

commercial and residential users. For example, Cambridge Electric in Massachusetts has long sold its steam to Harvard University. The Key-Span company of Brooklyn, New York, is building cogeneration plants that will produce electricity from natural gas and will sell the heat by-product to hospitals, apartments, and the city jail complex (Silver 2000, 4).

### Renewable Energy

Renewable energy—not counting hydroelectricity—accounted for slightly less than 5% of total energy output in America in 1999, but renewable sources produced 26% more power than in 1990. Renewable energy sources are much less damaging to the environment and are becoming more economically competitive with conventional sources. The U.S. DOE (2000, 28) expects the amount of energy from renewable sources to nearly double between 1998 and 2020.

### Wind

Wind energy can be generated on a commercial basis by wind turbines that reach up to 250 feet high, have blades of more than 100 feet long, and are located on windy hilltops. Although wind energy produces no pollution, the siting of several turbines on a wind farm can be controversial because of the visual impacts on the landscape. In addition, wind turbines may be fatal to birds and they produce some noise. However, wind energy has substantial potential. North Dakota has an estimated capacity to generate 250 *gigawatts* from wind power; compare this to the Grand Coulee Dam, one of the nation's largest hydroelectric dams, which produces just over 6 gigawatts of electricity (Dashefsky 1993, 264). (A watt is a measure of electrical power equal to 1 joule per second. A kilowatt is 1,000 watts. A megawatt is 1,000 kilowatts or 1 million watts, and a gigawatt is 1,000 megawatts or 1 billion watts).

The 107-megawatt wind power plant near Lake Benton, Minnesota—one of the largest in the

world—can provide electricity to 43,000 homes (*ibid.*, 23). By the end of 2001, wind generators were expected to produce enough electricity for 1.7 million U.S. homes (Jehl 2000b, 46). Several states allow small-scale power system owners to sell electricity generated by methane, sun, and wind to the grid at the retail price, but commercial utilities are also getting into the electricity from wind business.

A major issue with the development of wind energy is the siting of turbines. Typically, ridgelines and hilltops are ideal for turbines. Yet, there may be visual impacts on neighboring landowners, and the turbines produce noise when the blades are spinning. While states have regulations governing the siting of electrical power plants, local governments would be wise to establish standards for the siting of wind generators.

### Solar Energy

Nationwide, an estimated 156,000 homes used solar energy in 2002 (Rocky Mountain Institute 2002). Solar energy can provide hot water, electricity, and even cooling for homes, businesses, and industry. Solar energy systems come in two forms: active and passive. Active systems can provide hot water or electricity. Solar hot water systems feature panels mounted on a roof. The panels contain water or another fluid to absorb heat from the sun. The heated water is then pumped to a heat exchanger, which transfers the heat from the water to the home hot water heater. Hot water systems are used to heat homes and thousands of home swimming pools.

Photovoltaic cells mounted on roof panels convert sunlight to electricity. The cost of photovoltaics has come down in recent years, making them attractive for individual home use. The creation of large active solar power plants remains to be seen.

Passive systems feature trombe walls and barrels filled with water that heat up to provide space heating and hot water. Also, a solarium is a room that has a south to southeast exposure to

capture sunshine; when the solarium heats up, the heat can be blown by fan to other parts of the house.

Solar energy use varies by time of year (hours of daylight) and geographic location. Solar energy has particular application in the southern and southwestern states where daylight hours are longer on average and there are more sunny days than in the northern states. Access to sunlight in the design of new buildings, and the retrofitting of older buildings and construction on neighboring lots to maintain solar access, are all important considerations for promoting solar energy. Local governments have enacted solar access ordinances so that new construction or alterations to existing buildings do not reduce the potential to use solar energy on neighboring properties.

### **Geothermal Energy**

Geothermal energy is the tapping of the earth's heat primarily for turning turbines to make electricity. Deep geothermal sources are found only in a relatively few places—primarily in California and other western states where hot springs and volcanic activity are fairly common. By the late 1990s, geothermal sources generated about 6% of California's electricity. Also growing in popularity are heat pumps that draw on shallow geothermal sources. Contamination of groundwater is possible because some heat pumps use antifreeze. Geothermal heat may also be passive. For instance, "berm houses" are built partially underground to take advantage of the earth's relatively stable temperature. Typically, an earth berm is constructed outside the north-facing wall. Berm houses can easily be built to combine passive solar heating, with a southeast exposure and trombe walls, or active solar photovoltaic cells on the roof.

### **Biomass Energy**

Biomass is energy from plant and animal products and includes: the burning of wood chips; ethanol

from corn; and methane gas from animal manure, garbage, and composting wood. The burning of wood chips to generate electricity is a way to use harvest slash and lumber pieces that would otherwise end up abandoned or in landfills. However, the burning of wood chips raises air pollution concerns. Ethanol from corn has been widely used in midwestern Corn Belt states to power cars, usually as a mix with ordinary gasoline. A potential problem with ethanol is a harmful effect on the engine's carburetor that mixes air and fuel. Methane is naturally produced by decomposing organic matter. On livestock farms, animal manure digesters can capture methane gas to generate electricity. For example, Mason-Dixon Farms near Gettysburg, Pennsylvania, produces virtually all of the electricity used on the 2,000-head dairy farm. Decomposing garbage at landfills produces methane, which is increasingly sold to nearby users for generating electricity. Although methane is a greenhouse gas with more than 20 times the concentration of carbon dioxide, harnessing it as an energy source, rather than letting it escape into the atmosphere, makes sense (see Chapter 6).

### **Hydrogen Fuel Cells**

Hydrogen fuel cells, touted as a coming technology to power cars, can also be used to generate heat and electricity for homes and commercial buildings. Hydrogen fuel, derived from natural gas, is passed through a membrane to produce electricity and generates heat and water as by-products. The only long-term drawback to hydrogen fuel cells is the use of natural gas as a feedstock.

## **FEDERAL ENERGY PLANNING**

There are four federal agencies that deal directly with energy issues:

1. the DOE;
2. the EPA;
3. the Bureau of Land Management (BLM) within the Department of the Interior; and