



Wind

What Is Wind?

Wind is simply air in motion. It is caused by the uneven heating of the Earth's surface by radiant energy from the sun. Since the Earth's surface is made of very different types of land and water, it absorbs the sun's energy at different rates. Water usually does not heat or cool as quickly as land because of its physical properties.

An ideal situation for the formation of local wind is an area where land and water meet. During the day, the air above the land heats up more quickly than the air above water. The warm air over the land expands, becomes less dense and rises.

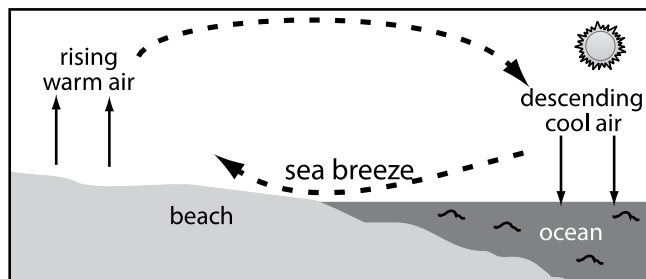
The heavier, denser, cool air over the water flows in to take its place, creating wind. In the same way, the atmospheric winds that circle the Earth are created because the land near the Equator is heated more by the sun than land near the North and South Poles.

Today, people use wind energy to make electricity. Wind is called a **renewable** energy source because the wind will blow as long as the sun shines. Wind only accounts for a small amount of U.S. **energy consumption**—1.6%—but it is one of the fastest growing renewable sources of energy, and generates 10.5 percent of U.S. electricity.

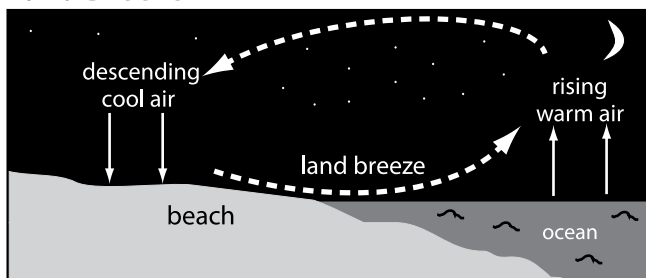
Wind Direction

A weather vane, or wind vane, is used to show the direction of the wind. A wind vane points toward the source of the wind. Wind direction is reported as the direction from which the wind blows, not the direction toward which the wind moves. A north wind blows from the north toward the south.

Sea Breeze



Land Breeze



Wind Speed

It is important in many cases to know how fast the wind is blowing. Wind speed can be measured using a wind gauge or **anemometer**.

One type of anemometer is a device with three arms that spin on top of a shaft. Each arm has a cup on its end. The cups catch the wind and spin the shaft. The harder the wind blows, the faster the shaft spins. A device inside counts the number of rotations per minute and converts that figure into miles per hour. A display on the anemometer shows the speed of the wind.

History of Wind Machines

Since ancient times, people have harnessed the wind's energy. Over 5,000 years ago, the ancient Egyptians used the wind to sail ships on the Nile River. Later, people built windmills to grind wheat and other grains. The early windmills looked like paddle wheels. Centuries later, the people in Holland, (the Netherlands), improved the windmill. They gave it propeller-type blades, still made with sails. The Netherlands is famous for its windmills.

In this country, the colonists used windmills to grind wheat and corn, to pump water, and to cut wood at sawmills. Today, people occasionally use windmills to grind grain and pump water, but they also use modern wind turbines to make electricity.

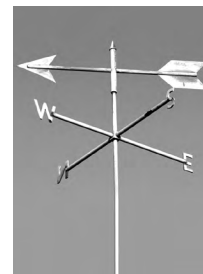
Today's Wind Turbines

Like old-fashioned windmills, today's **wind turbines** use blades to capture the wind's kinetic energy. Wind turbines work because they slow down the speed of the wind. When the wind blows, it pushes against the blades of the wind turbine, making the rotor spin. The parts of a turbine work together to power a generator to produce electricity.

Windmill



Weather Vane



Anemometer



Most wind turbines have the same basic parts: blades, shafts, gears, a generator, and a cable. (Some turbines do not have gear boxes.) These parts work together to convert the wind's energy into electricity.

1. The wind blows and pushes against the blades on top of the tower. The blades catch the wind and spin the rotor.
2. The rotor is connected to a low-speed shaft. When the rotor spins, the shaft turns. The shaft is connected to a gear box. The gears in the gear box increase the speed of the spinning motion on a high-speed shaft. All of the gears are housed inside the nacelle.
3. The high-speed shaft is connected to a generator. As the shaft turns inside the generator, it produces electricity.
4. The electricity is sent through cables down the turbine tower to a transformer and then to a transmission line.

The amount of electricity that a turbine produces depends on its size and the speed of the wind. Wind turbines come in many different sizes. A small turbine may power one home. Large wind turbines can produce enough electricity to power up to 1,000 homes. Large turbines are sometimes grouped together to provide power to the electricity **grid**. The grid is the network of power lines connected together across the entire country.

Wind Power Plants

Wind power plants, or **wind farms**, are clusters of wind turbines used to produce electricity. A wind farm usually has dozens of wind turbines scattered over a large area.

Choosing the location of a wind farm is known as **siting** a wind farm. The wind speed and direction must be studied to determine where to put the turbines. As a rule, wind speed increases with height, and over open areas with no windbreaks.

Turbines are usually built in rows facing into the **prevailing wind**. Placing turbines too far apart wastes space. If turbines are too close together, they block each other's wind.

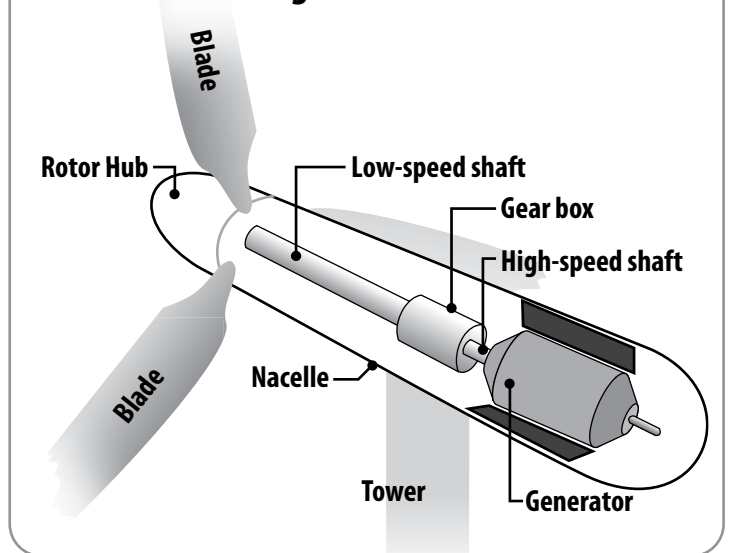
The site must have strong, steady winds. Scientists measure the winds in an area for several years before choosing a site. The best sites for wind farms are on hilltops, on the open plains, through mountain passes, and near the coasts of oceans or large lakes. Texas, the number one producer of wind energy in the U.S., has plentiful open space with steady winds. The Midwest and Rocky Mountain states are also prime states for wind energy production.

The wind blows stronger and steadier over water than over land. There are no obstacles on the water to block the wind. There is a lot of wind energy available **offshore**.

Offshore wind farms are built in the shallow waters off the coast of major lakes and oceans using fixed turbines. In deeper waters, floating structures can be used. Offshore turbines produce more electricity than turbines on land, but they cost more to build and operate.

The first offshore wind farm in the United States, off the coast of Block Island, RI, began operating in 2016. It includes five turbines that power 17,000 homes. A two-turbine wind farm was completed by Dominion Energy in 2020 off the coast of Virginia. Dominion, Vineyard Wind Offshore, and Orsted have larger projects underway on the Atlantic Coast, with generation expected to come online as early as 2025 for these projects.

Wind Turbine Diagram



WIND FARM



Image Credit: Adobe Stock/ Imagevixen

Wind Production

Wind produces only a small amount of the electricity this country uses, but the amount is growing every year. One reason wind farms don't produce more electricity is that they can only run when the wind is blowing at certain speeds. On Midwestern wind farms, the wind is optimum for producing electricity between 65 and 90 percent of the time.

Environmental Impacts

In some areas, people worry about the birds and bats that may be injured by wind turbines. Some people believe wind turbines produce a lot of sound, and some think turbines affect their view of the landscape.

On the other hand, wind is a clean, renewable energy source that produces no air pollution. And wind is free to use. Wind power may not be the perfect answer to our electricity needs, but it is a valuable part of the solution.