Lec #5: Can We Avoid Another Oil Crisis?
PREVIOUS: Exponential Growth & Finite Resources
THIS WEEK: Expiration of Finite Resources
• How Long Will A Resource Last?
• Historical Energy Consumption Trends
• Per Capita Consumption and GDP

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

How Do We Estimate Lifetime?
1. assume resource is infinite
   • discoveries must keep pace with consumption
2. deplete at constant amount (current use rate)
   • must decrease per capita use at same rate as population increases
   • production must maintain current pace
3. exponential growth until resource expires
   • production rate must also increase exponentially
4. Hubbert model
   • early exponential rise
   • production slows & peaks when 1/2 resource is consumed
   • steady decline in production rate
   • symmetric, bell-shaped curve

Hubbert Curves

PA Anthracite Coal  US Petroleum

“Hubbert’s Peak: The Impending World Oil Shortage” (Deffeyes, 2001)

Production v. Cumulative Consumption
Total Yield When Production -> 0

Total Recoverable World Oil ~ 2.1 Trillion Barrels
US Discovery History

11-year Lag Between US Discovery and Production

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**Total World Oil Production**

12 Month Centered Moving Average

Data: U.S.A. D.O.E. EIA, H14-03, February 2005

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**The Growing Gap**

Past discovery based on ExxonMobil (2002). Revisions backdated

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**What Causes a Crisis?**

- Different assumptions give different $T_{exp}$:
  - exponential expiration is shortest
  - "@ current rate" is much longer
  - Hubbert curve $\rightarrow \infty$, but forever decreasing

- When does the "crisis" occur?
  - Population growth is slowing (but still growing exponentially)
  - Can per capita rate drop fast enough to keep pace with population growth?
  - Finite resources becoming increasingly difficult to exploit (hence the Hubbert peaks)
  - Running out of the resources is NOT the problem!
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)