

Wind Power: How to Determine if it is Practical for You

Determine if a Wind Turbine System is Practical for You

- What are the benefits to homeowners from using wind turbines?
- Is wind power practical for you?
- Is your site right?
- Additional Considerations
- Potential Legal and Environmental Obstacles
- The Economics of Wind Power for Home Use
- Wind System Basics
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What are the benefits to homeowners from using wind turbines?

Wind energy systems provide a cushion against electricity price increases. Wind energy systems reduce our dependence on fossil fuels, and they don't emit greenhouse gases. If you are building a home in a remote location, a small wind energy system can help you avoid the high costs of extending utility power lines to your site.

Although wind energy systems involve a significant initial investment, they can be competitive with conventional energy sources when you account for a lifetime of reduced or altogether avoided utility costs. The length of the payback period—the time before the savings resulting from your system equal the system cost—depends on the system you choose, the wind resource in your site, electric utility rates in your area, and how you use your wind system.

Is wind power practical for you?

Small wind energy systems can be used in connection with an electricity transmission and distribution system (called grid-connected systems), or in stand-alone applications

that are not connected to the utility grid. A grid-connected wind turbine can reduce your consumption of utility-supplied electricity for lighting, appliances, and electric heat. If the turbine cannot deliver the amount of energy you need, the utility makes up the difference. When the wind system produces more electricity than the household requires, the excess can be sold to the utility. With the interconnections available today, switching takes place automatically. Stand-alone wind energy systems can be appropriate for homes, farms, or even entire communities (a co-housing project, for example) that are far from the nearest utility lines. Either type of system can be practical if the following conditions exist.

Conditions for stand-alone systems

- You live in an area with average annual wind speeds of at least 4.0 meters per second (9 miles per hour)
- A grid connection is not available or can only be made through an expensive extension. The cost of running a power line to a remote site to connect with the utility grid can be prohibitive, ranging from \$15,000 to more than \$50,000 per mile, depending on terrain.
- You have an interest in gaining energy independence from the utility
- You would like to reduce the environmental impact of electricity production
- You acknowledge the intermittent nature of wind power and have a strategy for using intermittent resources to meet your power needs

Conditions for grid-connected systems

- You live in an area with average annual wind speeds of at least 4.5 meters per second (10 miles per hour).
- Utility-supplied electricity is expensive in your area (about 10 to 15 cents per kilowatt-hour).
- The utility's requirements for connecting your system to its grid are not prohibitively expensive.
- Local building codes or covenants allow you to legally erect a wind turbine on your property.
- You are comfortable with long-term investments.

Is your site right?

The actual wind resource on your site will vary depending on topography and structure interference, and a localized site with good winds, such as a ridge top. You will need site-specific data to determine the wind resource at your exact location. If you do not have on-site data and want to obtain a clearer, more predictable picture of your wind resource, you may wish to measure wind speeds at your location for a year. You can do this with a recording anemometer, which generally costs \$500 to \$1500. The most accurate readings are taken at "hub height" (i.e., the elevation at the top of the wind turbine tower). This requires placing the anemometer high enough to avoid turbulence

created by trees, buildings, and other obstructions. The standard wind sensor height used to obtain data is 10 meters (33 feet).

You can have varied wind resources within the same property. If you live in complex terrain, take care in selecting the installation site. If you site your wind turbine on the top or on the windy side of a hill, for example, you will have more access to prevailing wind than in a gully or on the leeward (sheltered) side of a hill on the same property. Consider existing obstacles and plan for future obstructions, including trees and building, which could block the wind. Also realize the power in the wind is proportional to its speed (velocity) cubed (v^3). This means that the amount of power you get from your generator goes quadruples when the wind speed double.

Additional Considerations

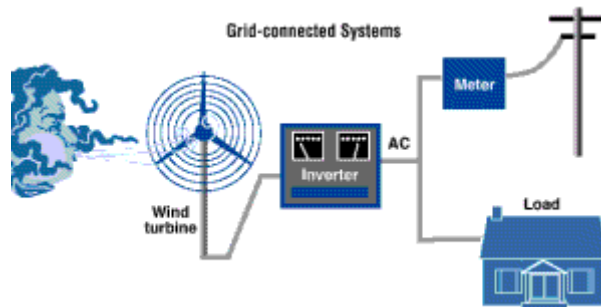
In addition to the factors listed previously, you should also

- research potential legal and environmental obstacles
- obtain cost and performance information from manufacturers
- perform a complete economic analysis that accounts for a multitude of factors
- understand the basics of a small wind system
- review possibilities for combining your system with other energy sources, backups, and energy efficiency improvements.

You should establish an energy budget to help define the size of turbine that will be needed. Since energy efficiency is usually less expensive than energy production, making your house more energy efficient first will likely result in being able to spend less money since you may need a smaller wind turbine to meet your needs.

Potential Legal and Environmental Obstacles

Before you invest any time and money, research potential legal and environmental obstacles to installing a wind system. Some jurisdictions, for example, restrict the height of the structures permitted in residentially zoned areas, although variances are often obtainable. Your neighbors might object to a wind machine that blocks their view, or they might be concerned about noise. Consider obstacles that might block the wind in the future. If you plan to connect the wind generator to your local utility company's grid, find out its requirements for interconnections and buying electricity from small independent power producers.



Wind System Basics

All wind systems consist of a wind turbine, a tower, wiring, and the "balance of system" components: controllers, inverters, and/or batteries.

Wind Turbines

Home wind turbines consist of a rotor, a generator mounted on a frame, and (usually) a tail. Through the spinning blades, the rotor captures the kinetic energy of the wind and converts it into rotary motion to drive the generator. Rotors can have two or three blades, with three being more common. The best indication of how much energy a turbine will produce is the diameter of the rotor, which determines its "swept area," or the quantity of wind intercepted by the turbine. The frame is the strong central axis bar onto which the rotor, generator, and tail are attached. The tail keeps the turbine facing into the wind.

A 1.5-kilowatt (kW) wind turbine will meet the needs of a home requiring 300 kilowatt-hours (kWh) per month, for a location with a 6.26-meters-per-second (14-mile-per-hour) annual average wind speed. The manufacturer will provide you with the expected annual energy output of the turbine as a function of annual average wind speed. The manufacturer will also provide information on the maximum wind speed in which the turbine is designed to operate safely. Most turbines have automatic speed-governing systems to keep the rotor from spinning out of control in very high winds. This information, along with your local wind speed distribution and your energy budget, is sufficient to allow you to specify turbine size.

Towers

To paraphrase a noted author on wind energy, "the good winds are up high." Because wind speeds increase with height in flat terrain, the turbine is mounted on a tower. Generally speaking, 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. A general rule of thumb is to install a wind turbine on a tower with the bottom of the rotor blades at least 9 meters (30 feet) above any obstacle that is within 90 meters (300 feet) of the tower.

Experiments have shown that

relatively small investments in increased tower height can yield very high rates of return in power production. For instance, to raise a 10-kW generator from a 18-meter (60-foot) tower height to a 30-meter (100-foot) tower involves a 10% increase in overall system cost, but it can produce 25% more power.

There are two basic types of towers: self-supporting (free standing) and guyed. Most home wind power systems use a guyed tower. Guyed-lattice towers are the least expensive option. They consist of a simple, inexpensive framework of metal strips supported by guy cables and earth anchors.

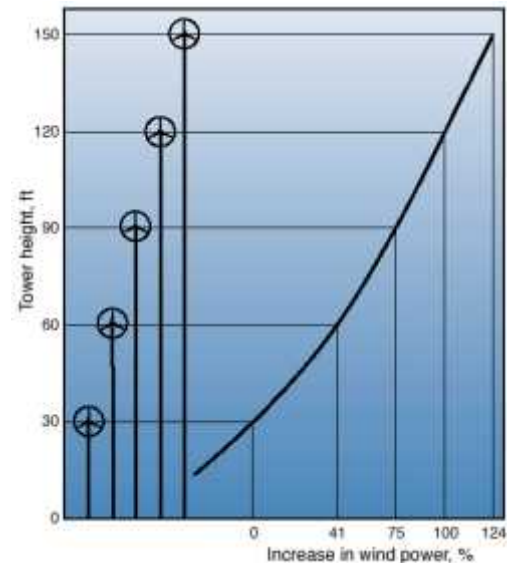
However, because the guy radius must be one-half to three-quarters of the tower height, guyed-lattice towers require enough space to accommodate them. Guyed towers can be hinged at the base so that they can be lowered to the ground for maintenance, repairs, or during hazardous weather such as hurricanes. Aluminum towers are prone to cracking and should be avoided.

Balance of System

Stand-alone systems require batteries to store excess power generated for use when the wind is calm. They also need a charge controller to keep the batteries from overcharging. Deep-cycle batteries, such as those used to power golf carts, can discharge and recharge 80% of their capacity hundreds of times, which make them a good option for remote renewable energy systems. Automotive batteries are shallow-cycle batteries and should not be used in renewable energy systems because of their short life in deep cycling operations.

In very small systems, direct current (DC) appliances operate directly off the batteries. If you want to use standard appliances that require conventional household alternating current (AC), however, you must install an inverter to convert DC electricity to AC. Although the inverter slightly lowers the overall efficiency of the system, it allows the home to be wired for AC, a definite plus with lenders, electrical code officials, and future home buyers.

For safety, batteries should be isolated from living areas and electronics because they contain corrosive and explosive substances. Lead-acid batteries also require protection from temperature extremes.



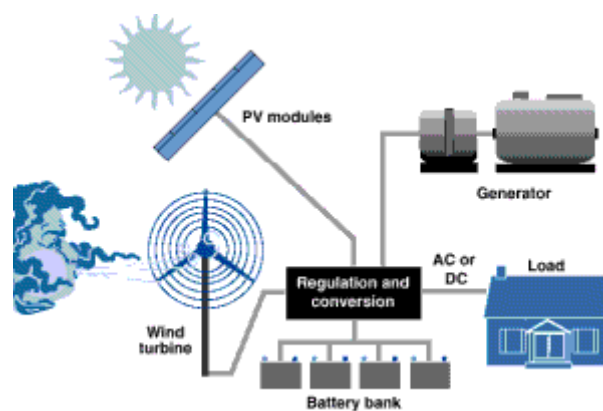
Wind tower height increase power output

In grid-connected systems, the only additional equipment is a power conditioning unit (inverter) that makes the turbine output electrically compatible with the utility grid. No batteries are needed. Work with the manufacturer and your local utility on this.

Hybrid Wind Systems

According to many renewable energy experts, a stand-alone "hybrid" system that combines wind and photovoltaic (PV) technologies offers several advantages over either single system.

For the times when neither the wind generator nor the PV modules are producing electricity (for example, at night when the wind is not blowing), most stand-alone systems provide power through batteries and/or an engine-generator powered by fossil fuels.



If the batteries run low, the engine-generator can be run at full power until the batteries are charged. Adding a fossil-fuel-powered generator makes the system more complex, but modern electronic controllers can operate these complex systems automatically. Adding an engine-generator can also reduce the number of PV modules and batteries in the system. Keep in mind that the storage capability must be large enough to supply electrical needs during non-charging periods. Battery banks are typically sized for one to three days of windless operation.

Summary

By investing in a small wind system, you can reduce your exposure to future fuel shortages and price increases and reduce pollution. Deciding whether to purchase a wind system, however, is complicated; there are many factors to consider. But if you have the right set of circumstances, a well-designed wind energy system can provide you with many years of cost-effective, clean, and reliable electricity.