Peak Oil and Energy Transition

Energy in a Historical Perspective

- Slaves
- Domestic animals
- Wind and water
- Steam (ships and locomotives)
- Gasoline (internal combustion followed by turbine engine)
- Nuclear
Global Primary Energy Sources

- Oil
- Coal
- Gas
- Combustionable renewables and waste
- Nuclear
- Hydro
- Geothermal/Solar/Wind

Global Primary Energy Supply

Share of Total Primary Energy Supply* in 2004

Evolution of Total Production of Energy from 1971 to 2004

– Estimated reserves: educated guesses about the location and size of oil or natural gas deposits
– Proven reserves: how much oil can be economically obtained from the oil field
– Production: withdrawal of oil or gas from the oil field

Fossil fuels formation
Fossil fuels formation

Problems concerning the dependence on oil and other fossil fuels

- Oil is the primary source of energy for transportation
- Most industrial nations are net importers of oil
- Access to oil reserves are usually guaranteed by a military might
- The military spendings associated with the operations to maintain access to oil production regions are about $61 per barrel:
  
  So the real cost of oil is:
  
  \[
  \text{initial costs} + \text{military support services} = \text{91 per barrel of oil}
  \]

- Production, transportation and consumption of fossil fuels are the basic sources of pollution
- The price of the oil is increasing and not stable
- Burning fossil fuels is increasing the greenhouse gas concentrations and accelerating global warming
- Fossil fuels are being depleted in an increasing rate, and the prices are increasing
Depletion of Oil: Hubbert’s curve

• Fundamental assumptions behind Hubbert’s curve
  – With increased cumulative production, production increases (the reinforcing production loop)
  – With diminishing reserves, production declines (the balancing depletion loop).
• Uncertain factors influencing the scale and timing of the peak on the Hubbert’s curve.
  1. Total reserve.
  2. Growth in energy demand.
  3. Other factors influencing production rate (prices, conservation efforts, technology, substitutes etc.)

Fundamental assumptions are decisive over above uncertainties, such that the pattern is insensitive.
World Production Peak

Oil Prices
Adjusting to Higher Prices

To increase the oil production
• Exploratory drilling is stepped up
• Fields that had been closed down as uneconomical were reopened

To decrease consumption of crude oil
• Standards were set for automobile fuel efficiency
• Conservation efforts via insulation in building and increased efficiency in appliances were increased
• The development of alternative energy sources was begun

Other Fossil Fuels

• Natural gas – 50-year supply
• Coal – 400-year supply
• Shale and sand oil, shale gas – complex extraction technologies.
### Table 12-3 CO₂ Emissions per Unit Energy for Fossil Fuels
(Natural Gas = 100%)

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Emissions (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas</td>
<td>100%</td>
</tr>
<tr>
<td>Gasoline</td>
<td>134%</td>
</tr>
<tr>
<td>Crude Oil</td>
<td>138%</td>
</tr>
<tr>
<td>Coal</td>
<td>178%</td>
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</tbody>
</table>

*Source: Data from Energy Information Administration, U.S. Department of Energy.*

References

- Tim Appenzeller, “The End of Cheap Oil”, *National Geographic Magazine*, June 2004
- BP Statistical Review of World Energy, 2002