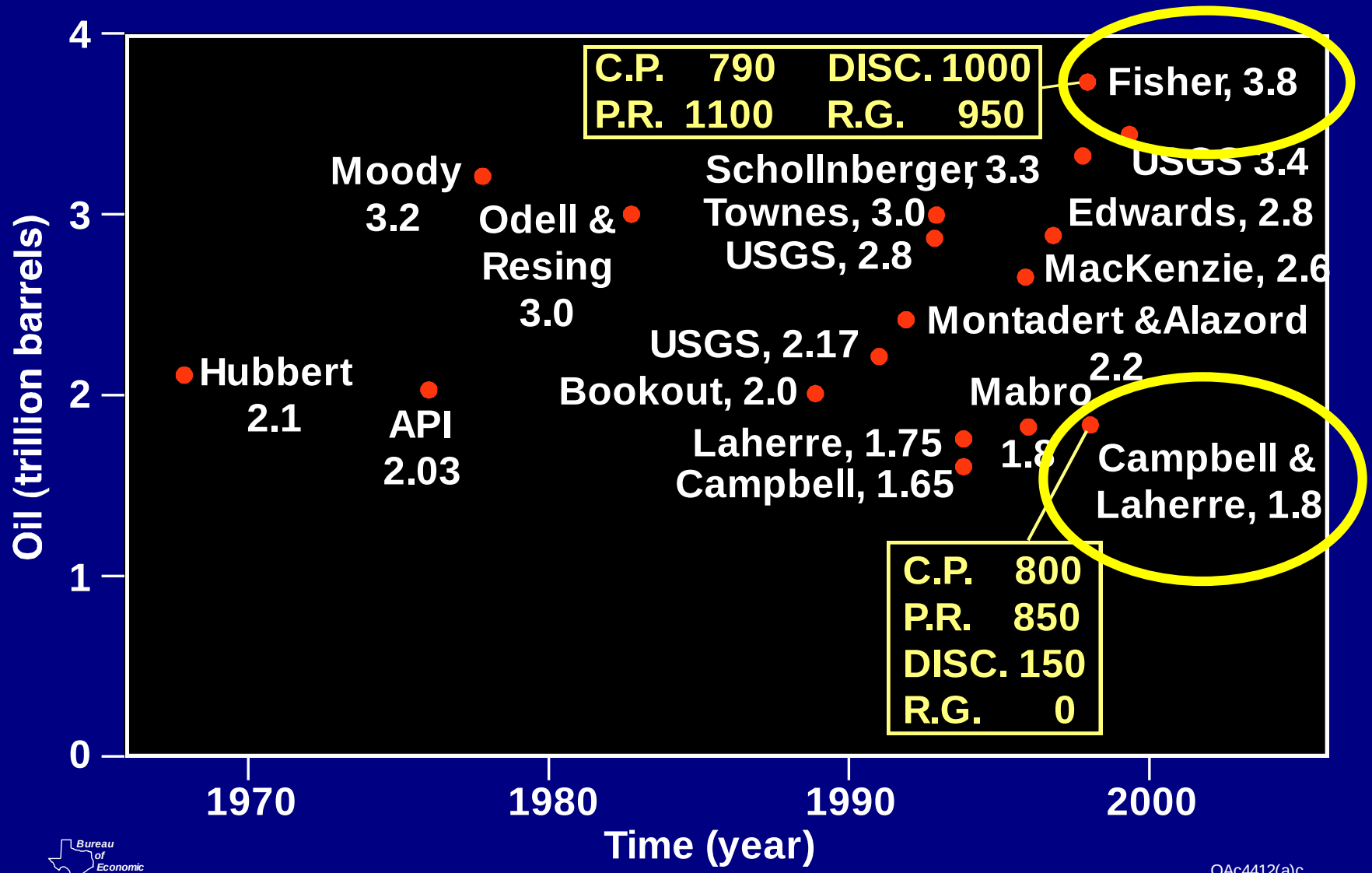
Estimate of the world oil needs.

Estimate of the U.S. oil needs.

U.S. AND WORLD NATURAL GAS ACCOUNT (TCF)

	U.S.	World
Cumulative production	900	2000
Proved reserves	166	5790
To be discovered (estimated)	850	12,000
Reserve growth (estimated)	900	3000
Nonconventional (estimated)	450	5000
Ultimate	3266	27,790
Remaining	2366	25,790
Percent used	28	7

RECENT ESTIMATES OF ULTIMATE OIL RECOVERY FOR THE WORLD.



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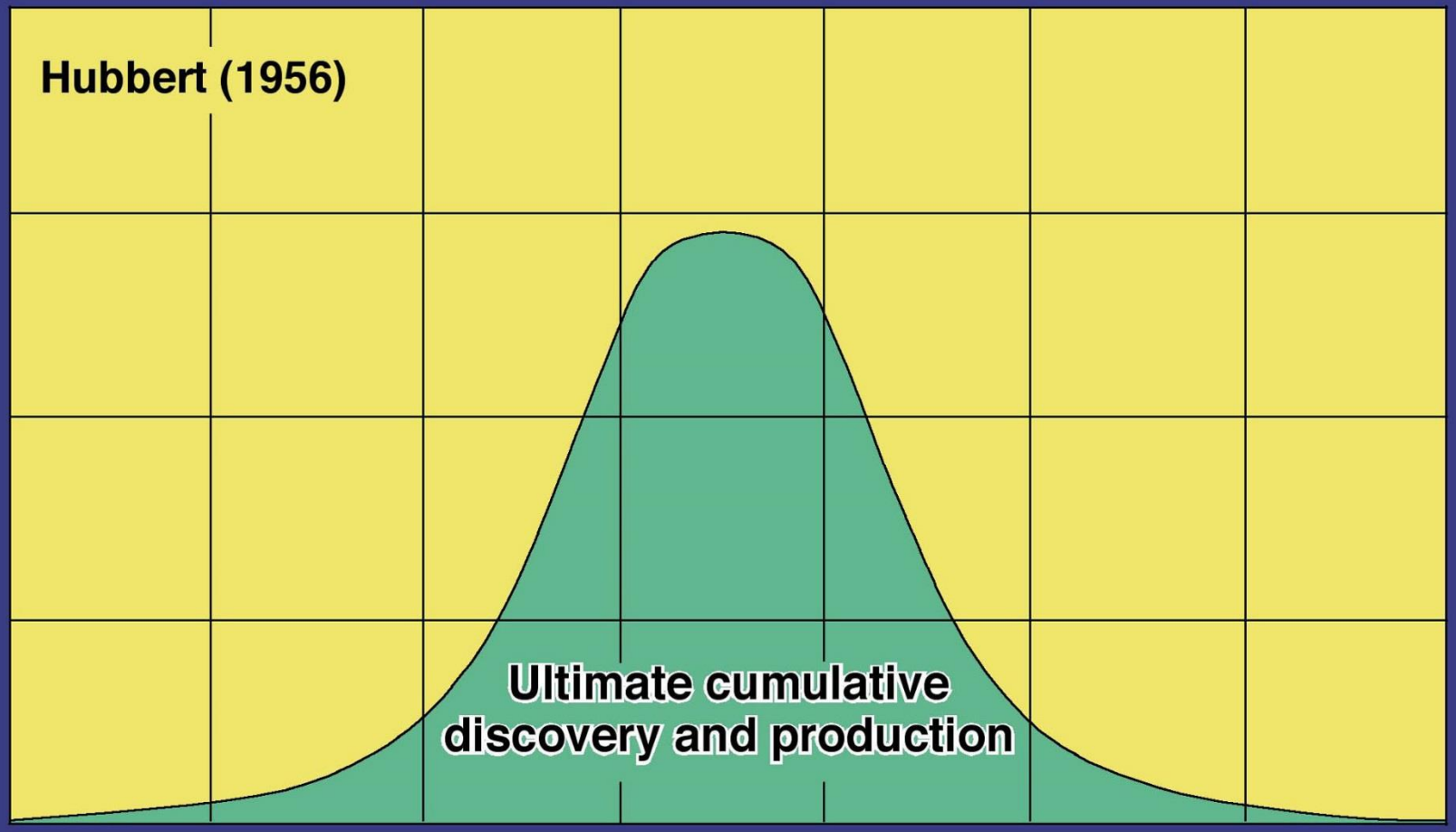
THE SYMMETRICAL LIFE CYCLE



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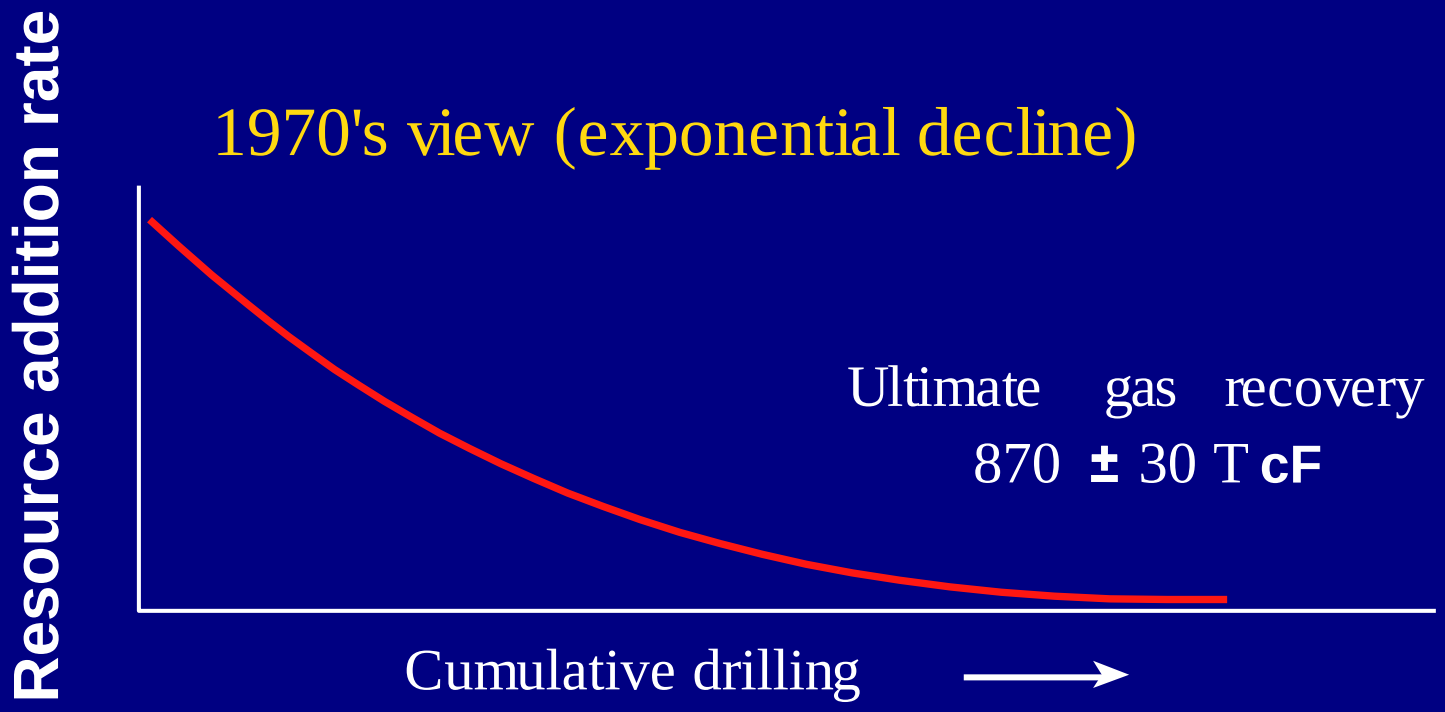
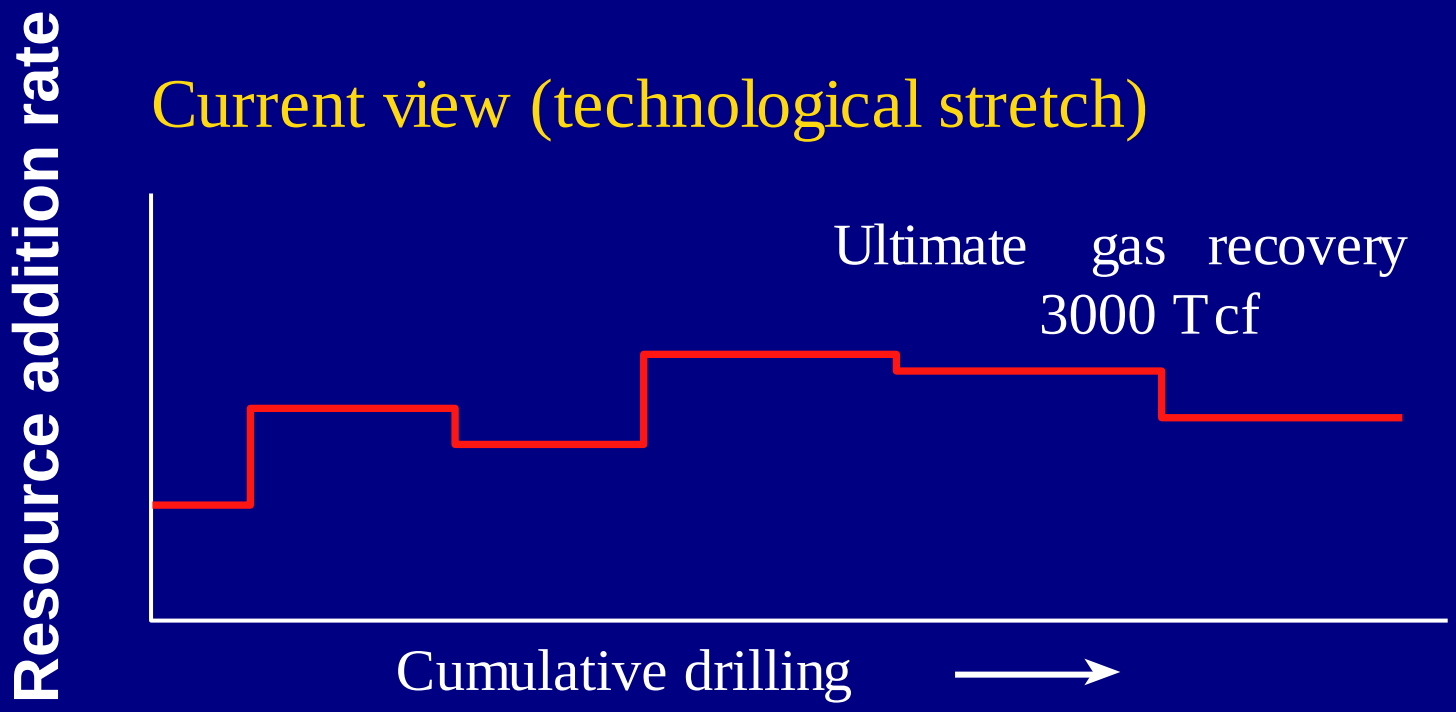
Geology

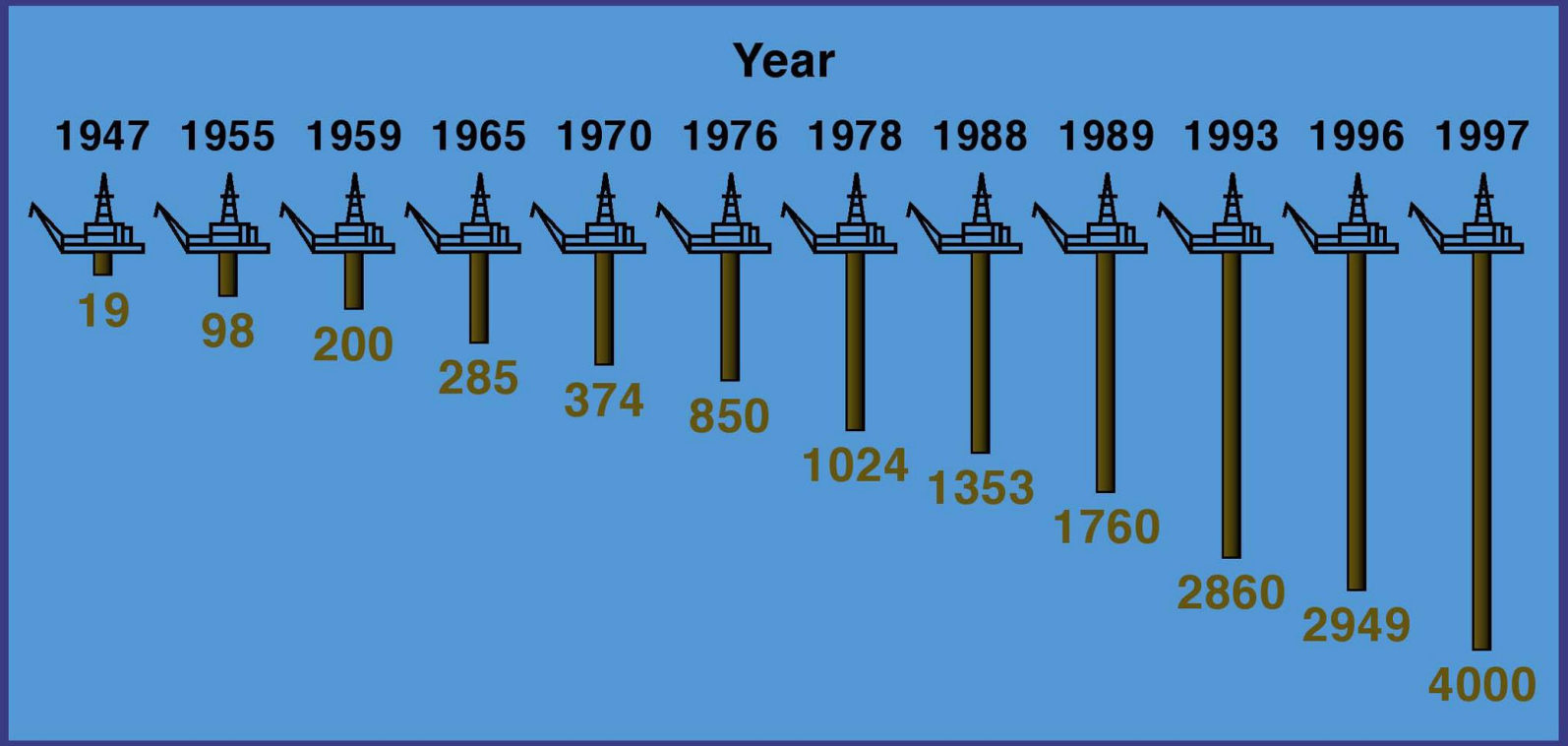
CHANGING VIEWS OF RESOURCE DEPLETION



CHANGING VIEWS OF RESOURCE DEPLETION



OFFSHORE PRODUCTION PLATFORM MILESTONES



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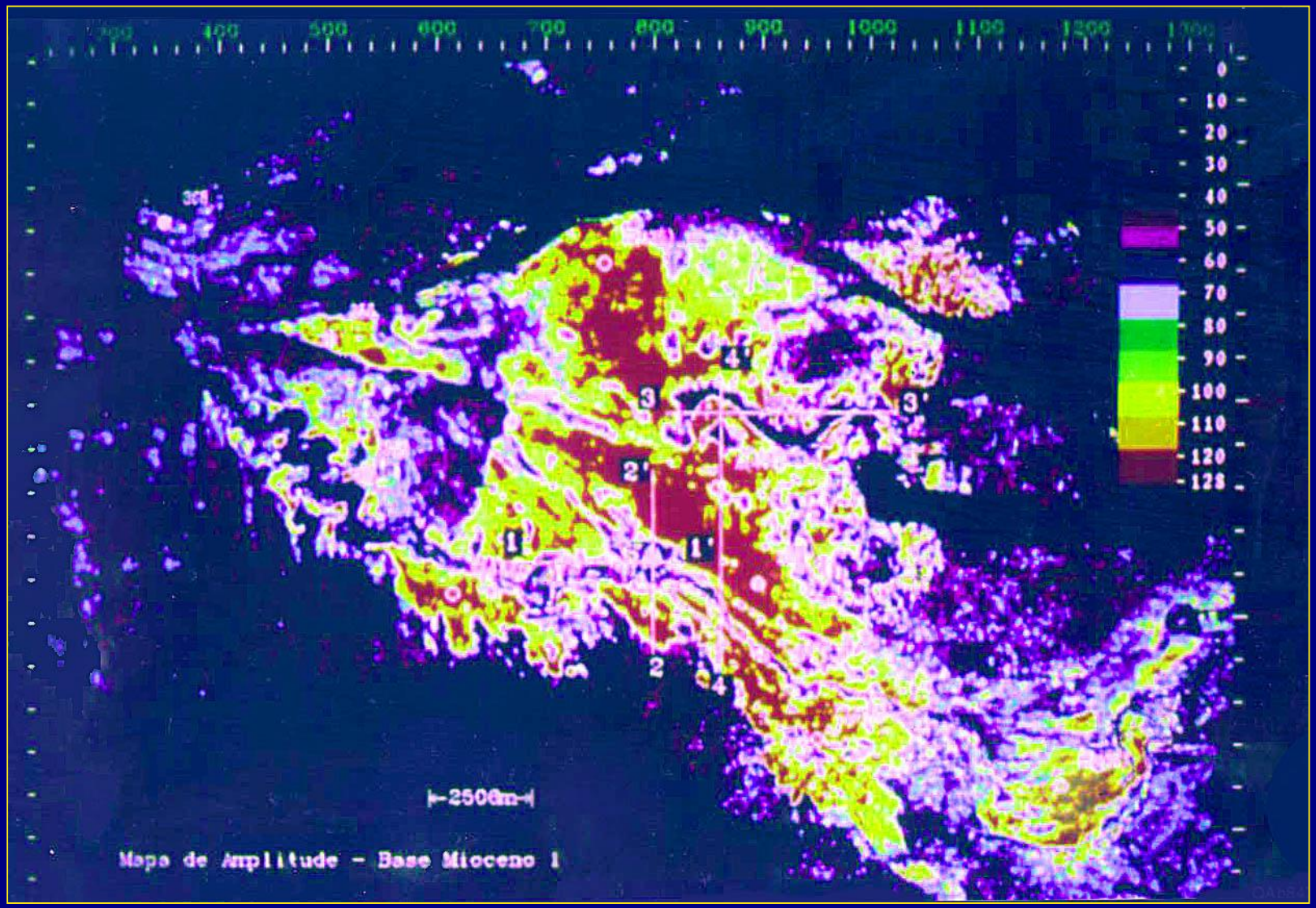
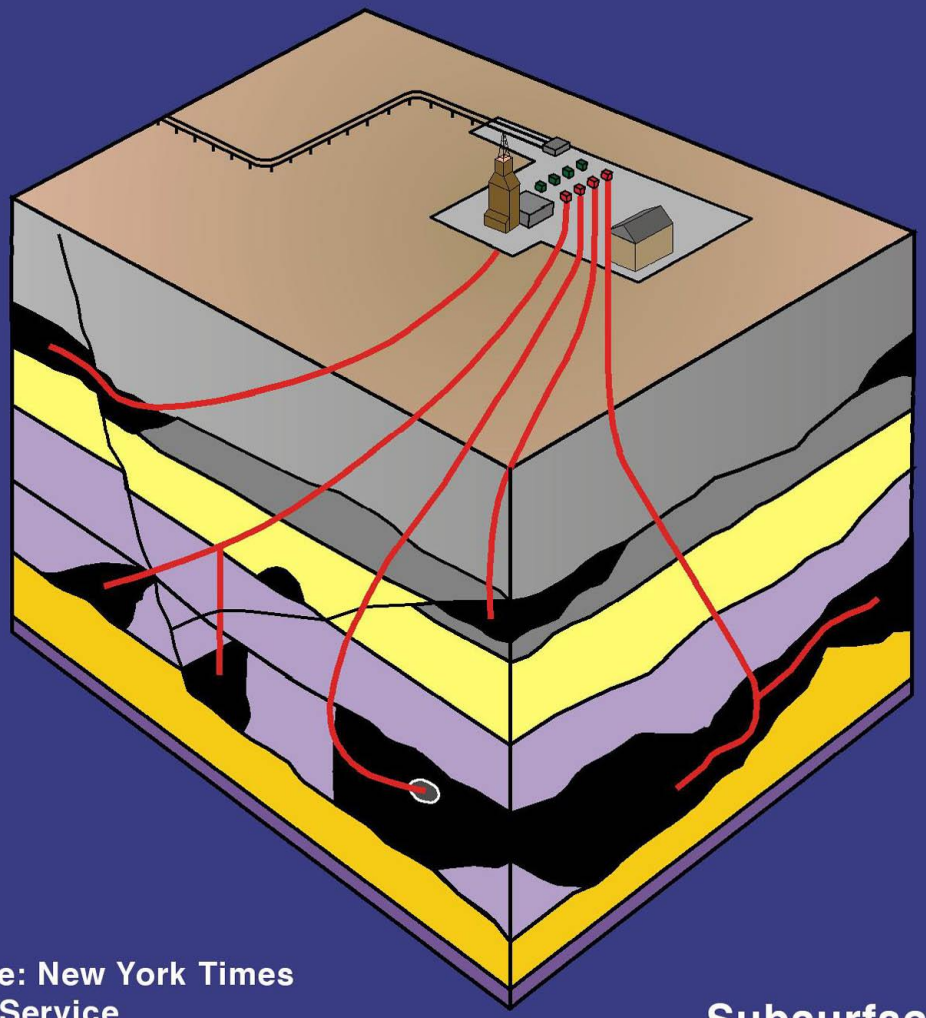
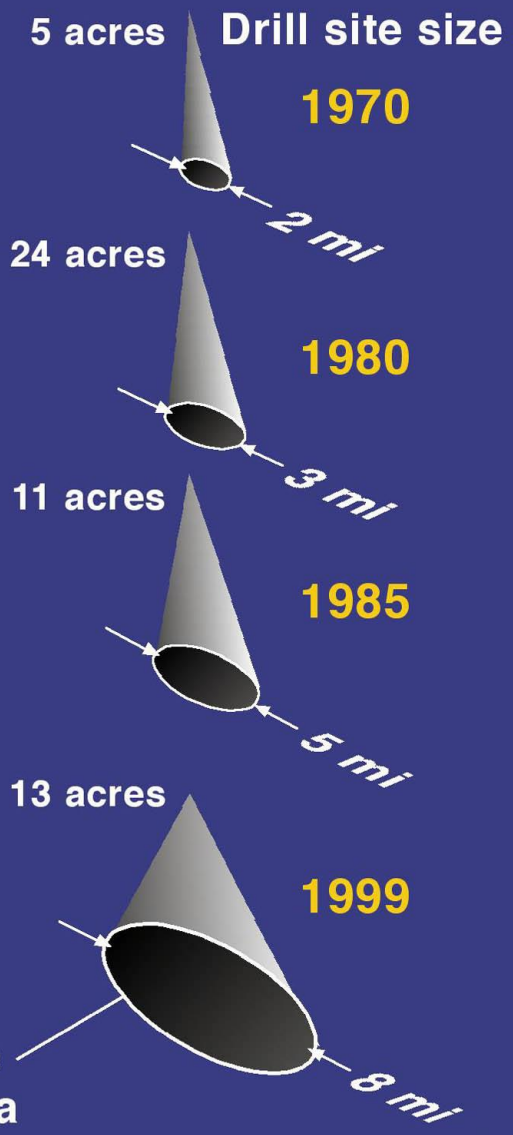
SEISMIC IMAGE OF AN OIL FIELD



DIRECTIONAL, EXTENDED-REACH DRILLING





Source: New York Times News Service

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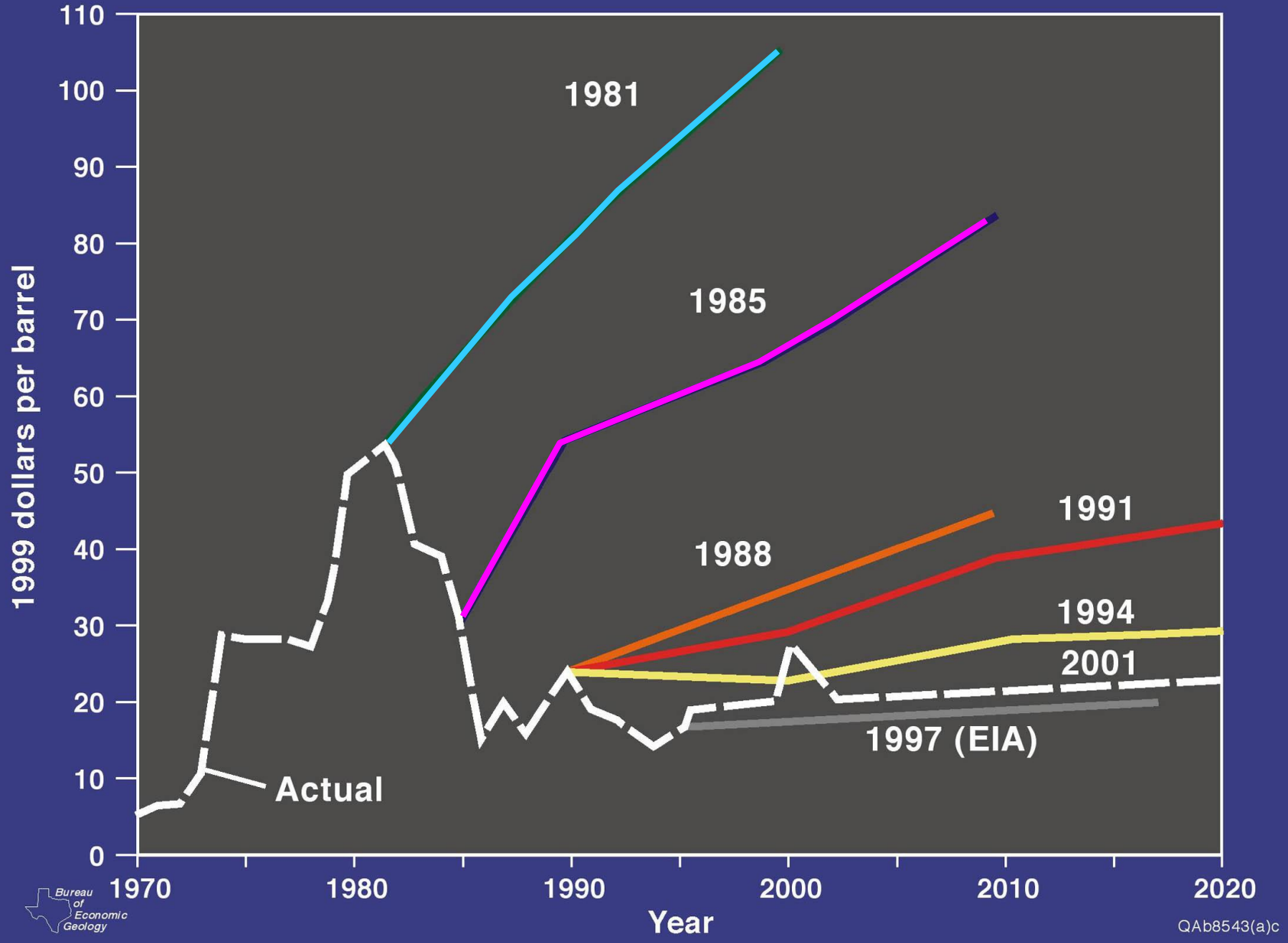
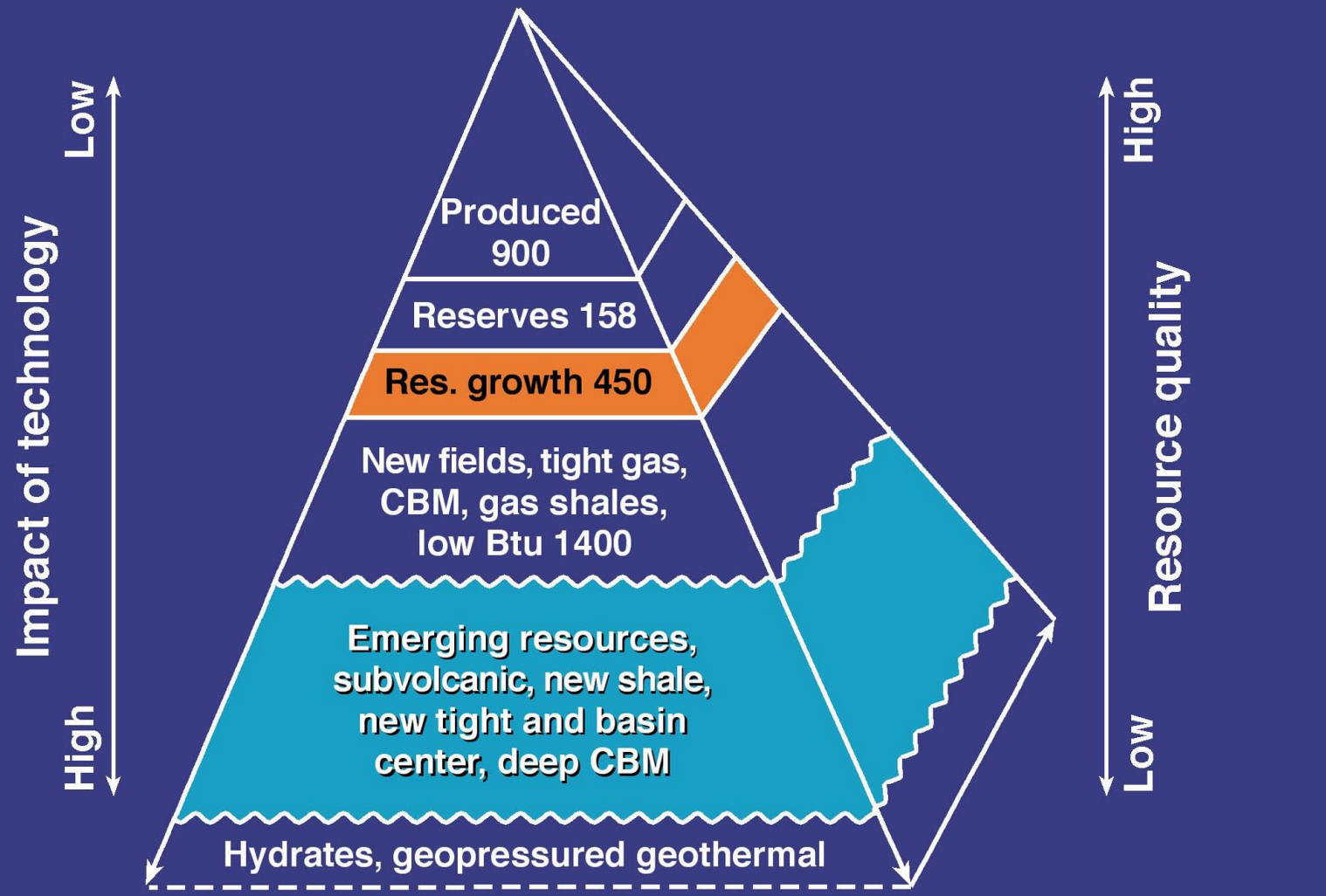
MEAN OF OIL PRICE FORECASTS



NATURAL GAS RESOURCE PYRAMID
U.S. LOWER 48 STATES



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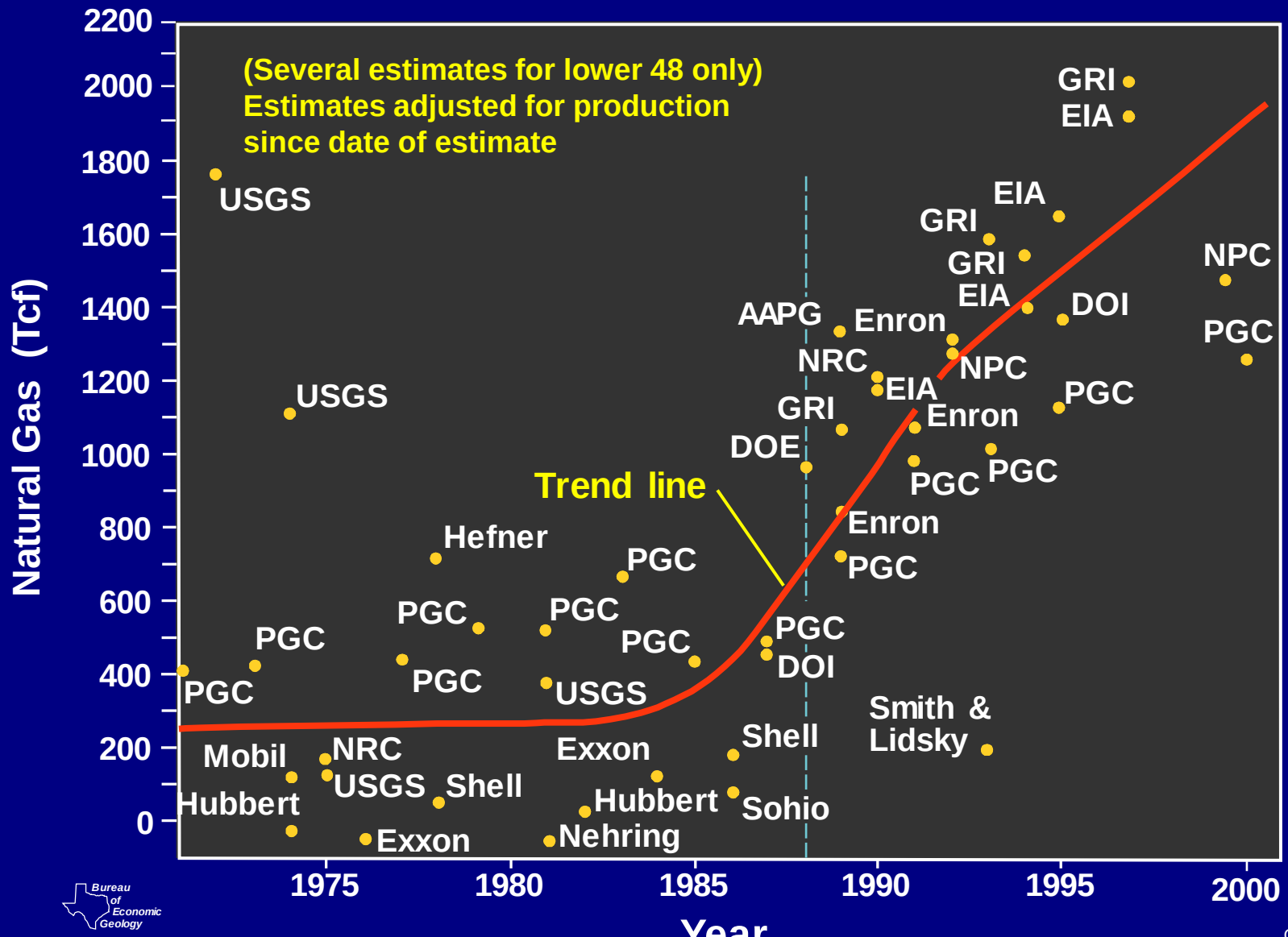
ESTIMATES OF REMAINING NATURAL GAS IN THE UNITED STATES



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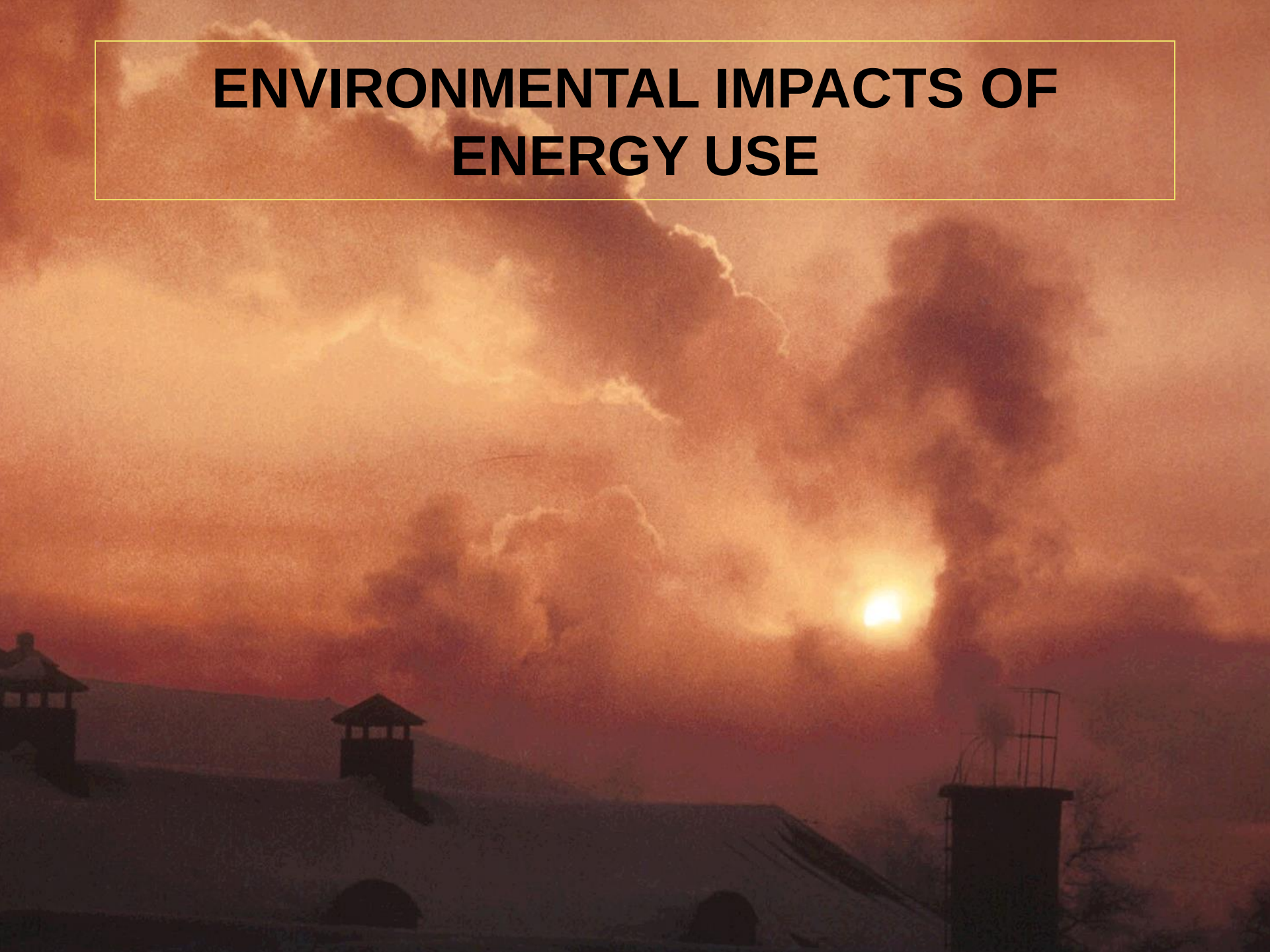
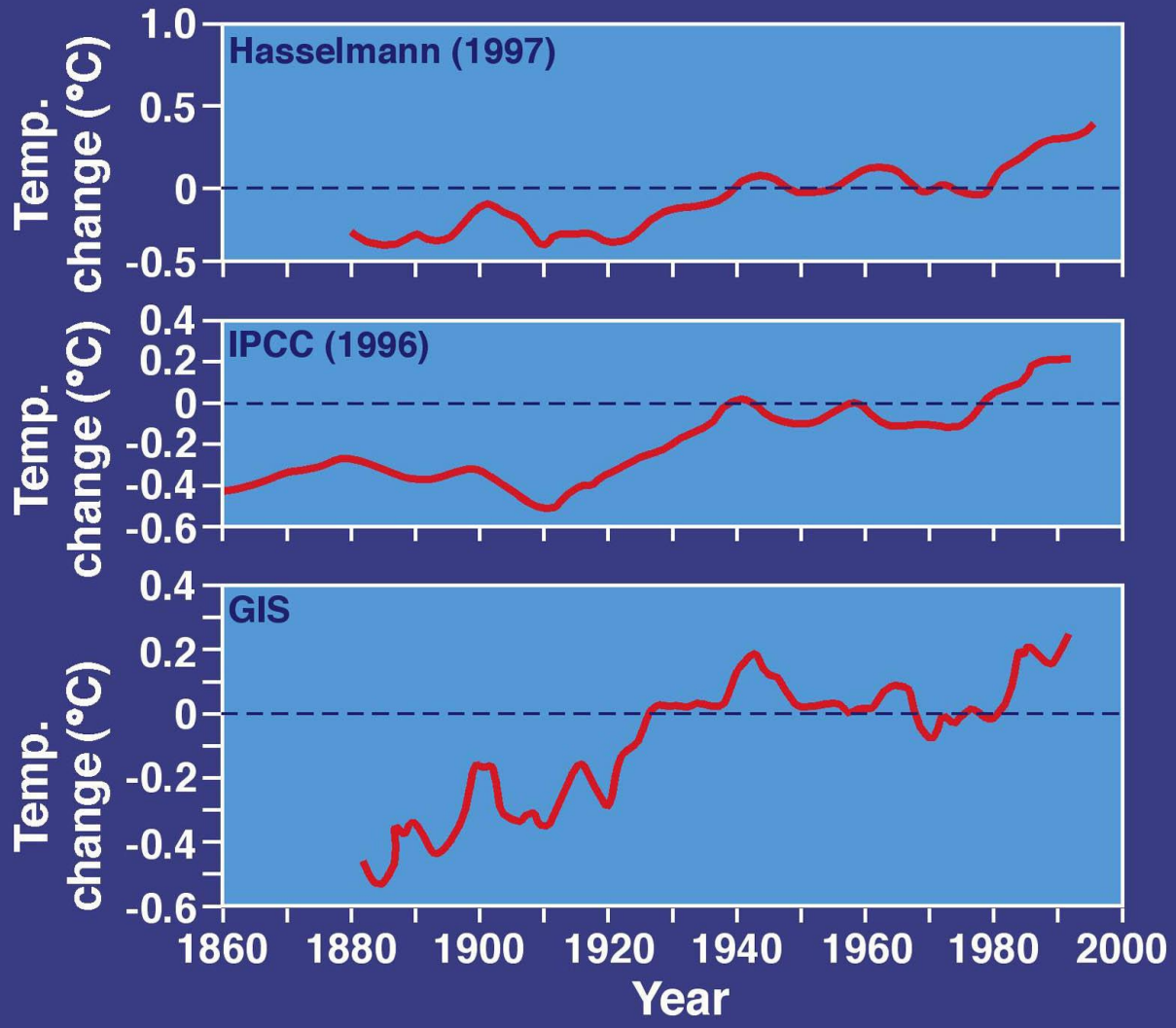
ENVIRONMENTAL IMPACTS OF ENERGY USE



AVERAGE GLOBAL SURFACE TEMPERATURES



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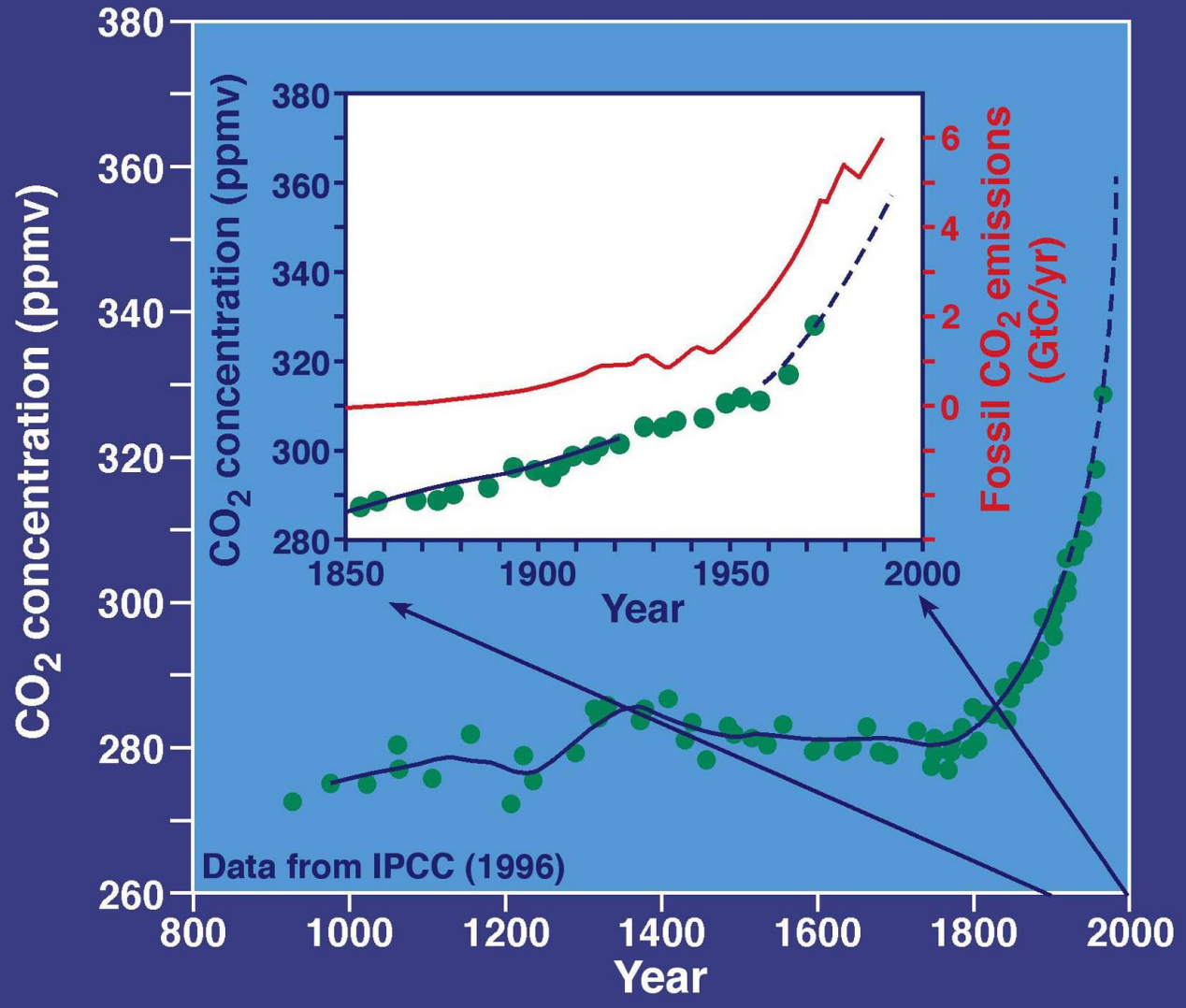
CO_2 CONCENTRATIONS



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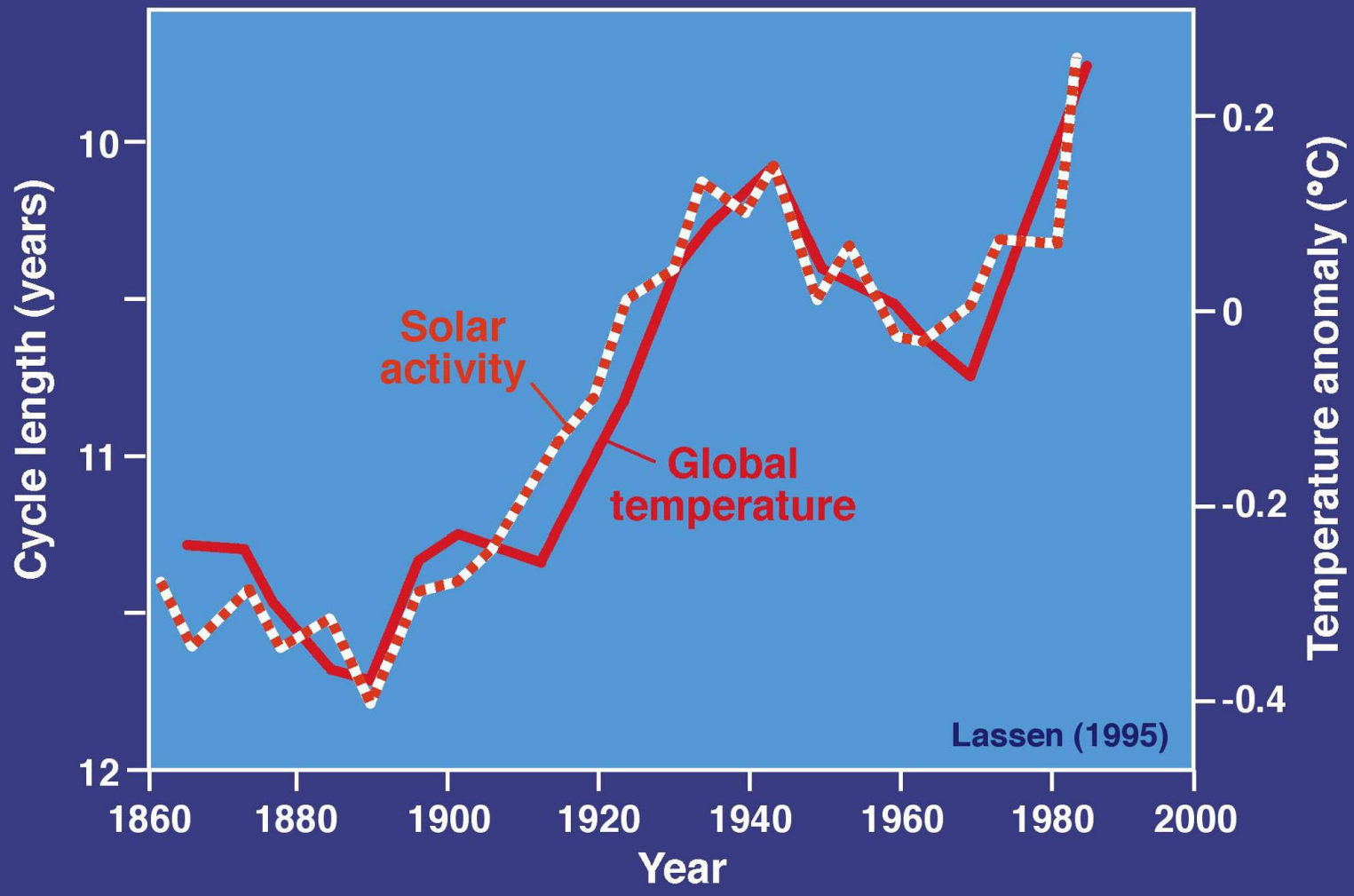
GLOBAL TEMPERATURE AND SOLAR ACTIVITY



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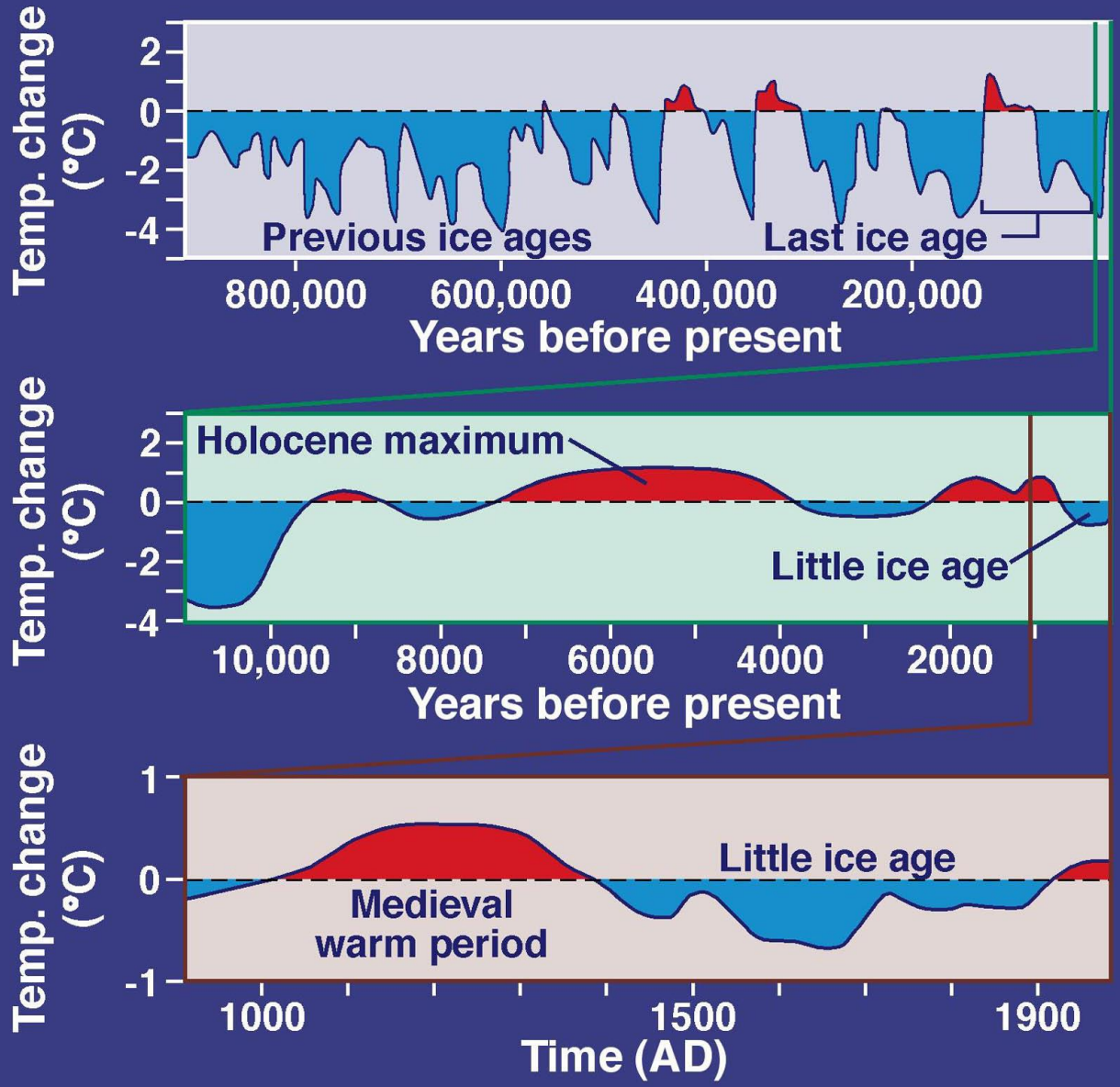
TEMPERATURE CYCLES OF THE RECENT GEOLOGIC PAST



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CARBON CONTENT (GtC) OF AVAILABLE FOSSIL FUEL RESOURCES

Fuel	Proved reserves	Total resource
Natural gas	70	290
Oil	140	340
Coal	920	4450
Totals	1130	5080

Bureau of Economic Geology

Modified from Linden (1998)

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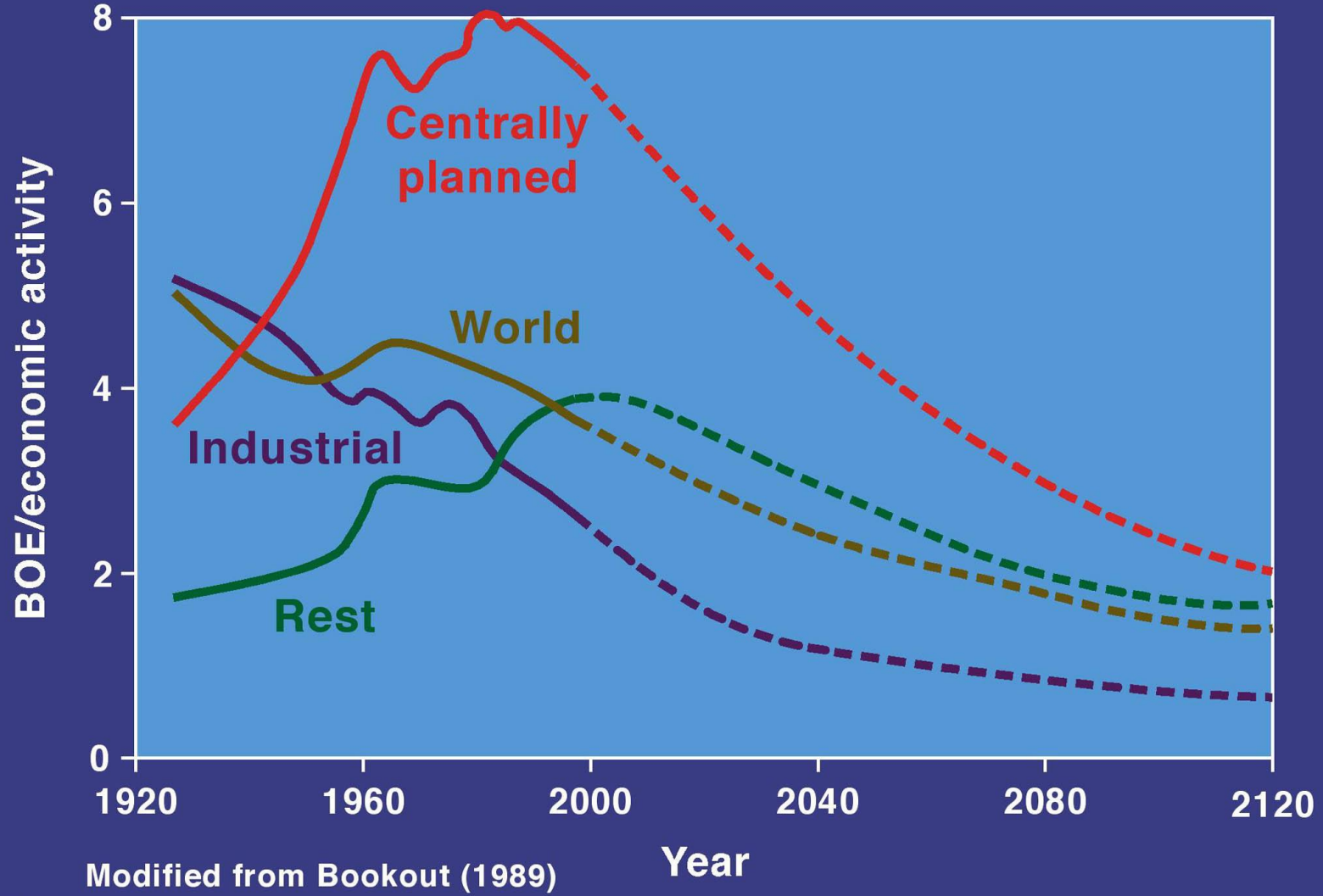
WORLD ENERGY USE INTENSITY



Modified from Bookout (1989)

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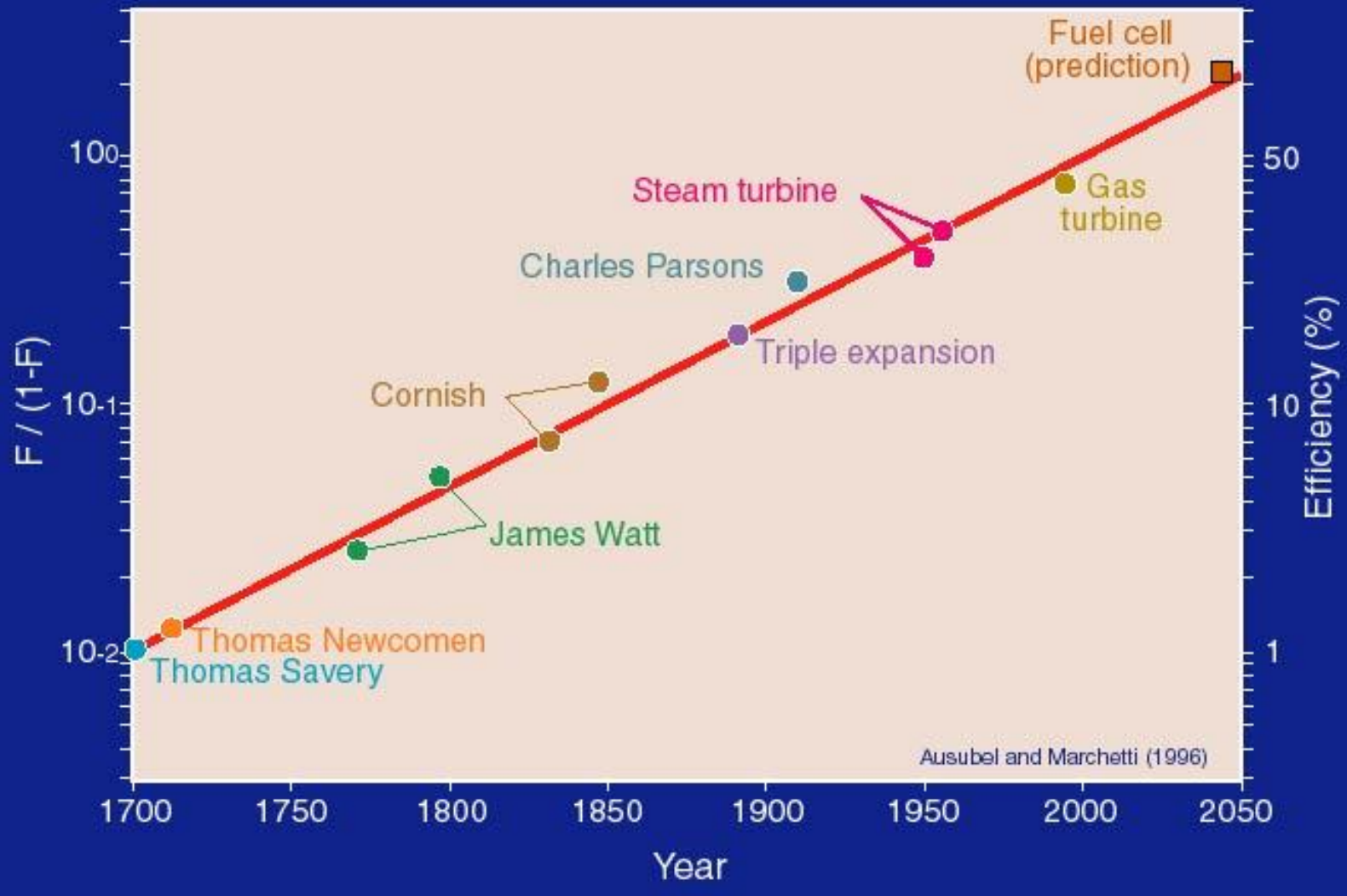
IMPROVEMENT IN MOTOR EFFICIENCY



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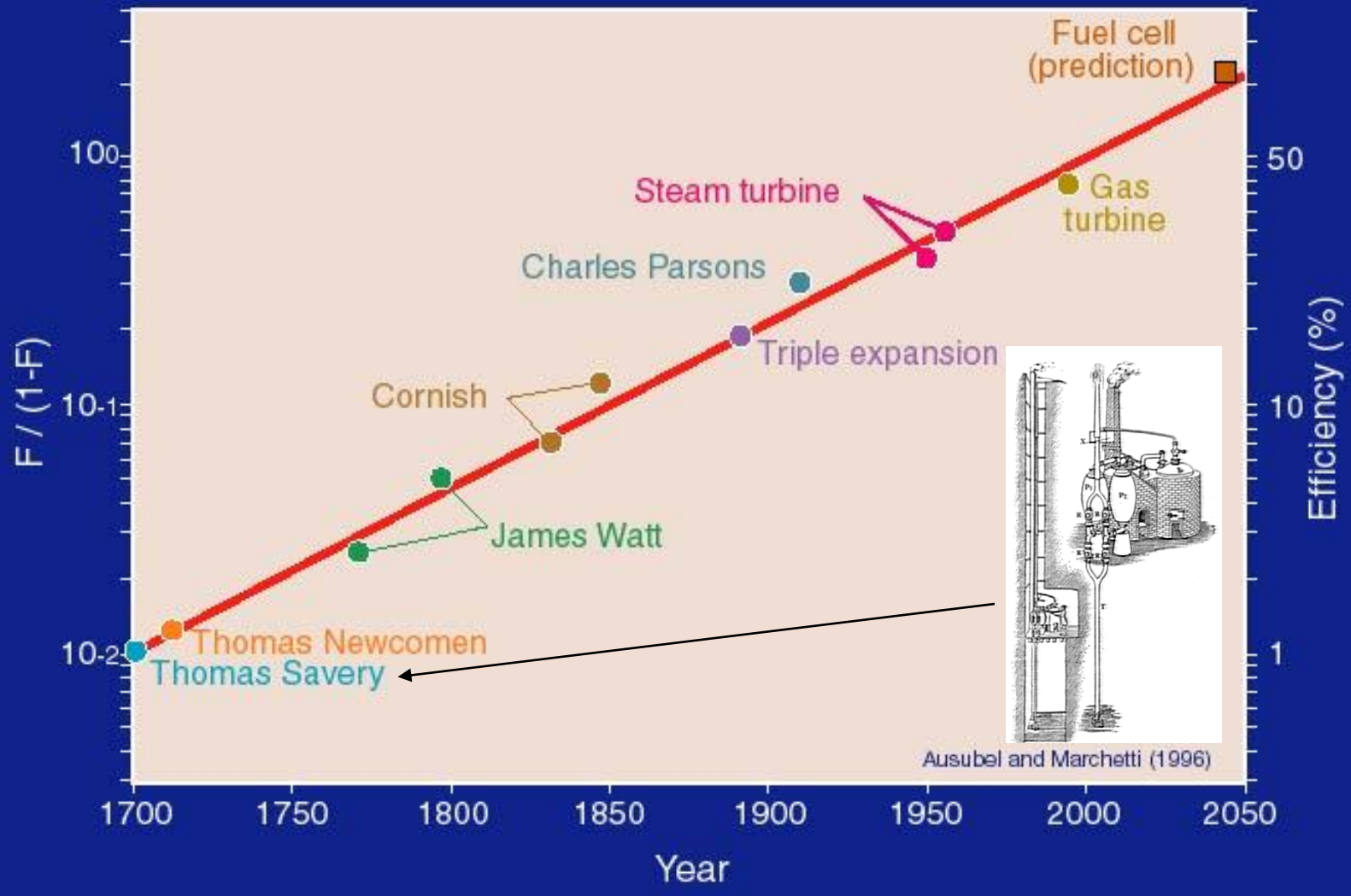
IMPROVEMENT IN MOTOR EFFICIENCY



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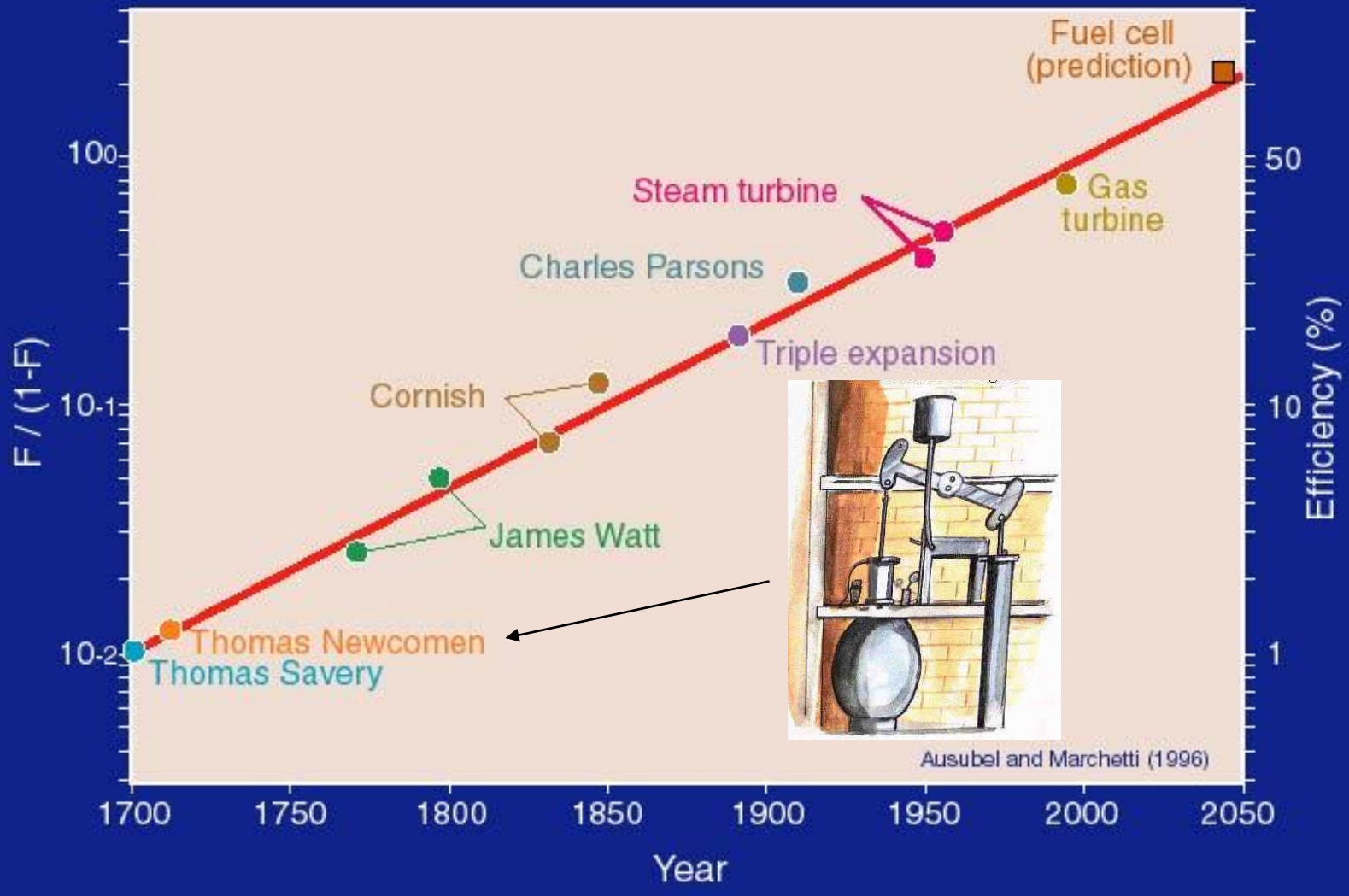

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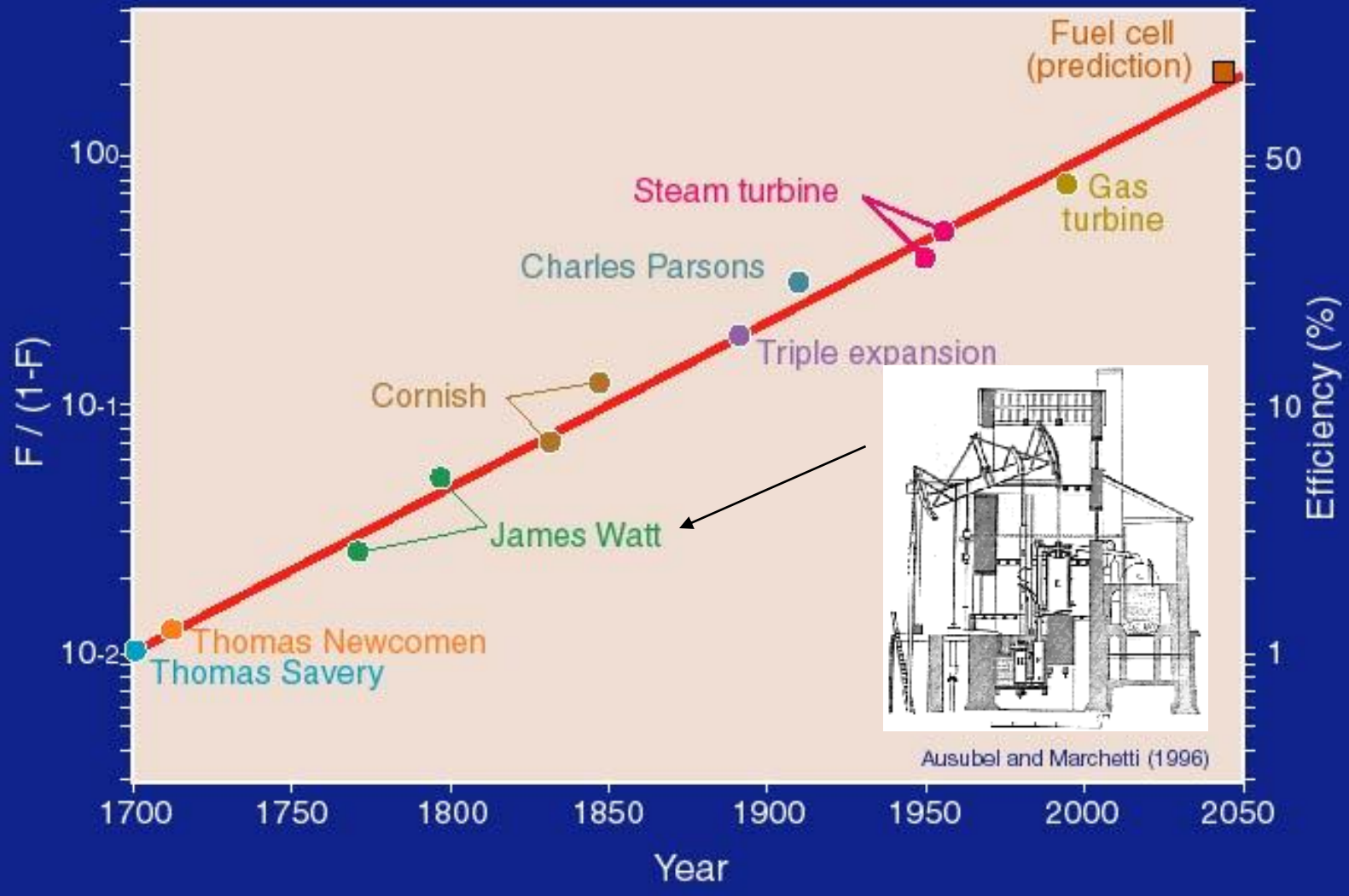

Ausubel and Marchetti (1996)

Bureau of Economic Geology

QAc9587c

IMPROVEMENT IN MOTOR EFFICIENCY

Fuel cell (prediction)

Steam turbine

Gas turbine

Charles Parsons

Triple expansion

Cornish

James Watt

Thomas Newcomen

Thomas Savery

Ausubel and Marchetti (1996)

F / (1-F)

100

10-1

10-2

Efficiency (%)

50

10

1

1700 1750 1800 1850 1900 1950 2000 2050

Year

Bureau of Economic Geology

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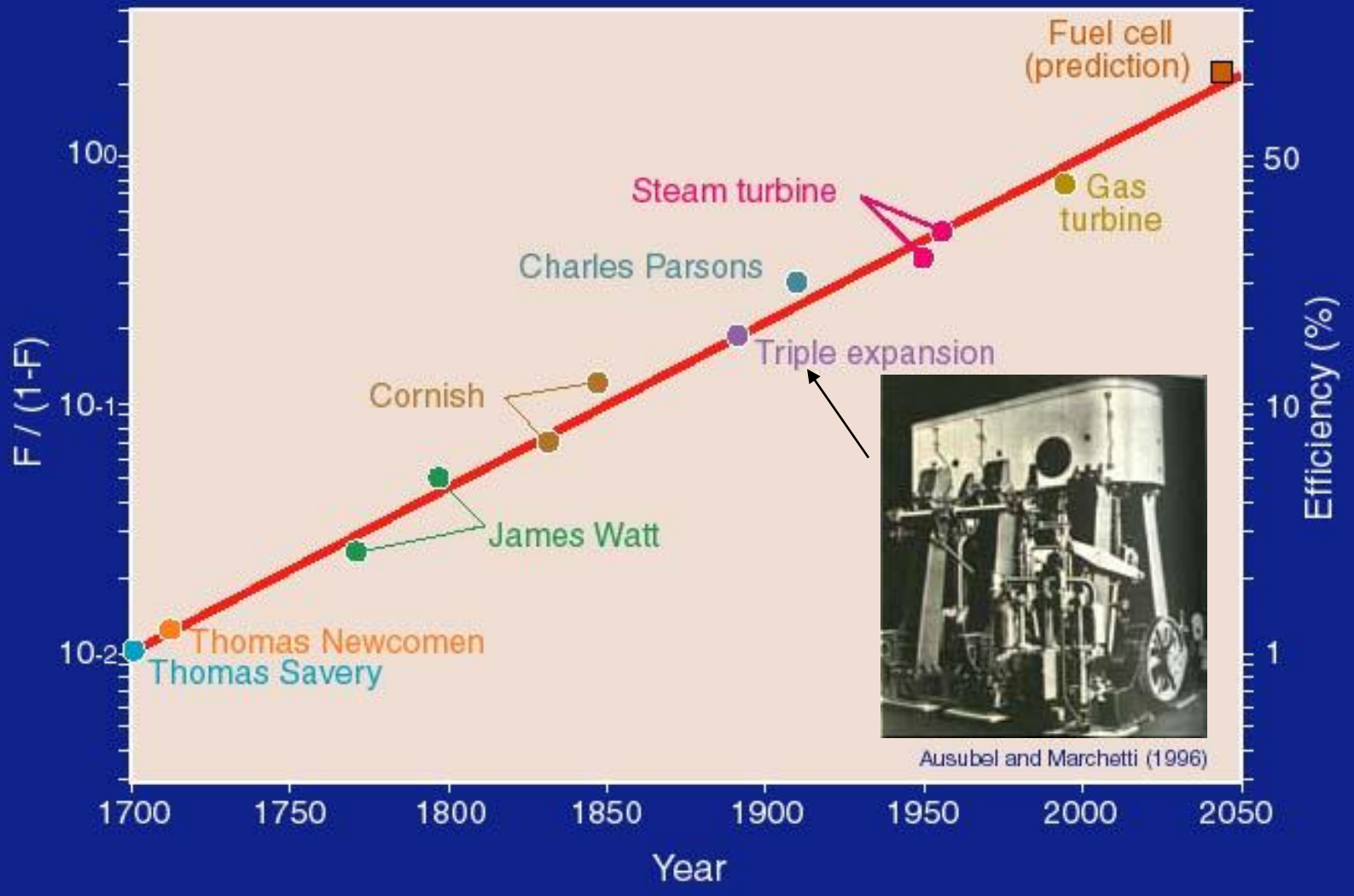
IMPROVEMENT IN MOTOR EFFICIENCY



Bureau of Economic Geology

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10-1

10-2

Efficiency (%)

50

10

1

1700 1750 1800 1850 1900 1950 2000 2050

Year

Bureau of Economic Geology

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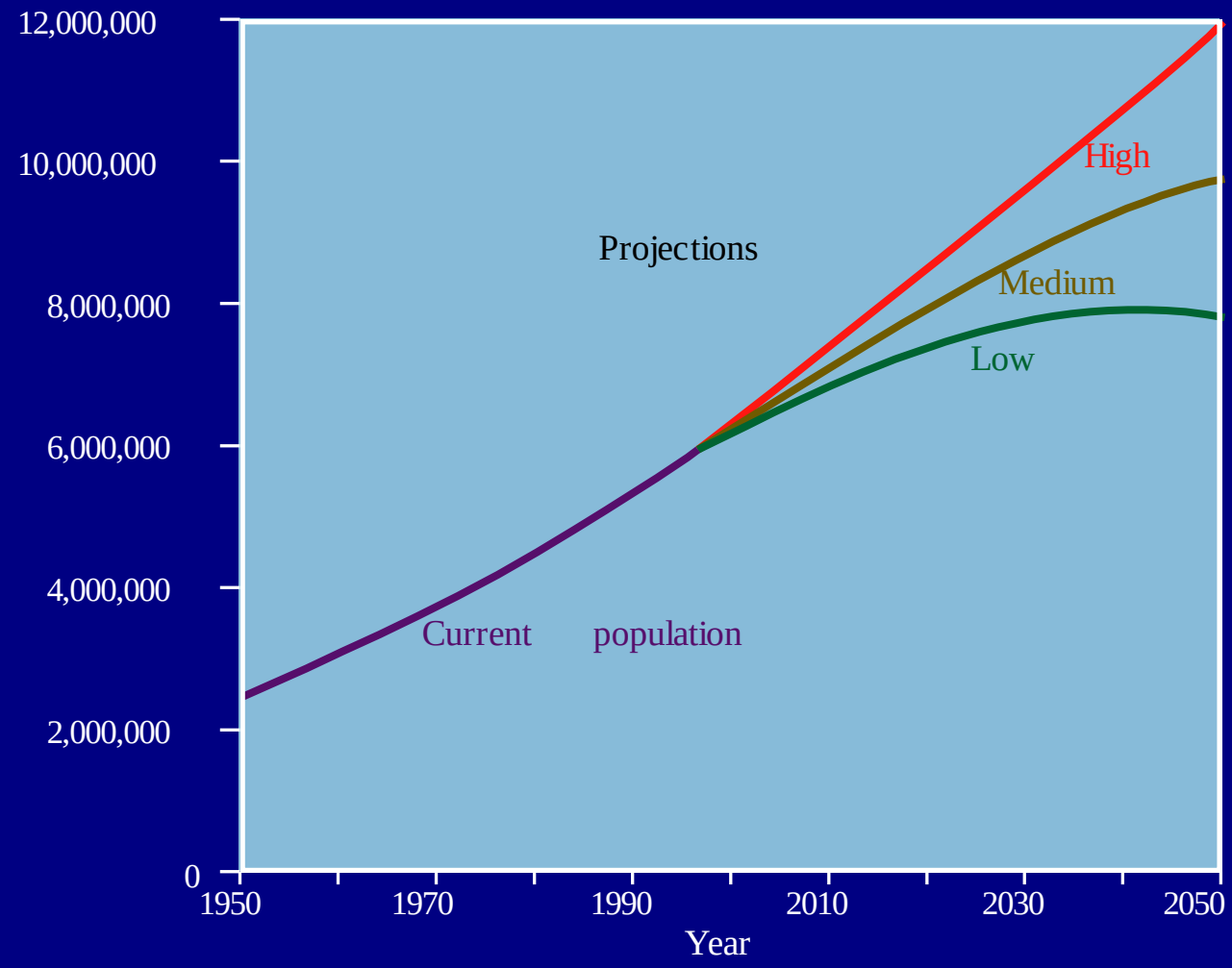
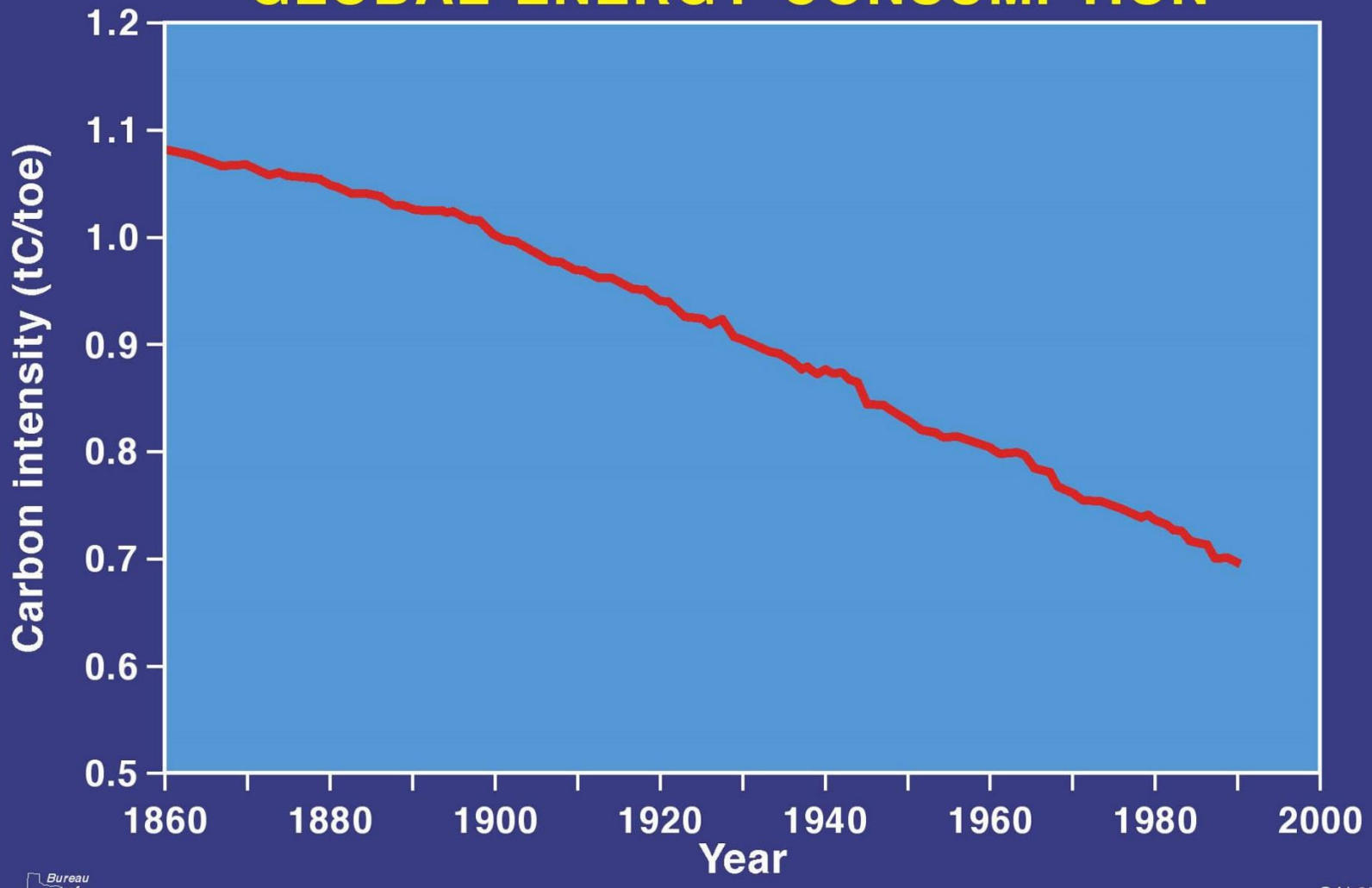
WORLD POPULATION PROJECTIONS



United Nations (1994)

CARBON INTENSITY OF GLOBAL ENERGY CONSUMPTION



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Conclusions

Many of the pessimistic predictions of resource availability have been wrong.

We are currently moving toward plentiful and clean energy.

We should not exhaust ourselves worrying about problems before they occur.

Acknowledgements

Thanks to:

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Mayfield Fund of Geology Foundation
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Bureau of Economic Geology
Jay Banner
Gary Kocurek
Deanna Combs

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Dr. William Fisher

Dr. Fishers' principal interests are in basin analysis, sequence stratigraphy, depositional systems, and petroleum geology. Dr. Fisher also researchers analytical efforts in energy resource assessment and energy policy.

Within the University Dr. Fisher chairs the Executive Committee of the Geology Foundation and chairs the Steering Committee of the Jackson School of Geosciences. He also serves on the National Petroleum Council which is advisory to the Secretary of Energy, the Interstate Oil and Gas Compact Commission, the Board of Environmental and Energy Systems of the National Research Council, and several committees of professional geological societies. Fisher is trustee of the American Association of Petroleum Geologists Foundation, the American Geological Institute Foundation, and the Southwest Research Institute. Within the National Academy of Engineering he currently chairs Section 11 (Petroleum, Mining and Geological Engineering).