What can the wind do for me?

wind power

Wind power has been used by mankind for thousands of years to ease manual labor. Historically, in Wisconsin, windmills have pumped water for home and farm use, as witnessed by the many old water-pumpers still visible in the countryside. The familiar American farm windmill was developed after the Civil War. Wind-electric plants dating from the 1930s and 1940s can still sometimes be found on barn or house roofs. These small wind generators provided electricity for the bare necessities of Depression-era life: lights in the kitchen, barn, and chicken coop, and the all-important parlor radio.

Wind electric generator design continued to evolve, becoming more reliable and efficient with time. Today, wind electric systems can power a variety of loads, either directly or indirectly. The most common application is the production of electricity. In the 1970s and 1980s, designers scaled up the machines to be used in clusters, called wind farms, to generate large quantities of electricity. Electricity generated from wind farms is sent out onto the power line just like the electricity produced by coal-fired generators, hydroelectric dams, gas turbines, or nuclear reactors. For example, California hosts 16,000 wind turbines, which collectively are capable of electrifying a city the size of San Francisco.

Wind power is a technology that has been around for many years, with new innovations and applications.

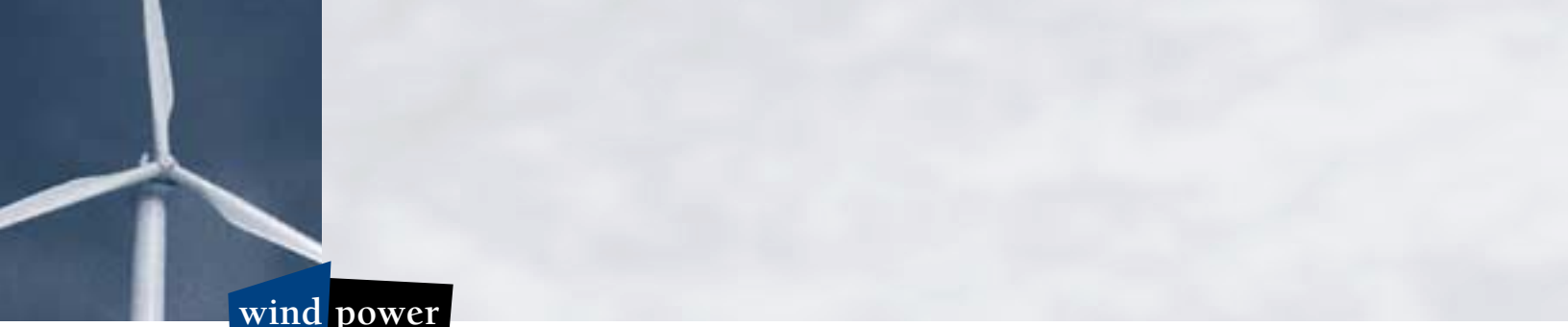
WHAT ABOUT WIND ENERGY FOR MY HOME?

Most of today's home-sized wind generators are used to produce electricity, either to offset electricity normally provided by the local utility, or to generate electricity independently of the utility. Wind turbines can be sized to offset all of the electricity you consume, or a little of it. For instance, you could power a cottage or cabin in the woods or your electric grid-connected home or business. The larger the system you install, the more money you spend upfront. However, larger systems produce electricity more cost effectively than smaller systems.

Grid-connected wind systems are the most common application in use today. The wind turbine generates electricity and the turbine's electronics system ties the wind turbine to the utility's "grid" network of power lines. In essence, the grid is used as storage for excess electricity that the wind turbine produces but the household cannot immediately use. When you produce more than you consume, your electric meter runs backwards, essentially "crediting" you for your excess electricity. In times of low winds, you use this credit up as you buy electricity back from the utility. This arrangement is known as "net metering" by the utility, and in Wisconsin, is limited to a maximum of 20kW of combined generating capacity (wind, photovoltaics, hydroelectric). Systems connected to a utility are the simplest and least expensive to purchase since they do not rely on an expensive battery bank to store electricity.

ENERGY CENTER
OF WISCONSIN
We show you how

595 Science Drive
Madison, WI 53711
Phone: 608.238.4601
Fax: 608.238.8733
www.ecw.org



wind power

Off-grid wind systems are not tied to the utility's network of power lines. These systems store the electricity they produce in a battery bank for use as needed. Unless you live in a deep valley with no wind movement, most areas of Wisconsin are suitable for a home-sized wind system.

WHAT DO I NEED TO DO TO START USING WIND ENERGY?

Before you go shopping for a wind generator, contact your local utility company and building or zoning department for the appropriate application information. Make sure that the building and zoning administrators are aware of your project, and that you secure the required building permits well before you put a down payment on any equipment. They will likely want to know how tall a tower you plan to install and where on your property the tower will be located. Some zoning departments require a "fall zone" for the tower, meaning that, in the unlikely event the tower should fall, it will fall on your property and not on a neighbor's.

For those living in rural areas, the land restriction is less of an issue. But it always pays to contact your immediate neighbors and tell them what you are up to. Getting them on your side, or at least answering any concerns they might have before a zoning hearing takes place, will go a long way toward getting your project permitted. In Wisconsin, zoning concerns develop only if a system is considered a threat to "public health or safety" according to Wisconsin State Statue 66.031 and 66.032.

HOW DO I GET MY EQUIPMENT HOOKED UP TO THE GRID?

Your utility will require you to apply for an interconnection contract before you hook your system up to the grid. This is a formality so that the utility knows where these systems are. The application is a simple form, but it does require information about the size of the wind turbine you plan to install, and the electrical specifications of the system. You can get this information from either your wind dealer or the equipment manufacturer. In addition, the utility will require that you provide a certificate of insurance indicating that you have liability insurance of at least $100,000. Most homeowner insurance policies are written for at least $300,000 today, so this should not be a problem.

Finally, the utility will require that you install an external disconnect switch for the system, next to your electric meter. This switch allows the utility to "lock out" the generating device in the event of a power outage when linemen are working on the utility lines in your neighborhood.

WHAT ABOUT THE WIND?

Besides a building or zoning permit and a contract from your utility if you are going to connect the system to the grid, the only other thing you need to operate your wind turbine is wind. The equipment manufacturer or your wind dealer will help you size the equipment for your needs, or you can use the following table to help you determine the wind generator you will need. Tower sizing is discussed in the next section.

Notice that the table lists only two wind speeds, 10 and 12 mph. In most areas of Wisconsin, these wind speeds can be achieved at the hub height of the wind generator, atop the tower. Also notice that electricity production increases considerably at 12 mph compared to 10 mph. Higher wind speeds can be achieved with taller towers. It is almost cheaper to install a taller tower than to install a larger wind generator to yield more electricity. Since towers need to be climbed to install and service the wind generator, the human element usually enters the picture and limits tower height.

TYPICAL COMPONENT PRICES

(March, 2000)

	Turbine	Tower	Blade Area-FT2	Wind Speed 10 mph*	12 mph*
AIR 403	$595	$442-45' kit	11	17	29
Whisper H20	$1190	$2413-60'TUT	20	31	53
W/S 503	$1075	$2413-60'TUT	20	31	53
Whisper H40	$1690	$3233-80'TUT	40	63	105
BWC XL.1	$1495	$3233-80'TUT	58	91	147
Whisper H80	$2790	$3233-80'TUT	80	124	193
BWC 1500	$4700	$2500-80'45G	79	150	225
Jake Short	$6500	$5000-100'45G	154	250	440
Whisper 175	$4990	$5491-105'TUT	175	341	538
BXC XL	$19,500	$7500-120'G	415	1050	1650
Jacobs 29-20	$24,184	Included	660	1644	2691

* = Estimated monthly kWh production @ 10 & 12 mph average wind speeds

TUT = Lake Michigan Wind & Sun's Tilt-up Towers

45G = Rohn 45G guyed tower

G = BWC guyed tower

Utility intertie inverters are included in the prices for the BWC XL & Jacobs 29-20

Prices do not include shipping, batteries & interconnects, wiring, connectors, and electrical boxes, concrete & rebar, excavation or heavy equipment, or installation costs

HOW DOES THE TURBINE WORK?

The most obvious part of any wind generator is the set of rotating blades, called the rotor. Blades are aerodynamic devices that operate somewhat akin to an airplane wing. However, instead of lifting a load and moving it through the air to another place like an airplane wing, air masses move through the wind turbine's rotor, causing it to rotate. The load on the airfoil-shaped blades is the electric generator, to which the blades are attached. The rotating generator shaft produces electricity.

Home-sized wind turbines have tails that allow them to move side-to-side to track the wind. All wind generators have some sort of governor which limits the amount of electricity that the wind turbine will produce. This protects the equipment from overproducing and burning up in high winds, but also limits the dangerous centrifugal forces that all rotating equipment experiences at high speed revolutions.

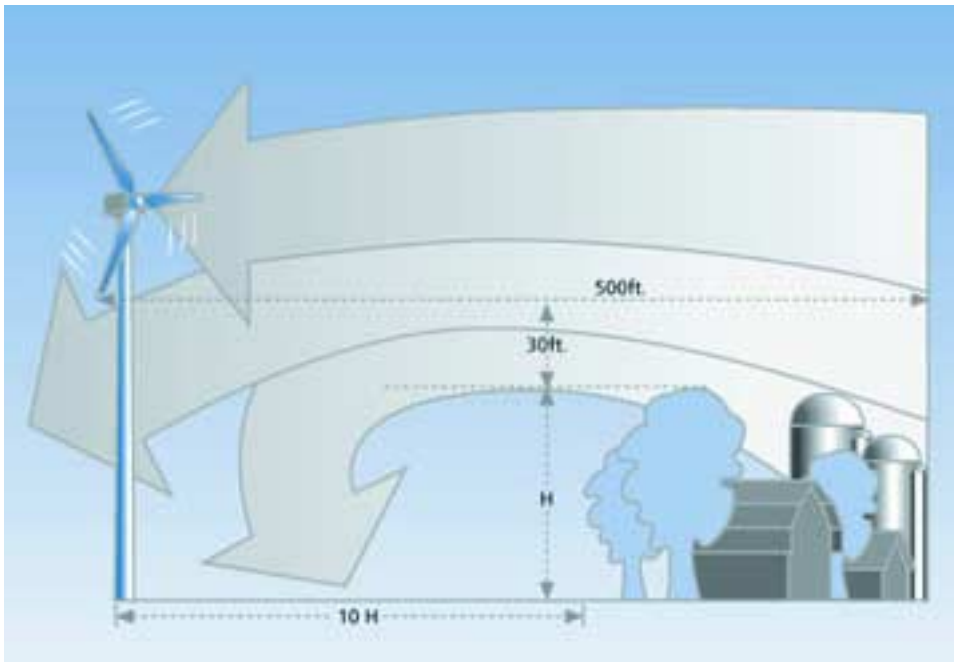
Home-sized wind generators have either two or three blades in the rotor. Two blades are more efficient than three, but experience unbalancing during each revolution. Three blades, while less efficient, spin more smoothly, assuring a longer life for the equipment.

Wind is an awesome force, as can be witnessed during any severe storm. Since it is the job of the wind generator to take that force and convert it to electricity, it is important that the wind generator itself be properly built to survive severe winds. This usually equates to a heavy duty machine. Experience shows that while lighter duty equipment is less expensive than heavier equipment, it usually won't survive as long. Heavy metal is your cheapest insurance against the unpredictable destructive forces found in the wind.

WHAT KIND OF TOWER SHOULD I HAVE?

In order to assure good access to their fuel, wind generators are mounted high atop towers. There are two reasons for this. First, ground drag, the friction between moving air masses and the earth, decreases with increasing height above the earth's surface. Second, turbulence caused by obstacles on the earth, trees and buildings, for example, is also reduced with height above those obstacles.

The rule of thumb used in siting a home-sized wind turbine is that the entire wind turbine rotor should be at least 30 feet above anything within 500 feet of the tower. Remember to take into account the future growth of trees. Since the rotor extends down an equal amount that it extends above the tower height, the length of one blade is added to the tower height to give us the appropriate "hub height" for the wind generator.



As a rule of thumb, the entire wind turbine rotor should be at least 30 feet above anything within 500 feet of the tower.

Note that the minimum hub height is just that; it's the minimum tower height that you can get by with and still produce electricity without all of the wind's power being eaten up by either ground drag or turbulence. Increasing tower height above the minimum results in an increased wind system power output. It is usually cost effective to increase tower height up to a point, depending on the size of the system and the local obstacles, usually trees.

Since towers can add considerably to the cost of a home-sized wind system, there are other rules of thumb that a dealer uses to size the tower height. Home-sized wind turbines are usually categorized by rotor diameter. Micro-turbines have up to a 48-inch diameter rotor, and will power only a few loads at most average sites, usually lights, and maybe a television or radio. A mini-turbine will have a rotor diameter of 5 to 7 feet and can power a weekend cottage or frugal cabin with lights, TV, radio, plus a few appliances or tools. Mid-sized turbines have rotor diameters from 10 to about 16 feet. These turbines can power average homes with most any appliances or tools, and even some air conditioning. Finally, large-sized turbines have rotor diameters from 23 to 29 feet. These systems can power an all-electric home complete with central air conditioning, or even a small farm or business.

Turbine tower height should be driven by the site at which the system will be installed. However, the cost of the turbine also seems to enter into the equation, often influencing the tower height decision.

Different styles of towers are available and can be chosen based on cost, available space, and ease of maintenance.

Due to their low cost and power output, many micro-turbine owners are reluctant to invest much money in a tower. Mini-turbine owners usually install towers in the 60- to 80-foot range. A mid-sized turbine commands a tower height of 80 to 100 feet, while an all-electric home system will require towers of 100 to 120 feet in height. Remember to include the mature tree height into your consideration of tower height.

There are several different styles of towers that small wind generators are mounted on – free-standing, guyed lattice, and tilt-up. Old windmill towers are a good example of freestanding towers. Either three- or four-legged, these towers are relatively heavy duty and stay upright without the help of any guy cables. As such, they are the heaviest towers, and therefore the most expensive, you can purchase for a wind turbine. They occupy a relatively small footprint on your property, and are the best choice when space is a consideration. They also use the most concrete of any tower style to keep themselves upright.

A radio broadcast tower is a good example of a guyed lattice tower. These towers use guy cables to anchor the tower and keep it upright using relatively little concrete. Cables stretch from three points near the top of the tower to the ground at some distance from the base of the tower. These towers are quite light compared to free-standing towers, and therefore are the least expensive towers for supporting a wind turbine. However, they require a larger area to accommodate the guy cables.

Tilt-up towers are usually made of pipe, but can also be guyed lattice towers. Instead of being guyed in three directions, they are guyed in four directions. This allows the entire tower to be tilted down to the ground. Unlike freestanding and guyed lattice towers, which must be climbed to install and service the wind generator, tilt-up towers tilt down to ground level for any work done on the equipment. They require even more space than guyed towers, and are priced between the more expensive freestanding tower and the less expensive guyed lattice tower.

WHERE DO I GET MORE INFORMATION?

Grid connection - The Public Service Commission of Wisconsin publishes a booklet titled “Renewable Energy Resources” that deals with interconnection requirements in Wisconsin. The booklet also lists the designated contact people for Wisconsin utilities. Contact Public Service Commission of Wisconsin, P.O. Box 7854, Madison, WI 53707-7854, phone 608.261.8524.

Finding a dealer/installer - The Wisconsin Energy Bureau publishes “Wisconsin’s Renewable Energy Yellow Pages,” which lists the renewable dealers doing business in Wisconsin. Contact Wisconsin Energy Bureau, P.O. Box 7868, Madison, WI 53707-7868, phone 608.264.9577. http://www.doa.state.wi.us/depb/boe/boeintro.asp

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ABOUT US

The Energy Center of Wisconsin is a private nonprofit organization dedicated to improving energy efficiency and renewable energy in Wisconsin. Funded in part by Wisconsin utilities, the Center invests $5 million annually in energy efficiency research, education and demonstrations aimed at residents, business and government.

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