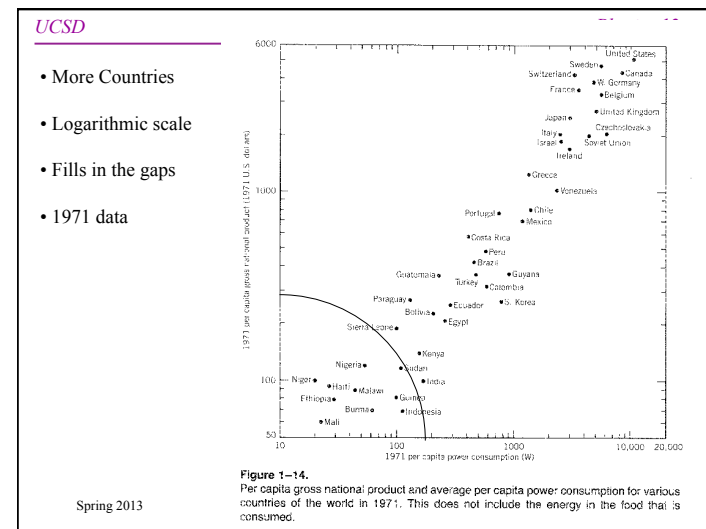
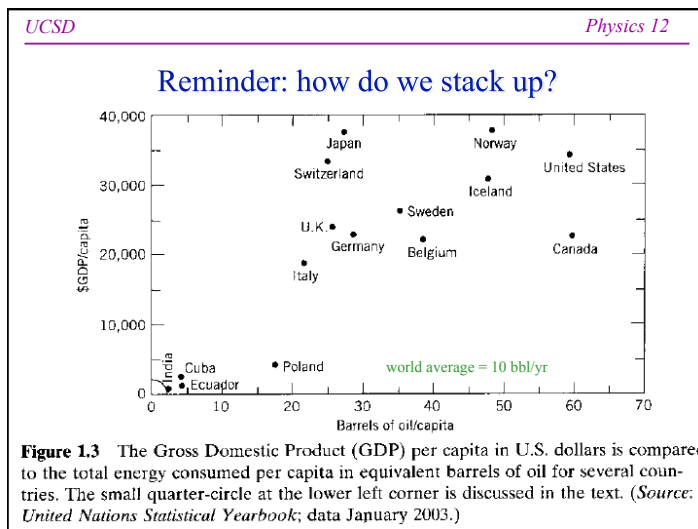


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The Global Energy Scene

- Global energy production is about 480 QBtu/yr
 - a QBtu is a quadrillion Btu, or 10^{15} Btu
 - so about 5×10^{20} J per year (1 Btu is 1055 J)
- U.S. share is about one fifth of this (10^{20} J)
 - 1996 value in book (1st edition) is 93 QBtu/year
 - 2003 value in second edition is 98.3 QBtu/year
 - 2011 number from E.I.A. is 97.3 Qbtu/year (recession)
- 10^{20} J/yr = 3×10^{12} W
 - divided by 300 million people (3×10^8) = 10^4 W per person (10 kW)

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The Fall of the Work Animal

- Used to rely completely on animals for transportation
- Trains entered the picture in the mid-1800s
- Cars entered the scene in a big way around 1920
- World has never been the same
- Work animal fell off the map around 1940
- Today automotive is over 95% of the story

Figure 14. Horsepower per capita of all prime movers in the United States since 1850. Only a small fraction of this available horsepower is in use at any given time. (Source: Historical Statistics of the United States, Colonial Times to 1970; Statistical Abstracts of the United States 2003; Washington, D.C.: U.S. Department of Commerce, Bureau of the Census.)

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Global Amounts and trends

- Doubled energy use in 36 years: 2% growth
 - Mtoe is million tons oil equivalent: 1 toe is 39.7 MBtu
- Fraction in fossil fuels went from 87% to 81%
 - still a fossil-dominated world: renewables are tiny

*Other includes geothermal, solar, wind, heat, etc.

Spring 2013 graphic from IEA: Key World Energy Statistics 6

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Evolution of Energy Sources

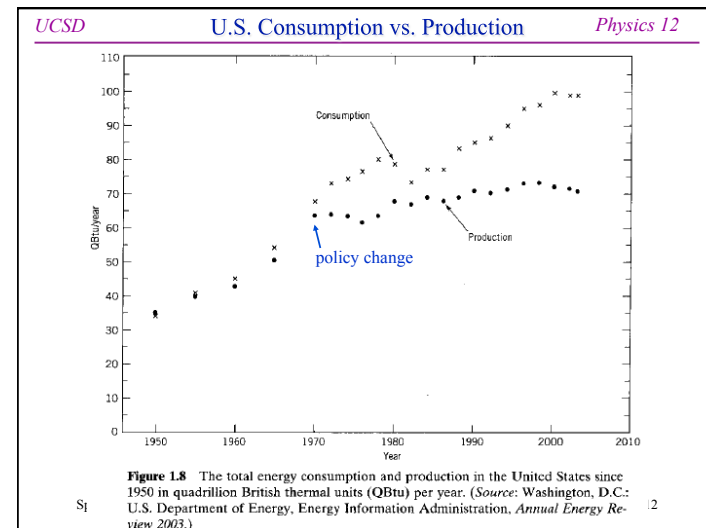
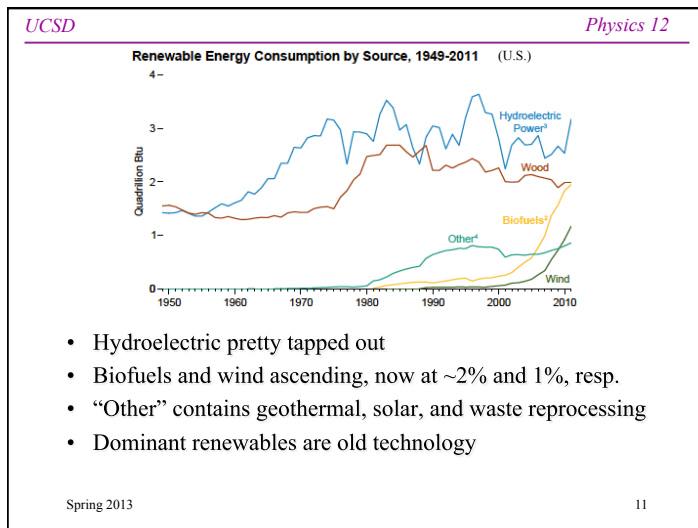
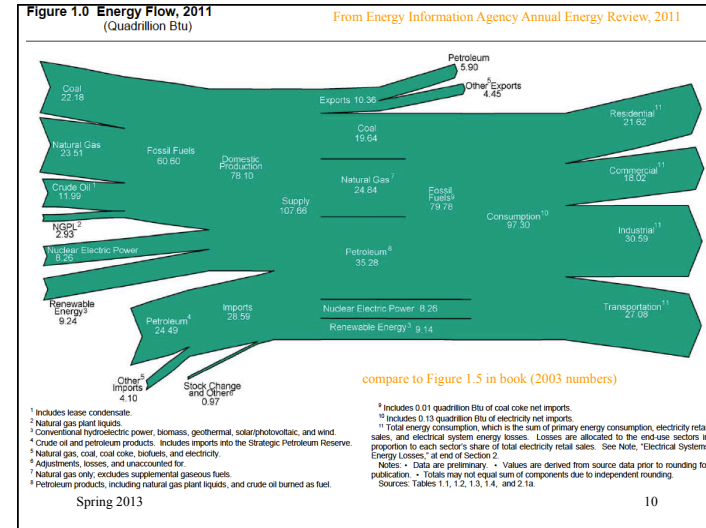
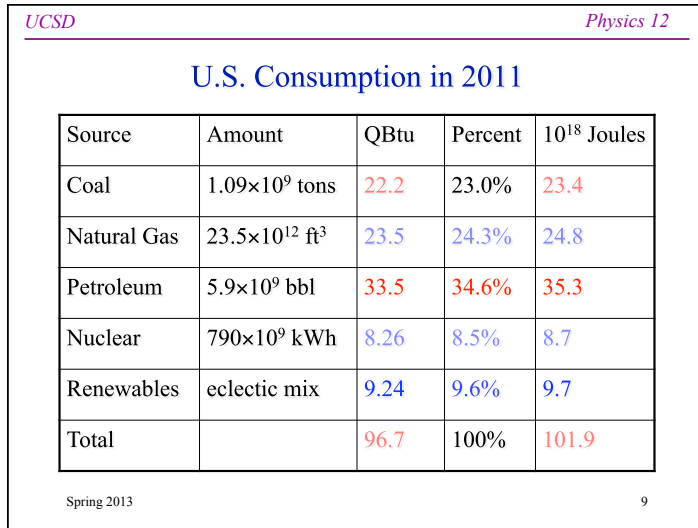
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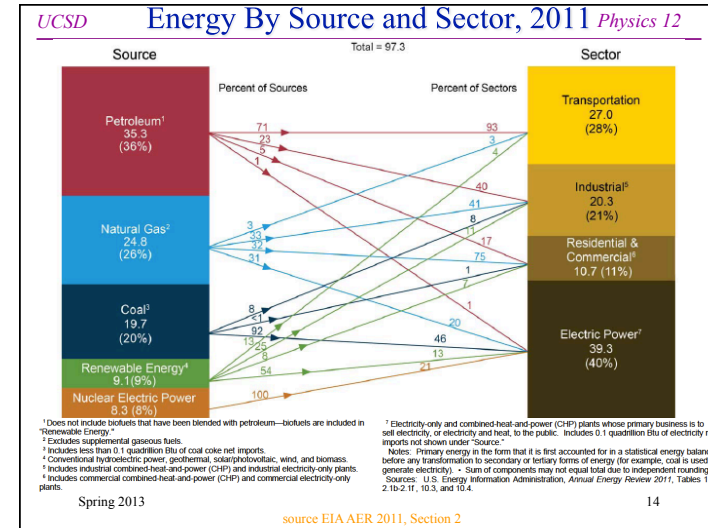
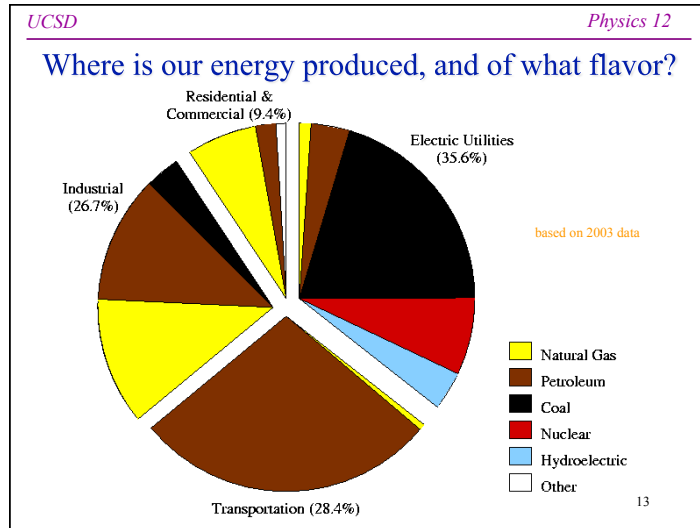
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U.S. Consumption in 2003

Source	Amount	Qbtu	Percent	10 ¹⁸ Joules
Coal	1.08×10 ⁹ tons	22.6	23%	23.8
Natural Gas	21.8×10 ¹² ft ³	22.5	22.9%	23.7
Petroleum	6.72×10 ⁹ bbl	39.1	39.8%	41.3
Nuclear	757×10 ⁹ kWh	7.97	8.1%	8.4
Renewables	578×10 ⁹ kWh	6.15	6.3%	6.5
Total		98.3	100%	103.7

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Interpreting the Spider Web

- The stacks themselves are straightforward
 - the left-hand stack you've already seen in other forms
- The connecting lines indicate % use of each branch
 - for instance, 93% of transportation comes from petroleum, 3% from natural gas, 4% from renewables
 - meanwhile, 71% of energy from petroleum goes to transportation, 23% in industry, 5% directly in homes, 1% for electricity
- Nuclear is *all* for electricity, and coal mostly so
 - almost half of electricity comes from coal
- Petroleum is primarily for transportation
- Natural gas is the most versatile, followed by renewables

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Lessons

- Our energy production is completely dominated by fossil fuels: 81%
 - nuclear and hydroelectric make up much of the balance
- Part of our enormous appetite is due to the expanse of our country: transportation is important
- Space heating is also an issue in a country where detached houses are the rule
- Any industrial society (at our current scale) is going to have a large demand for energy

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References & Assignments

- Energy Information Agency Annual Energy Review
 - <http://www.eia.gov/totalenergy/data/annual/index.cfm>
- International Energy Agency Key World Energy Statistics
 - http://www.iea.org/publications/freepublications/publication/name_31287.en.html
- A recent amazing book:
 - **Sustainable Energy—without the hot air**, by David MacKay
 - www.withouthotair.com (get book for **free!**)
 - see 10-page synopsis for quick-read/intro
- Another worthy book: *ENERGY: A Guidebook*, by Janet Ramage (more global perspective)
- Assignments
 - Quiz #1 ready on TED, due by 11:59 PM tonight
 - Read Chapter 2
 - Homework #2 to be found on the web: **get an early start!**

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