Chapter 4

Sustainability and Housing

Content Terms

sustainability
sustainable design
home automation
renewable energy sources
nonrenewable energy sources
photovoltaic (PV) system
geothermal energy
cogeneration
fuel cell
microturbine
volatile organic compounds (VOCs)
photovoltaic shingles
graywater
Zero Energy Home (ZEH)
Earthship housing

Academic Terms

bandwidth
off-gassing

Learning Outcomes

After studying this chapter, you will be able to

- define sustainability and sustainable design.
- summarize the importance of sustainable design.
- identify the principles or goals of sustainable design.
- determine reliable information sources for sustainable design.
- review examples of buildings with sustainable features.
- summarize the responsibilities of designers for sustainable design.

Reading with Purpose

Find an article on the *Google News* website that relates to the topics covered in this chapter. Print the article and read it before you read the chapter. Then, as you read the chapter, highlight sections of the news article that relate to the text.

Johnny Habell/Shutterstock.com

The future of the environment depends on how people use and protect natural resources. The term *sustainability* describes the interaction between people and their living environments. This chapter describes sustainability and shows ways that design professionals can and should promote and use sustainable design principles in creating housing and interior spaces.

Defining Sustainability and Sustainable Design

Sustainability is a term that describes human interaction with the resources in the earth's environment. These resources include the air, water, forests, and other materials. Humans use natural resources in creating and designing housing structures and living spaces. They not only use natural resources to build and furnish living spaces, but also to operate structures in heating and cooling spaces as well as heating water.

The idea of sustainability is that people today should responsibly use natural resources to meet their needs in a way that does not affect the ability of people in the next generation to also meet their needs. With sustainability, there is also the expectation of no negative impact on the people, communities, or environment.

Sustainable design refers to incorporating sustainability in the built environment. Sustainable design focuses on the responsible

- use of materials for building and furnishing interiors
- operation of living spaces
- practices in the manufacture of materials and production of buildings

Sustainable design is important because buildings and their interiors have a powerful impact on the environment of the earth. Buildings of all types account for over 40 percent of energy use worldwide. According to the U.S. Energy Information Administration in 2014, 41 percent of U.S. energy consumption was for residential and commercial buildings.

Designers and all professionals in the building industry can have a powerful impact on maintaining the environment. They do this by designing buildings and selecting all materials and systems based on the principles of sustainable design.

Green Choices

Eco-Friendly Labeling and Certification Programs

Many guides assist consumers or professionals in making decisions in finding green housing solutions. When selecting a new house or products for the home, choose an eco-friendly program to guide your choices.

Each of these programs certifies/labels green components in different ways and some are highlighted in *Green Choices* features throughout this textbook. Programs that certify or label green housing and products include

- **ENERGY STAR®**—Identifies products and structures that use at least 30 percent less energy than the standard products and structures (Environmental Protection Agency and U.S. Department of Energy)
- **Energy Guide Label**—Relates the approximate energy consumption and utility cost of operating the products and is required on all ENERGY STAR products (U.S. Environmental Protection Agency and U.S. Department of Energy)
- **LEED Rating System**—Certifies structures that have overall sustainable features (U.S. Green Building Council—USGBC)
- **Forest Stewardship Council (FSC)**—Sets standards for responsible forest management; works with FSC-accredited certifiers to identify companies that follow sustainable practices in wood harvesting and manufacturing
- **WaterSense® Label**—Identifies products that use less water; manufacturers have partnership agreement with the U.S. Environmental Protection Agency and have products certified through an EPA-licensed certifying body
- **Sustainable Furnishings Council**—Tags furniture that was manufactured using sustainable practices; promotes sustainable practices among furniture manufacturers
- **REGREEN**—Provides guidelines for incorporating green in remodeling projects (partnership between ASID and USGBC)
- **Carpet and Rug Institute (CRI)**—Verifies that products (carpet, adhesives, and cushions) have low-emission of VOCs (Indoor Air Quality testing)

Review & Assessment

1. Define sustainability and sustainable design.
2. Explain the importance of sustainability.
3. Why is sustainable design important?

Principles of Sustainable Design

Sustainability is incorporated into buildings through following principles of sustainable design. The principles that guide sustainable design include the following:

- use less energy in the operation of buildings
- use renewable energy sources for living environments
- select materials from renewable sources
- use recycled materials and/or materials that can be recycled
- conserve water use
- protect occupant health and safety
- produce less waste

Use Less Energy

A major principle of sustainable design is to use less energy in the operation of buildings. The interior designer and other building professionals can select equipment that uses less energy. This includes home appliances, space heating and cooling equipment, water heating equipment, and lighting. Specific energy efficient equipment, is covered in the appropriate sections of the text.

Energy-efficient homes are most effective if originally designed to use less energy. Many homes on the market, however, have energy-efficient features. Figure 4.1 provides a checklist of features of an energy-efficient home.

After the energy-efficient appliances and equipment are in the home, one way occupants can manage and control energy use is through **home automation**. Dwellings with home automation have an integrated and centrally controlled system based on computer technology. This system controls all the systems in the home and focuses primarily on one or more of the following areas:

- convenience
- energy management
- entertainment
- safety

Homes built today incorporate many versions and features of "smart" technology. The exteriors of homes with automated systems look like any other homes (Figure 4.2). These homes contain advanced systems, components, and materials—all the result of ongoing technological development.

Historically speaking, electronic houses were something that only appeared in science fiction for much of the twentieth century. In the 1980s, however, the National Research Center of the *National Association of Home Builders (NAHB)* helped the advancement of home automation by initiating The SMART HOUSE Project. The technology wired the home with a single multiconductor cable that included electric power wires, communications cables for telephone and video, and other connections to appliances and lamps. The multiconductor cable was then linked with electronic devices to control the supply of power throughout the home. The SMART HOUSE was designed to respond to the resident's needs by adjusting lighting, temperature, and even music. Currently, NAHB is no longer the leader in marketing home automation, but instead private companies are leading the way for home automation.

The basic idea of home automation, is to employ sensors and control systems to monitor a residence and adjust the systems according to the user's needs. By doing so, the home becomes a safer, more comfortable, and more economical residence. For example, the system can turn off the lights and lower the thermostat after everyone has gone to bed. It can monitor burglar and fire alarms and optimize the operation of the water heater by anticipating hot water usage.

Home automation technologies require broad changes to building construction. These changes may impact house wiring and cabling for power and communications. The development of a new information infrastructure offers many possibilities. For instance, such technology offers greater participation in civic and community activities, access to educational resources, as well as work and entertainment. Higher-bandwidth communication technologies provide the means for electronic community town meetings, distance learning, home shopping, and video-on-demand. ***Bandwidth*** refers to the capacity for data transfer of an electronic communications system.

After meeting technical and organizational challenges, many will find a fine line between an intelligent house that maintains comfort levels and an overbearing house that monitors the inhabitants too closely. Few people object to using a thermostat

Evaluating Energy Efficiency of a House

Use the following questions to evaluate and note the features for home energy efficiency.

Orientation and Landscaping

- What is the orientation of the long side of the house (N, S, E, or W)?
- How many windows face east? (Note number and calculate the area in square feet.)
- How many windows face west? (Note number and calculate the area in square feet.)
- How much shade from landscape features is on east or west sides of the house?
- Is the southern exposure unobstructed or shaded by deciduous trees?

Thermal Resistance

- How much insulation is in the attic? (Note the type and thickness.)
- Are the walls insulated? If so, how thick is the insulation?
- Is there under-floor insulation, especially in homes with crawl spaces, cold basements, and garages under living areas?
- Are the heating and cooling ducts, hot water pipes, and hot water heater insulated?
- Are the windows double- or triple-glazed (paned) with low-E glass?
- Are the doors solid-core wood or insulated metal?
- Are there storm doors?

Lighting and Windows

- Is energy-efficient lighting used in work areas (for example, fluorescent or LED)?
- Are windows or skylights located in work areas?
- Do windows occupy less than 10 percent of the total wall area? (Measure the window area and calculate its percentage of total wall area.)

Appliances

- Are ENERGY STAR appliances used?
- Is the refrigerator located away from range, dishwasher, and direct sunlight?

Ventilation

- Are ceiling fans or a whole-house fan used in the house?
- Are window and door placements appropriate for cross-ventilation?
- Is the attic properly vented with vents near the roof ridge and beneath the eaves?
- Is there adequate air infiltration?
- Are the windows properly fitted?
- Is weather-stripping located around doors, windows, and the attic entry?
- Is there adequate caulking around door frames, window frames, and penetrations for pipes and wiring?

Figure 4.1 Use this question list to compare houses for energy efficiency.

to control the temperature in a house. Most cherish, however, the power to set and reset the thermostat. As the hardware and software to control home automation systems become increasingly complex, designers must make it easy for inhabitants to program the house and to override preprogrammed settings.

Use Renewable Energy Sources

A principle of sustainable design is relying more on **renewable energy sources**—those that replenish themselves regularly—in providing energy to operate a building. The housing and interior design professional should have knowledge about the energy sources. In particular, he or she should know about renewable energy sources and how to promote them in buildings.

Fuel provides heat, and people need heat to live. Like all forms of energy, fuel begins as solar energy derived from the sun. Nature converts solar energy to raw materials such as oil and coal. The conversions take millions of years to complete.

Denys Prykhodov/Shutterstock.com

Figure 4.2 By looking at its exterior, you cannot identify this smart home. The controls shown on the tablet indicate it is a smart home.

The raw materials are then refined and used as fuel for electricity. Figure 4.3 shows natural gas is the nation's main source of electrical energy. Coal, nuclear power, hydroelectric power, and renewable energy are the other leading energy sources used to produce electricity in the country.

Nonrenewable energy sources, such as common energy sources of fuel as oil and coal, are depleting in supply. Renewable energy sources, on the other hand, replenish themselves regularly. Renewable sources of energy include the sun, wind, water, and geothermal energy, all of which can be converted to electricity.

The housing and interior design professional can help in promoting the use of renewable sources for energy uses in buildings. This focus is primarily on the use of solar energy, geothermal energy, and wind.

Solar Energy

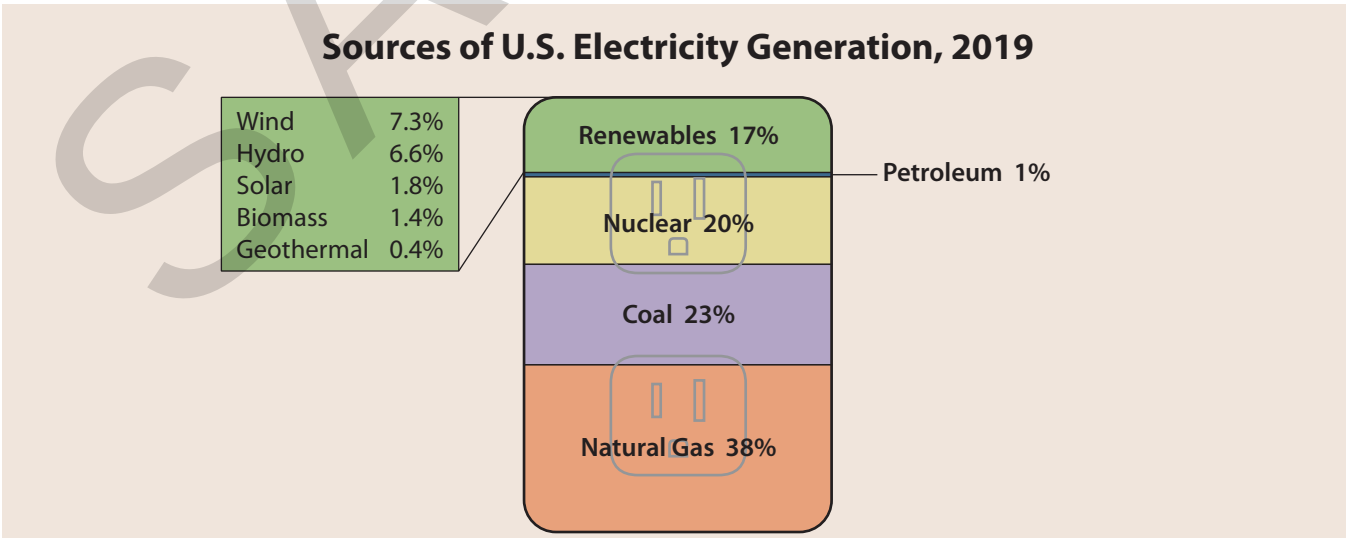
There are several ways to use solar energy in structures. One way is to use the natural heating effect of the sun by orienting the building to incorporate this heating effect. Designing the structure depends on the climate and other variables and must be done correctly (Figure 4.4). Another way to use solar in structures is to use it to heat the space or heat the hot water (Figure 4.5).

Solar energy could supply a majority of the energy needed to heat and cool buildings throughout the United States. Solar heating systems are usually expensive to install. A major part of the expense is the high cost of the component parts. Ongoing long-term research and development will help reduce costs, improve reliability, and improve performance of technologies that solar programs use.

Despite the high installation cost, those who use solar energy usually see a great reduction in their utility bills. In the long run, solar heating systems usually cost less than conventional systems.

Active solar systems can heat space, heat water, or produce electricity. An active solar system that converts sunlight into electricity is a **photovoltaic (PV) system**. The sun shines on panels (called *arrays*) and converts this solar energy into electricity.

The downside of photovoltaic systems is they generate electricity only when the sun shines. The system's batteries can store enough electricity



U.S. Energy Information Administration, Electric Power Monthly, February 2020, preliminary data

Figure 4.3 The United States relies heavily on coal to fuel the generation of electricity for industrial use.

pics721/Shutterstock.com

Figure 4.4 A sunroom is a beautiful and calming space; however, if the orientation is not correct, it can become hot like a greenhouse and be unusable space.

jessicakirsh/Shutterstock.com

Figure 4.5 This house has solar panels on the roof to take advantage of active solar heating.

to power a house for several days, but persistent overcast weather can deplete it. Deluxe systems can match the reliability of power supplied by utility companies, but they are expensive. As the cost of solar electric systems declines, environmentally conscious home owners will likely invest in this technology.

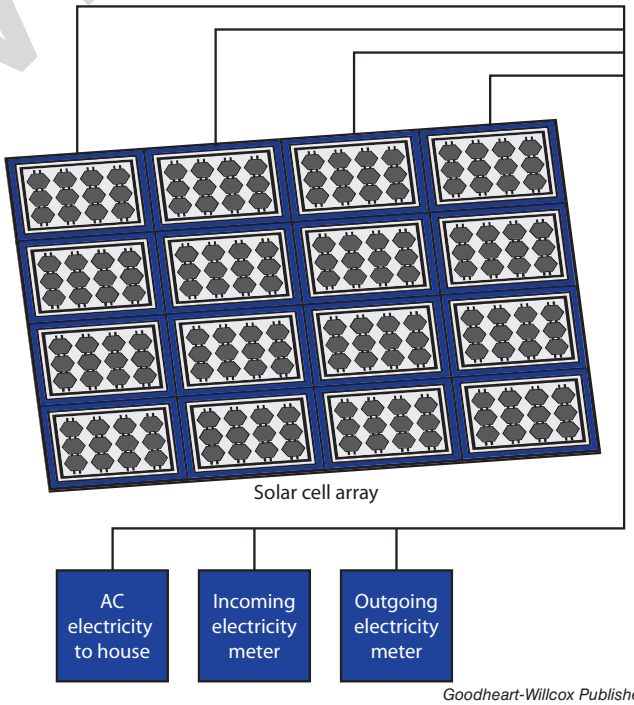
Some solar energy heating systems supply more energy than a home needs. Home owners can sell the excess to a utility company or store it in the lines until needed by the producer. *Net metering* programs also provide consumer investment in renewable energy generation. The plan allows customers to use their own generation to balance their consumption. The electric meters turn backward when they generate electricity in excess of their demand (Figure 4.6).

Geothermal and Wind Energy

Geothermal energy—energy that comes from the earth's core—and wind energy are the primary sources of energy the United States uses in power plants to produce electricity. Although most homes still use traditional furnaces and air conditioners, geothermal heat pumps are becoming more popular. In recent years, the U.S. Department of Energy (DOE) and the Environmental Protection Agency (EPA) have partnered with industry to promote the use of geothermal heat pumps.

Geothermal heat pumps use the earth's constant temperatures to heat and cool buildings. While temperatures above ground are unstable, temperatures in the upper 10 feet of the earth's surface remain constant. The soil temperatures are usually warmer than the air in winter and cooler than the air in summer. The heat pumps transfer heat from the ground (or water) into buildings in winter and reverse the process in the summer.

Geothermal energy has advantages and disadvantages. One advantage is its low cost in comparison to other fuels. It also is a source of heat that does not emit harmful pollutants into the environment. A third advantage is that geothermal energy is a renewable resource.



Goodheart-Willcox Publisher

Figure 4.6 In a photovoltaic system, silicon chips are joined with electrical wires to form solar cell arrays. The arrays collect different amounts of solar energy, depending on the season, time of day, and degree of cloudiness.

Career Focus Environmental Scientist

Can you imagine yourself as an environmental scientist? If you can, read more about this challenging and exciting career.

Interests/Skills: If you share any of the following interests, you may choose to explore a course of study that would lead to a career as an environmental scientist. Are you investigative and realistic? Do you enjoy working with ideas, and do you like to search for facts and figure out problems mentally? Do you prefer practical, hands-on problems and solutions? Do you appreciate the outdoors along with plants, animals, and real-world materials like wood, tools, and machinery? Environmental scientists typically have skills in the sciences, have critical-thinking ability, can express themselves to others in writing and speaking, and work well with people.

Career Snapshot: Environmental scientists find and fix pollution and other environmental problems. They figure out what is in the air, water, and soil to make sure that the environment is safe. They also give advice on how to clean the environment. For example, they might design a safe way to get rid of trash. Some environmental scientists help to make laws about protecting the environment. They also help companies follow the laws. Environmental scientists work in laboratories and offices. They also work outside, taking measurements.

Education/Training: All of these workers need a college degree in such STEM-related areas as environmental science or environmental studies. Some need an advanced degree—either a master's or a doctoral degree.

kosmos111/Shutterstock.com

Licensing/Examinations: (none currently)

Professional Association: National Association of Environmental Professionals (NAEP)

Job Outlook: The number of jobs for environmental scientists is projected to grow 8 percent from 2019 to 2029, faster than average for all occupations.

Sources: The Occupational Information Network (O*NET); the Occupational Outlook Handbook (OOH); the Bureau of Labor Statistics

There are some disadvantages to using an open-loop geothermal energy pump and pulling directly from the groundwater. Some geothermal waters contain chemicals that require responsible disposal. A second disadvantage is the direct use of geothermal energy can only occur near the production sites. Transportation of hot water over long distances cannot occur without losing heat and turning cold. Closed-loop systems address these problems. The geothermal loop is made of a tough plastic that is extremely durable and buried underground to allow heat to pass through efficiently. The fluid in the loop is water or an environmentally safe antifreeze solution that circulates through the pipes in a closed system.

The use of wind as energy dates back to early civilizations with the use of windmills to pump water and grind grain. Wind is gaining popularity as an energy source. Most wind machines today are the horizontal-axis type. They have blades like airplane propellers. A typical horizontal wind machine stands as tall as a 20-story building and has three blades that span 200 feet across. Wind machines stand tall and wide to capture more wind. A minimum average annual wind speed of 10 miles per hour is necessary to run a wind generator. An average above 12 miles per hour allows the development of an excellent wind system.

Some regions of the United States have strong, shifting winds that are useful for power generation. Wind turbine generators grouped together to form wind farms can convert air motion to electrical current (Figure 4.7). The electrical current that wind machines produce feeds into utility lines or storage systems. The systems keep the power flowing even when the air is still. Use of small wind electric systems for individual residences is possible, but is somewhat limited by a number of variables. One is the requirement of an acre of land for the wind turbine. A potential concern is resistance to what the wind turbine would look like.

nostal6ie/Shutterstock.com

Figure 4.7 This wind system converts the power from constant breezes to create electricity for nearby residents.

Another drawback is balancing the home energy level needed with the cost involved.

Cogeneration in Residences

Cogeneration—also known as *combined heat and power (CHP)*, and total energy—is an efficient, clean, and reliable approach to generating power and thermal energy from a single fuel source. CHP uses heat that is otherwise waste from conventional power generation to produce thermal energy. This energy provides cooling or heating for industrial facilities, district energy systems, and commercial buildings. The development of new technologies that produce electricity makes this system possible. These developments include photovoltaics, fuel cells, and microturbines.

- A **fuel cell** is an equipment system that produces electricity from the use of chemicals. Research is underway to handle the waste products of heat and water.
- A **microturbine** is a small turbine engine that produces electricity.

Cogeneration systems are available to small-scale users of electricity. Currently, modular systems are useful for commercial and light industrial applications. Several factors could affect CHP growth to more residences. They include the initial cost of buying a cogeneration system, maintenance costs, and environmental control requirements. CHP in residences makes the occupants less dependent on electrical utility companies to provide electricity. This can be helpful especially in blackouts and during natural disasters when electric power may not be available.

Select Renewable Materials

Interior designers can select materials that renew themselves regularly. An example is bamboo, a wood that is prevalent and can be used in flooring, furniture, and other building components (Figure 4.8). Many materials are renewable including wool.

When using wood materials, it is important that the production of the material has certification as environmentally friendly. According to the Forest Stewardship Council Certification guidelines, achieving environmentally friendly certification requires certain practices. These include

- harvesting the wood from the forest in a sustainable way that leaves the forest in good condition and able to grow additional wood

Karkas/Shutterstock.com

Figure 4.8 This bamboo floor serves well as a renewable material, but is also quite durable in this dining space.

- transporting and treating wood using sustainable practices
- keeping production waste to a minimum—possibly using waste products effectively in some future manner

Use Recycled or Recyclable Materials

Using recycled materials is environmentally healthy when new materials are not used for products. This reduces the environmental impact of buildings and interiors.

An example is the use of recycled materials in carpeting. Reclaiming materials from old houses and buildings when tearing them down is another example. A key approach is to use materials that can be recycled if they are no longer needed.

Reusing existing buildings versus tearing down and starting over is a sustainable practice. This reduces waste and also avoids new use of environmental resources such as wood. Historic preservation is a key practice that promotes sustainability.

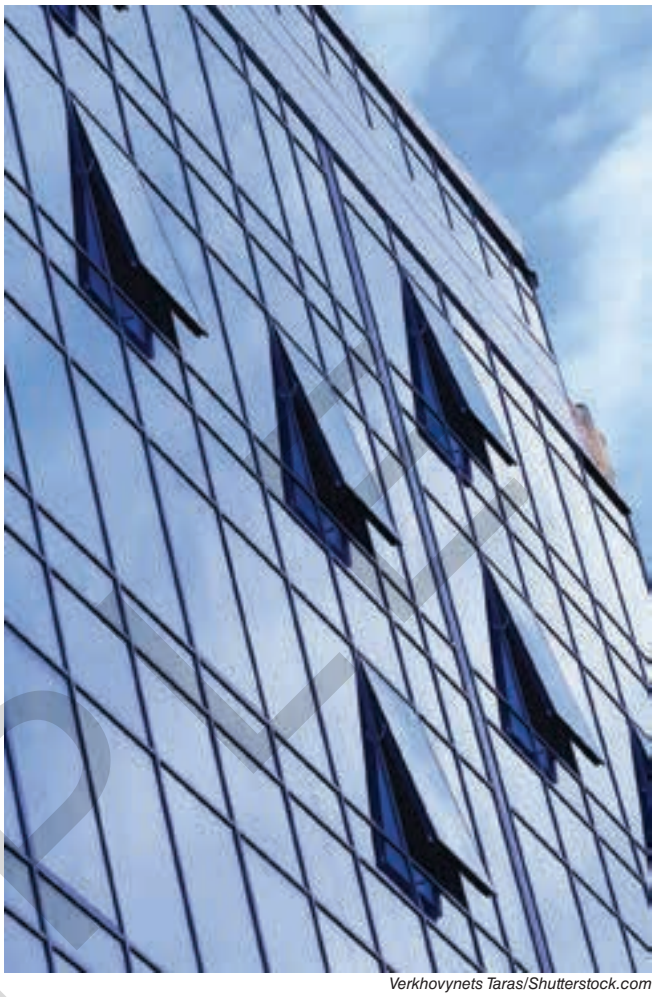
Protect Occupant Health and Safety

A principle of sustainable design is protecting the health and safety of occupants. To accomplish this, housing and design professionals select nontoxic materials and substances. A major concern is the *indoor air quality (IAQ)* and assuring that no contaminants are released into the space that can have harmful impact on humans. An example includes selecting materials that have low or zero off-gassing. ***Off-gassing*** is the release of fumes and chemicals in the air as a result of the treatment of a product, such as carpeting. Some wallcovering glues have contaminants that affect some people. An important concern for indoor air quality is the provision of natural ventilation and air circulation. Selection of windows that actually open is important (Figure 4.9).

Another strategy to protect occupants of a structure is to select paint that has low **volatile organic compounds (VOCs)**—chemicals that evaporate into the air. VOCs can cause breathing difficulties and health problems for some people.

Produce Less Waste

Interior designers and building professionals can produce less waste by carefully determining the correct amount of materials for a project. Selecting recyclable materials can also produce less waste. A key approach is to use materials that can be recycled if they are no longer needed.



Verkhovynets Taras/Shutterstock.com

Figure 4.9 Usually, skyscrapers do not have operable windows for safety reasons; however, this high-rise condominium has shallow windows to provide natural ventilation and good indoor air quality.

Review & Assessment

1. List the principles of sustainable design.
2. What is home automation, and what areas might this system control?
3. How does a heat pump use geothermal energy?
4. What is cogeneration?
5. Name three environmentally friendly guidelines for using wood materials according to the Forest Stewardship Council.
6. What is off-gassing, and what does it impact?

Features of Sustainable Buildings

As you recall, *green* buildings refer to those structures that use materials and techniques to conserve resources in all aspects of construction

and maintenance. The planning of such buildings uses *green design* or *sustainable design*. These buildings use one or more green products or measures in the structure. Green products conserve scarce resources and generally utilize sustainable and recyclable materials. For example, the use of steel in construction more often replaces the use of wood—wood is a limited commodity and thereby is costly. Using bamboo for flooring can be sustainable, depending on the source location and production methods.

Although these homes conserve resources, today's green-built homes are virtually indistinguishable from other homes. The following include some uses of green products and design in today's typical homes:

- **Doors and windows.** Insulation in exterior doors is an energy saver in cold and warm climates. Insulated, low-E glass in windows helps keep homes more comfortable and energy efficient.
- **Siding and decking.** Vinyl and fiber-cement siding reduce the need for cedar, redwood, and other products on exterior walls. Plastic lumber and composite products (made from recycled wood fibers and plastics) are common decking materials.
- **Roofing.** Such roofing materials as metal and fiber-cement are more durable. They reduce the need for frequent roof replacement. Some older-style roofing materials require frequent replacement and are a major source of landfill waste.
- **Heating, cooling, and hot water.** High-efficiency heating, cooling, and water-heating units greatly reduce energy use in most homes. Using passive-solar design takes advantage of the sun's energy to help heat homes through glass features with a southern exposure to the sun. In addition, proper insulation of walls and attics reduces energy loss in homes.
- **Fixtures and appliances.** New energy-efficient dishwashers, refrigerators, and clothes washers require less energy. Look for the ENERGY STAR label. New toilets and faucet aerators use less water to operate (Figure 4.10).

The steps you take to conserve energy lower energy costs, reduce pollution resulting from energy production, and save valuable resources. What are some simple steps you can take to start conserving energy now and in your future work as a housing and design professional? Continue reading to learn more about special programs that promote green and sustainable buildings.

Photo Courtesy of Kohler

Figure 4.10 New plumbing fixtures, such as this toilet, are designed to use less water.

Resources for Producing Sustainable Design

Many programs clearly define and direct the building of structures/interiors that meet the criteria of sustainable design. These certification programs guide professionals as well as consumers in reaching green housing solutions.

There are also many labeling programs that assist professionals and consumers in the selection of green products. Each of these programs certifies/labels green components in different ways and some are highlighted in *Green Choices* features throughout this textbook. See the *Green Choices* box in this chapter for a listing of these eco-friendly labeling and certification programs. A major program is the *Leadership in Energy & Environmental Design (LEED)* rating system. Sponsored by the U.S. Green Building Council, this certification program provides sustainability guidelines for residential, commercial, and other buildings. There are four levels of LEED certification: *Certified, Silver, Gold,* and *Platinum*.

Examples of Sustainable Buildings

As you read the *Green Choices* features throughout this text, you will notice numerous programs and organizations promote green and sustainable housing design. Many provide certification indicating that houses have features that support the environment and sustainability. One such outstanding organization is the *Southface Energy Institute.*

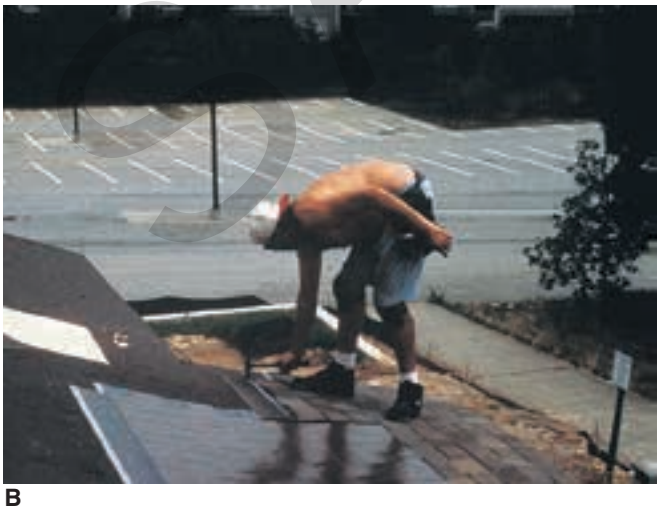
Southface Eco Office and Resource Center

The Southface Energy Institute is a resource for home owners, residential and commercial builders, and people who want to learn more about environmentally friendly design. With a mission to promote sustainable homes, workplaces, and communities, the campus of the Southface Energy Institute headquarters shows many techniques and features of sustainable design. The headquarters—located in Atlanta, Georgia—is a showcase for innovative building designs and techniques. It also has the LEED-Platinum designation (Figure 4.11).

The headquarters consists of a three-story commercial building, the Eco Office, an attached residential building, and the Resource Center. These buildings display many innovative features for homes and commercial structures. The buildings address energy efficiency, thermal comfort, indoor air quality, and accessibility. Also highlighted are ways to reduce waste and use recycled materials. These sustainable designs and technologies include the use of recycled building materials and utility-operating activities (such as energy, water, and waste management).

The headquarters has many energy-related features. These include passive solar heating, cooling solar water heating, and solar-electric systems. A special roof component of the Resource Center includes solar-electric shingles. These shingles are photovoltaic (PV), which means they convert sunlight into electricity. **Photovoltaic shingles** resemble conventional fiberglass roofing shingles. The electricity they produce supplies part

A



B

C

Southface Energy Institute, Atlanta, Georgia; Photos by Jonathan Hillyer

Figure 4.11 The Southface Eco Office and Resource Center buildings have many innovative features for offices and homes (A). Photovoltaic shingles are installed on the roof of the Southface Resource Center to make electricity from the sun's rays (B). The "light shelf" in the window area helps deliver the sunlight deep into this office space (C).

of the facility's electrical needs. As in other solar applications, the PV shingles are on a south-facing roof to receive full sun.

The Southface campus utilizes a well-planned passive solar design and daylighting. This office space takes advantage of sunlight as a prominent light source year-round. Exterior shades block direct sunlight while interior light shelves bounce sunlight deep into the office. The use of daylighting strategies offsets the larger need for artificial lighting and is balanced with light-monitoring sensors.

Other energy-saving measures at the Center include energy-efficient ENERGY STAR appliances (ENERGY STAR products are certified to save energy without sacrificing functionality or features) and a geothermal heat pump. In a practical sense, geothermal energy for heating and cooling involves a heat exchange via a buried, liquid-filled pipe designed in a loop. This creates an ultra-efficient heating and cooling system that utilizes the stable temperature of the surrounding earth. This approach is more efficient than conventional air-exchange systems.

The Center's landscape emphasizes the principles of drought-tolerant landscaping. In addition, the Center uses a rainwater catchment irrigation system for watering and flushing toilets. The landscaping also uses such recycled materials as wood-chip mulch and concrete rubble for stepping-stones. **Graywater** is wastewater from washing machines, showers, and sinks. It is not contaminated with human waste and can be used for landscape watering.

Career Focus Sustainability Coordinator

Do you care about the environment? Are you interested in making people more comfortable and healthy at work and at home? Do you dislike seeing garbage dumpsters full of construction waste? If you do, a career in sustainable design and management might be for you!

Interests/Skills: By far the most important skills in sustainable design coordination and management are communication and teamwork. These professionals must be able to communicate implementation-strategy plans for green initiatives verbally, visually, and in writing with a wide variety of architects, designers, contractors, tradespeople, engineers, and clients involved in the building process. Environmental professionals must think critically about the project goals (increasing natural ventilation, utilizing natural water sources, specifying recycled products, etc.) and come up with logical, but creative ways to meet them. Because this work involves much research and documentation, sustainability coordinators must have excellent organizational skills and pay attention to details.

Career Snapshot: Designers can create sustainable buildings that are more environmentally friendly, healthier for the occupants, use less water and energy, and utilize land and space more efficiently. Often, designers work toward getting their buildings LEED (Leadership in Energy and Environmental Design) certified, which is a method of identifying and awarding construction projects that have employed sustainable practices in site development, indoor environmental quality, water use, energy efficiency, and the use of earth-friendly products. Coordinators help establish overall and specific sustainability goals for construction projects and monitor the progress as the project develops.

Education/Training: The completion of a bachelor's degree in interior design, architecture, engineering, or building science is the minimum for understanding of sustainability. Many schools offer minors and entire degrees in sustainability and environmental design. Some professionals pursue a master's degree in a specific area of sustainability such as indoor air quality or urban planning.

Licensing/Examinations: All interior design graduates who pass the *National Council for Interior Design Qualification (NCIDQ)* licensing examination are tested on their basic knowledge of sustainability, especially for commercial interiors. For those wishing to pursue a more concentrated career, construction and design professionals will become *LEED Accredited Professionals*. This certification comes in two tiers. The first exam allows recent grads to demonstrate their basic knowledge of sustainability concepts. The second exam is for those who have experience with environmentally focused projects and desire to specialize in particular environments such as commercial interiors, residential developments, and existing structures.

Professional Associations: The American Society of Interior Designers (ASID); International Interior Design Association (IIDA); U.S. Green Building Council (initial developer of the LEED certification and accreditation system)

Job Outlook: Employment for sustainability coordinators and other environmental specialists is projected to grow 8 percent from 2019 to 2029, much faster than average for all occupations.

Sources: The Occupational Outlook Handbook (OOH); the Occupational Information Network (O*NET)

Zero Energy Homes (ZEH)

An example of a sustainable energy home is a Zero Energy Home (ZEH). The **Zero Energy Home (ZEH)** is a home that produces and uses its own energy—as much or more than it needs. A ZEH combines state-of-the-art, energy-efficient construction and appliances with commercially available renewable energy systems. These renewable systems include solar water heating and solar electricity. Even though the home may have a connection to an electrical grid, it has zero energy consumption from the utility company.

The U.S. Department of Energy partners with building professionals and organizations to further develop the ZEH concept. Design features of a Zero Energy Home include

- climate-specific design
- passive solar heating and cooling
- energy-efficient construction
- energy-efficient appliances and lighting
- solar water heating system
- small solar electric system

Specific advantages of Zero Energy Homes are many. They include

- improved comfort—because the energy-efficient structure reduces temperature variations in the home
- reliability—because the home will continue to operate even during blackouts
- energy security—because the home produces its own energy and protects the occupant from fluctuation in energy prices
- environmental sustainability—by saving energy and reducing pollution

Earthship Housing

Another example of sustainable building design is **Earthship housing**. The name of the housing, *Earthship*, suggests the need for housing to be self-sufficient just as a "ship" has to be self-sufficient. This housing uses passive solar and earth-sheltered design along with the use of recycled materials to produce sustainable dwellings. Earthships have the feel you might expect of housing built on another planet. This is because the form of the housing structure does not necessarily follow the angular dimensions people associate with traditional housing (Figure 4.12).

Michael Reynolds, an architect, founded the Earthship concept and the Earthship Biotecture business headquartered in Taos, New Mexico. Near Taos, whole communities of Earthships exist. Earthships have been built in the United States, Canada, Mexico, Honduras, Nicaragua, Bonaire, Jamaica, Bolivia, Scotland, England, France, the Netherlands, Spain, India, and Japan. There are over 3,000 Earthships worldwide.

The houses are all different from the outside, but share a number of features. Figure 4.13 shows the following features:

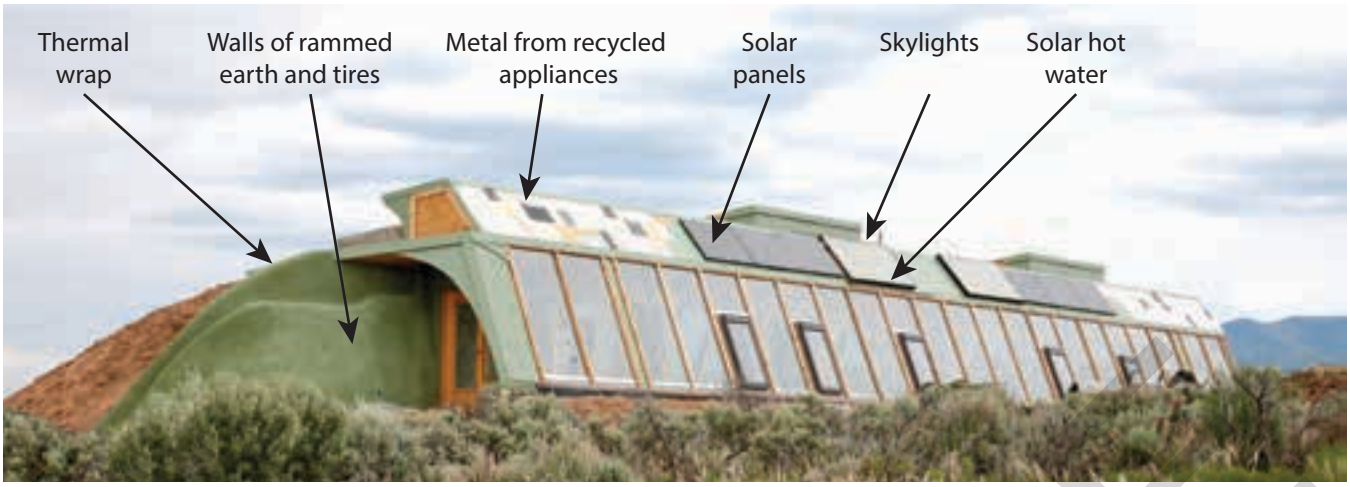
- building with recycled materials
- water harvesting
- contained sewage treatment
- solar/thermal heating and cooling
- solar and wind electric power
- food production

The southern side of an Earthship house faces the sun and collects the heat of the sun through windows to warm the home. Usually there are two sets of windows. The outer set creates a greenhouse where plants and food are grown. The interior set of windows connects

A *Earthship Biotecture, Taos, New Mexico*

B *Earthship Biotecture, Taos, New Mexico*

Figure 4.12 The Earthship housing has organic and natural shapes not usually found in angular traditional homes (A and B).



Earthship Biotecture, Taos, New Mexico

Figure 4.13 This diagram shows the features of Earthship housing.

to the living space and controls the amount of heat entering the house from the greenhouse space.

The back wall on the north side of the housing is actually built of earth, called a *berm*. The berm stores heat collected from the sun.

Recycled products form the building materials for these homes. For instance, used tires filled with earth form the walls. Then plaster fills in the cracks and forms a smooth surface on the walls. In addition, glass bottles serve as decoration as well as allow light into the houses. The glass bottles are cut crosswise and the bottoms connect to create cylinders. These cylinders are embedded into walls (Figure 4.14). The bottles appear as round lights in the photo.

Usually, owners attend workshops on construction methods and requirements to build the homes. The building of these homes is very labor intensive. In general, all these homes are individualized and reflect the lifestyle and interests of the owner.

Earthship Biotecture, Taos, New Mexico

Figure 4.14 This is the interior of an Earthship bathroom that uses bottles in the walls for decoration and transmission of light. The round "lights" are the bottles.

Review & Assessment

1. For each of the following home features, list one green product: doors and windows; siding and decking; roofing; heating, cooling, and hot water; and fixtures and appliances.
2. Name four housing concerns, other than energy use and conservation, addressed by the Southface Eco Office and Resource Center.
3. What are the key advantages of Zero Energy Homes?
4. Contrast the features of a Zero Energy Home (ZEH) with an Earthship home.

Designer Responsibilities for Sustainable Design

Housing and interiors professionals have the responsibility to promote and use principles of sustainable design. Because of the high use of natural resources in living environments, these professionals encourage the use of sustainability through their design.

Professionals in housing and interior design must know how to incorporate the principles of sustainable design into buildings and interiors. This knowledge includes programs that ensure and verify green or sustainable practices. Some professionals can be certified in these areas.

Using sustainable design is a good thing for maintaining the environment now and for future generations. Also, a trend exists among clients and consumers who want to include these

"green" features in their homes, where they work, and where they stay when traveling. Residential designers especially have clients who are requesting green products for their designs and remodeling projects. According to the *Travel Industry Association of America*, many travelers are willing to pay more for accommodations with green features and are more likely to stay at properties that utilize sustainable practices. Figure 4.15 lists some strategies that housing professionals and interior designers use in design projects.

Review & Assessment

1. List at least 10 sustainable practices recommended for interior designers.
2. Why are housing and interior design professionals encouraged to use sustainability in their designs?
3. List two strategies housing and interior design professionals can use to support sustainable design for each of the following: residential design, commercial design, and hospitality design.

Strategies for Sustainable Design Practices

Residential Design

- Use programs and guidelines for sustainable design such as
  - *REGREEN* (guidelines for specific sustainable practices for remodeling)
  - *Forest Stewardship Council (FSC)* (certification that wood used in furniture and building products was harvested and produced in an ecological manner from forests)
- Select products that do not cause health problems for occupants including
  - paint and other finishing materials with low VOCs
  - products free of urea formaldehyde, a known carcinogen
- Specify products for flooring and fabrics that are renewable, such as bamboo
- Use energy-efficient appliances with the ENERGY STAR™ rating
- Work with contractors who use sustainable rating systems such as LEED
- Select recyclable materials whenever possible

Commercial Design

- Design floor plans that are flexible for different ways to be used now and in the future (to avoid recycling or filling landfills with building products)
- Provide for natural lighting to offset reliance on electricity
- Provide ample and accessible recycling stations
- Select locally manufactured materials (within a 500-mile radius)
- Specify carpeting with sustainable results including
  - wool or recycled fibers
  - recycling existing carpeting (through *Carpet America Recovery Effort*)
- Be involved in selecting high-quality and energy-efficient lighting
- Suggest use of office equipment with the ENERGY STAR™ rating (copiers and computers)
- Promote healthy indoor-air quality by
  - selecting low-VOC materials and products
  - requiring a period of time before occupancy for VOCs to escape a building

Hospitality

- Use designs that will avoid or delay future renovations (classic, timeless designs since renovations produce recycling)
- Select products that promote healthy indoor air environments through reduced off-gassing including
  - paints and other materials with low VOCs
  - fabrics that are naturally flame-retardant versus fabrics with chemical flame retardants
- Specify occupant sensors for safety and reduced energy consumption including
  - ways to work with lighting when occupants are in a room
  - use of occupant sensors in public restrooms
- Recycle existing carpeting and wallcovering
- Recommend use of equipment with the ENERGY STAR™ rating such as televisions and refrigerators

Figure 4.15 Housing and interiors professionals have a responsibility to their clients and their profession to utilize sustainable design practices.

Chapter 4 Assessment

Summary

- Sustainability means that present generations use environmental products and resources to meet their needs, but also allows future generations to meet their needs.
- Sustainable design assures that buildings and interiors have less negative impact on the environment and assures consideration of natural resources.
- Principles of sustainable design include using less energy, using renewable energy sources, selecting materials from renewable sources, recycling, conserving water use, protecting occupant health and safety, and producing less waste.
- Many resources exist to guide sustainable design including a number of certification programs and labeling systems.
- Professionals in housing-related and interior design careers have a responsibility to promote and use sustainable design practices in their work.
- Knowledge of the certification programs and other practices that guide sustainable design is essential for all housing and interior design professionals.

Terms in Action

Term antonyms Individually or with a partner, create a T-chart on a sheet of paper and list each of the *Content* and *Academic Terms* from the beginning of the chapter in the left column. In the right column, list an *antonym* (a word of opposite meaning) for each term. Discuss how understanding antonyms can help reinforce word meanings.

Think Critically

1. **Analyze evidence** In the text, the author indicates that "after use of energy-efficient appliances, one way occupants can manage and control energy use is through *home automation*." Use the text and additional reliable resources to investigate and analyze evidence about home automation. How available is such technology to the average consumer? What are the pros and cons of home automation? Discuss your analysis of this evidence with the class.
2. **Analyze recycling** New uses for recycled materials are continually changing. Make a list of three items that are currently not recycled in your community. Analyze how recycling these items could benefit new housing. Some examples include converting old auto frames into steel beams and other building materials and recycling plastic water bottles into carpeting. What are your ideas? Post your ideas to the class blog for discussion.
3. **Predict consequences** Environmental scientists and others study the impact of housing on the environment. Predict the consequences of failure to build and renovate housing that has little to no impact on the environment. Discuss your predictions with the class.

Core Skills

1. **Technology and speaking** Consult a home builder in your city to find out how he or she uses new technology in constructing houses. This should include sustainable building materials, construction techniques, and equipment. Ask if he or she has built an automated house or a house utilizing green or sustainable building technology. How is this type of housing becoming more affordable in your community? Write a summary of your findings to share with the class.
2. **Photo essay and speaking** Check the buildings in your community to see how many have solar heating systems. Using a digital camera, photograph the visible solar collectors. Compile a photo essay with presentation software complete with written photo descriptions to share with your class. What types of buildings (residential, commercial, or government) seem to use solar power most often? Present your findings to the class with your illustrated report.
3. **Research and writing** Presume you are an investigative writer for a building technology magazine. Your assignment is to research and

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predict the most common trends for housing that has little to no environmental impact 50 years from now. Write an article in which you discuss the top five sustainable items. Post your article to the class discussion board.

4. **Research and speaking** In teams, research economic considerations related to sustainability and housing. What are the economic costs to the United States of failure to build and renovate housing that meets sustainability standards? Give an oral report to share your research with the class.
5. **Research and writing** Presume you are an investigative reporter for your school online news network. Your assignment is to research techniques and materials that can be used in housing to promote sustainability. Research the use of cogeneration systems, such as fuel cells and microturbines, for the home. What is the benefit of such systems? How will such systems help home owners become less dependent on energy from other sources outside the home? Write an article summarizing your findings and post it to the online school news network.
6. **Research and speaking** Using information on your community website, determine technological applications that can be used in housing and other buildings to promote sustainability. What are the community's projected goals for use of solar and other sustainable applications in the future? How will such applications impact economics and energy usage in your community? Discuss in class.
7. **CTE college and career readiness** To find out more about LEED-certified buildings in your community, survey several architects to determine which community buildings have LEED certification. To learn about sustainable design features and LEED, arrange a tour of one or more LEED buildings for your FCCLA chapter. Use the FCCLA *Planning Process* to plan, carry out, and evaluate your activity. Consider using this tour as part of a project for the FCCLA *Career Connection* program. Write a summary about what you learned during the field trip to share on the school website. How is striving for LEED certification on buildings part of responsible citizenship?

Design Practice

1. **Green interior design** Use your problem-solving skills to analyze and solve the following problem. Presume you have been hired to design a "green" kitchen remodel for a home in your community. You have been involved with the client as extensive renovations to most rooms and all the house systems (heating, cooling, and water) have been done over time. The kitchen size is 16 feet by 24 feet. The client desires an eat-in kitchen that makes use of green products and finishes in the design. Research sustainability practices that affect interior design using the *REGREEN Residential Remodeling Guidelines (ASID/USBGC)* as a resource along with any relevant local building code information. Include the following in your "green" kitchen interior design plan:
   - CADD floor plan drawing that shows the kitchen layout including eating area, food preparation area, and a food storage area with a pantry.
   - CADD elevation drawing to show cabinetry and storage.
   - Sample selections for ceiling, wall, and floor treatments; cabinetry and trim finishes; furnishings (table and chairs); kitchen appliances (range or cooktop/ovens, refrigerator, dishwasher, and microwave or convection oven).

   Then prepare a design presentation board and a written summary about each of the products and finishes you chose for this "green" kitchen design project to share with the client (the class).
2. **Portfolio** Create a digital brochure using presentation software that promotes affordable green and sustainable housing design. Illustrate your presentation with photos or drawings and cite the source of the images. Share your digital brochure with the class and save a copy on a CD or a USB storage device (such as a thumb drive or flash drive) for your portfolio.