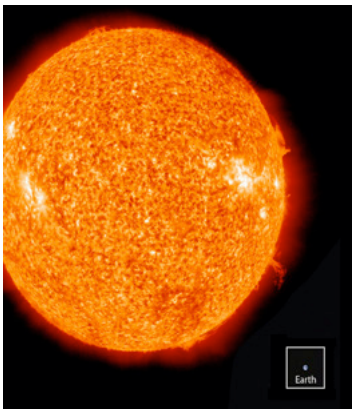
Chapter 17: Detailed Summary

Capturing Energy



Electricity is a carrier of energy—not a source of energy. To create electricity, one needs a source of energy, such as solar energy or the burning of a fossil fuel. This energy is used to turn a loop of wires within a magnetic field. This produces an electric current, which can be sent over long distances. *Power* is a measure of the rate at which energy is delivered. A lot of power means a lot of energy in a short period of time. The same amount of energy delivered over a longer period of time provides less power. The unit of power is the *watt*, which equals 1 joule per second. The typical U.S. household requires power at a rate of about 800 watts, which is 0.8 kilowatt. The amount of energy consumed is given in units of *kilowatt-hours*.

Fossil fuels are found throughout the globe, but in some places more so than in others. The Middle East nations are well known for their large petroleum reserves, which is about 65 percent of the world's supply. The United States has large deposits of coal, which add up to about 26 percent of the world's supply. The former Soviet Union (39 percent) just edges out the Middle East (34 percent) for having the world's largest supply of natural gas. But fracking technologies within the U.S. have made this country the leading exporter of natural gas. A fourth form of fossil fuel is the methane hydrates, which are deposited along the sea floor throughout the planet. The supply of methane hydrate likely exceeds all other fossil fuels combined. Because it is more difficult to collect, however, this energy source has yet to be developed.

Coal is the filthiest of fossil fuels in that it contains large amounts of such impurities as sulfur, toxic heavy metals, and radioactive isotopes. Petroleum is the preferred fuel because of its liquid form, which is relatively easy to transport. Petroleum is also versatile. It contains all the commercially important hydrocarbons, such as those that make up gasoline, diesel fuel, jet fuel, motor oil, heating oil, tar, and even natural gas. The purest of fossil fuels is natural gas, which is found in petroleum but also in vast deposits in underground geologic formations. Natural gas burns cleaner than petroleum or coal. It also can be used to generate electricity with great efficiency by way of the gas turbine. There are two types of natural gas: one containing primarily methane, CH_4, and the other containing primarily propane, C_3H_8.

As discussed in Chapter 5, there are two forms of nuclear energy. Nuclear fission is currently used for all nuclear power plants. European nations generate the greatest percentage of electricity by nuclear fission. In France, for example, close to 80 percent of all their electricity comes from nuclear fission power plants. In the United States, less than 20 percent of electricity is of nuclear origin. Early nuclear power plant designs are dependent upon active stability, whereby active measures, such as the shutting down of a vent, are in place to prevent meltdowns. New reactor designs now call for passive stability, in which natural processes, such as evaporation, are used to keep the reaction core

cool. Also, new power plant designs call for small, more modular nuclear power plants that are easier to manage.

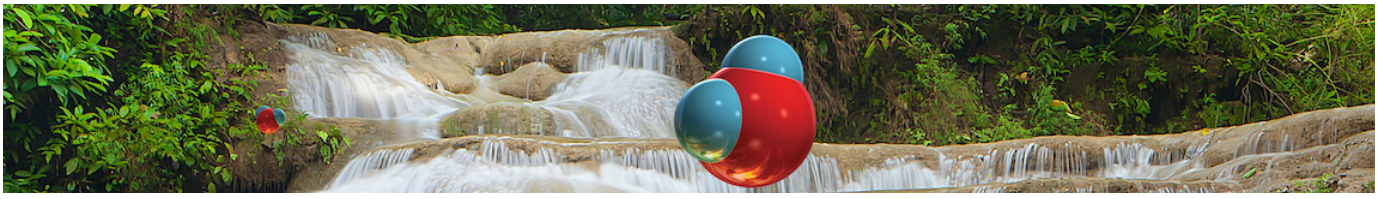
The building of a nuclear fusion power plant poses a much greater technical challenge. The first operational fusion nuclear power plant is under development in Caderache, France. Nuclear fusion is a potentially much cleaner form of energy in that it generates few radioactive wastes and no air pollution.

There are numerous energy sources that may supplement or even replace fossil and nuclear fuels. Of these, hydroelectricity offers the greatest amounts of power. The immense Three Gorges Dam in China, for example, has a generating capacity of about 22,000 MW. For comparison, a typical nuclear power plant supplies about 1500 MW. This dam, however, has had and will continue to have a significant environmental impact. Other energy sources involving water include ocean thermal energy conversion (OTEC), geothermal energy, and energy harnessed from ocean tides.

Growing plants capture energy from the sun through photosynthesis. We can access this *biomass* energy in two ways: process the biomass to produce transportable fuels, or burn the biomass to produce electricity. In the United States, ethanol obtained by the fermentation of grain currently accounts for about 1 percent of the nation's transportation needs, while about 10,000 MW of electricity are produced through the combustion of biomass. Currently, much research is going into the development of methods to extract fermentable sugars from cellulose, which, as discussed in Chapter 13, is the most abundant organic chemical on this planet. Biofuels can also be obtained in high yields from certain strains of algae, which is another area of intense research.

There are numerous ways in which we can tap into the energy of sunlight. We can use the sun's rays, for example, to heat our homes by way of well-placed insulated windows. Household water can also be heated within a rooftop solar energy collector. Mirrors and lenses can concentrate sunlight onto water to create steam for generating electricity. Sunlight causes winds, which can drive electricity-producing wind turbines. Modern turbines generate electricity at a cost comparable to conventional sources. Also, as discussed in Chapter 11, photovoltaics generate electricity directly from sunlight.

Much attention has been given to hydrogen as a "fuel of the future." Indeed, hydrogen is an ideal fuel in that it produces only water vapor when it burns. Its gaseous form, however, poses significant technical challenges. Also, how the hydrogen is generated is of great importance. If conventional sources such as coal are used, then little is to be gained, except for the development of infrastructure that would be there when significant amounts of hydrogen can be produced from more sustainable energy sources.



Summary of Terms

Biomass A general term for plant material.

Coal A solid consisting of a tightly bound network of hydrocarbon chains and rings.

Kilowatt-Hour The amount of energy consumed in 1 hour at a rate of 1 kilowatt.

Natural Gas A mixture of methane plus small amounts of ethane and propane.

Petroleum A liquid mixture of loosely held hydrocarbon molecules containing not more than 30 carbon atoms each.

Power The rate at which energy is expended.

Watt A unit for measuring power, equal to 1 joule of energy expended per second.