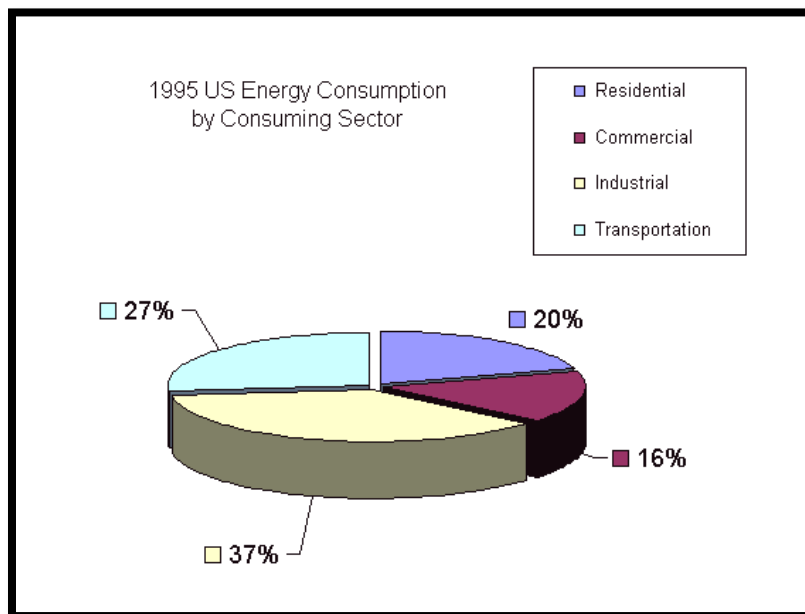


Total Energy Usage

Our total energy use can be divided into three principal areas each of which consume approximately equal amounts of energy on an annual basis:

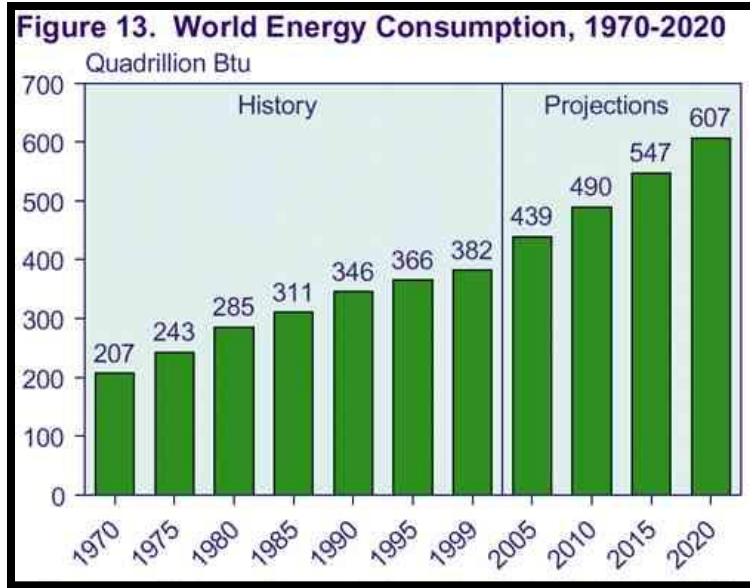
- Electricity Generation
- Space Heating
- Transportation

World Energy Consumption:



Fossil Fuels come in 3 principal forms from which many other products are derived:

- Coal
- Natural Gas
- Crude Oil



Most traditional Energy production comes about using steam driven turbines so the heating of water is what is essential.

- Coal Fired Steam
- Nuclear Fired Steam
- Oil/Natural Gas Fired Steam

The next table shows the Percentage changes in the number of quads delivered by various energy forms from 1973 to 1994

oil	- 1 %
natural gas	- 6%
coal	+ 33% Large Reserves in US
nuclear	+ 87% Most of this in 1970's
hydro	+ 3%
biomass	+ 18% Co-generation in Midwest

The primary energy input to generate electricity was 30.9 quads. About 2/3 of the energy was lost in conversion processes, leaving about 10 quads as electricity. 2/3 of the delivered energy was delivered to the residential/commercial sector and 1/3 to industry.

Electricity as a percentage of total energy use has been increasing ever since electricity was introduced. In 1973 about 25% of primary energy used to make electricity. In 1994 the percentage of energy used to make electricity had increased to 34% of total energy.

The Need for Alternative Energy

- Basic concept of alternative energy sources relates to issues of sustainability, renewability and pollution reduction.
- In reality, Alternative Energy means anything other than deriving energy via Fossil Fuel combustion
- Basic Barrier to all forms of alternative energy lies in initial costs

The simple problem is that there are simply not enough fossil fuels left to sustain its usage as the foundation of our energy production. Forget about global warming for the moment, the issue is more basic than that.

Intensive scientific interest has been paid in the last few decades to the possible consequences of human activities on earth climate .One main such activity is considered to be the increasing levels of atmospheric CO₂ concentrations.

The possible effect of CO₂ spectral infrared absorption properties on the earth climate was first discussed by Arrhenius who pointed out that reducing atmospheric CO₂ levels by half, may bring Europe into an ice age. These concerns have triggered the international community

to establish the “Intergovernmental Panel on Climate Change” IPCC in 1988. This panel of a large number of scientists is concerned with the task of assessing the effect of CO₂ and other gases on the earth climate. The IPCC issued several reports since it was established. The IPCC used all published results related to climate change to build its famous IPCC2007 report .The most important conclusion in this report is that there is at least 90% probability that the earth climate is getting warmer as a result of the increase of CO₂ emissions. Even so, there has been a significant number of research works which tend to dispute the results of the IPCC 2007 report arguing that the observed climate change cannot specifically linked to increased atmospheric CO₂ concentration. Reasons such as natural cyclic weather changes or sun activity are blamed for any climate change observed .A compilation of many references related to both sides of the argument can be found in reference.

Forms of Alternative Energy:

- **Solar:** Advantages: Always there; no pollution

Disadvantages: Low efficiency (5-15%); Very high initial costs; lack of adequate storage materials (batteries); High cost to the consumer

- **Hydro:** Advantages: No pollution; Very high efficiency (80%); little waste heat; low cost per KWH.

Disadvantages: Fish are endangered species; Sediment buildup and dam failure; changes hydrological cycle
- **Wind:** Advantages: supplemental power in windy areas; best alternative for individual homeowner

Disadvantages: Highly variable source; relatively low efficiency (30%); more power than is needed is produced when the wind blows; efficient energy storage is thus required
- **Geothermal:** Advantages: very high efficiency; low initial costs since you already got steam

Disadvantages: non-renewable (more is taken out than can be put in by nature)
- **Ocean Thermal Energy Conversion:** Advantages: can be used on large scale; exploits natural temperature gradients in the ocean

Disadvantages: extremely high cost; Damage to coastal environments
- **Tidal Energy :**Advantages: Steady source; energy extracted from the potential and kinetic energy of the earth-sun-moon system; can exploit bore tides for maximum efficiency

Disadvantages: low duty cycle due to intermittent tidal flow; huge modification of coastal environment; very high costs for low duty cycle source
- **Hydrogen Burning:** Advantages: very high energy density; good for space heating

Disadvantages: No naturally occurring sources of Hydrogen; needs to be separated from water via electrolysis which takes a lot of energy; Hydrogen needs to be liquefied for transport - takes more energy.
- **Biomass Burning:** Advantages: Biomass waste (wood products, sewage, paper, etc) are natural by products of our society

Disadvantages: Particulate pollution from biomass burners

