Wind Turbines

A wind turbine is a machine for converting the kinetic energy in wind into mechanical energy.

Windmills

If the mechanical energy is used directly by machinery, such as a pump or grinding stones, the machine is usually called a windmill.

Wind Turbines

If the mechanical energy is then converted to electricity, the machine is called a wind generator.

Types of Wind Turbines

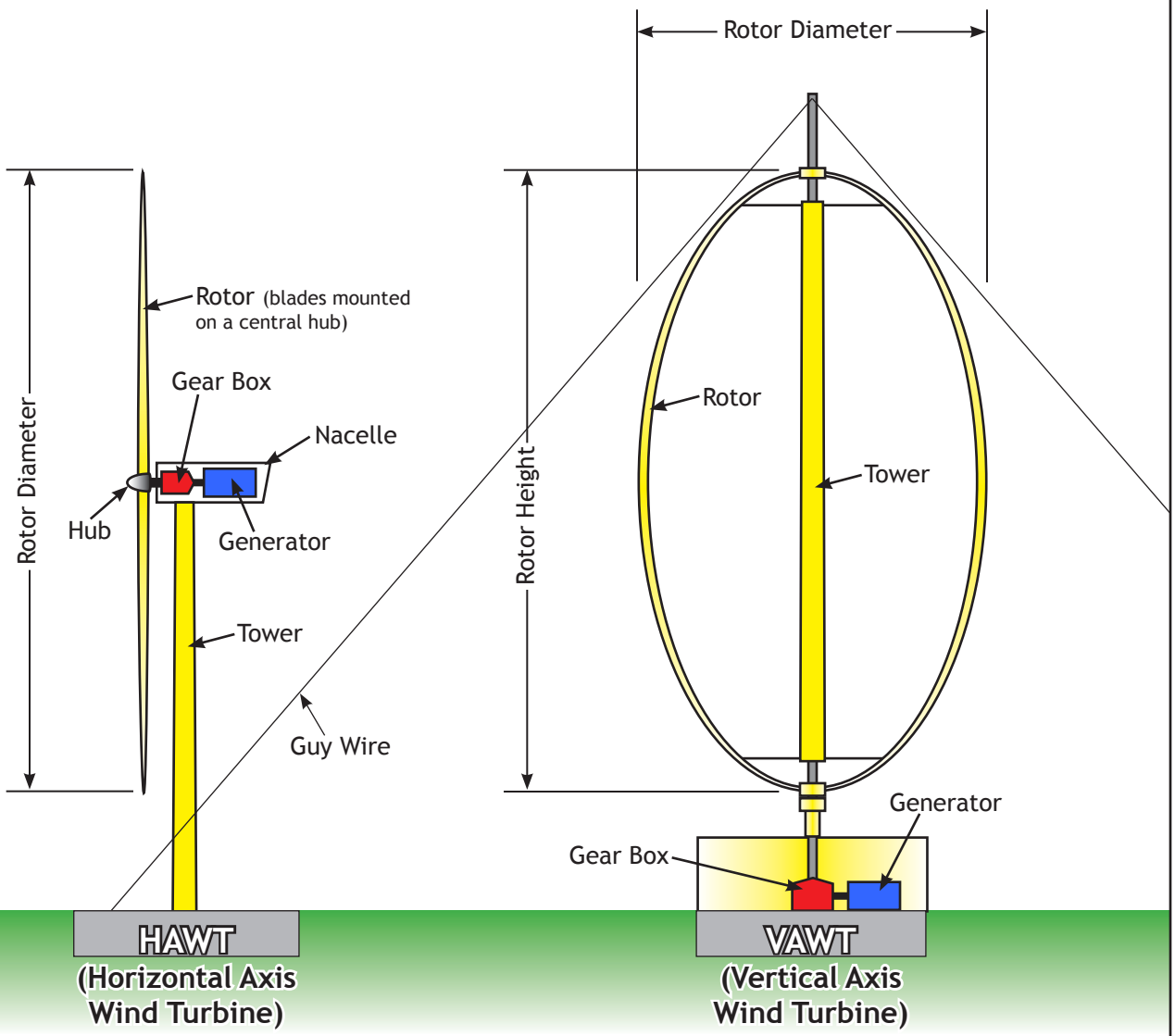
Wind turbines are classified into two general types: horizontal axis and vertical axis. A horizontal axis machine has its blades rotating on an axis parallel to the ground. A vertical axis machine has its blades rotating on an axis perpendicular to the ground. There are a number of available designs for both and each type has certain advantages and disadvantages. However, compared with the horizontal axis type, very few vertical axis machines are available commercially.

Vertical Axis Wind Turbine (HAWT)

Horizontal Axis Wind Turbine (HAWT)

Parts of a Wind Turbine

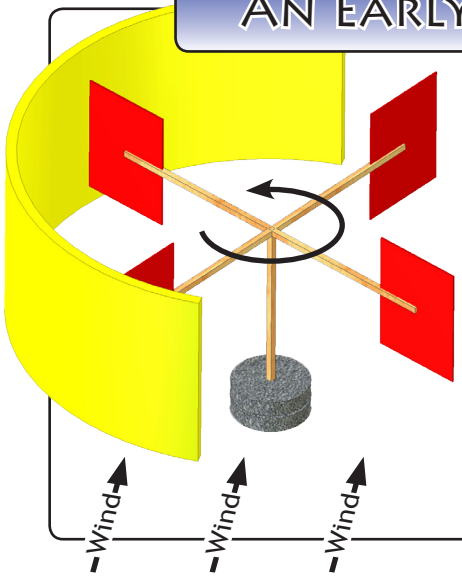
- The nacelle contains the key components of the wind turbine, including the gearbox, and the electrical generator.
- The tower of the wind turbine carries the nacelle and the rotor. Generally, it is an advantage to have a high tower, since wind speeds increase farther away from the ground.
- The rotor blades capture wind energy and transfer its power to the rotor hub.
- The generator converts the mechanical energy of the rotating shaft to electrical energy
- The gearbox increases the rotational speed of the shaft for the generator.



Vertical Axis Wind Turbines

Although vertical axis wind turbines have existed for centuries, they are not as common as their horizontal counterparts. The main reason for this is that they do not take advantage of the higher wind speeds at higher elevations above the ground as well as horizontal axis turbines.

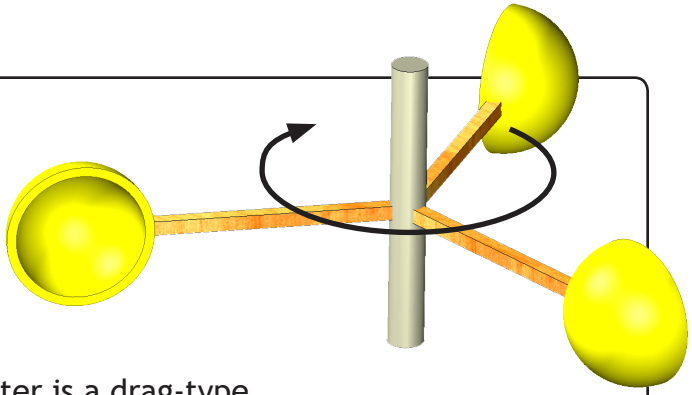
An Early Wind Turbine



The Persian windmill was used around 1000 b.c. to turn a grindstone. It is the oldest known windmill design. The machine works by blocking the wind blowing on ½ of its sails. The sails exposed to the wind are pushed downwind due to drag, causing the windmill to rotate.

Anonometer

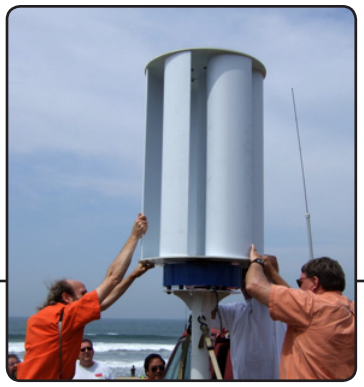
The anonometer is an instrument for measuring the speed of airflow.

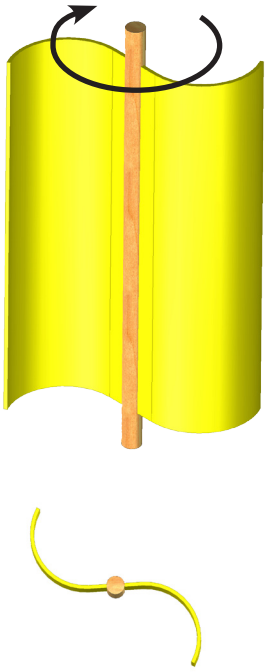


A cup anemometer is a drag-type vertical axis wind turbine

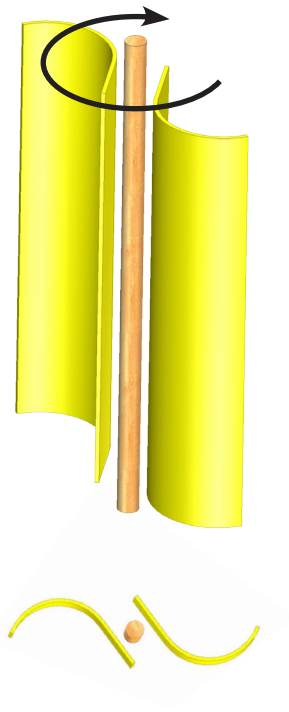
Savonius Wind Turbine

The Savonius turbine is S-shaped if viewed from above. This drag-type VAWT turns relatively slowly, but yields a high torque. It is useful for grinding grain, pumping water, and many other tasks, but its slow rotational speeds make it unsuitable for generating electricity on a large-scale.



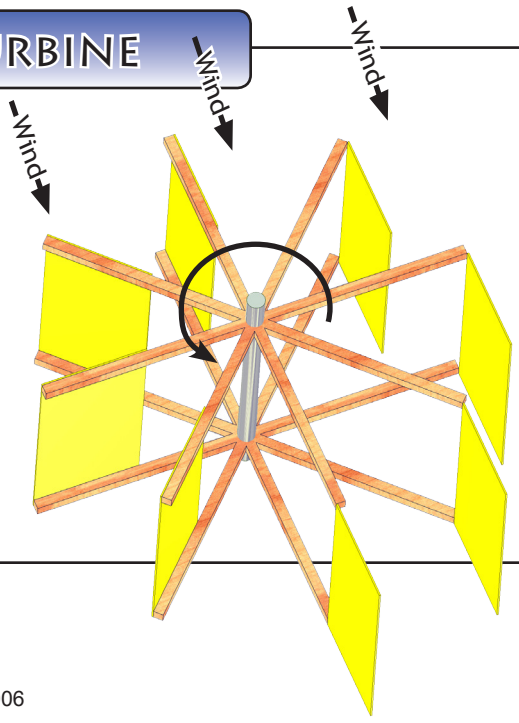


Split Blade



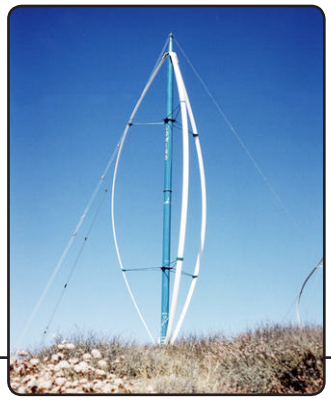
Flapping Panel Wind Turbine

This illustration shows the wind coming from one direction, but the wind can actually come from any direction and the wind turbine will work the same way.

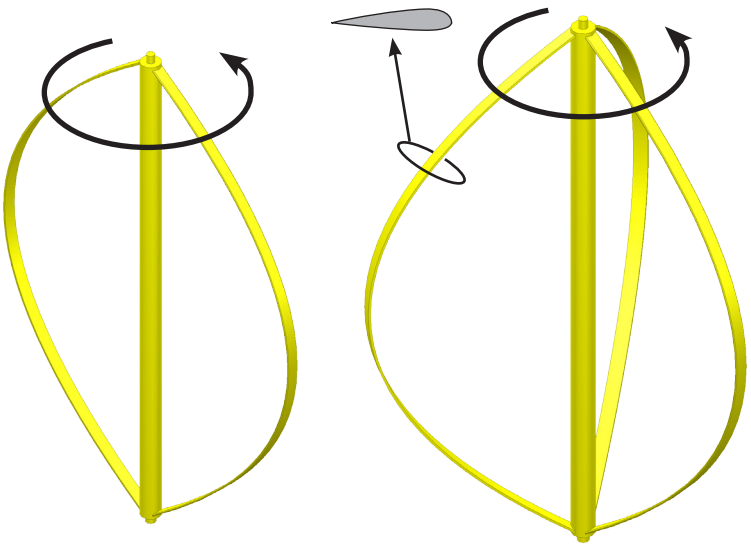


Darrieus Wind Turbine

The Darrieus turbine is the most famous vertical axis wind turbone. It is characterised by its C-shaped rotor blades which give it its eggbeater appear-ance. It is normally built with two or three blades.

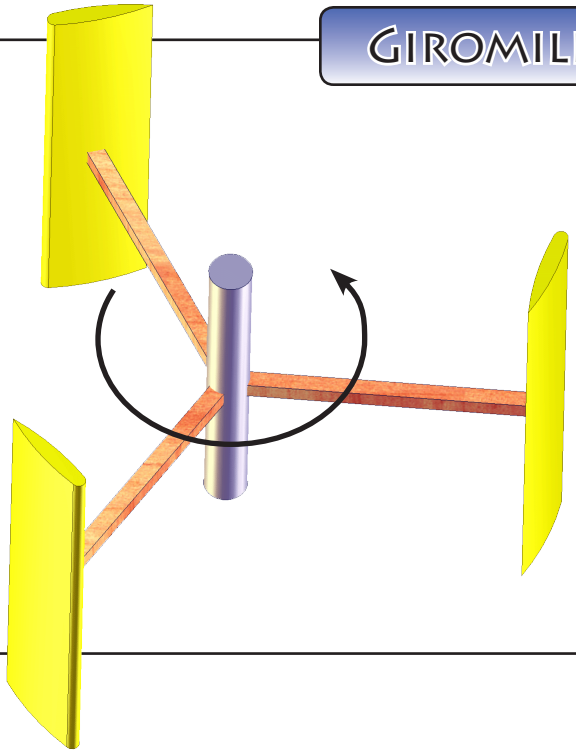


Air Foil Shape



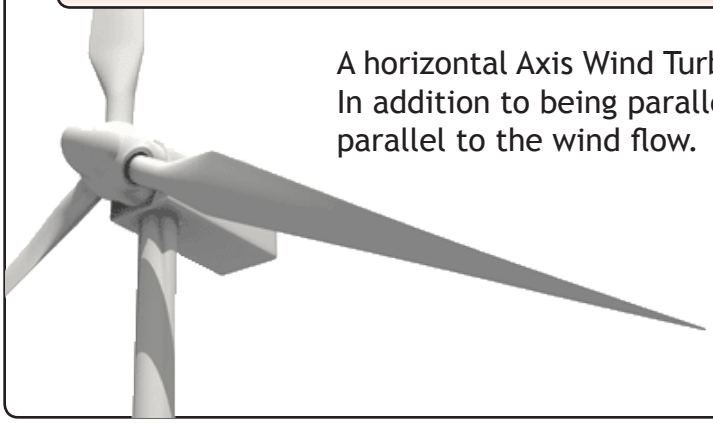
The Darrieus turbine is not self starting. It needs to start turbing before the wind will begin rotating it.

Giromill Wind Turbine



The giromill is typically powered by two or three vertical aerofoils attached to the central mast by horizontal supports. Giromill turbines work well in turbulent wind conditions and are an affordable option where a standard horizontal axis windmill type turbine is unsuitable.

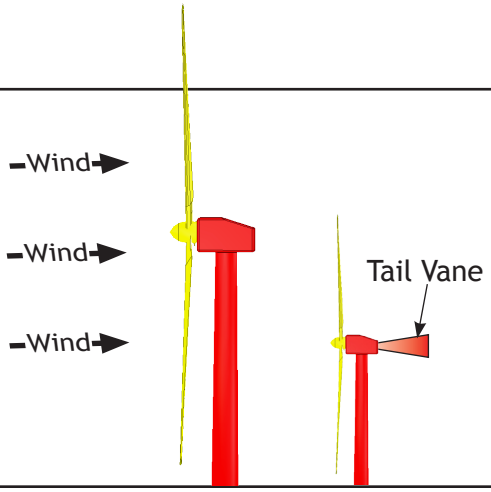
A. Horizontal Axis Wind Turbines



A horizontal Axis Wind Turbine is the most common wind turbine design. In addition to being parallel to the ground, the axis of blade rotation is parallel to the wind flow.

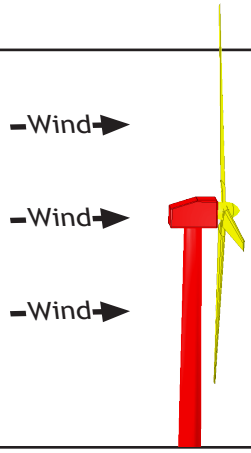
Up-Wind Turbines

Some wind turbines are designed to operate in an upwind mode (with the blades upwind of the tower). Large wind turbines use a motor-driven mechanism that turns the machine in response to a wind direction. Smaller wind turbines use a tail vane to keep the blades facing into the wind.



Down-Wind Turbines

Other wind turbines operate in a downwind mode so that the wind passes the tower before striking the blades. Without a tail vane, the machine rotor naturally tracks the wind in a downwind mode.



Shrouded Wind Turbines

Some turbines have an added structural design feature called an augmentor. The augmentor is intended to increase the amount of wind passing through the blades.