Small Wind Electric Systems

Small wind electric systems are one of the most cost-effective, home-based renewable energy systems. These systems are also nonpolluting.
If a small wind electric system is right for you, it can do the following:

- Lower your electricity bills by 50–90%
- Help you avoid the high costs of having utility power lines extended to a remote location
- Help uninterruptible power supplies ride through extended utility outages.

Small wind electric systems can also be used for a variety of other applications, including water pumping on farms and ranches.

A small wind system going up on Pine Ridge Reservation

How a Small Wind Electric System Works

Wind is created by relationship between Earth and Sun. Sun heats the Earth, radiating heat into the air. When hot air rises, cold air rushes in to take its place, bringing Winds. Wind turbines convert the energy in wind into clean electricity.

When the wind spins the wind turbine's blades, a rotor captures the kinetic energy of the wind and converts it into rotary motion to drive the generator. The manufacturer can provide information on the maximum wind speed at which the turbine is designed to operate safely. Most turbines have automatic overspeed-governing systems to keep the rotor from spinning out of control in very high winds.

A small wind system can be connected to an electric distribution system (grid-connected) or it can stand alone (off-grid).

Evaluating a Potential Small Wind Turbine Site

Estimating Your Wind Resource

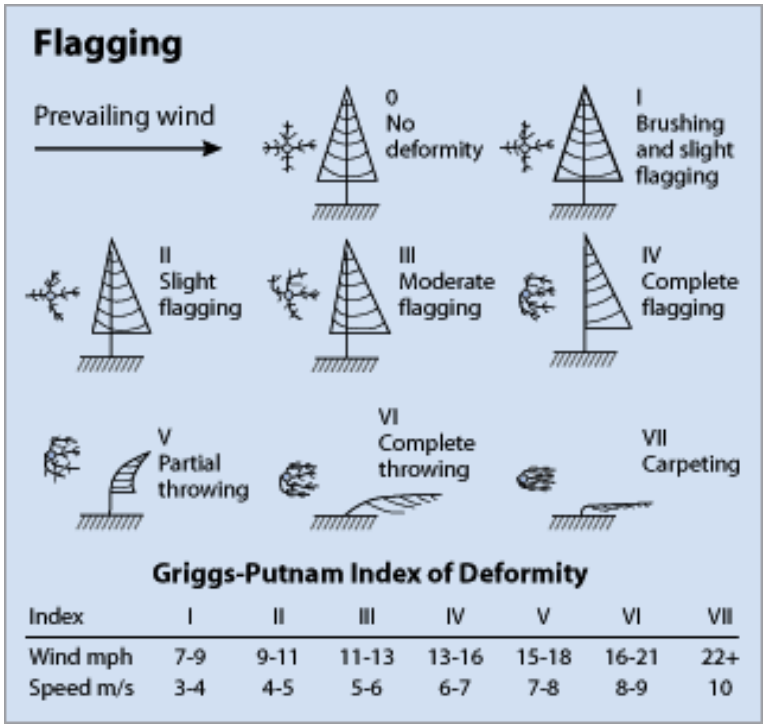
To help determine the suitability of your site for a small electric wind system, you need to estimate your site's wind resource. The wind resource can vary significantly over an area of just a few miles because of local terrain influences on the wind flow. You can use the following methods for estimating your wind resource.

Obtain Airport Wind Speed Data

Another way to indirectly quantify the wind resource is to obtain average wind speed information from a nearby airport. However, local terrain influences and other factors may cause the wind speed recorded at an airport to be different from your particular location. Airport wind data are generally measured at heights about 20–33 feet (6–10 meters) aboveground. Average wind speeds increase with height and may be 15–25% greater at a typical wind turbine hub-height of 80 feet (24 meters) than those measured at airport anemometer heights.

Observe Vegetation Flagging

Flagging—the effect of strong winds on area vegetation—can help determine area wind speeds. Trees, especially conifers or evergreens, can be permanently deformed by strong winds.



Griggs-Putnam Index of Deformity

Index	I	II	III	IV	V	VI	VII
Wind mph	7-9	9-11	11-13	13-16	15-18	16-21	22+
Speed m/s	3-4	4-5	5-6	6-7	7-8	8-9	10

Use a Measurement System

Direct monitoring by a wind resource measurement system at a site provides the clearest picture of the available resource. Wind measurement systems are available for costs as low as $600–$1,200.

The measurement equipment must be set high enough to avoid turbulence created by trees, buildings, and other obstructions. The most useful readings are those taken at hub-height, the elevation at the top of the tower where the wind turbine is going to be installed.

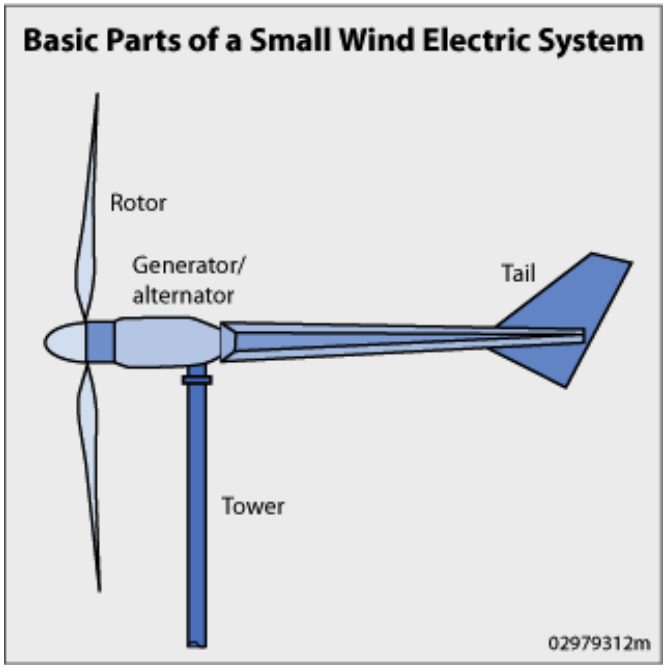
Obtain Data from a Local Small Wind System

If there is a small wind turbine system in your area, you may be able to obtain information on the annual output of the system and also wind speed data if available.

Small Wind Electric System Components

To capture and convert the wind's kinetic energy into electricity, a home wind energy system generally has the following:

- A wind turbine (blades) attached to a rotor, generator/alternator mounted on a frame, and usually a tail
- A tower



Small Wind Electric System Towers

Because wind speeds increase with height, a small wind turbine is mounted on a tower. In general, the higher the tower, the more power the wind system can produce. The tower also raises the turbine above the air turbulence that can exist close to the ground because of obstructions such as hills, buildings, and trees.

Tower Height

Relatively small investments in increased tower height can yield very high rates of return in power production. For instance, to raise a 10-kilowatt generator from a 60-foot tower height to a 100-foot tower involves a 10% increase in overall system cost, but it can produce 25% more power.

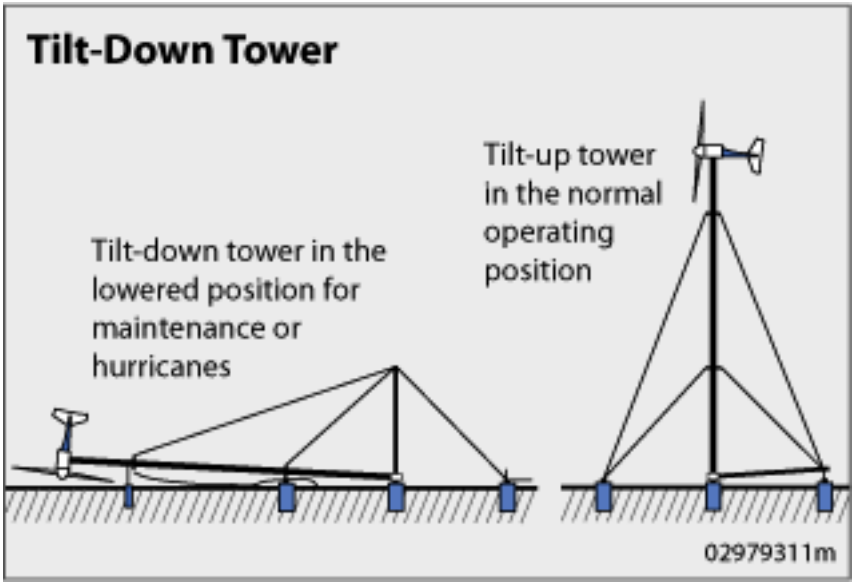
The estimated annual energy output and turbine size you'll need can help determine the best tower height.

Types of Towers

Most turbine manufacturers provide wind energy system packages that include towers. There are two basic types of towers: self-supporting (free-standing) and guyed. There are also tilt-down versions of guyed towers.

Most home wind power systems use a guyed tower, which are the least expensive. Guyed towers can consist of these components:

- Lattice sections
- Pipe
- Tubing, depending on the design
- Supporting guy wires.



Guyed towers are easier to install than self-supporting towers. However, because the guy radius must be one-half to three-quarters of the tower height, guyed towers require enough space to accommodate them.

While tilt-down towers are more expensive, they offer the consumer an easy way to perform maintenance on smaller light-weight turbines, usually 10 kilowatt or less. Tilt-down towers can also be lowered to the ground during hazardous weather such as hurricanes. Aluminum towers are prone to cracking and should be avoided.

Most manufacturers can provide you with a system package that includes all the parts you need for your particular application. For a residential grid-connected application, the balance-of-system parts may include the following:

- A controller
- Storage batteries
- An inverter (power conditioning unit)
- Wiring
- Electrical disconnect switch
- Grounding system
- Foundation for the tower.

Installation or Mounting

A general rule of thumb is to install a small wind turbine on a tower with the bottom of the rotor blades at least 30 feet (9 meters) above any obstacle that is within 300 feet (90 meters) of the tower.

Mounting small wind turbines on rooftops is not recommended. All wind turbines vibrate and transmit the vibration to the structure on which they are mounted. This vibration can lead to noise and structural problems with the building, and mounting on the rooftop can expose the turbine to excessive turbulence that can shorten its life.

Installing and Maintaining a Small Electric Wind System

With proper installation and maintenance, a small wind electric system should last up to 20 years or longer.

Before installing your system, you first need to do the following:

- Find the best site
- Size your wind turbine
- Decide whether you'll have a grid-connected or stand-alone system
- Understand your local zoning, permitting, and neighborhood covenant requirements.

The manufacturer/dealer should be able to help you install your small wind electric system. Many people elect to install the systems themselves. Before attempting to install your wind turbine, ask yourself the following questions:

- Can I pour a proper cement foundation?
- Do I have access to a lift or a way of erecting the tower safely?
- Do I know the difference between alternating current (AC) and direct current (DC) wiring?
- Do I know enough about electricity to safely wire my turbine?
- Do I know how to safely handle and install batteries?

If you answered no to any of the above questions, you should probably choose to have your system installed by a system integrator or installer.

Maintenance

Although small wind turbines typically are sturdy and reliable machines, they do require some annual maintenance.

- Check and tighten bolts and electrical connections as necessary.
- Check machines for corrosion and the guy wires for proper tension.
- Check for and replace any worn leading edge tape on the turbine blades, if appropriate.
- Replace the turbine blades and/or bearings after 10 years if needed.

If you do not have the expertise to maintain the system, your installer may provide a service and maintenance program.