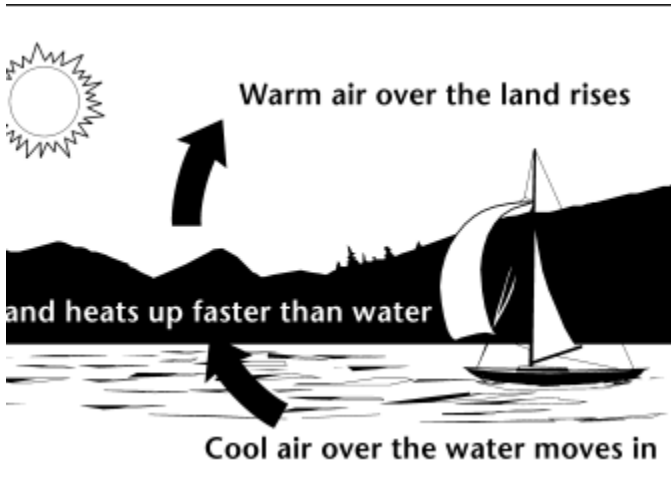


ENERGY FROM WIND



Wind is simple air in motion. It is caused by the uneven heating of the earth's surface by the sun. Since the earth's surface is made of very different types of land and water, it absorbs the sun's heat at different rates.

During the day, the air above the land heats up more quickly than the air over water. The warm air over the land expands and rises, and the heavier, cooler air rushes in to take its place, creating winds. At night, the winds are reversed because the air cools more rapidly over land than over water.

In the same way, the large atmospheric winds that circle the earth are created because the

land near the earth's equator is heated more by the sun than the land near the North and South Poles.

Today, wind energy is mainly used to generate electricity. Wind is called a renewable energy source because the wind will blow as long as the sun shines.

The History of Wind

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

American colonists used windmills to grind wheat and corn, to pump water, and to cut wood at sawmills. As late as the 1920s, Americans used small windmills to generate electricity in rural areas without electric service. When power lines began to transport electricity to rural areas in the 1930s, local windmills were used less and less, though they can still be seen on some Western ranches.

The oil shortages of the 1970s changed the energy picture for the country and the world. It created an interest in alternative energy sources, paving the way for the re-entry of the windmill to generate electricity. In the early 1980s wind energy really took off in California, partly because of state policies that encouraged renewable energy sources. Support for wind development has since spread to other states, but California still produces more than twice as much wind energy as any other state.

The first [offshore wind](#) park in the United States is planned for an area off the coast of Cape Cod, Massachusetts (read an article about the [Cape Cod Wind Project](#)).

HOW WIND MACHINES WORK

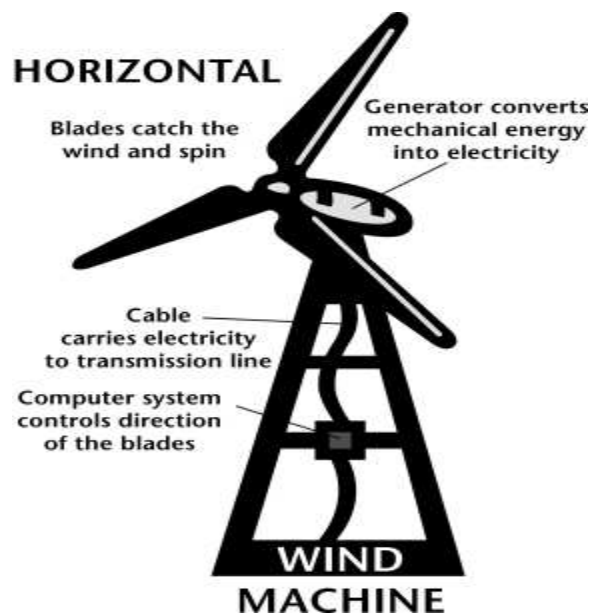
Like old fashioned windmills, today's wind machines use blades to collect the wind's kinetic energy. Windmills work because they slow down the speed of the wind. The wind flows over the airfoil shaped blades causing lift, like the effect on airplane wings, causing them to turn. The blades are connected to a drive shaft that turns an electric generator to produce electricity. A wind turbine is similar to its forerunner the windmill. However, windmills are typically used to directly power a piece of machinery for example: a pump or a grinder for grain; wind turbines are dedicated to the production of electric power for use off-site. With the new wind machines, there is still the problem of what to do when the wind isn't blowing. At those times, other types of power plants must be used to make electricity.

TYPES OF WIND MACHINES

There are two types of wind machines (turbines) used today based on the direction of the rotating shaft (axis): horizontal-axis wind machines and vertical-axis wind machines. The size of wind machines varies widely. Small turbines used to power a single home or business may have a capacity of less than 100 kilowatts. Some large commercial sized turbines may have a capacity of 5 million watts, or 5 megawatts. Larger turbines are often grouped together into [wind farms](#) that provide power to the electrical grid.

Horizontal-axis

Most wind machines being used today are the horizontal-axis type. Horizontal-axis wind machines 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. The largest wind machines in the world have blades longer than a football field! Wind machines stand tall and wide to capture more wind.



Vertical-axis

Vertical-axis wind machines have blades that go from top to bottom and the most common type (Darrieus wind turbine) looks like a giant two-bladed egg beater. The type of vertical wind machine typically stands 100 feet tall and 50 feet wide. Vertical-axis wind machines make up only a very small percent of the wind machines used today.

The Wind Amplified Rotor Platform (WARP) is a different kind of wind system that is designed to be more efficient and use less land than wind machines in use today. The WARP does not use large blades; instead, it looks like a stack of wheel rims. Each module has a pair of small, high capacity turbines mounted to both of its concave wind amplifier module channel surfaces. The concave surfaces channel wind toward the turbines, amplifying wind speeds by 50 percent or more. Eneco, the company that designed WARP, plans to market the technology to power offshore oil platforms and wireless telecommunications systems.

WIND POWER PLANTS

Wind power plants, or **wind farms** as they are sometimes called, are clusters of wind machines used to produce electricity. A wind farm usually has dozens of wind machines scattered over a large area. The world's largest wind farm, the Horse Hollow Wind Energy Center in Texas, has 421 wind turbines that generate enough electricity to power 220,000 homes per year.

Unlike power plants, many wind plants are not owned by public utility companies. Instead they are owned and operated by business people who sell the electricity produced on the wind farm to electric utilities. These private companies are known as Independent Power Producers.

Operating a wind power plant is not as simple as just building a windmill in a windy place. Wind plant owners must carefully plan where to locate their machines. One important thing to consider is how fast and how much the wind blows.

As a rule, wind speed increases with altitude and over open areas with no windbreaks. Good sites for wind plants are the tops of smooth, rounded hills, open plains or shorelines, and mountain gaps that produce wind funneling. Wind speed varies throughout the country. It also varies from season to season. In Tehachapi, California, the wind blows more from April through October than it does in the winter. This is because of the extreme heating of the Mojave Desert during the summer months. The hot air over the desert rises, and the cooler, denser air above the Pacific Ocean rushes through the Tehachapi mountain pass to take its place. In a state like Montana, on the other hand, the wind blows more during the winter. Fortunately, these seasonal variations are a good match for the electricity demands of the regions. In California, people use more electricity during the summer for air conditioners. In Montana, people use more electricity during the winter months for heating.

WIND PRODUCTION

In 2006, wind machines in the United States generated a total of 26.6 billion kWh per year of electricity, enough to serve more than 2.4 million households. This is enough electricity to power a city larger than Los Angeles, but it is only a small fraction of the nation's total electricity production, about 0.4 percent. The amount of electricity generated from wind has been growing fast in recent years. In 2006, electricity generated from wind was 2 1/2 times more than wind generation in 2002.

New technologies have decreased the cost of producing electricity from wind, and growth in wind power has been encouraged by tax breaks for renewable energy and [green pricing](#) programs. Many utilities around the country offer green pricing options that allow customers the choice to pay more for electricity that comes from renewable sources.

Wind machines generate electricity in 28 different states in 2006. The states with the most wind production are Texas, California, Iowa, Minnesota, and Oklahoma. Most of the wind power plants in the world are located in Europe and in the United States where government programs have helped support wind power development. The United States ranks second in the world in wind power capacity, behind Germany and ahead of Spain and India. Denmark ranks number six in the world in wind power capacity but generates 20 percent of its electricity from wind.

WIND AND THE ENVIRONMENT

In the 1970s, oil shortages pushed the development of alternative energy sources. In the 1990s, the push came from a renewed concern for the environment in response to scientific studies indicating potential changes to the global climate if the use of fossil fuels continues to increase. Wind energy is an economical power resource in many areas of the country. Wind is a clean fuel; wind farms produce no air or water pollution because no fuel is burned. Growing concern about emissions from fossil fuel generation, increased government support, and higher costs for fossil fuels (especially natural gas and coal) have helped wind power capacity in the United States grow substantially over the last 10 years.

The most serious environmental drawbacks to wind machines may be their negative effect on wild bird populations and the visual impact on the landscape. To some, the glistening blades of windmills on the horizon are an eyesore; to others, they're a beautiful alternative to conventional power plants.

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