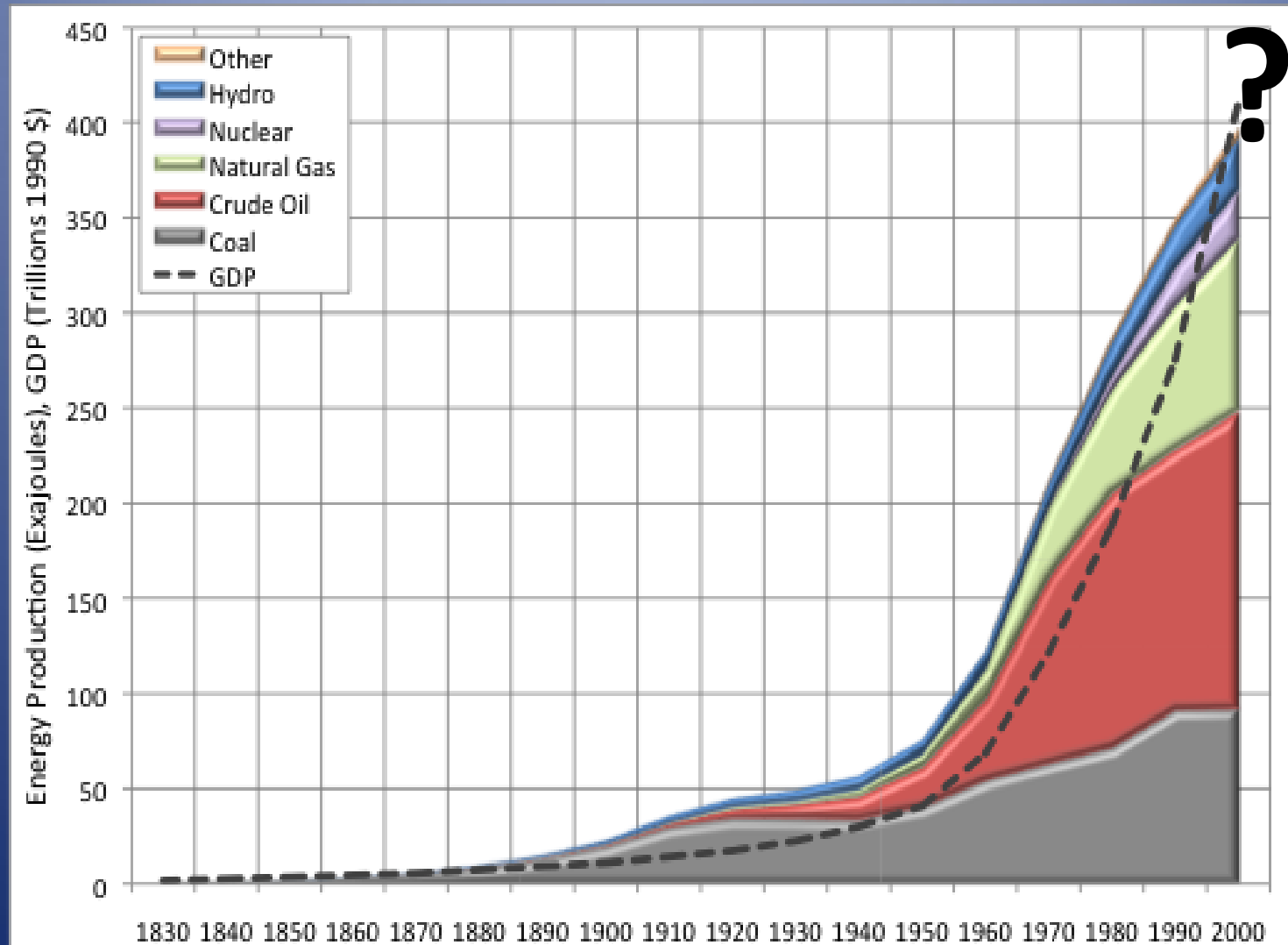


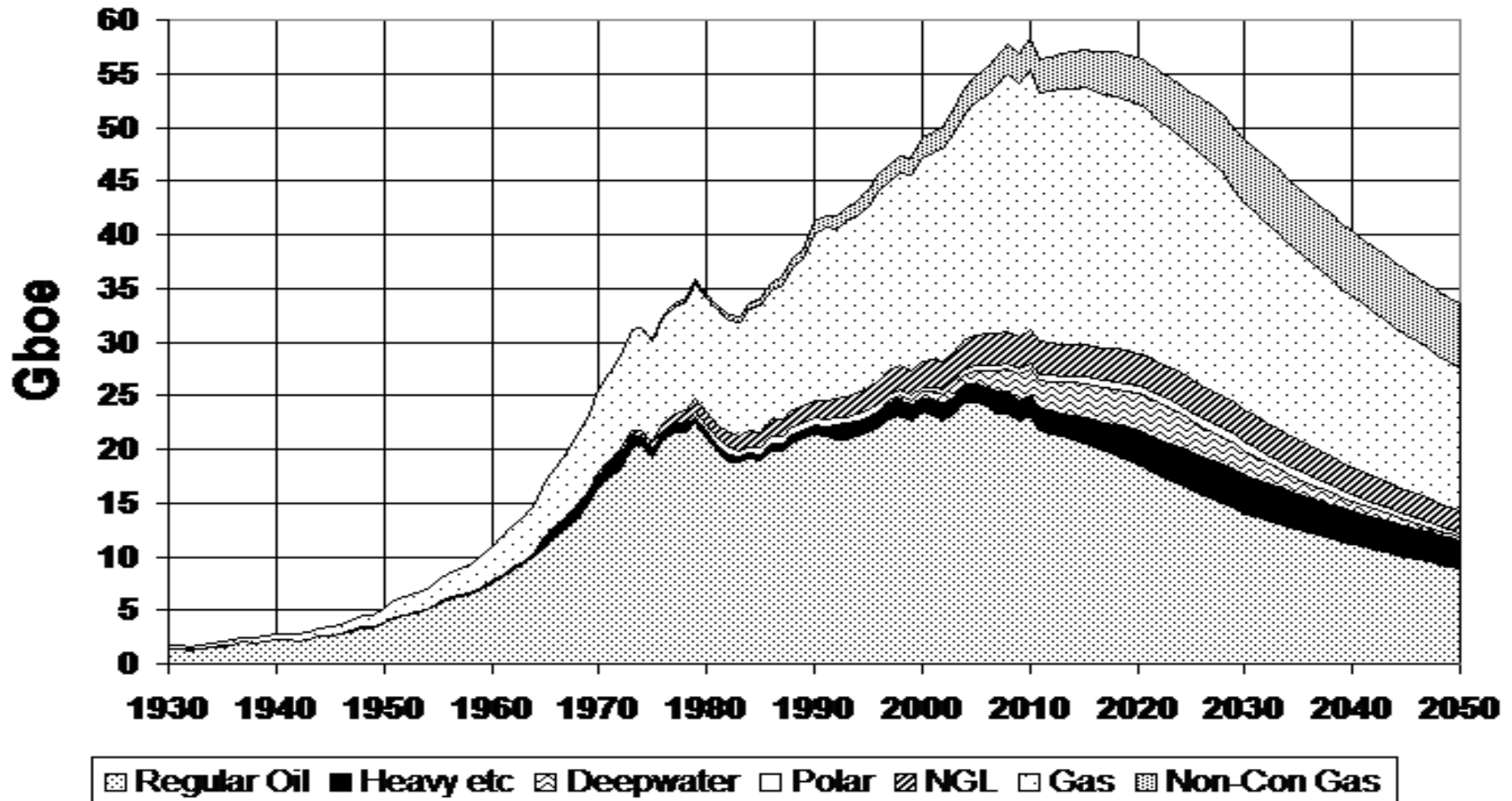
Sustainability for the second half of the age of oil

Charles A. S. Hall
State University of New York
College of Environmental Science and
Forestry

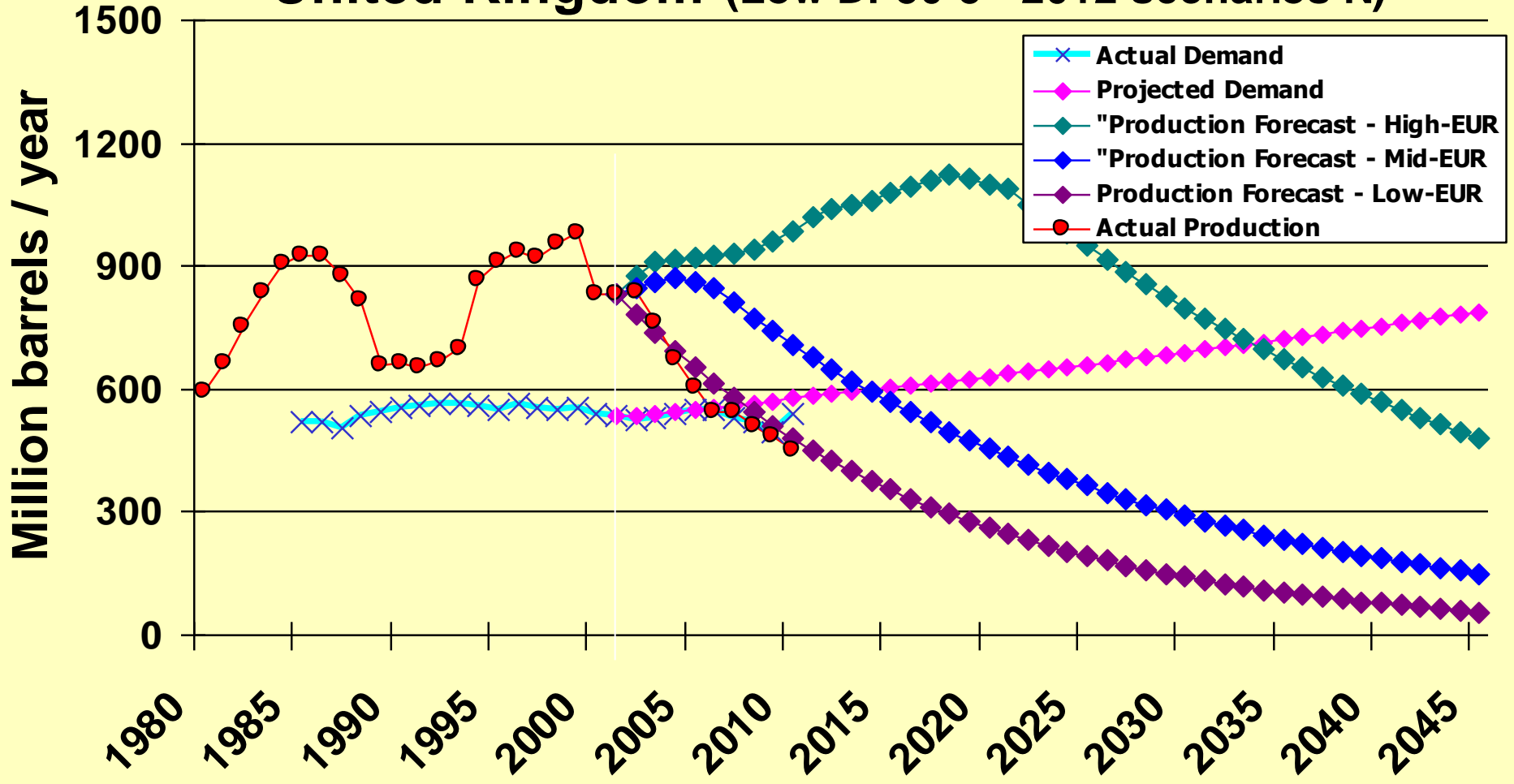
The dirty secret to wealth production: Use more energy



OIL & GAS PRODUCTION PROFILES 2010 Base Case



United Kingdom (Low-DP50-5 - 2012 scenarios N)



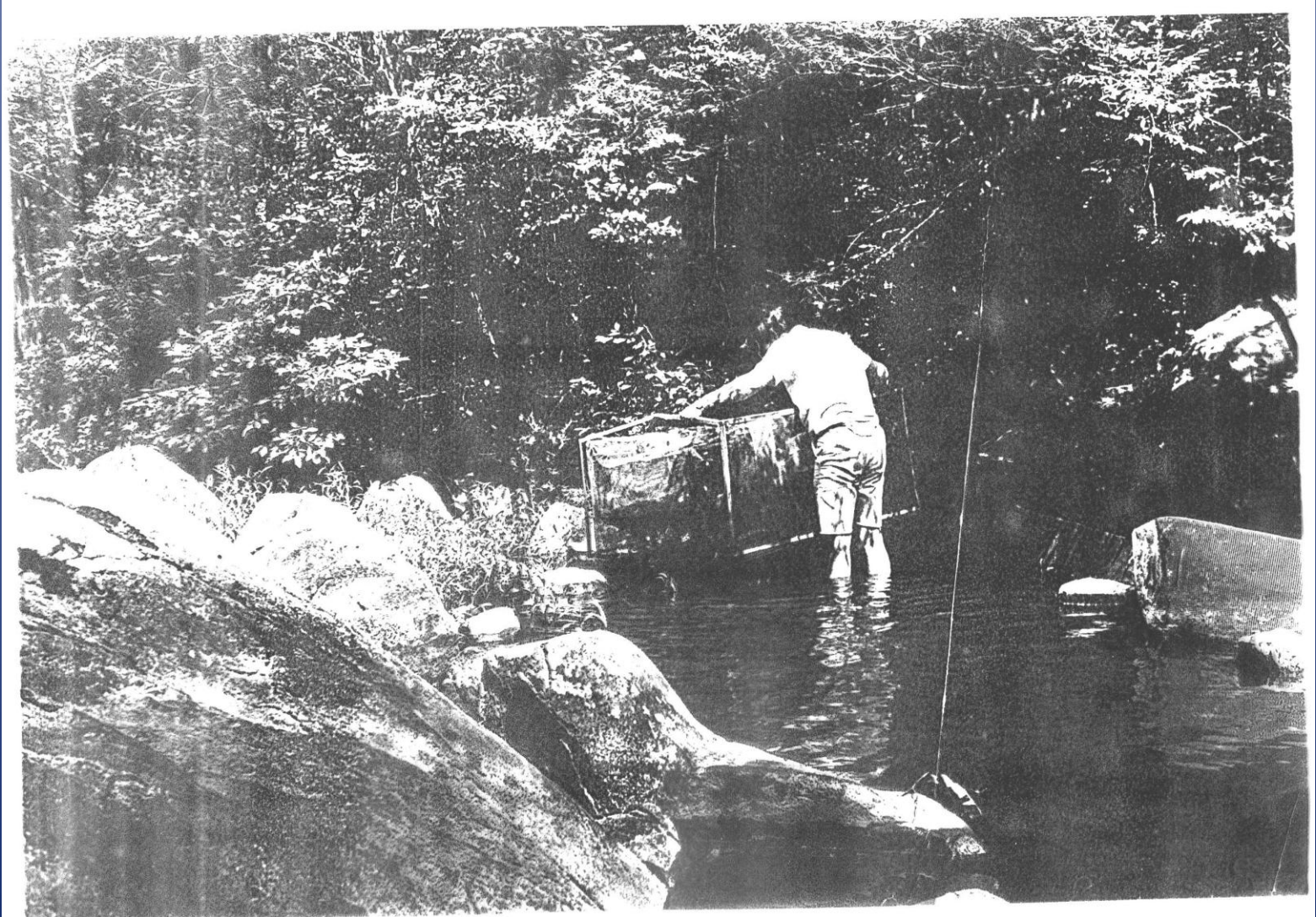
Our projections for UK oil production make sense only if low EUR -- Analysis by John Hallock

II. Declining EROI

Technology is real and important. But so is
depletion

The integral of their effects is reflected in EROI

EROI: Origin of concept



I. DEFINITION of EROI (Sometimes EROEI)

Energy return on investment for an activity:

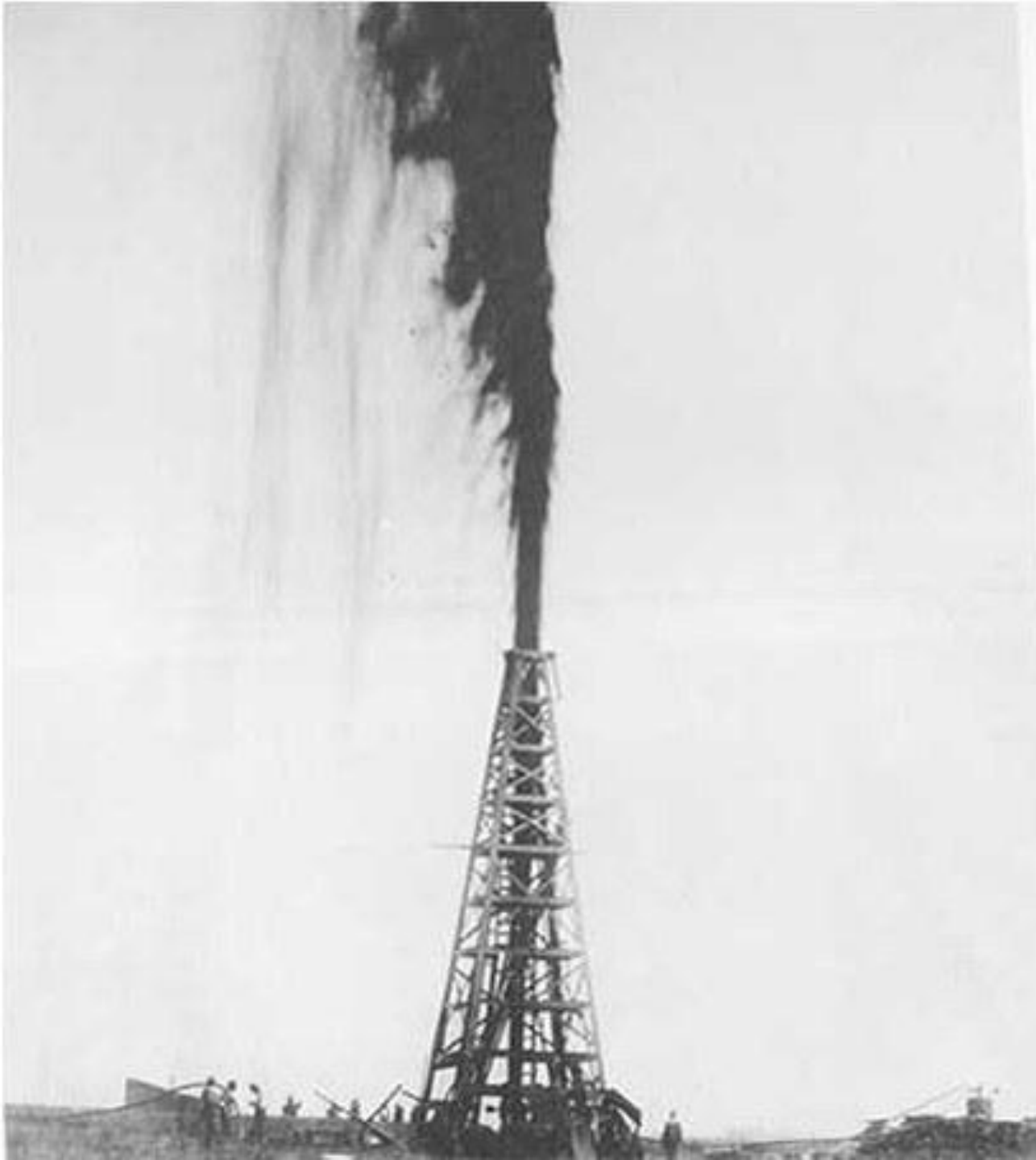
$$\text{EROI} = \frac{\text{Energy delivered to society}}{\text{Energy put into that activity}}$$

Usually consider energy invested *from society*





Williams probably used this "kicking or spring pole method"
for drilling his wells



- Spindletop ,
Beaumont
Texas, 1901.
- 18 million
barrels a year
from a trivial
investment.



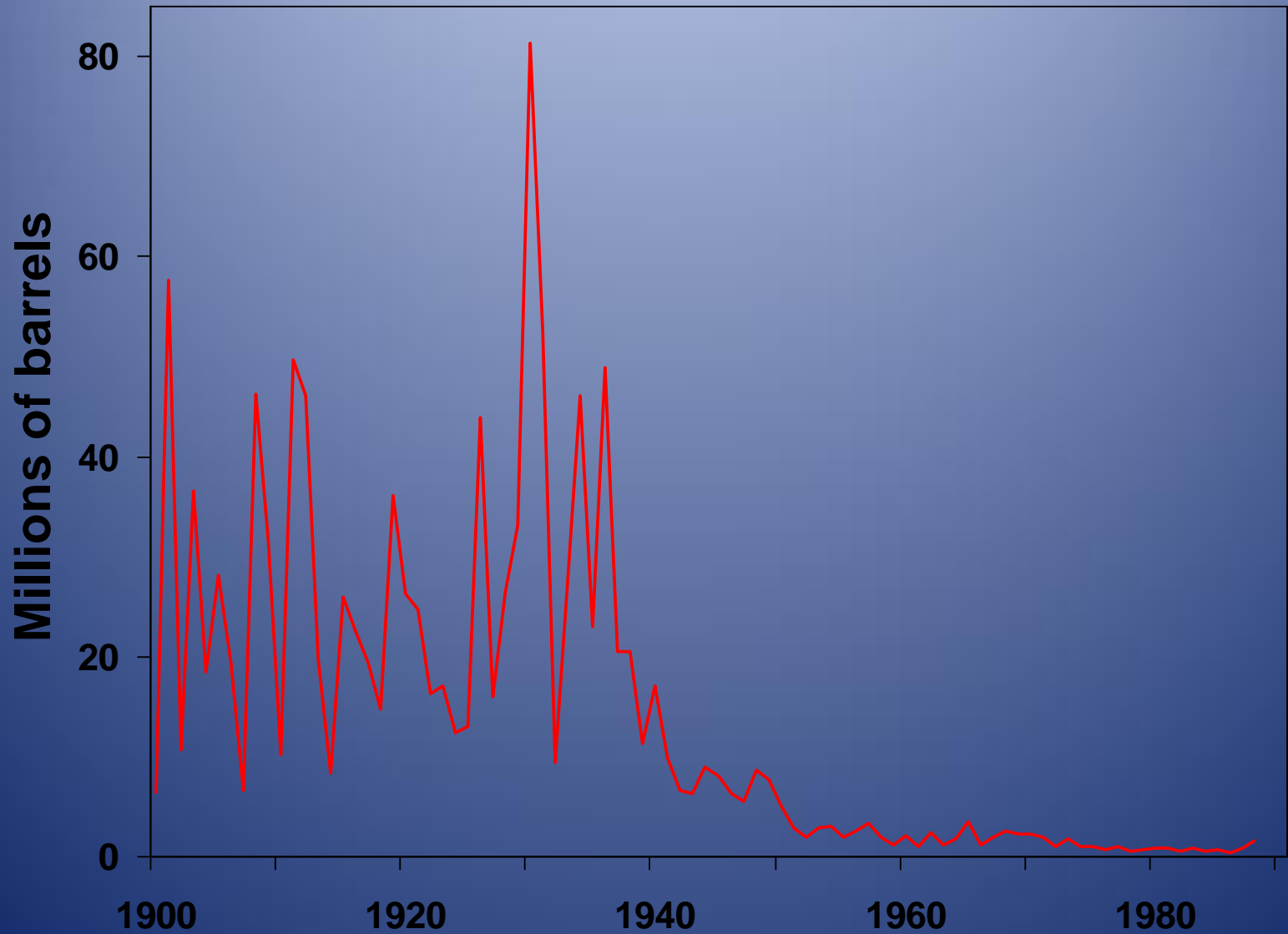
The energy cost of getting the next barrel is going way up



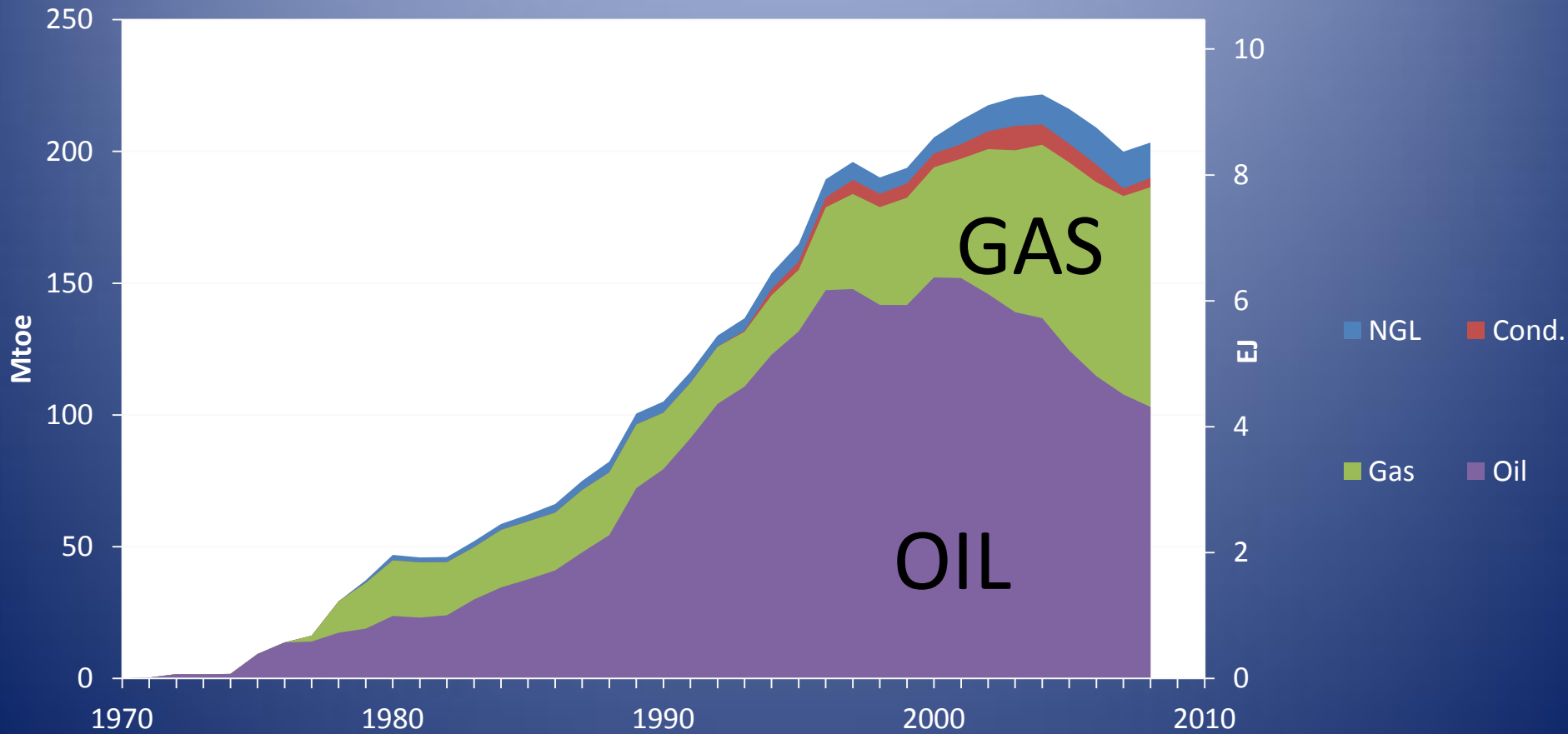
- Today: Thunder horse platform -- up to 90 million barrels a year –but investment is huge



US Oil Field Size

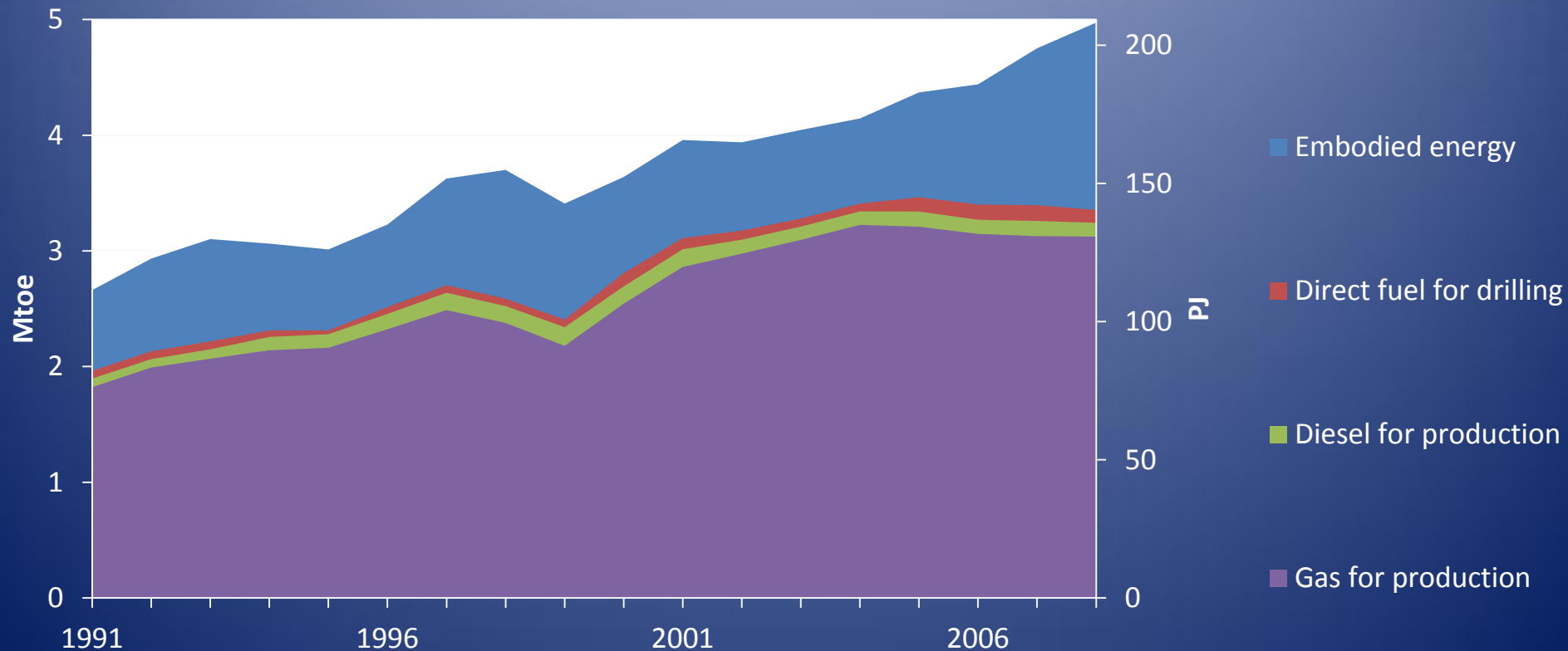


Petroleum production in Norway in 1970 – 2008

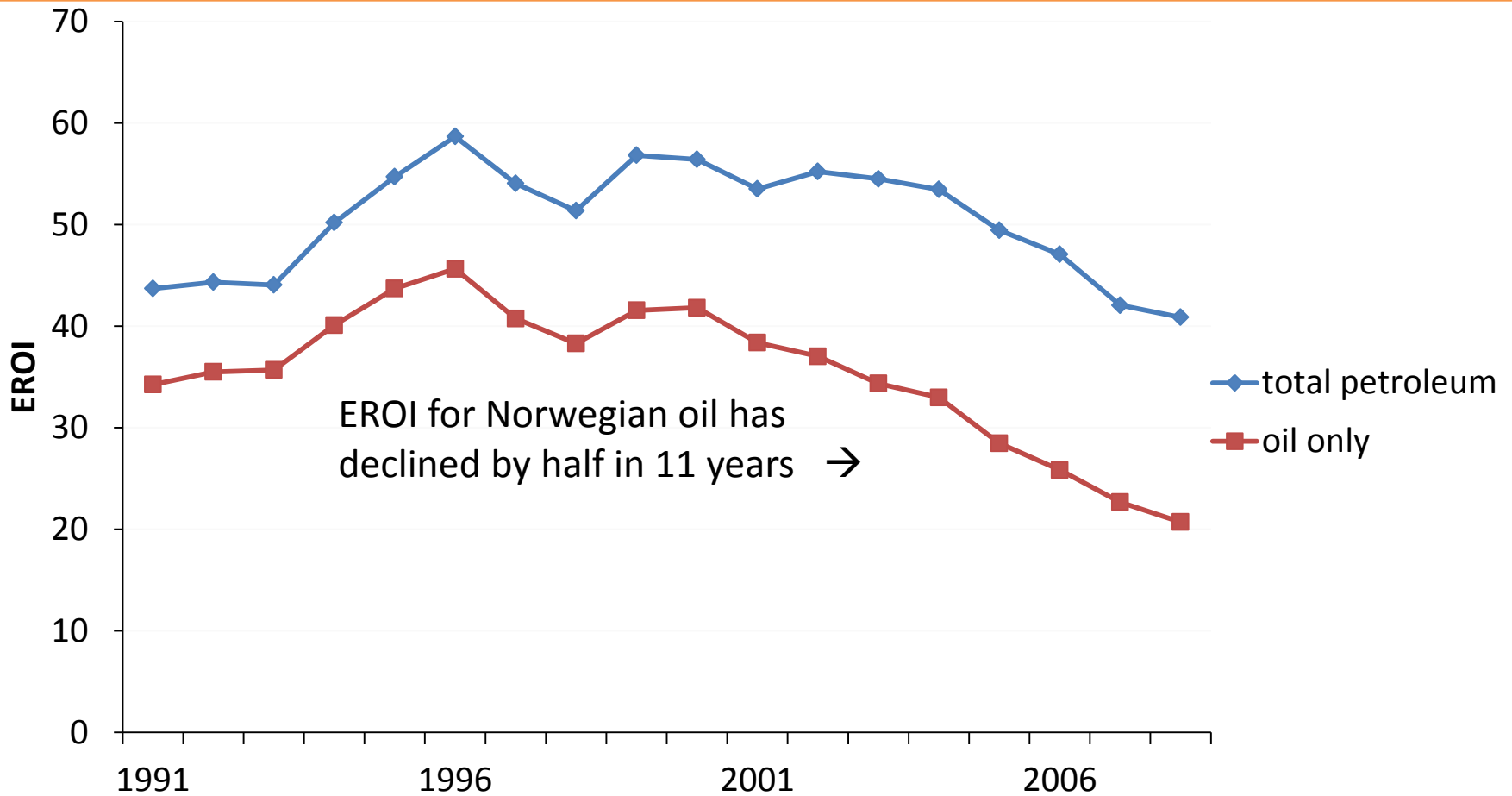


Energetic cost of petroleum production in Norway in 1991 – 2008.

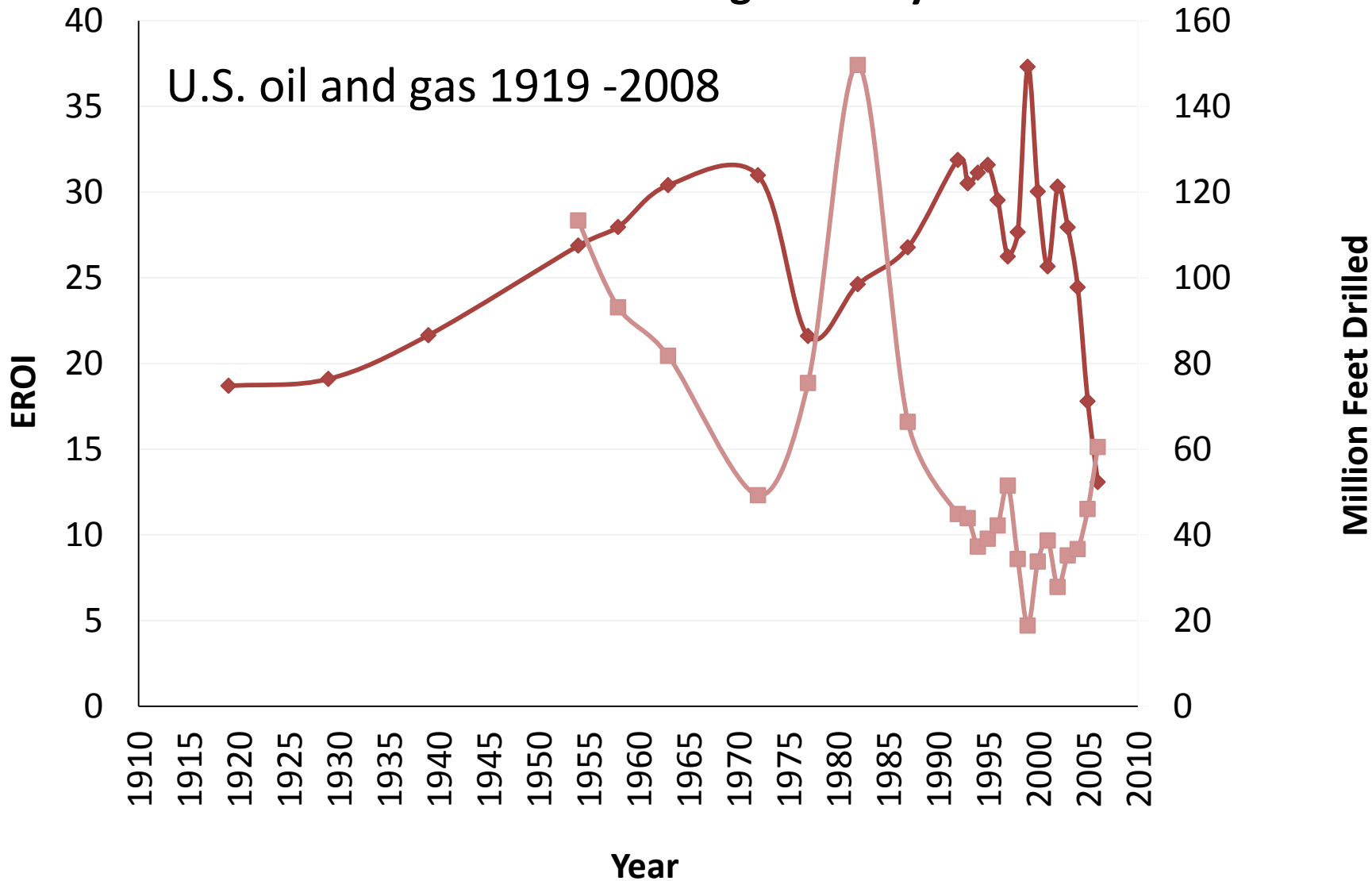
Leena Grandell



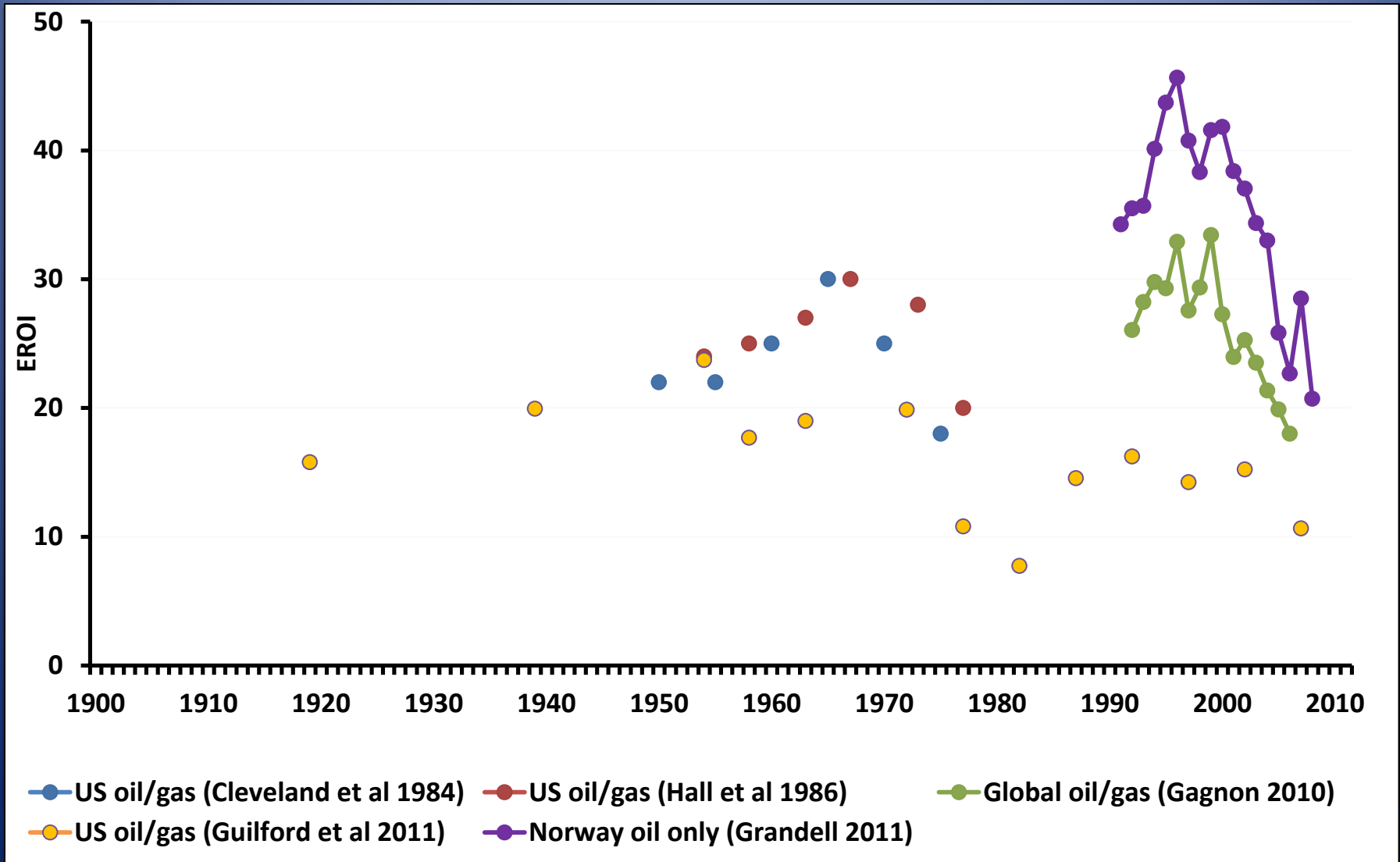
EROI of Norwegian petroleum production in 1991 – 2008



EROI and Drilling Intensity



EROI for Oil: US and other



III. Economic consequences

Economics is usually considered a social “science” , but the foundation of real economies is biophysical

Understanding the role of energy in economies (BPE) does what economics does not:

- 1) Is consistent with known scientific laws
- 2) Makes sense of history
- 3) Gives lie to indefinite growth
- 4) Explains residual in Cobb-Douglas equation & failure of Phillips curve
5. Gives an absolute limit to market solutions

- The economist will argue that should scarcity comes to oil the price will go up, giving incentives to go get more or develop the technology to do so.

OUR NEXT QUESTION:

What is economics?

- Economics is the study of the allocation of scarce resources among competing ends
- vs.
- Economics is the study of how people transform nature to meet their needs (Polanyi)

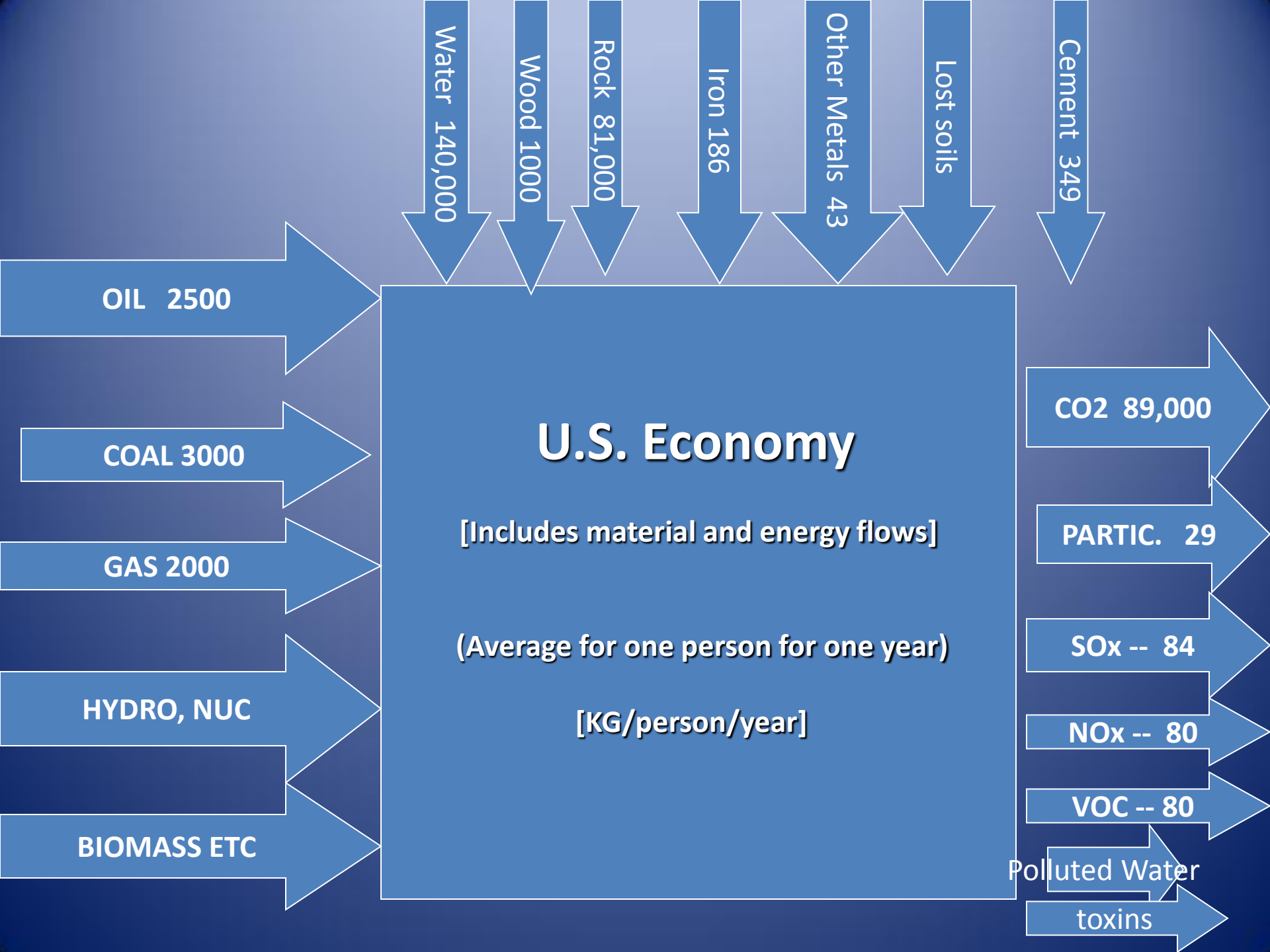
Standard view of inputs and outputs to an economy (U.S. in 1990)



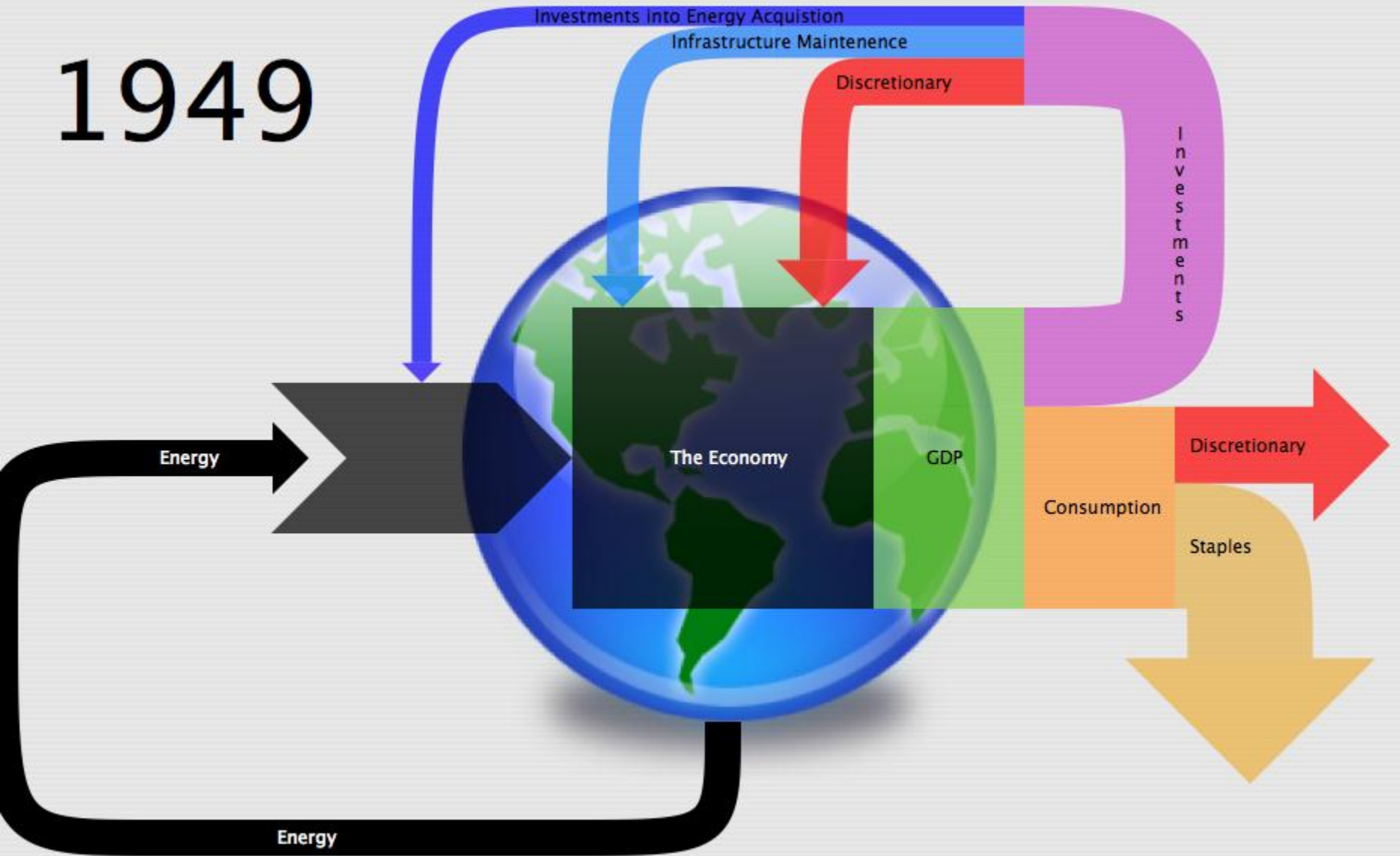
- This is a social definition of economics:
- It implies that scarcity is only relative scarcity, that humans are rational, that firms, households and markets are all that you need to make a legitimate economic analysis or understanding.

- We all know that that is not true.....

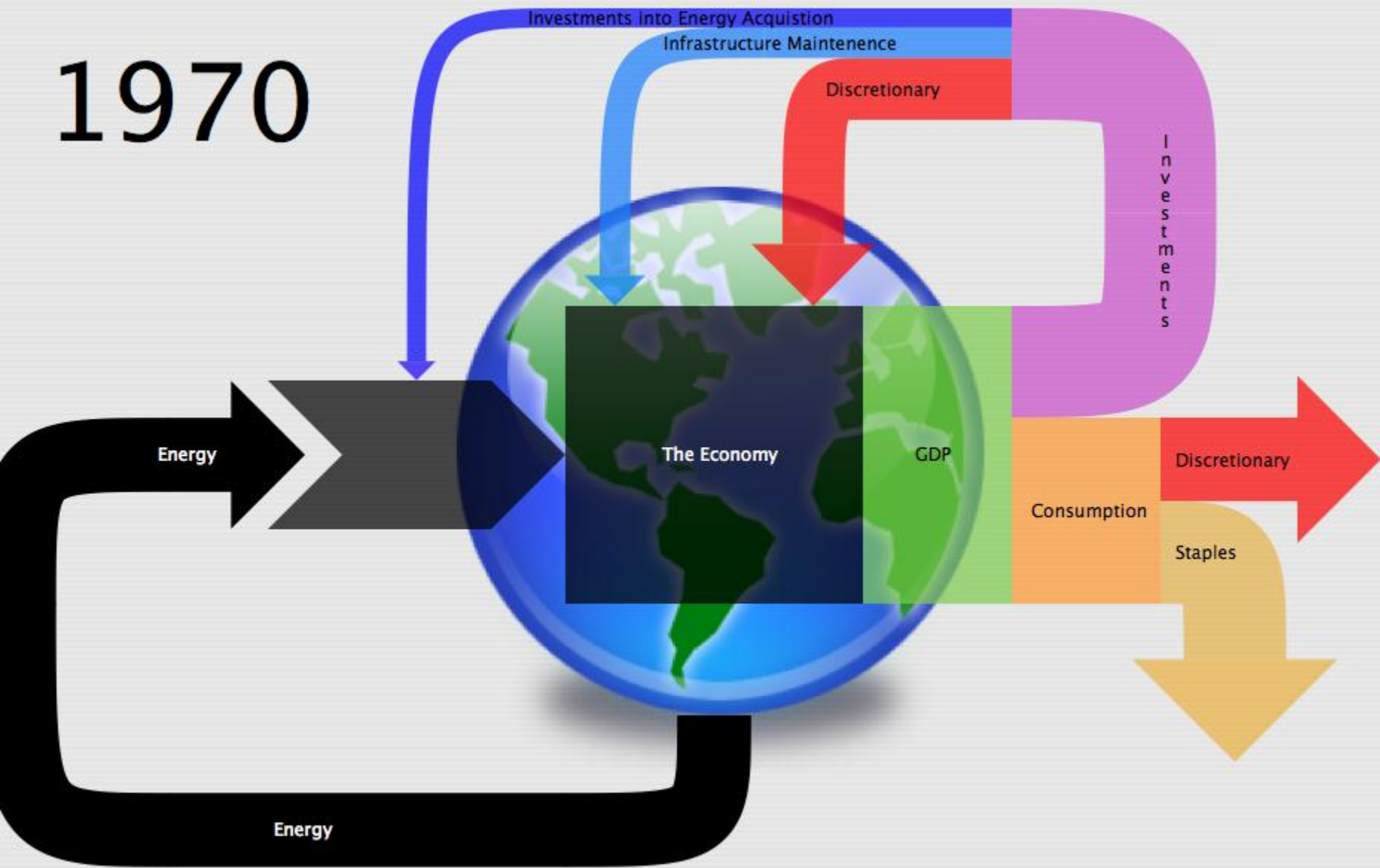
AN EQUALLY LEGITIMATE VIEW OF THE US ECONOMY



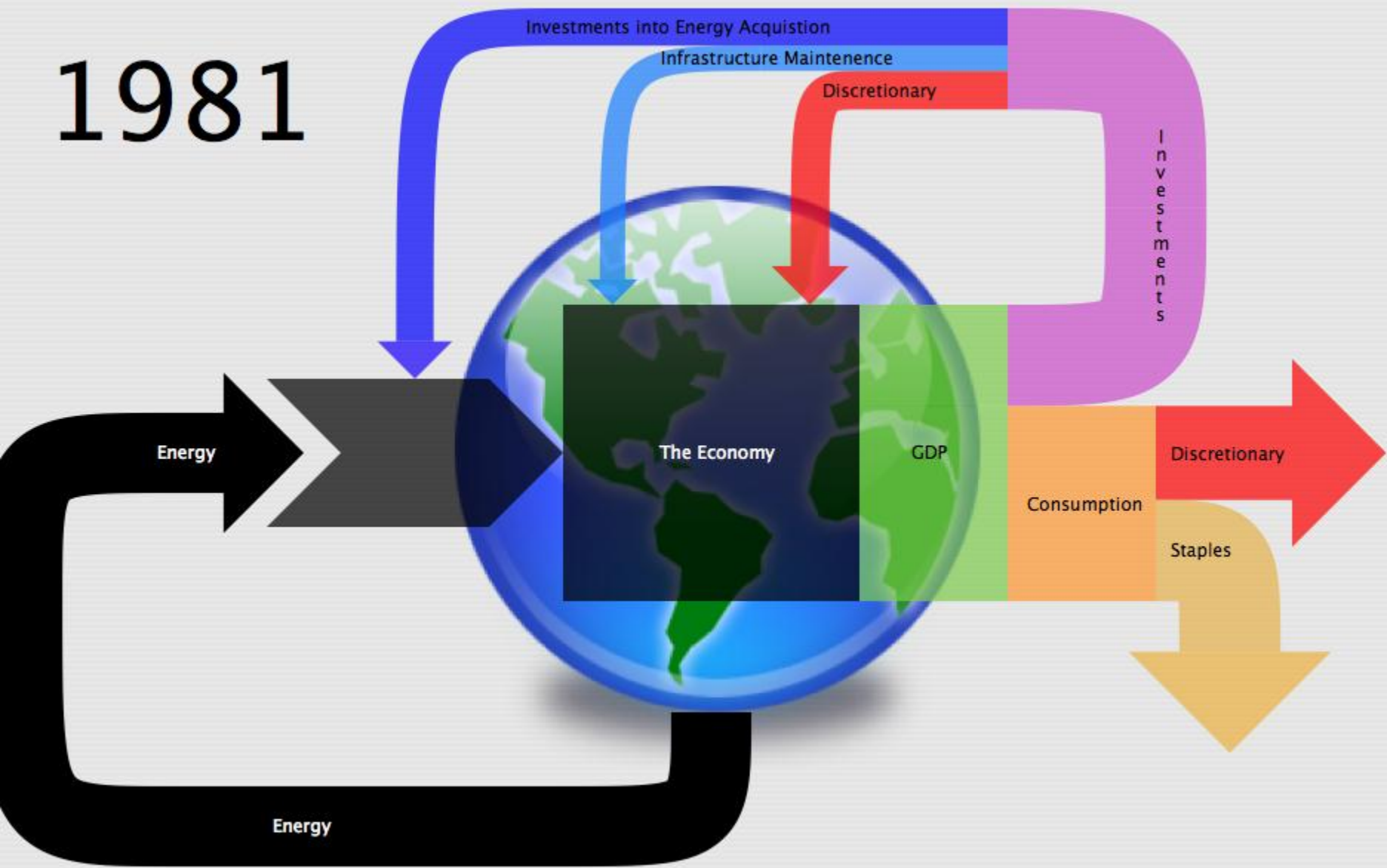
1949



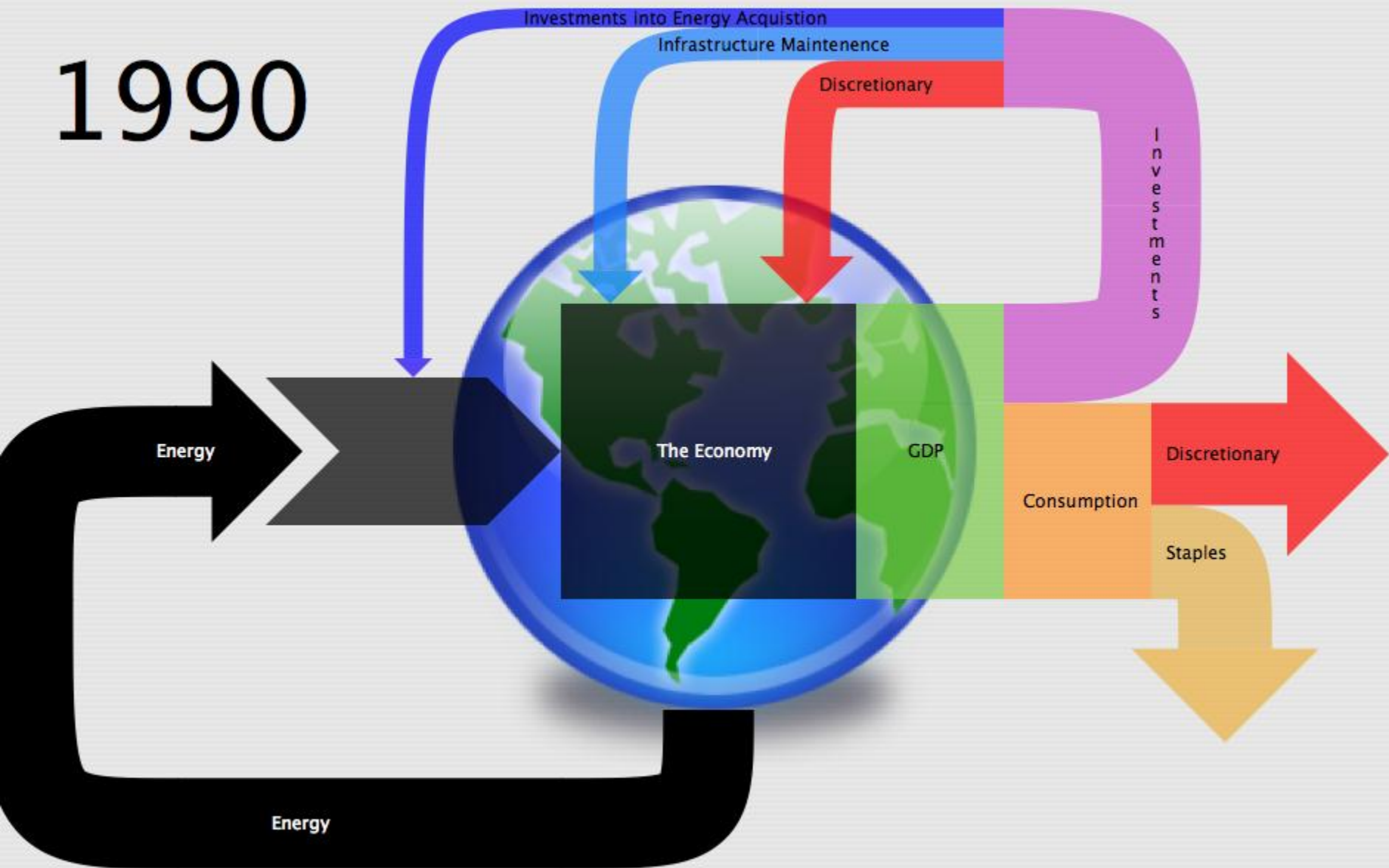
1970



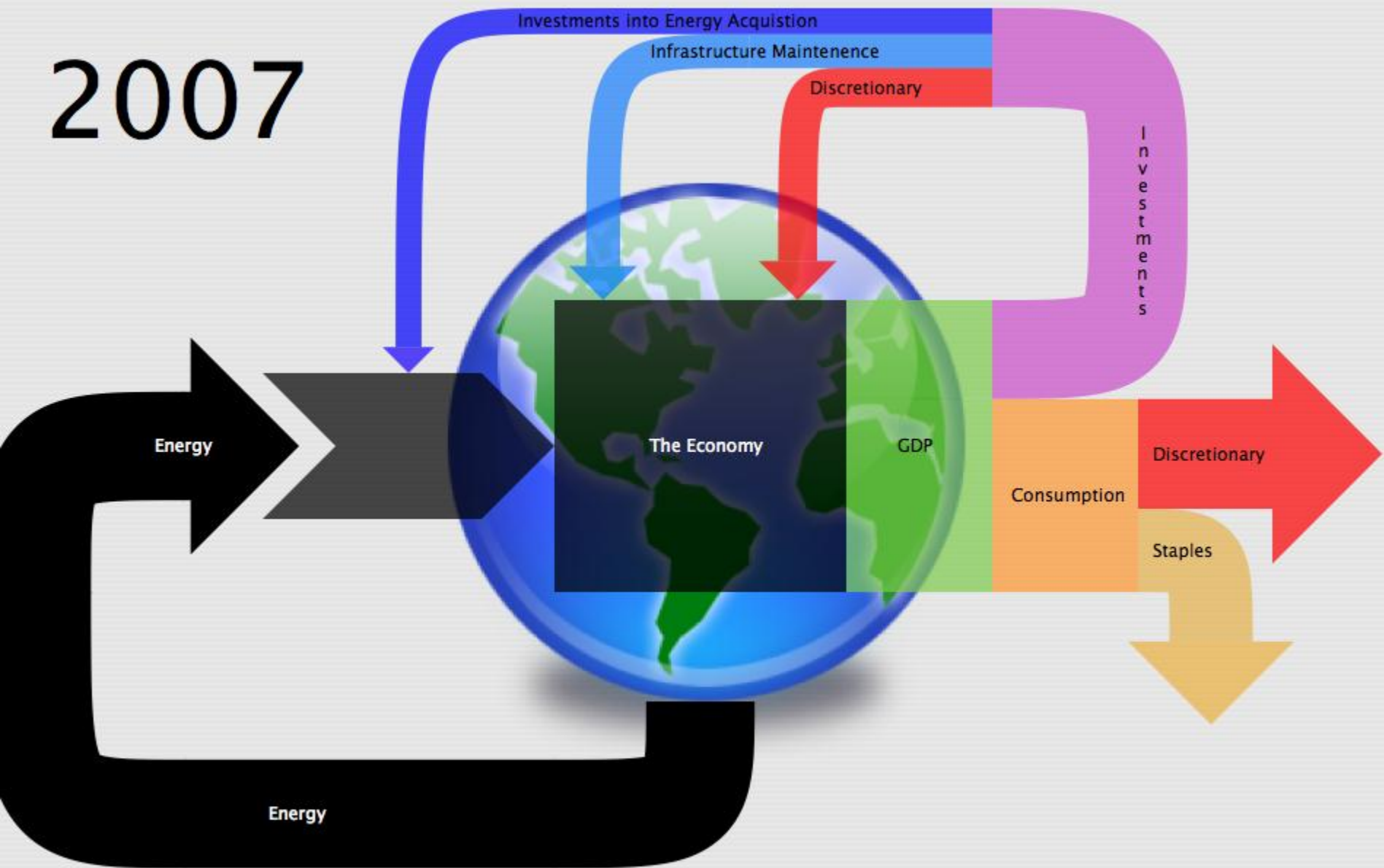
1981



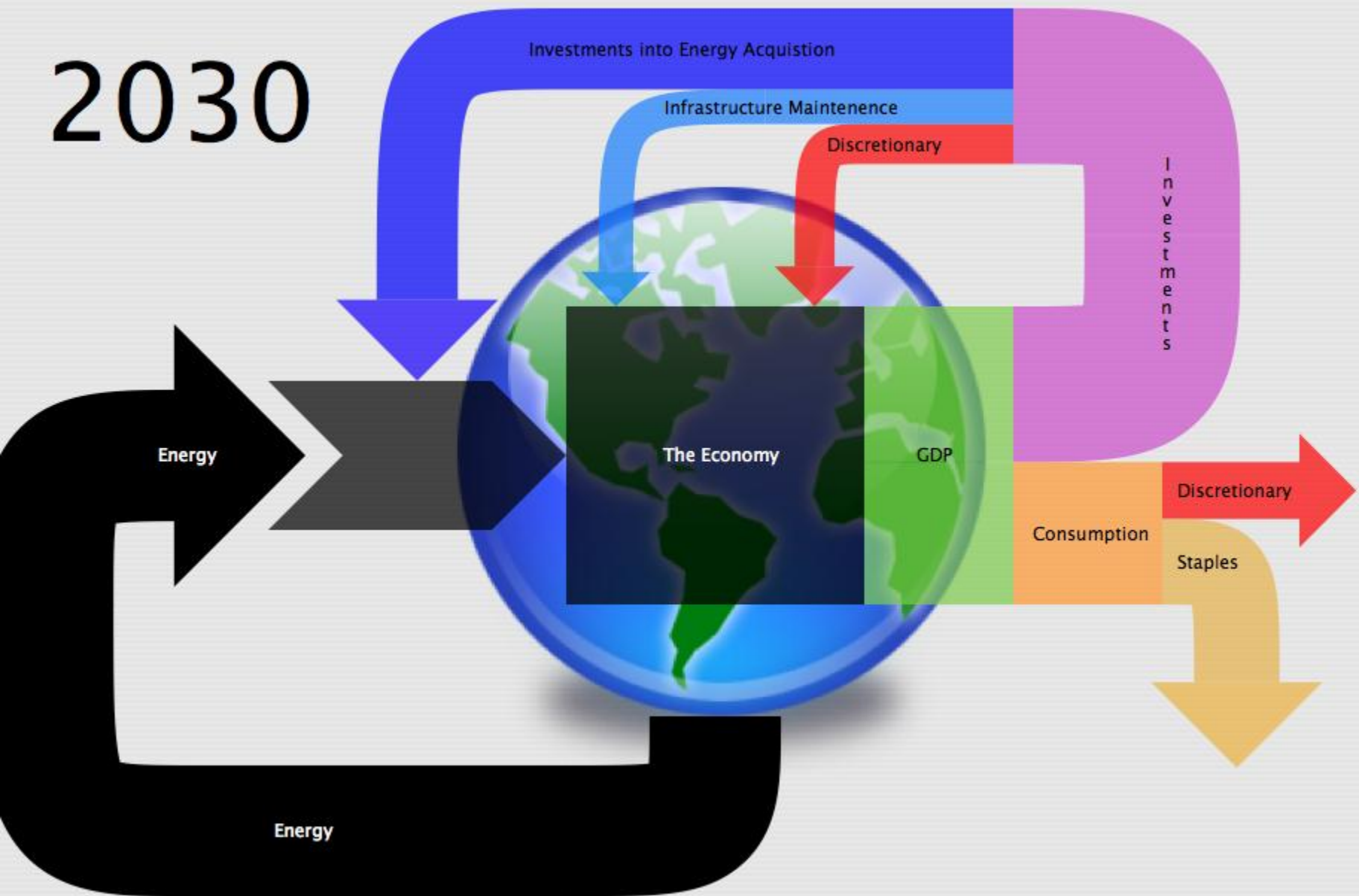
1990



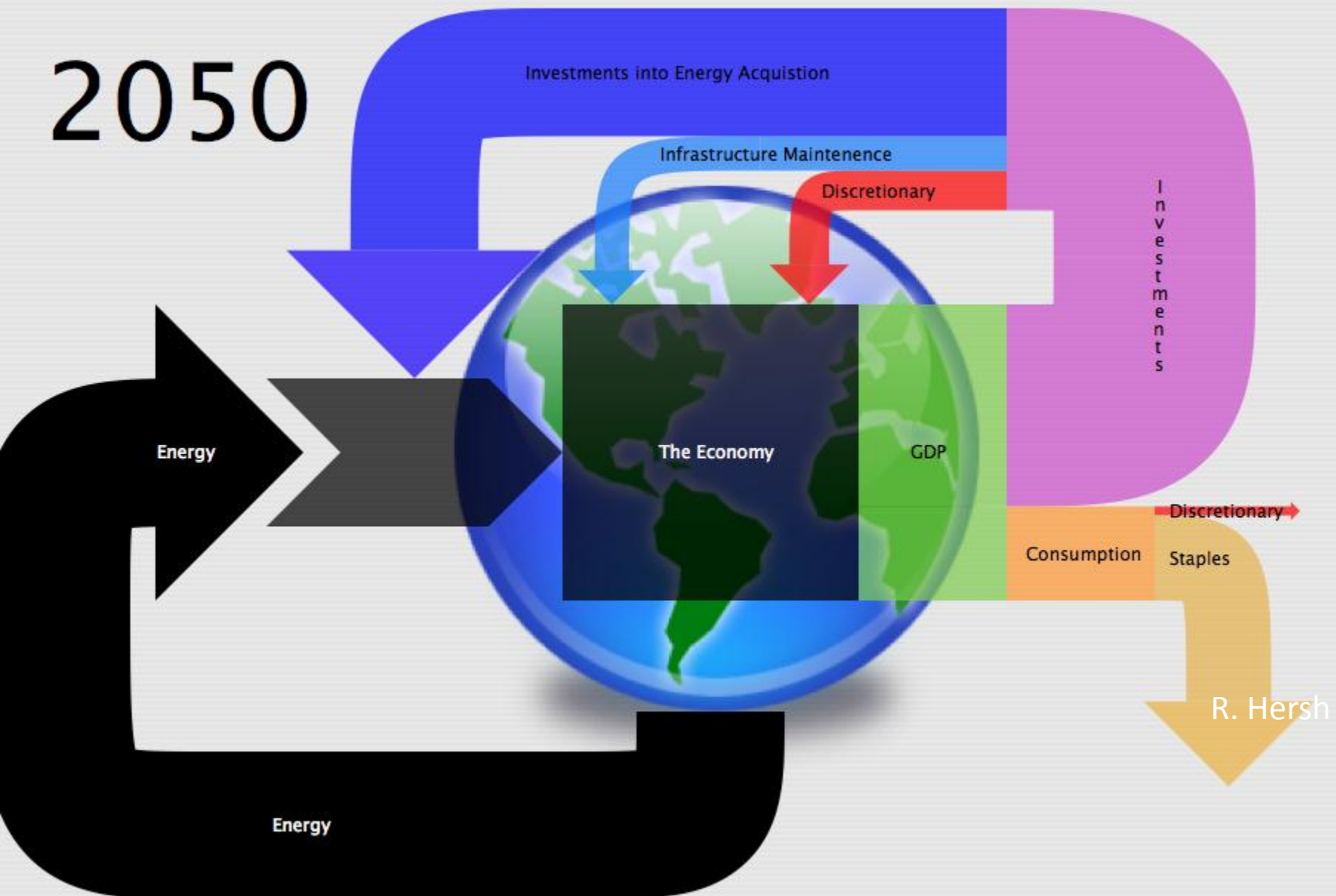
2007



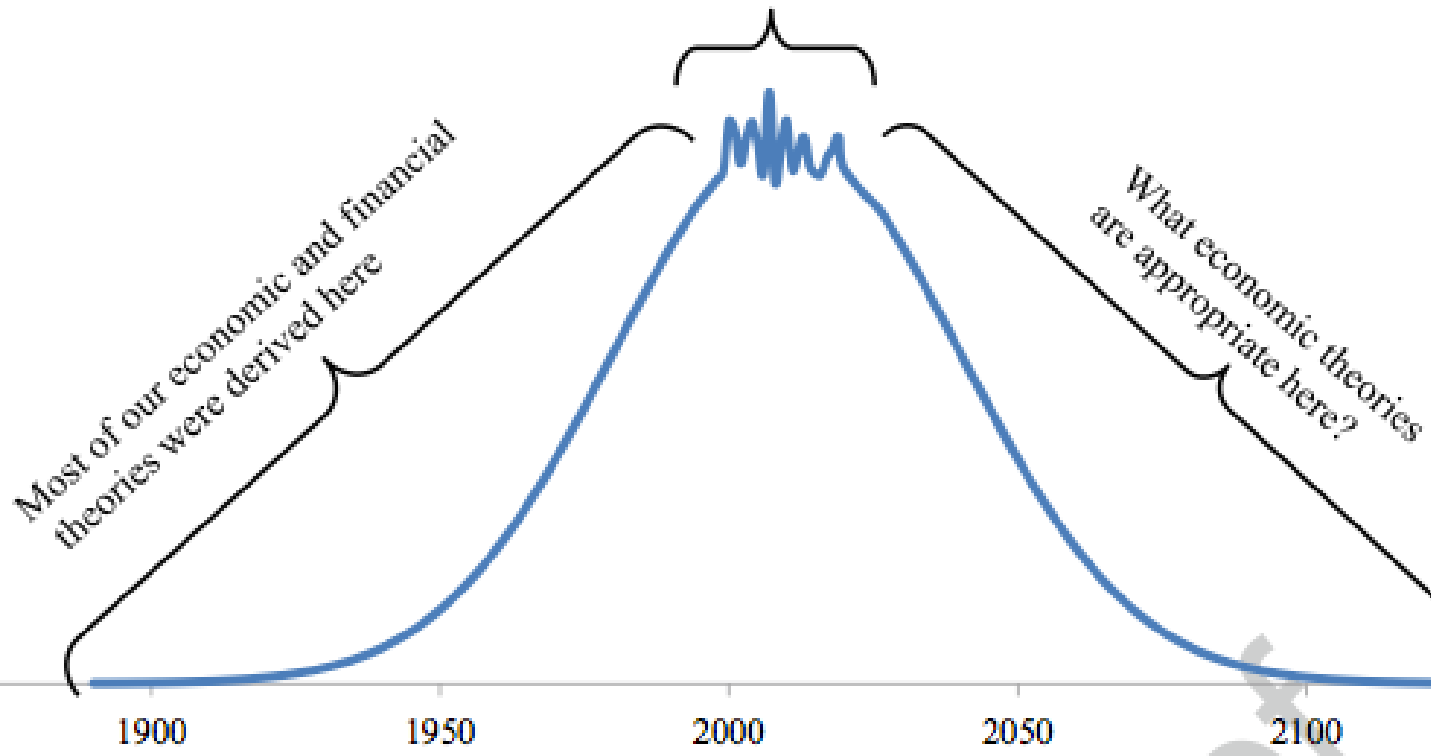
2030



2050



Current U.S. and Global Oil/Energy Situation



1850 1900 1950 2000 2050 2100 2150

Charles A.S. Hall · Kent A. Klitgaard

Energy and the Wealth of Nations

Understanding the Biophysical Economy



 Springer

My final professional goal

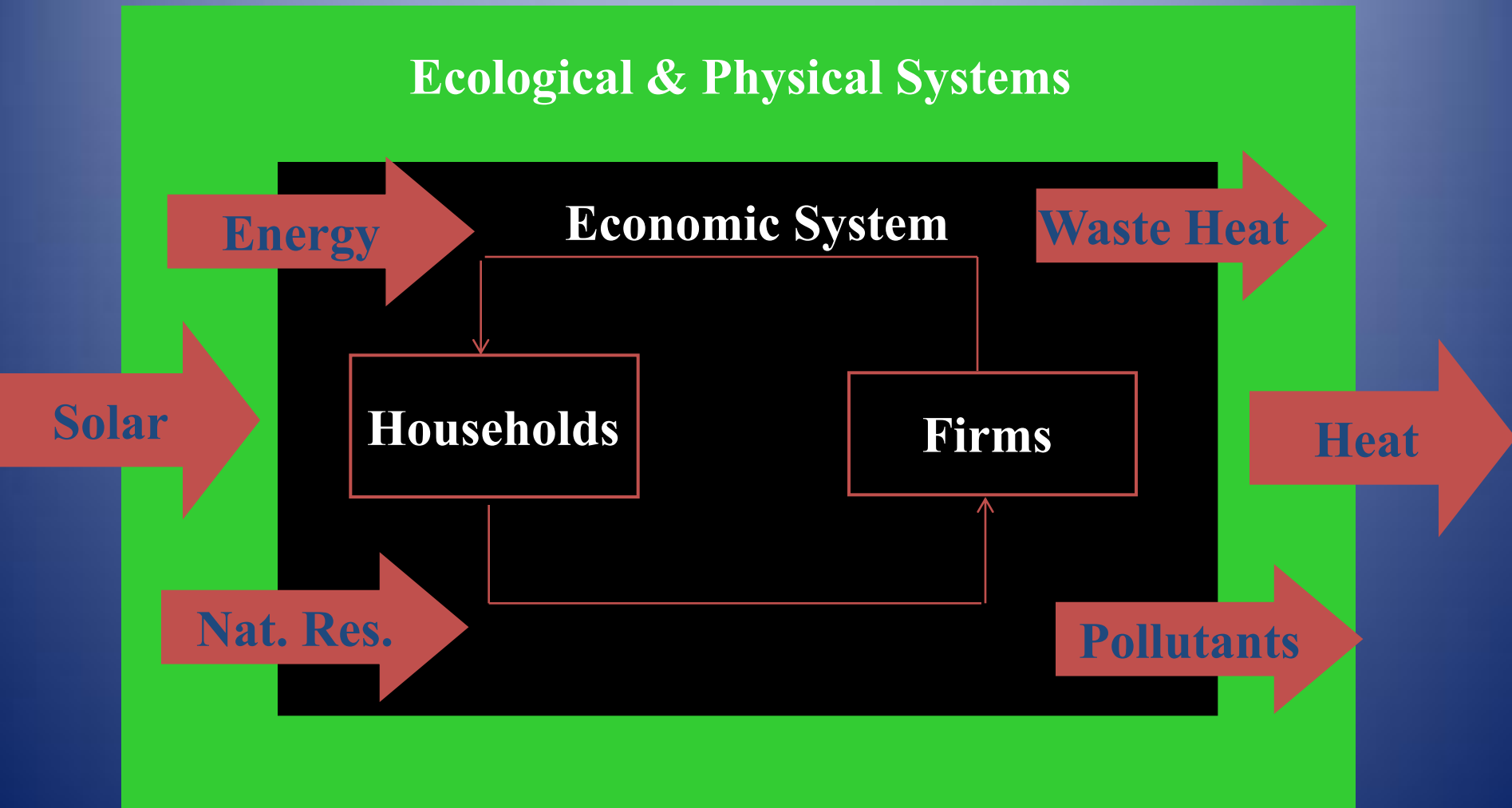


Neoclassical
economics

THE END



Interdisciplinary Economic Model



PHYSICAL
PROCESS
AND
RESOURCES

MAINTENANCE OF ENVIRONMENTAL
PREREQUISITES AND AMENITIES

CULTURAL TRANSFORMATIONS

Energy Sources

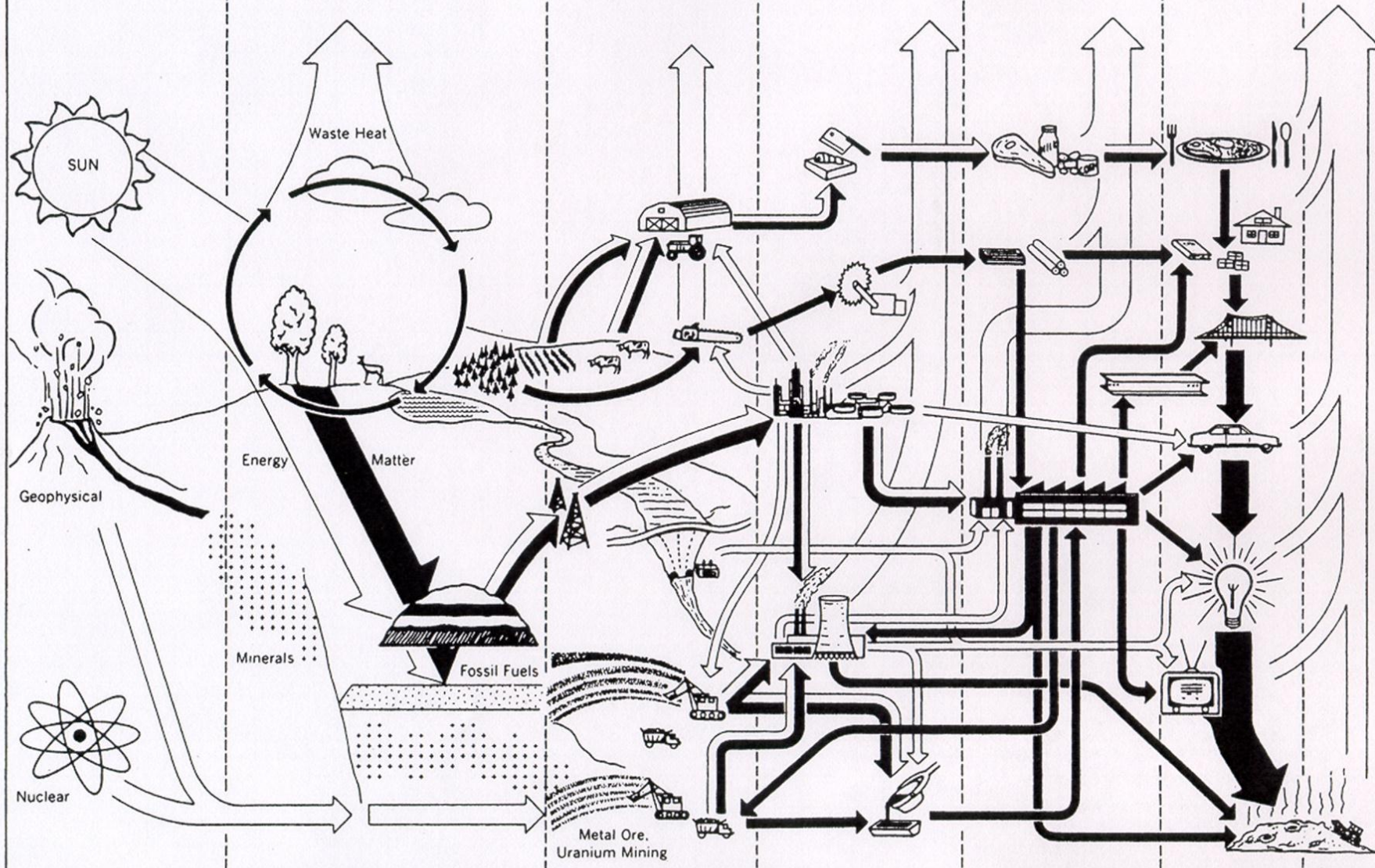
Raw Materials

Exploitation

Processing

Manufacturing

Consumption



ECONOMIC
TERMS

NATURAL RESOURCES

RAW MATERIALS

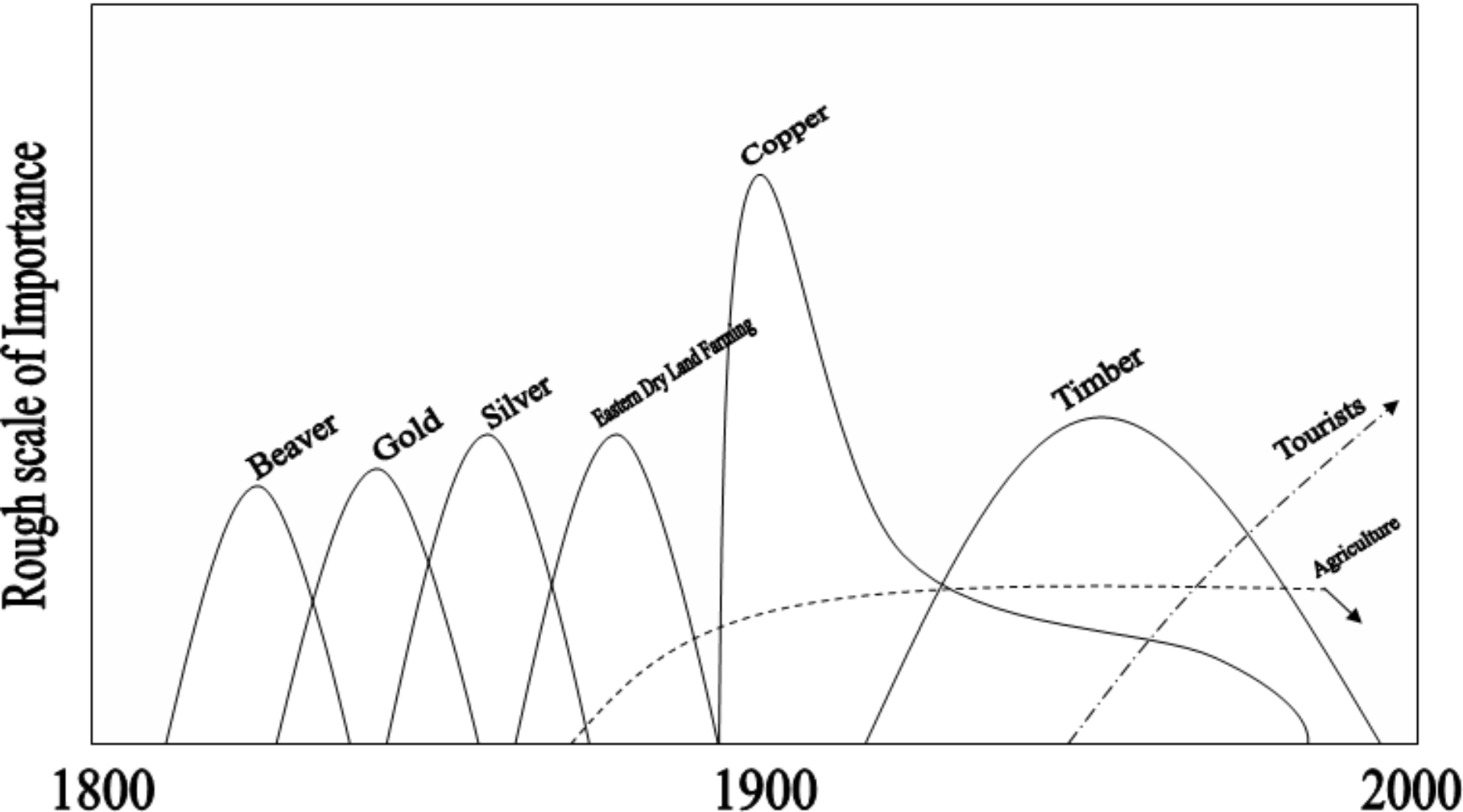
INTERMEDIATE GOODS

FINAL DEMAND

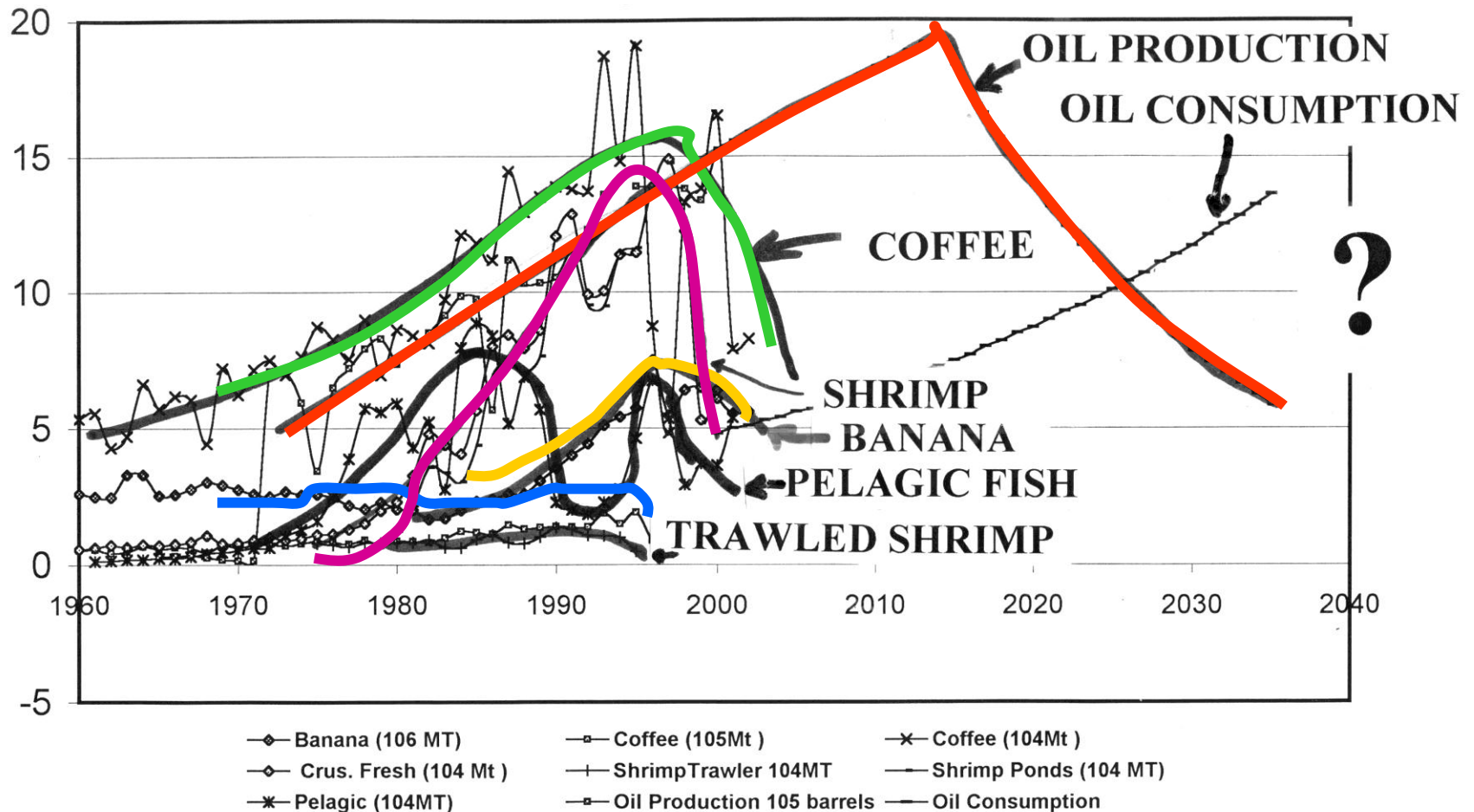
- Our second, quite different, definition of economics comes from the great Hungarian economic anthropologist Karl Polanyi (*Trade and Market in Early Empires*) who provided what he termed a **Substantive** definition of economics:
- **Economics is the study of how people transform nature to meet their needs.**

Economic development is often a series of resource booms and busts

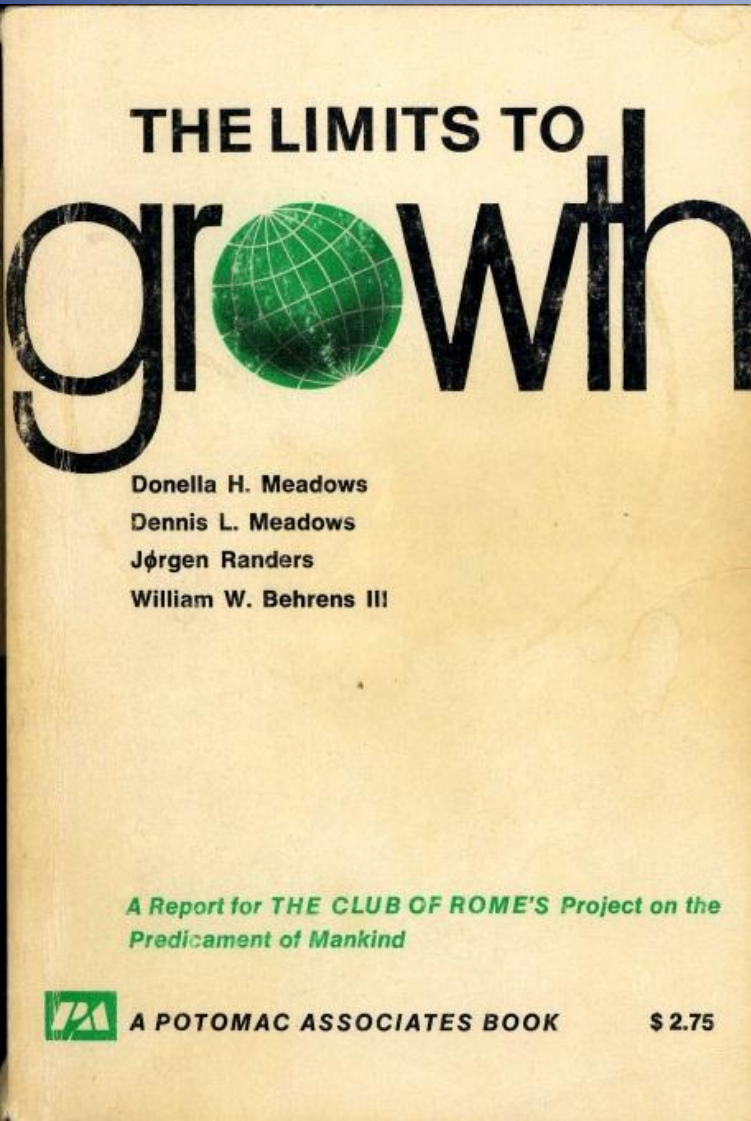
K. Ross Toole History of Montana



Ecuador's exploitation cycles



What if these guys were right?

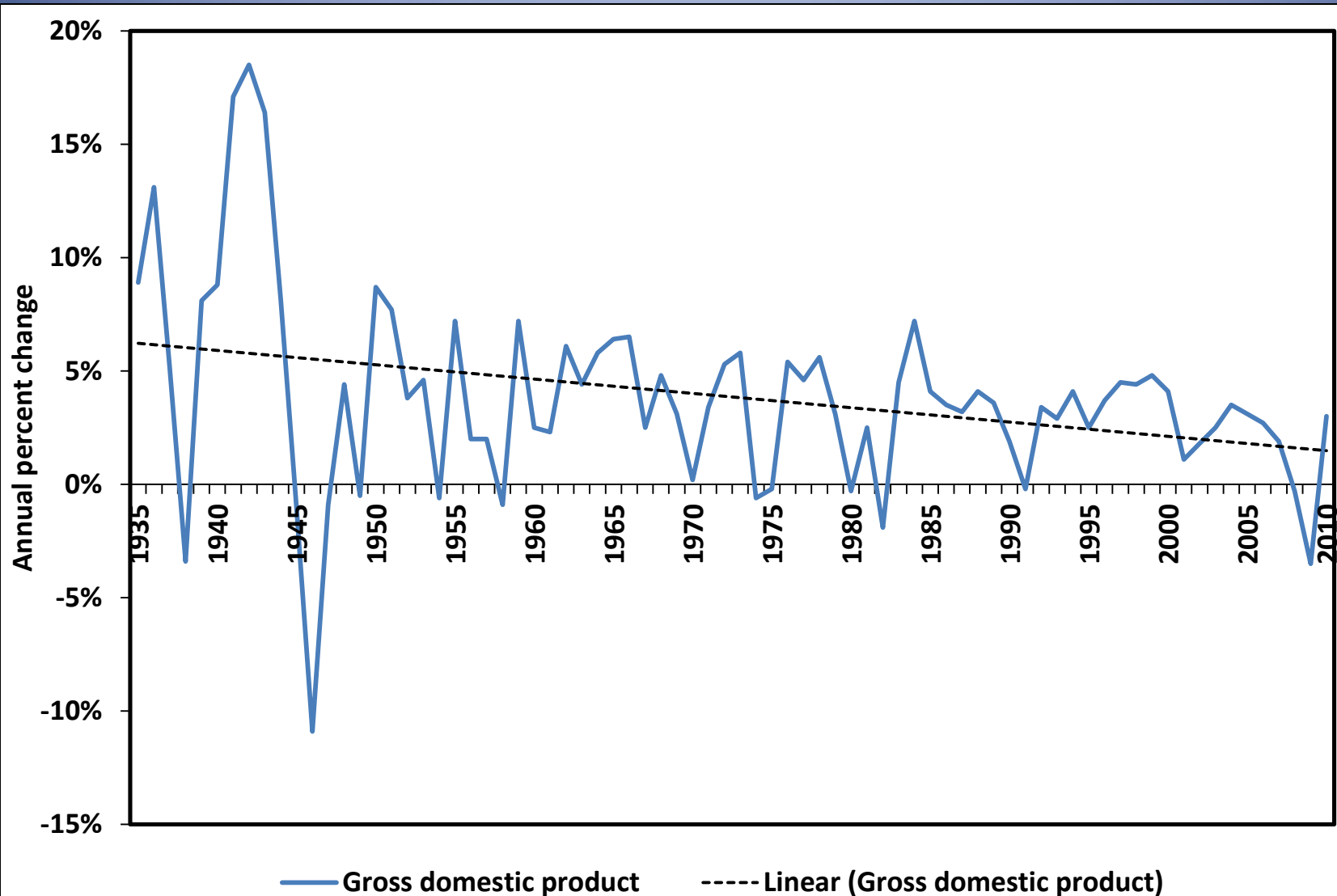


Revisiting the Limits to Growth After Peak Oil

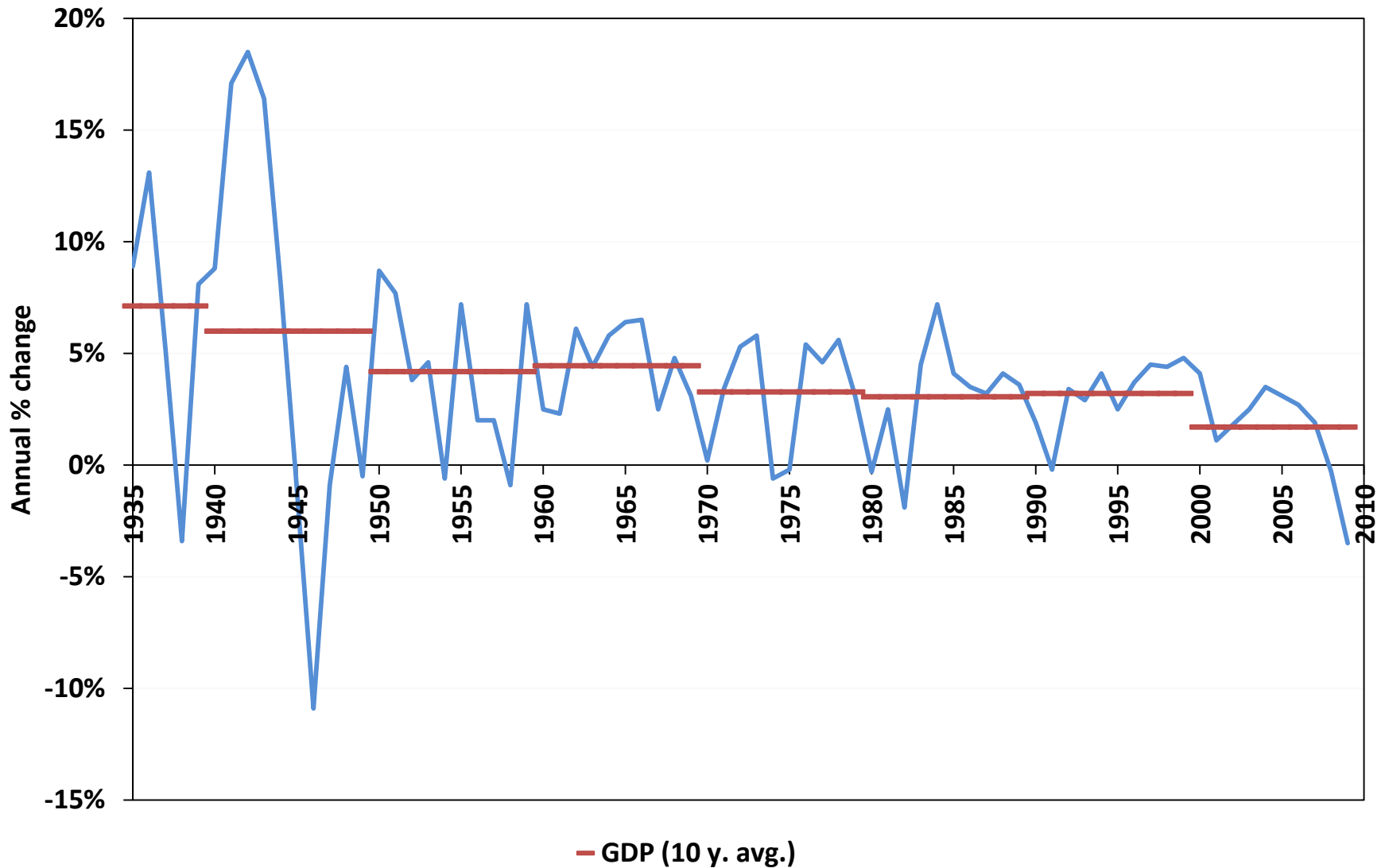
Charles A. S. Hall and John W. Day, Jr. 2009
American Scientist, Volume 97: 230-237

II. THE GROWTH RATE OF MANY ECONOMIES IS DECLINING

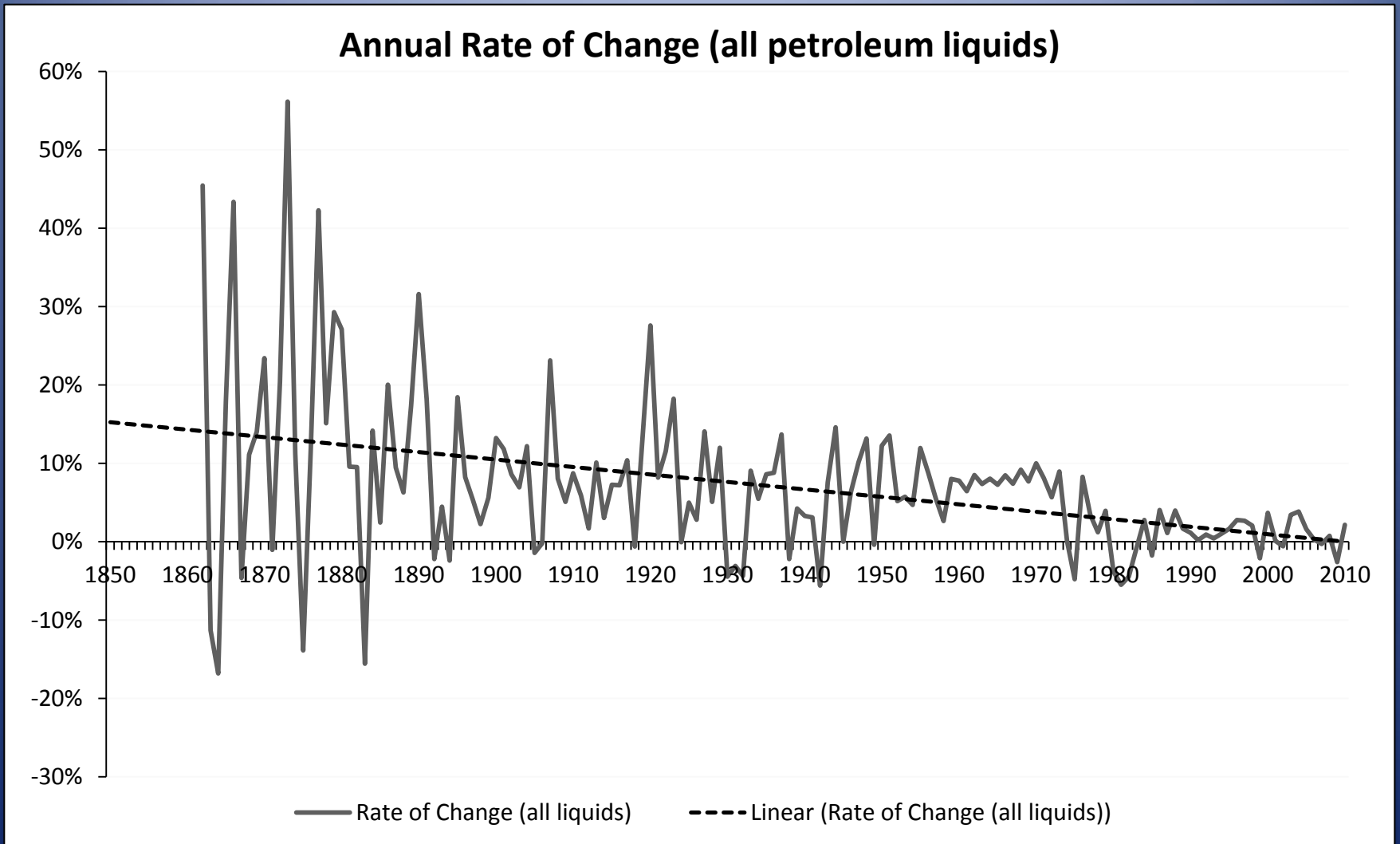
The evidence: declining growth rate of US GDP



Another way of looking at the same data



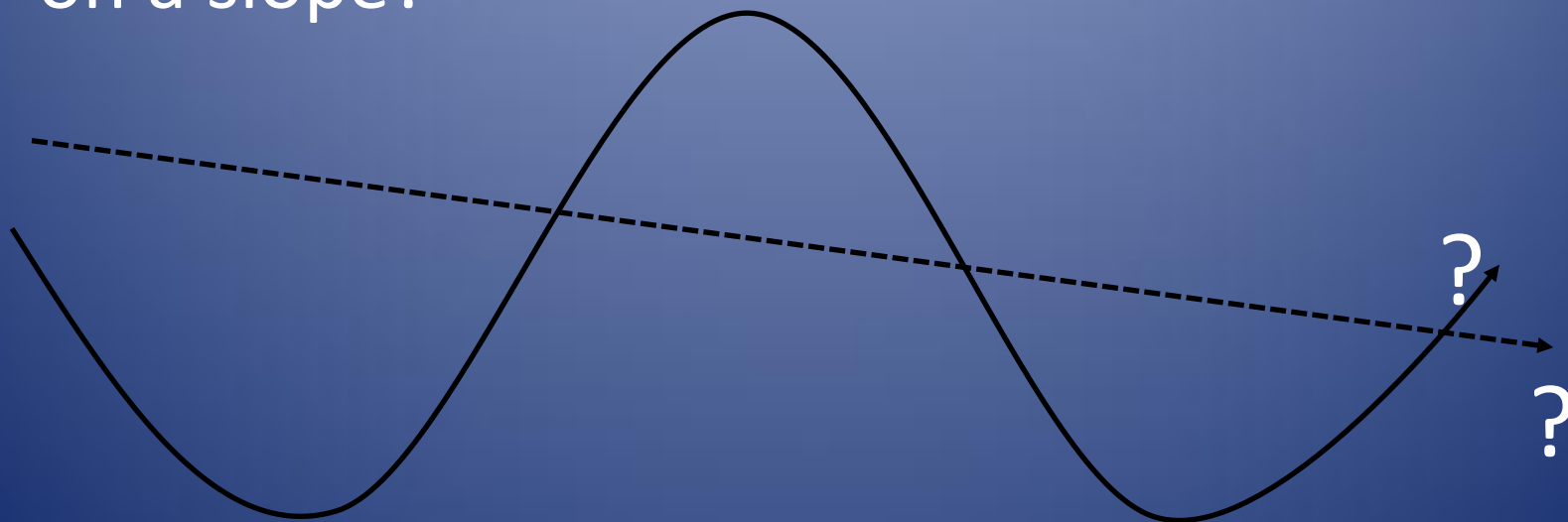
Global petroleum



Why is this the case?

Why is the economic growth in the US (and OECD and maybe the world) slowing down?

Are we just in an economic downturn or are we on a slope?



- For me economics is summarized as this:
- For every dollar you spend the energy equivalent of roughly a coffee cup's worth of oil is spent somewhere in the world to bring you that dollar's worth of good or service

OUR SECOND QUESTION

What is wealth and where does wealth
come from?

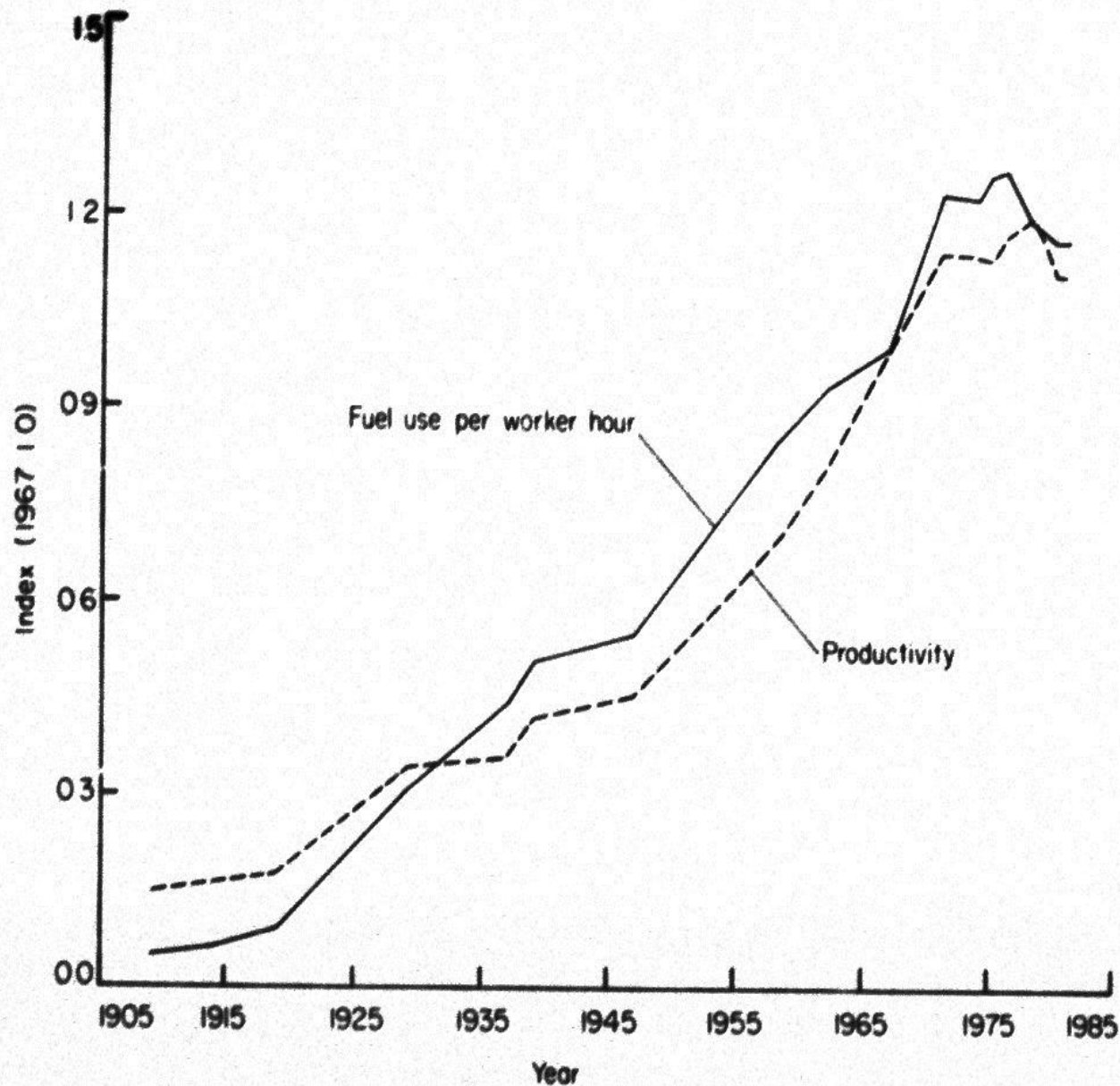


Figure 2.7. Labor productivity (dotted line), as measured by real value added per production worker-hour, and energy used

What
Denison
missed

THE END



