Energy Overview

Lecture 6

UCSD
Physics 12

Energy Supply and Consumption Overview
Sources and Uses

1973

12,150 Mtoe

6.11 Mtoe

ucsa

Other* = 10.4%
Hydro + wind 10.6%
Nuclear 0.7%
Coal/peat 24.6%
Oil 40.0%
Gas 16.8%

2009

ucsa

Other* = 10.4%
Hydro + wind 10.6%
Nuclear 2.3%
Coal/peat 27.2%
Oil 32.6%
Gas 16.8%

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

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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 x 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 EIA is 97.3 Qbtu/year (recession)
- 10^20 J/yr = 3 x 10^{13} W
  - divided by 300 million people (3 x 10^8) = 10^4 W per person (10 kW)

Reminder: how do we stack up?

Figure 1.3 The Gross Domestic Product (GDP) per capita in U.S. dollars is compared to the total energy consumed per capita in equivalent barrels of oil for several countries. The small quarter-circle at the lower left corner is discussed in the text. (Source: United Nations Statistical Yearbook; data January 2003.)

Figure 1.14 Per capita gross national product and average per capita energy consumption for various countries of the world in 1971. This does not include the energy in the food that is consumed.
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

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

U.S. Consumption in 2003

<table>
<thead>
<tr>
<th>Source</th>
<th>Amount</th>
<th>QBTu</th>
<th>Percent</th>
<th>10^18 Joules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>1.08x10^9 tons</td>
<td>22.6</td>
<td>23%</td>
<td>23.8</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>21.8x10^12 ft³</td>
<td>22.5</td>
<td>22.9%</td>
<td>23.7</td>
</tr>
<tr>
<td>Petroleum</td>
<td>6.72x10^9 bbl</td>
<td>39.1</td>
<td>39.8%</td>
<td>41.3</td>
</tr>
<tr>
<td>Nuclear</td>
<td>757x10^6 kWh</td>
<td>7.97</td>
<td>8.1%</td>
<td>8.4</td>
</tr>
<tr>
<td>Renewables</td>
<td>578x10^6 kWh</td>
<td>6.15</td>
<td>6.3%</td>
<td>6.5</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>98.3</td>
<td>100%</td>
<td>103.7</td>
</tr>
</tbody>
</table>
### U.S. Consumption in 2011

<table>
<thead>
<tr>
<th>Source</th>
<th>Amount</th>
<th>QBTu</th>
<th>Percent</th>
<th>10^{18} Joules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>1.09x10^8 tons</td>
<td>22.2</td>
<td>23.0%</td>
<td>23.4</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>23.5x10^{12} ft³</td>
<td>23.5</td>
<td>24.3%</td>
<td>24.8</td>
</tr>
<tr>
<td>Petroleum</td>
<td>5.9x10^6 bbl</td>
<td>33.5</td>
<td>34.6%</td>
<td>35.3</td>
</tr>
<tr>
<td>Nuclear</td>
<td>790x10^6 kWh</td>
<td>8.26</td>
<td>8.5%</td>
<td>8.7</td>
</tr>
<tr>
<td>Renewables</td>
<td>eclectic mix</td>
<td>9.24</td>
<td>9.6%</td>
<td>9.7</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>96.7</td>
<td>100%</td>
<td>101.9</td>
</tr>
</tbody>
</table>

### Note

- Hydroelectric pretty tapped out
- Biofuels and wind ascending, now at ~2% and 1%, resp.
- “Other” contains geothermal, solar, and waste reprocessing
- Dominant renewables are old technology

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**Figure 1.0 Energy Flow, 2011**


*Compare to Figure 1.5 in book (2003 numbers)*

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**Figure 1.8 The total energy consumption and production in the United States since 1950 in quadrillion British thermal units (QBTU) per year.**

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
References & Assignments

- Energy Information Agency Annual Energy Review
  - http://www.eia.gov/totalenergy/data/annual/index.cfm

- International Energy Agency Key World Energy Statistics

- A recent amazing book:
  - Sustainable Energy—without the hot air, by David MacKay
  - www.withoutthehotair.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!