

## CHAPTER 14

# ENERGY RESOURCES – ALTERNATE SOURCES

### Important Concepts

1. Alternate energy resources include nuclear power, solar energy, geothermal power, hydropower, tidal power, wind energy, and biomass.
2. *Nuclear power* can be generated by the processes of *fission* and *fusion*. Commercial nuclear reactors employ fission, in which heavy atomic nuclei (such as atoms of U-235 isotope) are split into smaller nuclei with the release of a large amount of heat energy. Research continues into the development of fusion reactors that would allow fusion of light atomic nuclei (such as atoms of hydrogen and its heavier isotope deuterium), resulting in the release of heat energy. The heat energy generated by nuclear reactors is converted into electricity.
3. Although fusion energy is cleaner than fission energy, substantial technological problems remain to be solved before fusion energy can become commercially viable.
4. The essence of the design of a *breeder reactor* is to produce by the fission process more nuclear fuel than it consumes. The deployment of breeder reactors, if and when they become commercially viable, would extend the reserves of uranium, the basic fuel for fission reactors.
5. The generation of fission nuclear power poses many potential hazards: safety of the reactors (including *core meltdown*, possible sabotage); processing and handling of the nuclear fuel; and the disposal of nuclear wastes containing radioactive substances that would remain potent for a long time. Because of such concerns, no new nuclear plants have been built in the United States since 1978.
6. *Solar energy* represents an essentially inexhaustible, relatively pollution-free resource; however, several practical limitations exist. Sunlight is a very dispersed resource and is variable in intensity. Photovoltaic cells, or solar cells, used for converting solar energy into electricity are rather inefficient and expensive, making them inadequate for energy-intensive applications.
7. *Geothermal energy* is the energy derived from the earth's hotter interior. Most geothermal power plants are located at or near lithospheric plate boundaries. Although geothermal energy is largely pollution-free and can be economically competitive with conventional methods of generating electricity, the short life of geothermal fields, the stationary nature of the resource, and the small number of suitable sites for geothermal power generation have prevented geothermal power from being a significant contributor to the world's energy supply scenario.
8. *Hydropower* is a clean, renewable energy source that is competitive with other methods of producing electric energy. Like geothermal power, enhancing the hydropower generation capacity is limited by the lack of practical sites and the stationary nature of the resource. In addition, dams that will have to be built for the generation of hydropower pose some significant environmental problems (see chapters 6 and 10).
9. *Tidal power* harnesses the energy of moving water associated with the tides. Worldwide, the lack of sites where commercial tidal-power plants are feasible severely limits the use of tidal power as an energy source.
10. *Wind energy* is a clean, renewable resource. It is limited by being a dispersed resource and subject to the erratic behavior of the wind. Storage of electrical energy produced by wind power is another problem.
11. Biomass fuels are derived from living or recent organisms and are therefore renewable. Like fossil fuels, they may enhance the greenhouse effect by releasing carbon dioxide when burned. Examples of biomass fuels include wood, alcohol, and methane.

## Key Terms

active-solar heating	gasohol
biomass	geothermal energy
breeder reactor	hot dry rock
chain reaction	insolation
core meltdown	nuclear fuel
decommission (of nuclear reactors)	passive-solar heating
fission	photovoltaic cells
fusion	uranium deposits

## Multiple Choice

1. The fissionable isotope of uranium used in most nuclear power reactors is
  - a. uranium-238.
  - b. uranium-236.
  - c. uranium-235.
  - d. uranium-237.
2. In the United States, most uranium deposits are found in
  - a. limestone.
  - b. granite.
  - c. sandstone.
  - d. rhyolite.
3. Breeder reactors constitute what percentage of nuclear power plants in the United States?
  - a. 0
  - b. 6
  - c. 25
  - d. 65
4. The accident at the Three Mile Island nuclear plant was caused by
  - a. an earthquake.
  - b. partial loss of coolant.
  - c. an explosion of the nuclear fuel.
  - d. saboteurs.
5. All of the following are reasons why no new nuclear power plants have been ordered since 1978 except
  - a. nuclear plants have higher fueling and operating costs than coal-fired plants.
  - b. nuclear plants are more costly to build than coal-fired plants.
  - c. nuclear plants require a long time to plan, build, and license.
  - d. increased concerns over nuclear reactor safety.
6. A Chernobyl-style accident would be unlikely at a commercial nuclear plant in the United States because
  - a. American nuclear plant operators are better trained than Soviet operators.
  - b. American nuclear plants are not located near cities.
  - c. American commercial reactors use a safer nuclear fuel than do Soviet nuclear plants.
  - d. the design of American commercial nuclear reactors is different from that of the Chernobyl reactor.

7. Optimistic projections state that nuclear fission will supply about how much of the total energy used in the United States by the year 2020?
- one-quarter
  - one-third
  - one-half
  - three-quarters
8. The fuel to be used by fusion reactors is
- water.
  - helium.
  - uranium-236.
  - hydrogen.
9. Which of the following is a technological problem that must be solved before fusion reactors become a reality?
- concentrating fuel nuclei at extremely high temperatures
  - containment of fusing nuclei
  - achieving sustained containment time to produce net energy output
  - All of the above are correct.
10. Which one of the following is not an advantage of solar energy?
- It is a widely dispersed resource.
  - It is an inexhaustible resource.
  - It is available at no cost.
  - It is essentially pollution-free.
11. Maximum insolation occurs over the \_\_\_\_\_ United States.
- northeastern
  - northwestern
  - southeastern
  - southwestern
12. Currently, the best experimental solar cells have an efficiency of about \_\_\_\_\_ percent.
- 20
  - 30
  - 50
  - 65
13. Which of the following is not an advantage of geothermal power?
- It is almost pollution-free.
  - It is competitive economically with other methods of generating electricity.
  - There are no ash, radioactive-waste, or carbon-dioxide problems.
  - The useful life of a geothermal field is nearly endless.
14. Hydroelectric power provides about \_\_\_\_\_ percent of the total energy needs of the United States.
- 4
  - 7
  - 12
  - 17

15. Hydroelectric power
- is economically competitive with other methods of generating electricity.
  - supplies about 6% of all energy consumed worldwide.
  - does not pollute the water flowing through the generating equipment.
  - All of the above are correct.
16. A major limitation of hydroelectric power is that
- it is renewable only as long as the streams continue to flow.
  - it is a significant consumer of water.
  - it is limited to the stationary nature of streams.
  - it diverts water from other users.
17. Which region of the United States has the greatest potential for the development of large-scale windmill arrays?
- the Pacific Coast
  - the Great Plains
  - the Rocky Mountains
  - the New England states
18. In 1995, wind power accounted for what percentage of the electric generating capacity of the United States?
- about 3
  - about 7
  - 9
  - 20
19. The biomass energy source that provides about one-third of Hawaii's electricity is
- wastes from pineapple processing plants.
  - wastes from sugar-cane processing plants.
  - fish oil.
  - coconut fiber.
20. The gaseous fuel obtained from sanitary landfills is
- hydrogen.
  - carbon monoxide.
  - methane.
  - gasohol.

### Fill In the Blanks

- \_\_\_\_\_ is the splitting apart of atomic nuclei into smaller nuclei.
- \_\_\_\_\_ is the joining of atomic nuclei to form larger ones and the releasing of energy in the process.
- A \_\_\_\_\_ is a series of fission reactions occurring in a mass of fissionable material such as uranium-235.
- A \_\_\_\_\_ is a reactor that produces more fissionable nuclear fuel than it consumes.
- A \_\_\_\_\_ is a nuclear reactor accident caused by the loss of core coolant and the resultant overheating of the core.

6. \_\_\_\_\_, or solar cells, produce electricity directly from sunlight.
7. \_\_\_\_\_ energy is derived from the internal heat of the earth.
8. \_\_\_\_\_ is a potential geothermal energy source where thermal gradients are at least 40°C/kilometer and where groundwater is lacking.
9. \_\_\_\_\_ fuels are those derived from living or recent organisms.
10. \_\_\_\_\_ is a fuel consisting of a blend of 90% gasoline and 10% alcohol.

### True or False

Indicate whether the following statements are true or false. If false, correct the statement to make it true.

- \_\_\_\_\_ 1. The process used by commercial nuclear power plants is fusion.
- \_\_\_\_\_ 2. The United States has enough reserves of uranium-235 to last for 600 years.
- \_\_\_\_\_ 3. One problem with breeder reactors is that the process is very slow.
- \_\_\_\_\_ 4. Even if a nuclear reactor experienced a complete loss of core coolant, there would not be an explosion like an atomic bomb.
- \_\_\_\_\_ 5. The radioactive wastes produced by nuclear reactors can be rendered harmless by combining the wastes with chemicals to make them nonradioactive.
- \_\_\_\_\_ 6. Nuclear fusion is the process by which the sun generates its tremendous quantities of energy.
- \_\_\_\_\_ 7. Currently, space heating seems to be the most practical use of solar energy.
- \_\_\_\_\_ 8. Geothermal energy is being tapped most extensively at hot spots.
- \_\_\_\_\_ 9. In 1995, geothermal energy was the dominant renewable energy source in the United States.
- \_\_\_\_\_ 10. Potentially wind power could supply 25 to 50% of the electricity used by the United States if a major national program for wind-energy development existed.

## Review Questions

1. Describe the principle of fission reaction used for the generation of nuclear power in commercial reactors.
2. Describe the fusion process that may be employed for generating nuclear power in the future. Why is there no fusion reactor at the present time?
3. Explain the concept of a breeder reactor.
4. What are the major concerns about nuclear power?
5. What are the current uses of solar energy? Why is the contribution of solar energy so limited at present?
6. How is geothermal power utilized? What are the potential environmental impacts of this energy resource?
7. Discuss the prospect of biomass as a major contributor to our energy resource scenario.

## Surfing the Net

Online version of “Annual Energy Review,” a comprehensive compilation of U.S. and international energy information (Energy Information Administration, U.S. Department of Energy):

<<http://www.eia.doe.gov/emeu/aer/>>

Excellent discussion of renewable and alternate energy sources (Solstice):

<<http://solstice.crest.org/renewables>>

Information on the Nuclear Fuel Cycle (International Atomic Energy Agency):

<<http://www-nfcis.iaea.org>>

Information on commercial nuclear reactors (U.S. Nuclear Regulatory Commission):

(<http://www.nrc.gov>>

A series of satellite images of the Chernobyl area, with some information on the 1986 reactor accident and its aftermath (U.S. Geological Survey):

<<http://edcwww.cr.usgs.gov/earthshots/slow/Chernobyl/>>

## CHAPTER 14 ANSWER KEY

### Multiple Choice

- |      |       |       |       |
|------|-------|-------|-------|
| 1. c | 6. d  | 11. d | 16. c |
| 2. c | 7. b  | 12. b | 17. b |
| 3. a | 8. d  | 13. d | 18. a |
| 4. b | 9. d  | 14. a | 19. b |
| 5. a | 10. a | 15. d | 20. c |

### Fill In the Blanks

- |                    |                       |
|--------------------|-----------------------|
| 1. Fission         | 6. Photovoltaic cells |
| 2. Fusion          | 7. Geothermal         |
| 3. chain reaction  | 8. Hot dry rock       |
| 4. breeder reactor | 9. Biomass            |
| 5. core meltdown   | 10. Gasohol           |

### True or False

1. False. Nuclear fission is the only nuclear power process that is currently commercially feasible.
2. False. The United States has only enough uranium-235 to last for several decades.
3. True
4. True
5. False. Radioactive wastes cannot be neutralized by chemical reactions.
6. True
7. True
8. False. Most areas in which geothermal energy is being used are along or near lithospheric plate boundaries.
9. False. In 1995, hydropower was the dominant renewable energy source.
10. True