Be an Engineer!

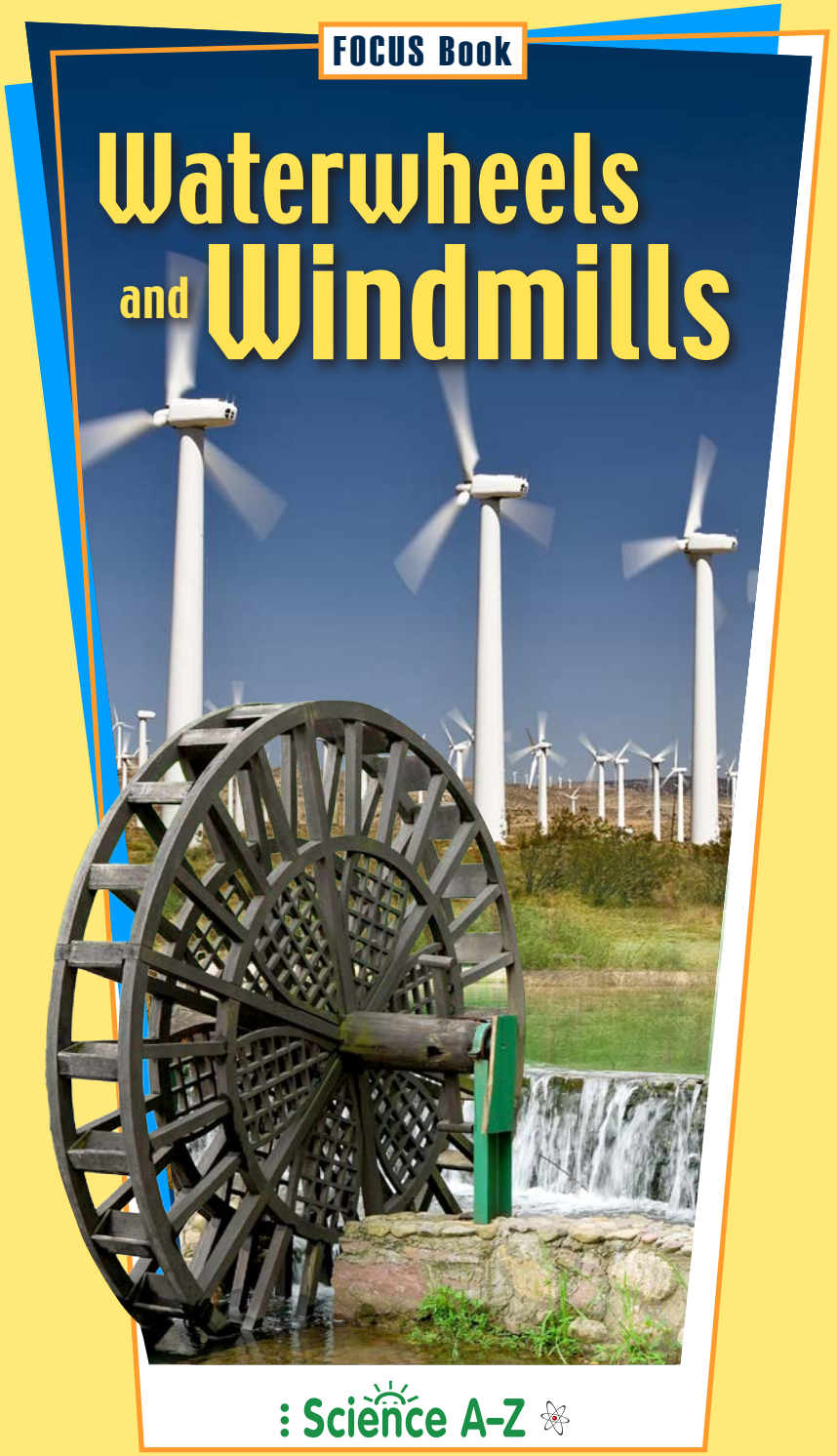
Design and test a waterwheel. First, decide which kind of waterwheel you will make. Look at the pictures of waterwheels on page 5. Draw a sketch, and then build it. Test your waterwheel using running water.

How could you make a waterwheel that spins faster? Draw your new design. Build a revised version and test it. Record your results.

As a challenge, try to use your waterwheel to perform a task, such as rolling a pencil off a table or making music on an instrument.

Beyond the Book

Use the Internet or the library to research the history of waterwheels or windmills in different parts of the world.



Waterwheels and Windmills

FOCUS Question

How do machines use water and wind for power?

Energy and Matter

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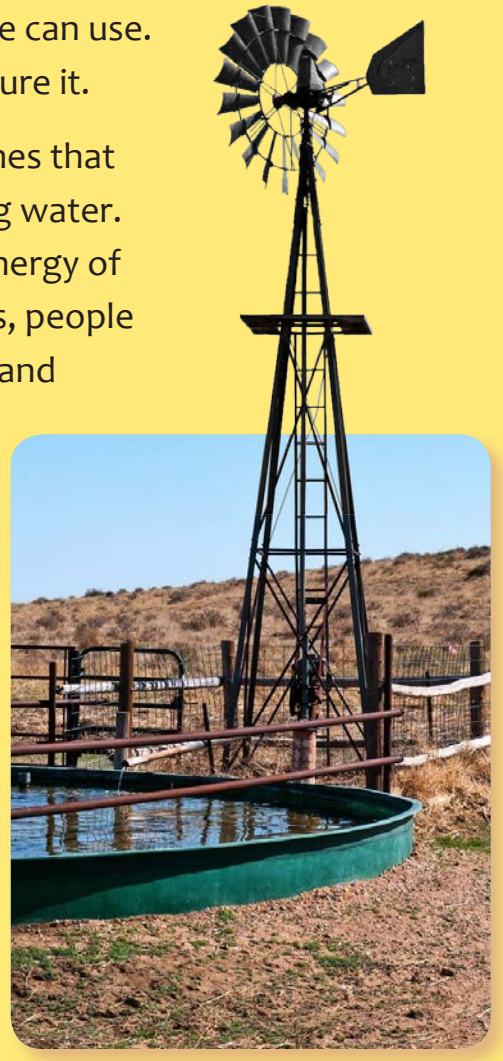
Energy in Motion

We need energy! We use it to run machines, to make food, and to turn on lights. Luckily, there is energy all around us. Earth's air and water are in constant motion. This motion can be turned into energy we can use. All we have to do is capture it.

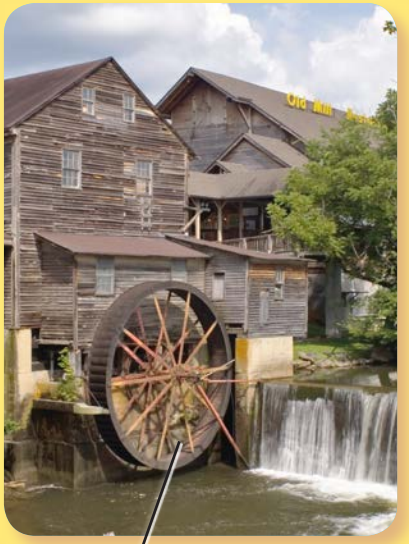
Waterwheels are machines that use the power of moving water. Windmills capture the energy of moving air. For centuries, people have used waterwheels and windmills in many different ways. Today, most people use them to make electricity. How do these machines work?



This windmill pumps water from the ground up to a tank.

Ye Old Waterwheel

A waterwheel changes the energy of motion into a different kind—one that can do work.



waterwheel

Water flowing down a river has a lot of motion energy. This energy pushes the blades of a waterwheel, causing the wheel and its axle to turn. Then the wheel and its axle can move other parts of the machine.

One water-powered machine is a *mill*. This is a machine that grinds down grains, beans, or other hard materials. In a sawmill, a waterwheel turns sharp blades that cut logs into lumber. Some creameries still use waterwheels to run a churn that makes ice cream, cheese, or butter.

Water can also provide the power to cut logs.

Types of Waterwheels

The simplest waterwheel lies flat on its side. This is a *horizontal* wheel. Part of it sticks into a stream of water. The stream turns the wheel and axle.

horizontal water wheel

Most waterwheels are *vertical*, or mounted upright. As the wheel turns, its axle turns a large gear. The large gear turns a smaller gear and the smaller gear turns faster. This system changes the water's movement into *mechanical energy*. This is energy that can be used to do work.

gears attached to the axle of a vertical waterwheel

In an overshot wheel, water pushes the wheel from the top.

A breastshot wheel sits lower in the water. The water fills buckets from the side of the wheel.

There are many kinds of vertical waterwheels. Two of the most common are the *overshot wheel* and *breastshot wheel.*

The turbines in modern hydroelectric dams are similar to waterwheels. Hydroelectric dams turn water energy into electricity.

Word Wise

A *turbine* is an engine powered by blades that are turned by water, wind, or steam.

Blowing in the Wind

Years ago, many windmills were used to pump water out of the ground or to grind wheat. The windmill blades were tilted to catch the wind, making them turn in the breeze like a pinwheel toy. As the blades turned, they rotated an axle. This turned gears, which then moved other parts inside the machine.

pinwheel toy

Most modern windmills are used for making electricity. These are called *wind turbines.* Their long blades spin in the wind. The energy from the moving turbines generates electricity.

a modern wind turbine

Modern Wind Turbines

Wind turbines are often quite tall, with massive blades. Way up in the air, they can catch more wind.

Some turbines are vertical. One example is called the *eggbeater* because it has oddly shaped blades. These blades are good at catching the wind. In vertical turbines, the control room is near the ground. This makes them easier to repair.

Horizontal turbines have blades that look like propellers. These turbines have a control room high off the ground. If something breaks, a worker has to climb all the way to the top to fix it.

vertical wind turbines

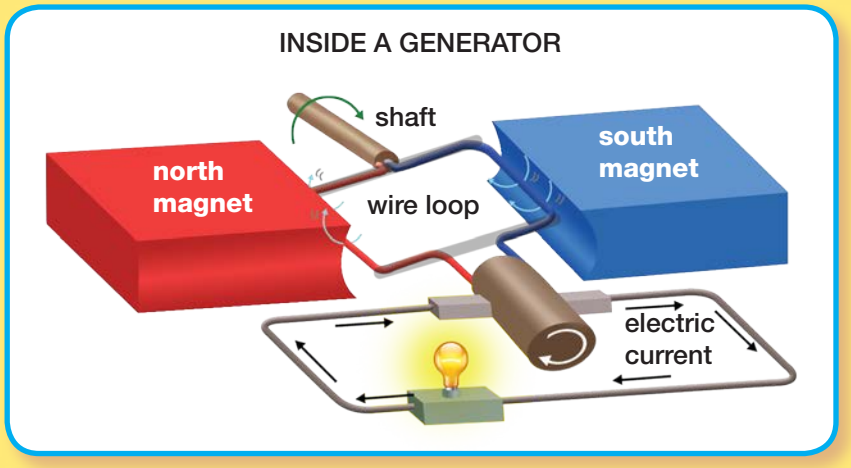
horizontal wind turbines

How Generators Work

You have read that turbines can generate electricity. How do they do it? With *generators!*

Generators change motion into electricity. A simple generator has an energy source, such as moving wind or water. It also has magnets and a loop of wires attached to an axle, or *shaft*.

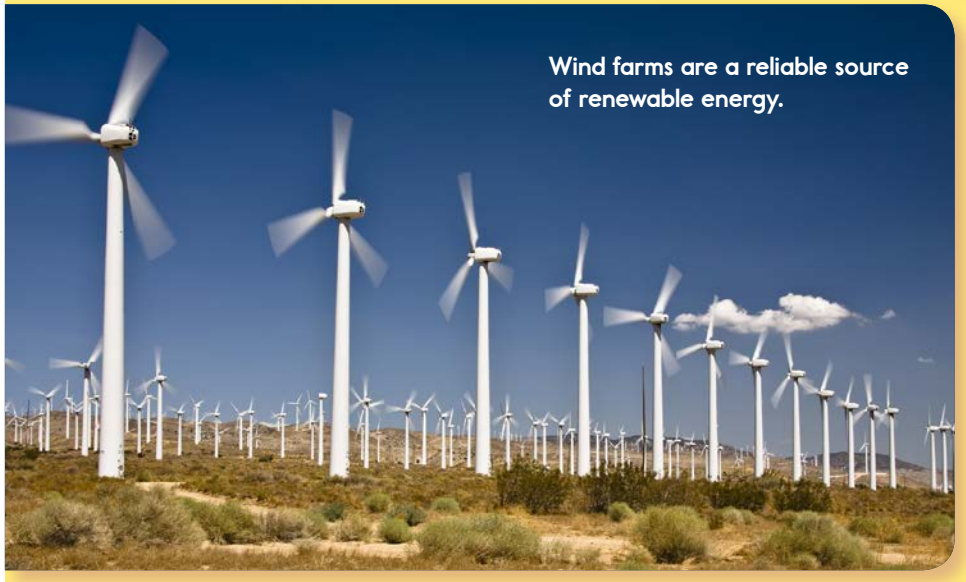
The wind- or water-powered turbine turns the gears, which then spin the wire loop. The loop spins between magnets. Electric current flows when the fast-moving wire loop passes by the magnets.



Energy for the Future

Wind and flowing water are two ways to spin turbines. Another way is to heat water to make steam that spins turbines. Using nuclear power and burning fossil fuels such as coal can both generate heat to make steam.

A benefit of wind and water power is that they are *renewable*. A renewable resource is one that can be used again and again. Getting electricity from water and wind means that no fossil fuel is burned. These power sources produce no dangerous gases or harmful chemicals. This keeps our air cleaner!



Wind farms are a reliable source of renewable energy.

Read-Think-Write

Write your answers on separate paper. Use details from the text as evidence.

1. How are waterwheels and windmills similar? How are they different?
2. Look at the diagram on page 6. Identify some simple machines in a wind turbine and explain their roles.
3. Describe how a generator produces electricity.
4. Which of these is *not* an advantage of *renewable* energy sources?
   - Ⓐ burns fossil fuel
   - Ⓑ can be replaced
   - Ⓒ keeps our air cleaner
5. Waterwheels and windmills can produce electricity from energy sources that will never run out. So why do you think fossil fuels are used more often to make electricity?

FOCUS Question

How do machines use water and wind for power? Describe some benefits of using water and wind to generate electricity.