Climate Change and Energy

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UALR
INCREASES IN POPULATION = INCREASES IN ENERGY DEMAND

ENERGY USAGE.... HISTORY

EARLY ENERGY USAGE.. SMALL POPULATION DENSITIES.

COMBUSTION - WOOD – Cooking, Heating, Pottery, Metallurgy – Charcoal

HUMAN POWER – Homes, Farming, Larger Populations → Pyramids

ANIMAL POWER – Horses, Oxen – Farming, Transportation...

WATER POWER – MILLS - Where you had accessible streams...

WIND POWER – MILLS – Where and when you had wind...

THEN CAME THE STEAM ENGINE and THE INDUSTRIAL REVOLUTION..
STEAM ENGINE

• James Watt ---- Watt is unit of Power

1712, Thomas Newcomen

1769 Watt Improves Engine
Steam Powered Locomotives

- Early 1800s

WOOD FIRED STEAM ENGINES
# Heating Values of Carbon Fuels

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Heating value (kJ/g)</th>
<th>Heating value (Btu/lb&lt;sub&gt;mass&lt;/sub&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>17</td>
<td>7700</td>
</tr>
<tr>
<td>Soft coal</td>
<td>23</td>
<td>10000</td>
</tr>
<tr>
<td>Hard coal</td>
<td>35</td>
<td>15000</td>
</tr>
<tr>
<td>Fuel oil, gasoline</td>
<td>44</td>
<td>19000</td>
</tr>
<tr>
<td>Natural gas</td>
<td>54</td>
<td>23000</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>143</td>
<td>61000</td>
</tr>
</tbody>
</table>

Table 15-1
Wood 17.5-18.3 – 12% moisture
Gasoline, Kerosene 41-48
Methane – 55.6
Propane 50.3
N-Butane- 49.5

Wood, Coal, Gasoline, Natural Gas – MIXTURES.. So they Vary in Heating Content!
JOINING OF CONTINENTAL RAILROAD – May 10, 1869

Coal Fired Steam Engines...
World Population reached:
1 billion in 1804
2 billion in 1927 (123 years later)
3 billion in 1960 (33 years later)
4 billion in 1974 (14 years later)
5 billion in 1987 (13 years later)
6 billion in 1999 (12 years later)

Unless we reduce our growth rate soon, World Population will reach:
7 billion in 2013 (14 years later)
8 billion in 2028 (15 years later)
9 billion in 2054 (26 years later)

U.S. and world combustion of coal (in millions of metric tons) has increased steadily from 1937 to the present. It is expected to increase even more between now and beyond 2040.

Mauna Loa CO₂ record
trend at Mauna Loa from Dec. to Dec. each year

Projection of CO₂ and Temperature to 2100
CO2 at 280 ppm for LONG TIME.

Then Industrial Revolution

Increasing use of energy – increases in food, etc. – increases in population!

Feedbacks.

Atmospheric Carbon Dioxide
Measured at Mauna Loa, Hawaii

Carbon dioxide concentration (ppmv)


Annual Cycle

Jan Apr Jul Oct Jan

CHARLES DAVID KEELING
Climate Science Pioneer
1928-2005
Biospheric Cycling

Northern Hemisphere
Mauna Loa
Keeling, et. al

Southern Hemisphere
Samoa
**Double Danger From CFCs**

Fully halogenated CFCs and many of the compounds being considered as alternatives have the potential both to deplete stratospheric ozone and to contribute to possible global greenhouse warming through the absorption of infrared energy. In this graph, the ozone-depletion and global-warming potentials are represented for various compounds relative to CFC-11, which is given a value of 1 on both axes. The circles are proportional in area to the compounds’ atmospheric lifetimes. The fully halogenated CFCs have long lifetimes and considerable potential to contribute to both problems. The hydrochlorofluorocarbons (HCFCs) break down much faster in the atmosphere and therefore have only about 2–5% of the ozone-depletion potential of CFCs. The hydrofluorocarbons (HFCs) contain no chlorine to threaten stratospheric ozone, but they do have some potential to act as greenhouse gases.

**Figure 2.10**

Absorption of radiation by gases in the atmosphere.
Radiative Forcing by Tropospheric Aerosols

AEROSOLS AND CLOUDS.. LARGEST UNCERTAINTIES FOR MODELS

VERY IMPORTANT FOR REGIONAL MODELS.... WE LIVE IN REGIONS...

Intergovernmental Panel on Climate Change.. IPCC
Our Planet is not HOMOGENEOUS

GLOBAL CHANGE – Global Climate Models (GCMs)

Wetter!

Present Land Area of Florida
Remaining Florida Land Area After 4-8 Meter Rise in Mean Sea Level
(extreme case)

DRIER!!

Hotter!

Colder!

Have you heard the latest? Dublin may become as cold as Spitzbergen in the Arctic circle because of global warming...
CHANGING ENERGY SOURCES REQUIRES CHANGING MAJOR INFRASTRUCTURES GLOBALLY

PROJECTIONS ARE FOR FOSSIL FUEL COMBUSTION TO CONTINUE....

NOTE THAT THE ENERGY DEMANDS ARE HUGE...

BILLIONS OF TONS OF OIL PER YEAR..
FOSSIL FUEL COMBUSTION..... NOT RENEWABLE OR SUSTAINABLE OVER LONG TERM...

PROJECTIONS.. NEXT FEW YEARS.. DEMAND WILL OVERCOME SUPPLY... ARE WE THERE ALREADY?

DEMAND IS HUGE.. AND GROWING..

GCM’s EXAMINE VARIOUS SCENARIOS..

Business as Usual...

Modest and Gradual Change towards Sustainable Energy

CLIMATE CHANGE WILL LIKELY ADD TO ENERGY DEMAND.

HOTTER... Need Air Conditioning

COLDER ... Need Heating

WATER IS ALSO CONNECTED TO ENERGY AND CLIMATE....
CLIMATE CHANGE.. Linked to

AIR QUALITY

WATER QUALITY

HEALTH  - From Heat Stress to More Tropical Disease.. West Nile Virus..

ENERGY NEEDS ... Linked to

AIR QUALITY

WATER QUALITY

HEALTH

AND BOTH ARE TIED TO POPULATION GROWTH AND WHAT LEVEL OF QUALITY OF LIFE for SUSTAINABLE GLOBAL ENERGY USAGE... MORE ON THIS ON WEDNESDAY!
After taking all of human history for population to reach one billion, it took only a little over a century to reach two billion in 1930. The third billion was added in just 30 years, the fourth in only 15 years.
LIGHTS FROM SPACE.... NASA

POPULATION MOVED FROM RURAL TO URBAN CENTERS
RESOURCES ARE NOT LIMITLESS.

IF DEMAND STAYS HIGH.

WE WILL BE FACING SHORTAGES

AS WELL AS CLIMATE CHANGE!

REQUIRES A BETTER UNDERSTANDING OF HOW THE EARTH SYSTEM WORKS.. For
BEST APPROACHES TO BE DEVELOPED..

ENERGY PORTFOLIO APPROACH LIKELY IN FUTURE.. AND CHANGE IS INEVITABLE...
TUESDAY...

CLIMATE MODELING...

NEED FOR BETTER PLANNING.. SOLUTIONS and ADAPTATION...

WEDNESDAY....

SLOWING THE CHANGE DOWN..

and GRADUATE SCHOOLS..

BECAUSE THERE WILL BE LOT OF WORK TO DO AND OPPORTUNITIES!