Solar energy

We can use the energy in sunshine to warm and light our homes, heat our water, and provide electricity to power our lights, stoves, refrigerators, and other appliances. This energy comes from processes called *solar heating, solar water heating, photovoltaic energy* (converting sunlight directly into electricity), and *solar thermal electric power* (when the sun's energy is concentrated to heat water and produce steam, which is used to produce electricity).

Solar heating

Have you ever sat in a car that was closed up on a sunny day? Did you notice how hot it was in the car? This warmth is just one example of solar heating. We can use the sun to heat other things, including our homes.

A passive solar home or building naturally collects the sun's heat through large, south-facing windows, which are just one aspect of passive design. Once the heat is inside, we need to capture and absorb it. Think about a sunny spot on the floor of your house on a cold day. That "sun spot" is nice and warm, right? It is warm because it holds the sun's heat, and we call such things *absorbers.*

In solar buildings, *sunspaces* are built onto the south side of the structure and act as large absorbers. The floors of sunspaces are usually made of tiles or bricks that absorb heat throughout the day, then release heat. When the air is colder than the floor, the tiles or bricks release the heat to the air. For more information on sunspaces, contact the Energy Efficiency and Renewable Energy Clearinghouse (see the list of Resources at the end of this publication).

A challenge with solar heating is keeping the heat inside the house. One way to do this is to use special windows that reflect the heat back into the house. Another aspect of solar heating is that the house absorbs heat even during hot weather, when the last thing you need is more heat! So, passive solar homes need to be designed to let the heat in during cold months and block the sun in the hot months. How can you do this?

You can use deciduous trees or bushes in front of the south-facing windows. These plants lose their leaves in the winter and allow most of the sun in, while in the summer, the leaves will block out a lot of the sunshine and heat. Or, you can design your house to have overhangs above the south-facing windows. This will block out the summer sunshine when the sun is high in the sky but let it in when the sun is lower in the winter.

Solar water heating

The sun also can heat water for bathing and laundry. Most solar water-heating systems have two main parts: the solar *collector* and the *storage tank.* The collector heats the water, which then flows to the storage tank. The storage tank can be just a modified water heater, but ideally it should be a larger, well-insulated tank. The water stays in the storage tank until it is needed for something, say a shower or to run the dishwasher.

A common collector is called a *flat-plate collector,* and is usually mounted on the roof. This collector is a rectangular box with a transparent cover that faces the sun. Small tubes run through the box, carrying the water or other fluid such as antifreeze to be heated. The tubes are mounted on a metal *absorber plate,* which is painted black to absorb the sun's heat. The back and sides of the box are insulated to hold in the heat. Heat builds up in the collector, and as the fluid passes through the tubes, it heats up.

Like solar-designed buildings, solar water-heating systems can be either active or passive. The most common systems are active, which means they use pumps to move the heated fluid from the collector and into the storage tank.

While a solar water-heating system can work well, it can't heat water when the sun isn't shining—and we all know it can be cloudy for days at a time! For that reason, homes also have a conventional backup system that uses fossil fuels.

Photovoltaic energy

The sun's energy can also be made directly into electricity using *photovoltaic (PV) cells,* sometimes called *solar cells.* PV cells make electricity without moving, making noise, or polluting. They are used in calculators and watches. They also provide power to satellites, electric lights, and small electrical appliances such as radios. PV cells are even being used to provide electricity for homes, villages, and businesses. Some electric utility companies are building PV systems into their power supply networks.

Although the PV cells used in calculators and watches are tiny—less than a half inch (1.2 centimeters) in diameter—PV cells for larger power systems are about 4 inches (10 centimeters) in diameter. When more power is needed, PV cells can be wired together to form a *module.* A module of about 40 cells is often enough to power a small light bulb. For more power, PV modules are wired together into an *array.* PV arrays can produce enough power to meet the electrical needs of your house—or for even larger uses.

Today, PV systems are mostly used for water pumping, highway lighting, weather stations, and other electrical systems located away from power lines. For example, if you had a cabin on a mountain top, a PV system would allow you to read some of your favorite books before you went to sleep!

Because PV systems can be expensive, they are not used in areas that have electricity nearby. But if someone needs electricity in a remote place, PV can be quite economical. Another aspect of PV power is "intermittency," which means that if the sun isn't shining, the system can't make electricity. Because PV systems only produce electricity when the sun is shining, these remote systems need batteries to store the electricity.

Solar thermal electric power

Solar thermal systems can also change sunlight into electricity, but not in the same way as PV cells. In most cases, solar thermal systems concentrate (focus) sunlight to produce heat. This heat boils water to make steam. The steam rotates a *turbine,* which is made of several rows of blades mounted on a large shaft. The steam's pressure flows through the turbine, pushes against the blades, and causes the shaft

to turn, much like you can make a pinwheel spin by blowing on it. The turbine is attached to a generator that makes electricity.

Like electricity from PV systems, solar thermal power can be intermittent. To avoid this problem, many systems use a backup system that relies on natural gas to heat the water. Because solar thermal systems concentrate the sun's energy, they need to be located in areas of the world that receive a lot of intense sunshine.