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ABSTRACT

This booklet provides an introduction to renewable energy, discussing: (1) the production of electricity from sunlight; (2) wind power; (3) hydroelectric power; (4) geothermal energy; and (5) biomass. Also provided are nine questions to answer (based on the readings), four additional questions to answer (which require additional information), and information on how turbine generators work. (JN)

DOE/CE-0108

INFORMATION
U.S. DEPARTMENT OF ENERGY
CONSERVATION AND RENEWABLE ENERGY INQUIRY AND REFERRAL SERVICE

Learning About Renewable Energy

Almost all the energy for the lights, heat and hot water in your home is probably produced from fossil fuels. Coal, oil, and natural gas are the most heavily used fossil fuels. Electricity is created in huge generating plants powered by oil, coal, or nuclear energy, your heat comes from the oil or natural gas burned in the furnance in your home, and your hot water comes from a heater warmed by electricity or natural gas.

Fossil fuels work well, but as they are burned to produce energy, they are changed into gases that cannot be used again. This is a problem since it has taken millions of years for the earth to create fossil fuels, and only a limited amount exists. Eventually we will use up all the fossil fuels on earth and we will then have to find other ways to run cars, heat homes, or turn on lights.

Fortunately, people have already found another way of supplying energy, called **renewable energy**, which will not run out for billions of years. The sun, wind, rivers and streams, and trees and plants are some of the sources of renewable energy. They can be used to make electricity, heat homes, or heat water, and, unlike fossil fuels, their supply is replaceable.

Producing Electricity From Sunlight

The sun's energy can be used to make electricity in several ways.

One method is to let the sun's light fall on panels made up of **photovoltaic cells** (also called **solar cells**). These solar cells absorb the sunlight and turn it directly into electricity. The cells are made of materials which are manufactured to enable them to generate electricity without moving, making noise, or polluting. These cells are already being used to power devices as small as calculators and watches, and as large as the lights and appliances of a whole house. To use solar cells to power your home, all you have to do is mount the panels where they will receive a great deal of sunshine, connect them to equipment that runs on electricity, and enjoy electricity from the sun. If the solar cells generate more electricity during the day than a home can use, the extra power can be stored in batteries or sold back to the power grid for other people to buy. In order to sell electricity to the power grid, the electricity must be sent through a special machine called an invertor which makes the electricity usable for everyone.

Solar cells can be used in many other ways than to provide electricity to homes. Factories, businesses, and almost anyone else who needs electricity can make use of solar cells. Some power companies are constructing large electricity generating plants using solar cells. Dozens of special devices hold large panels of solar cells; the power companies sell the electricity produced by the panels to their customers.

While solar cells are being used, they are not quite ready for use by everyone. The biggest problem with solar cells is that they cost a lot to make. But solar cell scientists are working hard to make the cells less expensive and more powerful, so that in a few years more people will be able to afford to buy solar cells for their homes.

One way to generate large amounts of heat or electricity directly from the sun is by using **solar thermal power towers.** If you have ever reflected the sun's light with a mirror you will have a good idea of

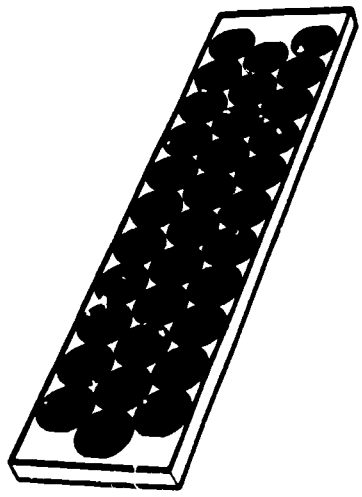

Figure 1. A photovoltaic cell panel used for generating electricity

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how a power tower works. Hundreds of large mirrors reflect the sun's light onto a receiver at the top of the power tower. The heat from the sunlight causes the water circulating through the tower to get very hot. The water gets so hot that it boils and turns to steam. This steam can then be used to turn a turbine to produce electricity in the same way that normal coal or oil burning power plants do. The steam can also be used in factories to make products that require high temperatures. There have been several power towers built. The largest one is in California and it has been generating a great deal of electricity for people in that area. So far, solar power towers are still very expensive to build, but as more power towers are built and scientists and engineers get more good ideas, researchers will learn how to construct them for less money. When that happens, the sun's energy will produce electricity, supply heat to industry and possibly even produce fuels to run our cars.

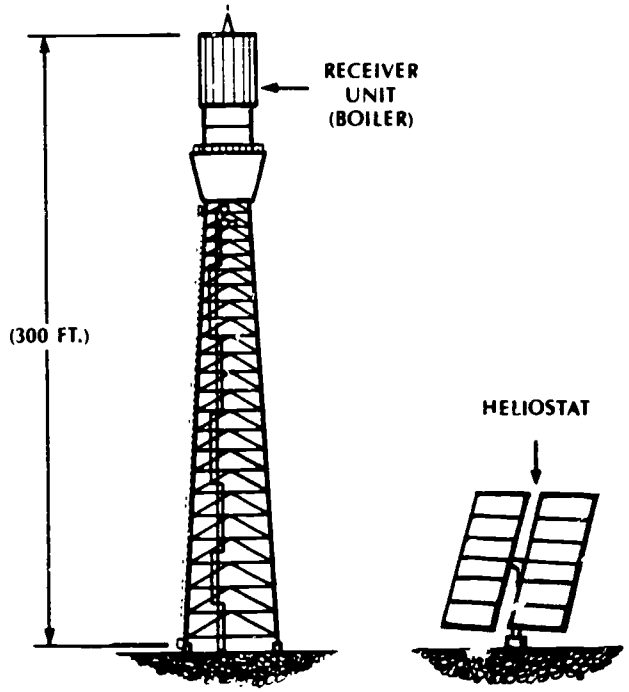

Figure 2. Power tower and heliostat (mirrors) used for generating electricity.

Wind Power

Windmills have been used for hundreds of years to pump water from wells, but only in the past few years have they been mainly used to make electricity. Most windmills built today have just two or three, long, light blades that can turn very fast when the wind blows. The larger the blades and the faster they turn, the more electricity they create. The good thing about windmills is that they can produce electricity at night as well as during the day. In California, hundreds and hundreds of these windmills have been built in a few areas that are very windy all year long. These areas are called windfarms and they are already generating large amounts of electricity for people in California. Some people are now using windmills to produce electricity for their homes, but windmills are not practical everywhere. They can only be used in a place that receives a steady amount of wind all year long, and where the wind is not blocked by buildings or trees.

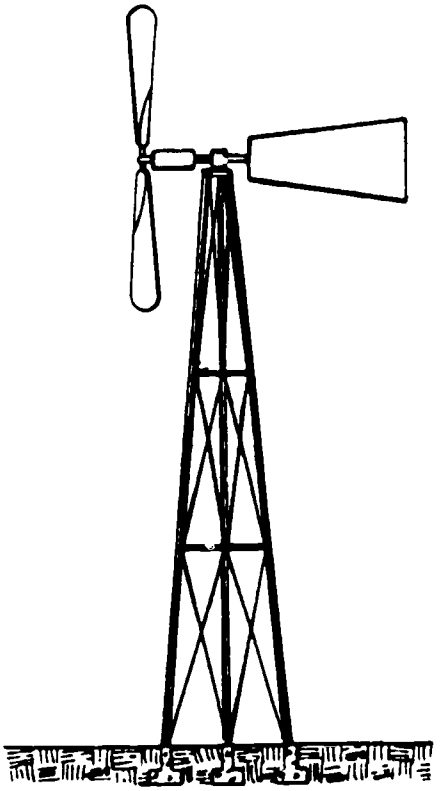

Figure 3. A small electricity-generating wind machine.

Hydroelectric Power

The water in rivers and streams has also been used for a long time to generate power. Electricity created from water power is called **hydroelectric power**. To create hydroelectricity, flowing water from a river or stream is directed through a turbine, which is a type of water wheel, causing the turbine to spin. The turbine spins an electric generator which produces electricity. Often a dam is built across the river to build up the water supply and enable the power plant to generate even more electricity.

There are many hydroelectric power plants in the United States large enough to supply electricity for whole towns. Recently many people have been building smaller hydroelectric systems that can make enough electricity to power one or several homes. Hydroelectricity creates no pollution and uses no fossil fuels. If you check around, you may find that there is a hydroelectric plant not too far from where you live.

Geothermal Energy

Not only can the sun, wind, and rivers be a source of energy, but also the heat inside of the earth can be tapped to provide energy for homes, industries, and utilities. Deep inside the earth, the rock is so hot that it is like a liquid. In some places, such as in the western part of the United States, this liquid rock comes quite close to the surface of the earth and heats large underground reservoirs of water. Such spots are potential sources of **geothermal energy** because they can be reached by drills. When a geothermal well has been drilled, the hot water in the well is pumped to the surface where its heat is recovered. Some geothermal wells contain very hot rock but no water. In order to get the heat from the rocks, cold water is pumped down into the well. As the water comes in contact with the hot rocks it is heated to a high temperature. The hot water is then pumped back out to the surface through another hole.

The temperature of the water from geothermal wells differs from place to place, so it is used in many different ways. Some wells heat the water enough so that it can be used by an industry to help it manufacture products. Some wells heat the water even more, so that the water turns to steam which can be used to produce electricity. So far, there are only a few geothermal power plants, but in the future, geothermal energy could be providing a lot of heat and electricity for people living near geothermal sources.

Biomass

Trees, farm crops, manure, and plants are all examples of **biomass**. Trees are a very popular source of biomass energy, and the wood from trees is often used in fireplaces. Though trees take 10-20 years to become large enough to cut down, it takes millions of years for fossil fuels to form. Many areas of the United States have large forests containing thousands of trees. If these trees are carefully cut down (so as not to damage the forest) or grown especially for use as an energy crop, they can be burned as fuel to heat homes, provide energy to industrial complexes, or generate electricity at a power plant. Many homes and companies are using wood today.

Other plants besides trees can provide energy. Wheat, corn and other crops can be processed to make alcohol, which can be added to gasoline used in cars (gasoline is made from fossil fuels). If you live in the midwest, your parents probably use gasoline that has been blended with alcohol fuel in their car.

Some farms and sewage treatment plants use a process for changing wastes into energy. Microorganisms (bugs smaller than the eye can see) convert the waste to methane gas which is a good energy fuel. Methane is used in both homes and industry. If you have a gas furnace or a gas stove it probably operates on methane gas.

We have listed the main kinds of renewable energy, but there are many other types which are being used or studied that will help reduce our need for fossil fuels. If you want to learn more about renewable energy, look for magazines or books that are about energy. Your teacher or librarian can help you locate other reading material.

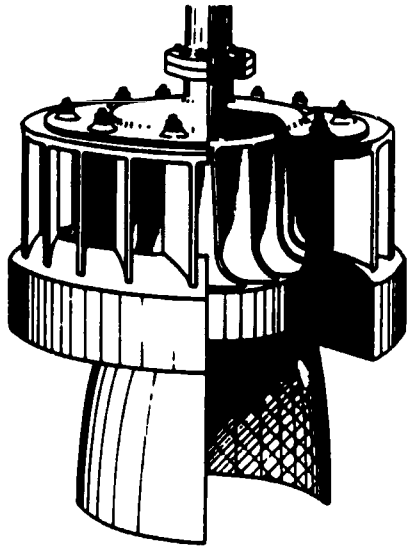

Figure 4. A Francis turbine used for hydroelectric generation

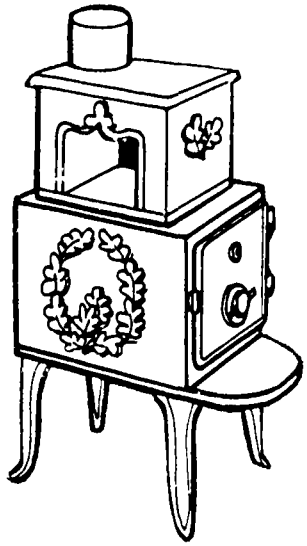

Figure 5. A double-chamber wood stove

What Have You Learned?

From Your Reading

1. Name four ways to produce electricity using renewable energy.
2. What are some of the main benefits of using renewable energy instead of fossil fuels?
3. If a family's photovoltaic panels make more electricity than the family can consume, what are two ways that the extra electricity can be used?
4. Why are photovoltaic cells not ready for use by everyone?
5. How are mirrors used in solar thermal power towers?
6. What advantages do windmills have over other types of renewable energy that rely on the sun?
7. Why are dams often needed in order to generate hydroelectric energy?
8. What are three possible ways to use wood as an energy source?
9. Why are trees and crops considered to be renewable sources of energy?

From Your Research

1. In what parts of the country do you think solar thermal power towers would work best? Where would windmills work best?
2. What type of renewable energy would work best in your area?
3. What did people use windmills for 100 years ago?
4. What are the names and locations of some of the biggest hydroelectric dams in this country?

If You Want To Know More...

How Turbine Generators Work

Turbine generators are the mechanisms most commonly used to produce electricity in fossil fuel power plants. When the fossil fuel is burned it heats water until the water boils and turns to steam. This steam is collected and placed under a great deal of pressure. The high pressure causes the steam to move with great force into the turbine which contains a long shaft ringed by hundreds of turbine blades. As the pressurized steam passes by the blades, it causes the blades to turn the shaft very rapidly. The shaft, which is attached to the generator, turns a rotor in the generator which produces electricity.

Specially designed turbine generators can be used in renewable energy power plants too. In solar thermal power towers and wood burning power plants, steam is produced and used to turn the turbine just as in fossil fuel power plants. But in hydroelectric plants, the fast moving water is sent through the turbine to turn the blades surrounding the shaft. No steam is needed. Windmills use the wind to turn the turbine blades which in this case are the blades of the windmill. Therefore, when you see the blades of a windmill moving, you are actually watching a turbine in action.

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