Lec #6: Lessons From History

MONDAY: Expiration of Finite Resources

TODAY: Lessons From History and the Need For A New Paradigm

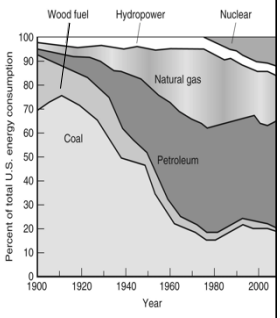
- Historical Energy Consumption Trends
- Per Capita Consumption and GDP
- Is the Sky Really Falling?

NEXT WEEK: Begin Mechanical Energy (Chapters 2 & 3)

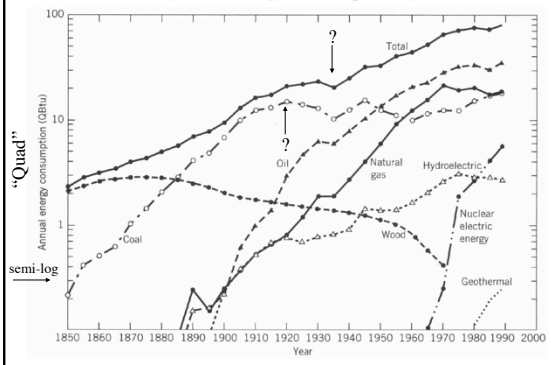
- Forms of Energy; Conversion of Energy
- Laws of Motion; Forces in Nature
- Work, Kinetic Energy, Potential Energy, Power

Energy Consumption & Economic "Growth"

- For most of history: manpower, animal power, water, wind, biomass
- Industrial Revolution fueled by consumption of non-renewable resources (did not account for replacement costs)
- Growth in GDP tied to growth in energy production...



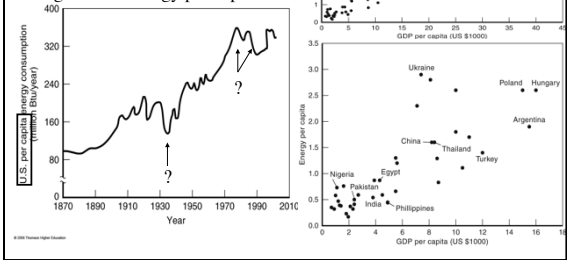
History of US Energy Consumption (by Source)



Per Capita Energy Consumption

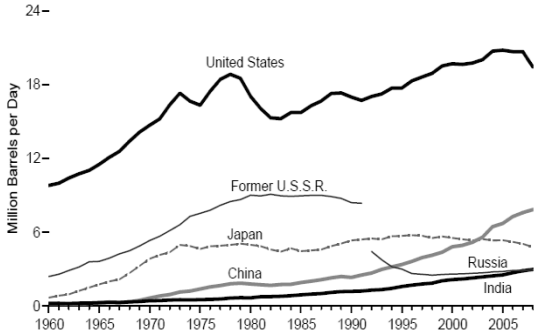
Much higher in North America than anywhere else

Western Europe & Japan achieve same or greater GDP per capita using far less Energy per capita



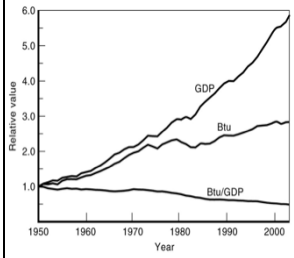
World Petroleum Consumption

Top Consuming Countries, 1960-2008

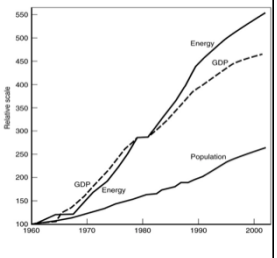


Source:http://www.eia.gov/totalenergy/data/annual/archive/038409.pdf

But, recent trends show that growth in consumption of resources is NOT required, at least to SUSTAIN wealth...

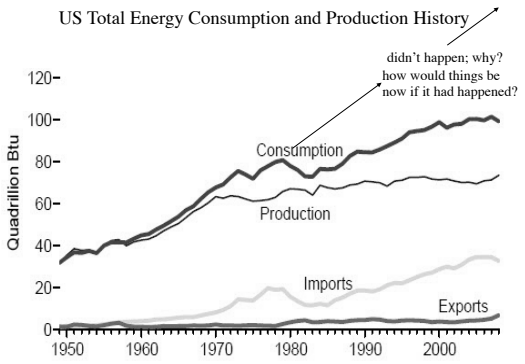


US GDP and Energy Consumption

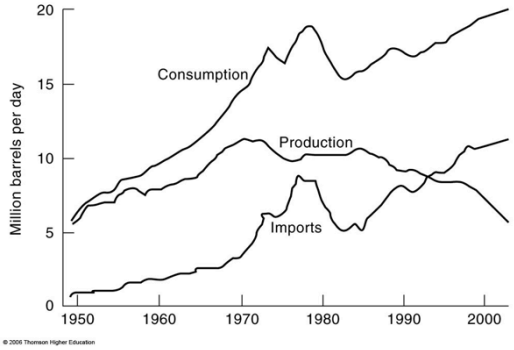


Different for "Developing" World

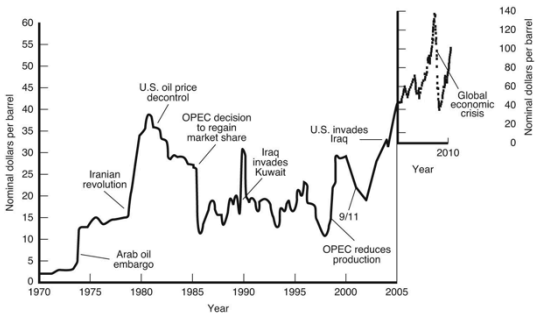
US Total Energy Consumption and Production History



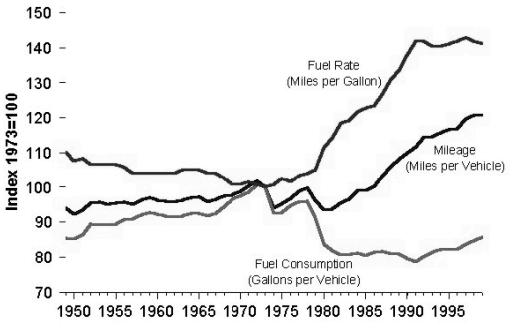
US **OIL** Consumption and Production History



Crude Oil Price History



So What Did We Do About It?



What Then Must We Do?

- Growth must stop. Earth has finite carrying capacity, and we are approaching it (almost certainly in *your* lifetime).
- Per capita use will go up in developing world; hopefully down in developed world.
- Tremendous investment in fossil fuels required.
- Must also accelerate pace of renewables.
- Nuclear power?
- Conservation plays a critical role!

"Consumption" of What?

ENERGY IN = ENERGY OUT

- in: {(energy "content")+(energy)} + (material & human input)
- out: {(useful energy)+(waste energy} + (by-products)

  – what is "consumed"? "produced"?
  – what do we want to maximize?
  – what do we want to minimize?

  – Resource consumption can grow much more quickly than population (increased per capita rates)
  [e.g. US oil 7%/y until mid 70's]

ENERGY IN

- Energy Content - natural; provided by gravity, sunlight, or formation of solar system; we can't change it
- Energy Input - (to produce and distribute fuel) some forms are intrinsically more difficult to extract; we should *minimize* this by using efficient sources
- Material and Human Input - finite resources; fossil fuels; often not accounted for in cost of production; would like to *minimize* this effort

ENERGY OUT

- Useful Energy Out - want to *maximize* this to keep up with growth and to keep cost down; use electrical power grids and on-site generation
- Waste Energy Out - unavoidable natural phenomenon in any process; want to find processes that *minimize* or make use of it
- Waste Products - environmental damage --> limitations; want to *minimize* (or find alternative uses for byproducts)