Energy Sources & Energy Consumption

Biological systems are generally powered by chemical reactions of some sort. In the case of animals these reactions generally involve the oxidation ("burning") of some fuel with the resulting liberated energy being used to facilitate activities such as metabolism, thinking, and motion. Other systems, such as plants, make use of sunlight and the processes of photosynthesis to power the chemical reactions necessary for growth. Yet others use the products of geothermal processes found deep beneath the seas to power their metabolisms. The processes used by the Earth's earliest life forms were very different from those found today. But the processes of life are largely based on chemistry.

One life form makes use of many power sources to generate the heat necessary for its survival and the maintenance of its cultures and societies. The principal external energy source used by primitive man (after the warmth of the Sun) was the burning of wood and similar materials following the "discovery" of fire - or, rather, the realization that fire could be controlled and used productively. Modern human civilizations now derive energy from many other sources - although the burning of wood remains important in many parts of the world.

Assignment due 24 October 2008:

1. Compose a list of the basic energy sources presently available, or potentially available, for human use . (Offhand, I can come up with about a dozen, beginning with Coal, Oil, ...)

2. Find out the present contribution of each to world energy production and consumption. (Expect to be a bit surprised.) Put everything in metric units (power in watts, energy in joules); look up conversion factors where necessary. (*e.g.*, How many joules in a BTU?)

3. Most of these energy resources are basically "solar" in origin since they really owe their existence to the effects of solar radiation on the Earth and its systems. Explain this statement. Which of the sources on your list do not arise as a consequence of solar radiation?

4. A few of the items on my list ("potentially available") have not really been utilized to produce commercially useful power, mostly because they require technologies yet to be developed, are not yet cost-effective, or possibly never will be. Find some examples or energy resources in this category and describe them. Why have they not yet been implemented?

Astronomy 301G
15 October 2008

A partial list:
1. Coal (and Peat) ~23%
2. Oil ~40%
3. Natural Gas ~23%
4. Biomass (Wood, grain-based ethanol,...)
5. Hydroelectric ~ 7%
6. Wind
7. Solar Direct (concentrators, photovoltaics)
8. Tidal
9. Geothermal
10. Nuclear ~7% (About 1% in biomass, wind, solar, geothermal, etc.)

Items 1 - 7 are all basically solar, assuming that the first three are of biological origin. See, however, Gould, "The Deep Hot Biosphere" for the view that mush of the terrestrial methane is primordial and that non-photosynthetic biological activity might be the origin of natural gas and petroleum. Solar radiation dominates the surface heating of the Earth and drives the weather (wind) and evaporation of water. Tidal flows are driven mostly by a combination of lunar and solar gravitational influences, the solar contribution to the tidal force is about 30% of the total. The internal heat of the Earth which provides the source of geothermal power (usually in the form of superheated water) is partly of primordial origin and partly produced by the decay of naturally occurring radioactive isotopes - also of primordial origin. These same elements (principally the isotopes of uranium) are mined and refined to provide the fuels for nuclear power reactors. (Or thermopile-based nuclear "batteries"). "Nuclear" is nuclear fission; nuclear fusion is still underdevelopment.

Other sources might include:
11. Oceanic temperature gradients (produced mainly by solar heating)
12. Atmospheric electric gradients (see the trials by Nicolai Tesla)
13. Methane ice ("frozen" methane under high pressure at the sea floor)
14. Geomagnetism (see proposal for a "tethered" spacecraft)

Number 12 is of basically solar origin, being generated by air currents arising from solar heating. If the methane is of biogenic origin then it too can be considered "solar".

One should, perhaps, add some other "chemical" sources: One can make electric "batteries" from naturally occurring chemicals and that other types of energy releasing chemical combinations can be found in nature. Nitrates, for example, can be powerful oxidizing agents and form the basis for many explosive mixtures. The traditional source of nitrates in the nineteenth century and before was guano from birds and bats. (Of course, "buffalo chips" are also a fuel source.) But there are energy-generating "inorganic" (i.e., non-biogenic) chemical in nature.

Note: Hydrogen alone (as opposed to its presence in hydrocarbons) is not really available as a fuel but is, rather a storage mechanism. Its production requires the expenditure of energy.