

# Small-Scale Wind Energy Production

Thank you for requesting information about small-scale wind energy. To assist our members, we have developed this packet of information to answer many of the questions you may have as you begin your research. We want to give you the tools you need to make an informed decision.

In this packet, you will find the following documents:

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**Pella Cooperative Electric Association**  
2615 Washington Street  
PO Box 106  
Pella, IA 50219

P: (641) 628-1040, (800) 619-1040  
W: [www.pella-cea.org](http://www.pella-cea.org)

# Ten Steps to a Small Wind System

Is a small wind system right for you? These 10 steps will help you decide.

1. **Determine how much electricity you use and what it costs, annually and by the kilowatt-hour. Then, find ways to make your home more efficient and reduce your energy use.**

Start by calculating your average electricity bill. Pella Cooperative Electric can provide this information upon your request.

Then, conduct an energy audit of your home to identify ways of using energy more efficiently and ways of reducing energy use. Touchstone Energy's Online Energy Audit is a great resource for doing just that. Log on to [www.pella-cea.org](http://www.pella-cea.org) to access the complimentary tool.

Implementing energy efficiency opportunities may offer a quicker return on your investment and additionally may enhance the viability of a wind turbine project through a lower capital expense associated with a smaller turbine that will satisfy the new lower energy load.

2. **Determine your site suitability and wind resource.**

**Site suitability.** Most experts recommend that you have at least one acre of land if you are considering the installation of a small wind system. Smaller parcels may be suitable if adequate tower setbacks can be achieved.

Examine your site for potential turbulence. When wind flows around buildings, trees, and other structures in the landscape, it slows down or becomes turbulent. A wind turbine should be placed in a location where turbulence is minimized. It also should be placed upwind of buildings and trees.

In addition, you should determine the "roughness" – the terrain and density of vegetation on the landscape – within a radius equal to 20 times the tower height, in the prevailing wind direction.

Information on determining site suitability is available to;

- Small Wind Electric Systems: A U.S. Consumer's Guide [http://www.eere.energy.gov/windandhydro/windpoweringamerica/pdfs/small\\_wind/small\\_wind\\_guide.pdf](http://www.eere.energy.gov/windandhydro/windpoweringamerica/pdfs/small_wind/small_wind_guide.pdf)
- Small Wind Industry Implementation Strategy (SWIIS) Consortium's website: [http://www.smallwindindustry.org/fileadmin/ewea\\_documents/documents/projects/swiis/technology/050406SWTsiting050405.pdf](http://www.smallwindindustry.org/fileadmin/ewea_documents/documents/projects/swiis/technology/050406SWTsiting050405.pdf)

**Wind resource.** Wind speed varies from year to year, season to season, with the time of day, and with the height above ground. For a grid-connected wind system, an average annual wind speed of 10 mph is usually considered the cutoff. Most experts recommend average annual wind speeds between Class 2 (11.5 at hub height) and Class 4 (13.4 mph at hub height). Class 3 sites have

average wind speeds of 12.5 at hub height. Hub height is the distance from the ground to the center of the turbine rotor.

A small increase in average wind speed results in a large increase in power produced. A site with an average wind speed of 15 mph contains nearly 54% more energy than a site with an average wind speed of 13 mph. The ideal wind resource has relatively stable high speeds. If your trees and vegetation are permanently deformed because of constant wind exposure – known as “flaggin” – you may have a good wind resource to generate electricity.

There are several websites with wind resource maps. One is the National Renewable Energy Laboratory’s (NREL) Wind Energy Resource Atlas of the United States, <http://rredc.nrel.gov/win/pubs/atlas>. The Iowa Energy Center has state-wide wind speed maps for each month and annual averages at <http://www.energy.iastate.edu/Renewable/wind/maps-index.htm>.

NREL also provides a United States Annual Wind Resource Potential map, where you can find location by zip code. <http://mapserve2.nrel.gov/website/wind-resource1/viewer.htm>.

These resources can give you an estimate on the wind speeds at your location. However, the most accurate data comes from an on-site survey of the wind over a period of time.

You can measure the wind speed at your site using an anemometer on a tower, but this can be expensive. One option is to review data from nearby sites such as airports or state-administered meteorological stations. But airports tend to be sited in sheltered locations, so data on wind speeds may not be a reliable indicator of wind speeds at your site. Computer models are available that can help you estimate your wind resource.

Although the wind at a given site may blow more frequently from the west, more wind energy at that same site may come from different directions. You should find out which directions have the best winds for electricity.

You may want to find an installer at this point. Be sure to ask for references, licenses and certifications, proof of insurance, and a performance bond. A good installer can do a site assessment for you.

At this point, you should talk to your cooperative about what you are considering.

**3. Determine how much electricity you want your wind generator to produce. Select turbine and calculate tower height based on that output.**

**Energy output.** An installer can also look at your historic electricity usage and the amount of energy you want a small wind generator to produce. With this information, the installer can help you select a turbine size and tower height.

Most small turbine manufacturers provide an estimated monthly energy output in kilowatt-hours. Experts caution consumers about taking these figures at face value, however. Question the manufacturer regarding the conditions under

which the output was calculated and request to speak to customers who have installed similar systems about their actual output levels.

**Turbine features.** Once you know how much electricity you want your generator to produce, monthly or annually, you can look at the specifications of all turbines matching that output. Important features to consider include the rotor diameter and the turbine's revolutions per minute (rpm). Turbines with a lower rpm tend to be quieter and last longer.

The amount of power that a turbine will produce is determined mainly by the diameter of its rotor and its tower height. The diameter defines the rotor's sweep area (the area through which the rotor blades spin) of the generator's rotor, the more electricity it can produce. Swept area is the feature that will help you compare the output of one wind generator with another.

For more information on selecting a turbine, see Home Power magazine's "Wind Turbine Buyer's Guide"

<http://www.homepower.com/files/featured/TurbineBuyersGuide.pdf>.

*Other considerations.* Look for turbines with a good track record and a good warranty – five years, if possible. Some experts believe that weight matters; in their view, the heavier the machine, the more robust it is. They say a heavy-duty wind generator is more likely to handle sites with stronger winds and turbulence than a lighter turbine. But lighter weight turbines typically have lower "cut-in" wind speeds and produce more power in lower winds.

**Tower height.** One of the most common installation mistakes is mounting a wind turbine on a tower that is too short. A rule of thumb for tower height is that the wind generator should be at least 30 feet above any trees, building, or other structures within 500 feet. Taller towers result in higher wind generation because of reduced ground drag. An additional 40 feet on a tower can substantially increase the power available – by as much as 200% - and return the incremental initial investment with greater energy generation revenues over the lifetime of the turbine. But taller towers are also more expensive.

The question you need to answer is whether the increased tower height is economically justified compared with the increased electricity production.

**4. Find out what incentives – rebates, buydowns, and loans – are available , and whether you qualify for a U.S. Department of Agriculture (USDA) Section 9006 grant.**

The Database of State Incentives for Renewables & Efficiency (DSIRE) provides detailed information on each state's incentives that apply to renewable energy systems, including small wind. You can access the database at <http://www.dsireusa.org>.

The Farm Security and Rural Investment Act of 2002, which expired September 30, 2007, included a provision – Section 9006 – that provided grants of \$2,500 to \$500,000 or up to 25% of the eligible costs of rural renewable energy projects.

The Farm Bill Extension Act of 2007, which continues agricultural programs through 2012, provides \$500 million in grants for small-scale renewable energy projects.

The grants are only available for agricultural producers that earn at least 50% of their income from agricultural products. Small rural businesses also are eligible. But the application process for a grant or loan under Section 9006 can be complicated and time consuming. A sample application for is available on the DOE's energy efficiency and renewable energy (EERE) web site at [http://www.eere.energy.gov/windandhydro/windpoweringamerica/pdfs/farm\\_bill\\_small\\_wind\\_sample\\_application.pdf](http://www.eere.energy.gov/windandhydro/windpoweringamerica/pdfs/farm_bill_small_wind_sample_application.pdf).

**5. Determine estimated installed cost of system and calculate return on investment.**

A rule of thumb for estimating the cost of a small wind system is \$4 - \$10 per installed watt. The total installed cost is the cost of the wind generator and tower plus the cost of permitting, installing, and – if you so choose – interconnection.

The payback for a small wind system is the amount of time it takes for the system to pay for itself in energy savings. You can estimate a simple payback by the following formula, assuming the system is properly sized not to exceed your demand:

(Installed cost including interconnection costs, \$)

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(kwh/year x retail price of electricity, \$/year) – (annual operation and maintenance cost, \$/year)

The annual operation and maintenance costs include insurance premiums, maintenance calls, service contracts, and the net present worth of long-term repairs.

**6. Determine what zoning regulations, if any, apply to the installation of a wind turbine, and what permits – building, electrical – are required. Talk with your neighbors about your plans.**

**Zoning.** Zoning regulations vary from state to state, and from one local jurisdiction to the next. Contact your local county officials to learn about zoning laws. These laws may include height restrictions and may require that a wind turbine be set back from your property line. The standard setback for a small wind system is calculated as a distance from the property line equal to the height of the tower. Sometimes, the setback requirement restricts where a tower can be installed.

In many cases, local municipalities do not have any zoning restrictions that apply to the installation of wind turbines or towers. As a result, a zoning hearing often becomes part of the processes that an applicant must go through before a building permit is issued.

At zoning hearings, neighbors are allowed to express any concerns they might have about the small wind system. Preparation for these types of meetings is

key. The more answers you have ready for questions that are likely to arise, the easier the process will be.

**Permitting.** Contact your local building inspector, board of supervisors, or planning board to learn whether you will need to obtain a building permit. They will provide you with a list of requirements, which will probably include a site plan, a structural analysis on the foundation and tower, and an electrical one-line diagram.

At this stage, talk with neighbors about your plans and listen to any of their concerns. If there are any other small wind turbine owners in your area, talk with them about any concerns their neighbors had and how they dealt with those concerns.

**7. Ask your cooperative about interconnection requirements, including costs and liability insurance.**

If you have not already talked with your cooperative about your plans, do so now. Discuss the steps you have taken to get to this point, and provide information on the small wind system you are considering. You need to make sure that the system meets the cooperative's criteria if you wish to interconnect with the distribution grid. An interconnection agreement must be established before distributed generation can be connected.

Pella Cooperative Electric has a packet of information regarding interconnecting to the grid available. To request, please contact the Member Relations Department.

**8. Find a small wind system installer (if you haven't already done so.)**

You might want to start looking for an installer by asking any current small wind system owners in your area for references. In addition, contact the manufacturer of the wind turbines you are interested in for recommendation and suggestions for authorized installers.

Pella Cooperative Electric does not endorse one particular vendor. There are several resources, the Iowa Energy Center for example, which may give you some additional background information on a particular vendor. Members should fully research a company before purchasing generating equipment. Pella Cooperative Electric suggests you ask these questions of your vendor:

- 1. How reliable is the rated energy output? How did you calculate the output?** Experts advise ignoring peak output and power curve provided by vendors. Rather, look for the monthly or annual energy numbers – in kilowatt-hours – for the generator. For example, if you are considering a wind turbine, ask the manufacturer to calculate the output for the average wind speeds that you expect or have measured at your site. If the vendor does not provide energy production estimates, find another manufacturer.
- 2. Is the inverter UL listed?** If the inverter is not UL listed, find another vendor. Most utilities require that an inverter have a UL 1741 certification for interconnection with the grid. As part of the certification, the inverter is required to fail open in the absence of power on the grid.

3. **What is the estimated total installed cost?** It's important to know the total installed cost of a system to ensure sufficient budgeting. For a wind system, you would need to budget not only for the turbine, but also the tower, installation labor expenses, as well as the cost of equipment rental, materials, shipping, and sales tax.
4. **How long is the warranty? What does it cover? Parts? Labor? Can it be extended? If so, what will it cost?** Warranties generally range from one to five years. The longer the warranty, the better. Make sure the warranty covers labor as well as parts. Cooperative members should ask owners of systems purchased from the same vendor about performance and reliability before making a decision on an extended warranty, if available. (Special Note: If you live in an area prone to lightning strikes and are considering a wind system, you should consider the option of lightning protection. If not available through the vendor, third-party vendors can design and install adequate protection systems.)
5. **What are your credentials? How long have you been in business? How many systems have you sold? Have your systems been certified?** Look for vendors that have been in business for at least five years, or have acquired the product line of another vendor. In addition, cooperative members should ask the vendor for the names of at least two people who have installed a system that is the same as or similar to the model the cooperative member is interested in.

Once you have a short list of vendors and installers, contact at least three of them for quotes for the equipment and installation. Question any quote that appears to be too high or too low.

## 9. Order the turbine and tower.

Before actually placing an order, ask the manufacturer or installer for the names of consumers who have installed the same make and model. Contact those consumers to ask about machine performance and reliability and support from the manufacturer. Ask if the system is meeting their expectations.

Ensure that the manufacturer offers at least a one-year warranty with an optional extended five-year warranty for all hardware, and that the inverter is Underwriters Laboratories (UL) listed.

If you plan to purchase a rebuilt or remanufactured wind generator, find out the history of the machine, obtain the remanufacturing report of the specific turbine you will be purchasing, be sure there is a warranty, ask about a maintenance contract, and ask about the availability of spare parts.

Additional information is available in the Wind Turbine Buyer's Guide at <http://www.homepower.com/files/featured/TurbineBuyersGuide.pdf>.

## 10. Contract for installation of your small wind system.

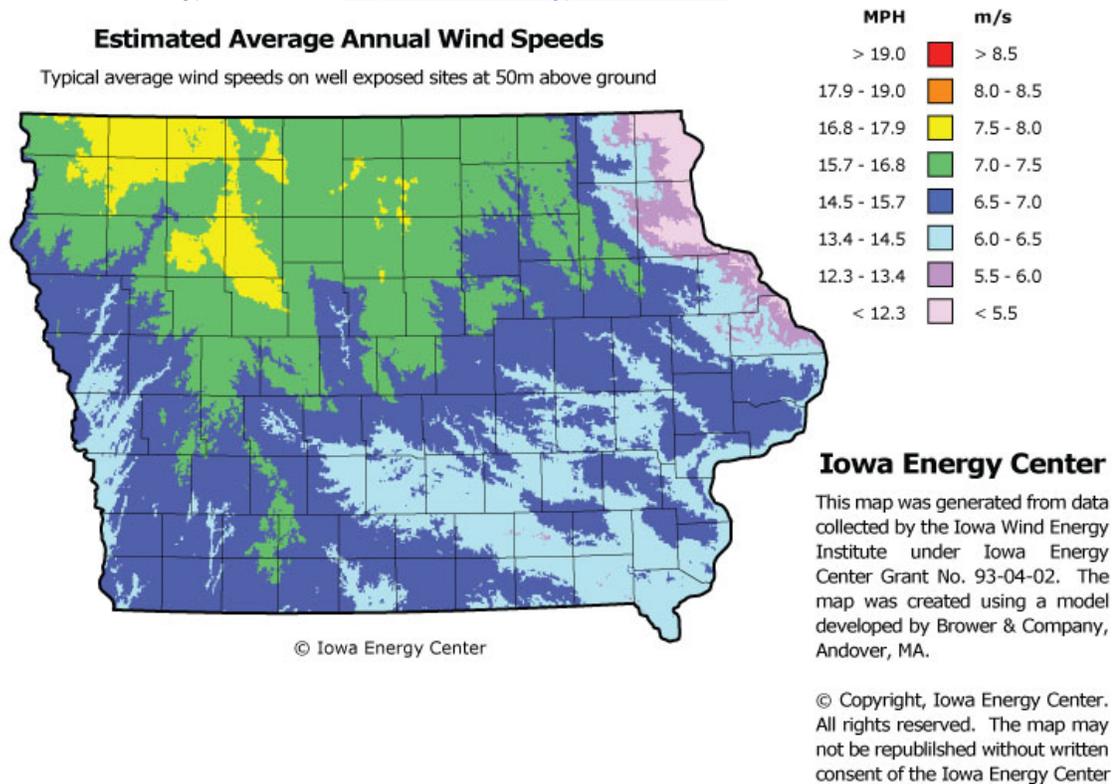
This is the final step. If you did not contract for the installation of your wind generator with the manufacturer, contact the installer you found in step 8 and arrange for installation.

## Frequently Asked Questions: Small Wind Systems

- 1. How much electricity can be generated?** You should first determine how much electricity you want to generate, and when you need to generate it. Based on your current electricity usage, decide how many kilowatt-hours you would like to produce. Once you know how much energy you want, you can select the right system to meet your needs.

The vendor should be able to give you an idea of the output capacity of the system, but it's also necessary to look at local conditions. For example, the wind speed at your site at the height you intend to erect your wind turbine is a critical factor in estimating your energy output and may vary from the figures your vendor used to calculate output.

Below is a map of the average wind speeds in Iowa. Monthly maps are available from the Iowa Energy Center at <http://www.energy.iastate.edu>.



- 2. What happens if I produce more electricity than I need?** Ideally, with an appropriate sized wind turbine you will consume all the electricity you produce. This is the most cost effective use of the energy produce. However, if you produce more energy than you consume, you can deliver that excess power back to the grid. To do so, you must establish and interconnection agreement with the cooperative and install the

appropriate interconnection equipment. For more information interconnecting your small wind system, or other distributed generation, contact the cooperative.

- 3. How reliable are wind turbine systems? Will I have to perform much maintenance?** Most wind turbines are designed for a long life and operate completely automatically. Obtain at least two references from the company that produces and/or sells the wind generator model that you are considering. Ask those owners about the generator's reliability and its maintenance requirements.

Find out what maintenance the turbine manufacturer recommends. Small wind experts recommend an annual inspection of your wind turbine. Check bolts and electrical connections, and tighten if necessary. Also check and replace any worn leading edge tape on the blades. After 10 years, the blades or bearings may need to be replaced.

If you do not have the expertise to maintain the wind generator, find out what companies provide maintenance services in your area. Make sure the companies give references, and ask what a service contract will cost.

As one small wind expert has noted, if you do not change the oil in your automobile, you're unlikely to carry out the maintenance on your wind turbine.

- 4. Do I have to pay any taxes, such as property taxes, if I install a small wind system?** Depending on the particular situation, the generator may be subject to some replacement taxes. This question should be directed to your tax accountant and/or tax lawyer.

- 5. Is a small wind system really worthwhile to put up?** Installing your own generation is an individual decision for each member. A cooperative's role in this process is to help educate the member regarding the co-op's expectations in this process. First and foremost, Pella Cooperative Electric must protect the safety of cooperative members and employees as well as maintain the integrity and reliability of the grid and establish mechanisms to ensure cost fairness. The greatest payback to the member occurs when you consume all the energy produced by the generator.

The cooperative will try to help you obtain information you deem relevant to your decision-making process. However, the decision is one you must make on your own or with the assistance of consultants hired to provide you with advice.

- 6. I want to use wind as a cash crop on my farm. How do I accomplish this?** Even though you receive electric service from a cooperative, you have the right to allow other electric utilities or businesses to install wind turbines on your property. Typically, the companies involved in constructing a wind farm will review wind patterns and available infrastructure such as transmission facilities when determining the location of wind turbines. Other variables will also come into play as these companies evaluate the attractiveness of your property for a wind farm.

## Wind Energy Resources

### **American Wind Energy Association**

1501 M Street, NW, Suite 1000  
Washington, DC 20005

P: (202) 383-2500

W: <http://www.awea.org>

### **Iowa Energy Center**

2521 University Boulevard, Suite 124  
Ames, IA 50010-8229

P: (515) 294-8819

W: <http://www.energy.iastate.edu>

### **Iowa Office of Energy Independence**

Lucas State Office Building  
312 East 12<sup>th</sup> Street  
Des Moines, IA 50319

P: (515) 281-0187

W: <http://www.energy.iowa.gov>

### **U.S. Department of Energy – Energy Efficiency and Renewable Energy**

Office of the Assistant Secretary  
Energy Efficiency and Renewable Energy  
Mail Stop EE-1  
Department of Energy  
Washington, D.C. 20585

P: (877) 337-3463

W: <http://www.eere.energy.gov>