Is Small Wind Right for You?

Ten Steps to a Sound Decision

Two statements have a high probability of being true: (1) Electric prices will increase more quickly than the rate of inflation for several years, and (2) Small wind energy systems require a substantial investment of money and effort. **So, is a small wind energy system right for you? Only you can answer the question.** These 10 steps will help you make an informed decision from an economic perspective. You may want to factor in other objectives. (The following discussion includes several Internet addresses for more information. Be sure to copy the entire address into your Web browser's location bar.)

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.**

   You wouldn't buy a new furnace or air conditioner without first insulating your walls or ceiling. Nor should you invest in alternative energy without first reducing your total needs. Start by understanding the value of saving or generating one kilowatt-hour (kWh). Divide your total annual electric bill (minus the monthly customer charges) by the annual kWhs used. Deduct the monthly customer charges because neither conservation nor a wind energy system will offset the entire bill unless you totally disconnect from the grid. For a Midwest Energy residential customer, the customer charges are $156.00 per year. The resulting average price (excluding customer charges) is the value of saving or generating one kWh.

   Then, conduct an energy audit of your home to identify ways to use less energy. Implementing energy efficiency measures will almost always offer a quicker return on your investment. Conservation may enhance the viability of a wind turbine project through a lower capital expense associated with a smaller turbine to serve the new lower energy load. The National Rural Electric Cooperative Association (NRECA) recently reviewed several Web sites that host online energy audits. The review identified one Web site – Home Energy Saver – as among the best http://hes.lbl.gov .

   However, Internet-based audit tools all make assumptions about average construction practices, occupant lifestyles, etc. that may not be right for you. A professional energy audit that is adjusted to your actual energy use history will be more accurate.

   Midwest Energy provides a range of low cost/no cost energy services including audits, air infiltration tests, infrared scans, etc. More information can be found at http://www.mwenergy.com/energyservices.aspx or contact Midwest Energy at 800-222-3121 to schedule an appointment.

Midwest Energy's How$mart® program http://www.mwenergy.com/howsmart.aspx can provide funds for energy efficiency projects. Monthly savings are used to repay the cost.

Don't forget to replace old incandescent bulbs with compact fluorescent lights (CFLs). If you need to replace an appliance, choose an Energy Star model. Learn more about Energy Star products here: http://www.energystar.gov/index.cfm?c=home.index

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. A rule of thumb is that the turbine should be at least 30 feet higher than any obstacle within 300 feet. If growing trees are within this range, plan for their mature height. It also should be placed upwind of buildings and trees relative to the prevailing wind direction.

Information on determining site suitability is available from the US Department of Energy in this publication: Small Wind Electric Systems: A U.S. Consumer's Guide http://www.eere.energy.gov/windandhydro/windpoweringamerica/pdfs/small_wind/small_wind_guide.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 mph at hub height) and Class 4 (13.4 mph at hub height). Class 3 sites have average wind speeds of 12.5 mph at hub height. (Hub height is the distance from the ground to the center of the turbine rotor.)

A small increase in average wind velocity (V) results in a large increase in power produced. Energy output will increase by this ratio: (V2xV2xV2) divided by (V1xV1xV1). A site with an average wind speed of 15 mph contains nearly 54 percent more energy than a site with an average wind speed of 13 mph. The ideal wind resource has relatively stable high speeds. If trees and vegetation are permanently deformed because of constant wind exposure – known as "flagging" – you probably have a good wind resource to generate electricity.

There are several Web sites with wind resource maps. The best place to start is at the KCC wind energy page: http://www.kcc.state.ks.us/energy/wind_maps.htm. This page includes average wind speed and wind power density for several tower heights. For residential and farm size units, use the 30 meters (98 feet) map. Except for localized sites hindered by trees, buildings or surrounding hills, most of Midwest Energy's service area experiences Class 3 winds or better.

3Tier Group is a forecasting company that provides information on average wind speeds by hub height and city, address, or geographic coordinates. The model, called First Look, can be found at http://firstlook.3tiergroup.com 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 government meteorological stations. But anemometers may be in sheltered locations, so historical weather data on wind speeds may not be a reliable indicator of wind speeds at your site.

The American Wind Energy Association (AWEA) http://www.awea.org/smallwind/ provides considerable information on siting, zoning and technical issues.

You may want to find a wind turbine dealer/installer at this point. A good dealer can do a site assessment for you. Given the cost of wind turbines, a second opinion is a good idea. (Section 8 below provides recommendations on selecting dealers/installers.)

At this stage of planning you should also talk to Midwest Energy about what you are considering. Distances to power lines, class of service, transformer size and available phases may impact the type of system you purchase, as well as installation costs.

3. Determine how much electricity you use and what a given wind generator might produce. Select turbine and calculate tower height based on that output.

Energy output. Midwest Energy can provide a copy of your historic electricity use or you can check your monthly statement. With this information, the dealer/installer can help you select a turbine size and tower height. Don't assume the turbine should supply 100 percent of your needs. That question should be answered by an economic analysis.

Most small turbine manufacturers provide an estimated monthly energy output in kilowatt-hours (kWh) based on the wind resource you determined in Step 2. Experts caution consumers about taking these figures at face value, however. **There are no industry-wide standards for comparing wind turbine performance!** But, the Small Wind Certification

Council is developing a certification process for performance, durability, and safety requirements for small units: http://www.smallwindcertification.org/about.html

The Small Wind Capital Cost Recovery Worksheet will enable you to estimate the annual energy output in kilowatt-hours. **Repeat the analysis for various machines.**

A researcher at the National Renewable Energy Lab (NREL) developed this estimating formula that uses rotor size and wind speed: annual energy output in kWh = 0.01328 x rotor diameter (feet) squared x average wind speed (mph) cubed. That is, annual kWh = 0.01328 x D x D x V x V x V, where D = rotor diameter (feet) and V = average wind speed (mph).

Turbine features. Once you know how much electricity you want your wind generator to produce, monthly or annually, you can look at the specifications of all turbines matching that output. 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 may last longer.

The amount of power that a turbine can produce is determined mainly by the diameter of its rotor and its tower height. The diameter defines the rotor's swept area – the quantity of wind intercepted by the turbine. The larger and higher the swept area (the area through which the rotor blades spin) of the generator's rotor, the more electricity it can produce if the rotor and generator sizes are properly matched. Swept area is the feature that will help you compare the potential output of one wind generator with another.

For another opinion on selecting a turbine, see *Home Power* magazine's "Wind Turbine Buyer's Guide" http://www.homepower.com/basics/wind/ .

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 or 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. Remember the rule of thumb for tower height: the wind generator should be at least 30 feet above any trees, buildings, or other structures within 300 feet. Are nearby trees still growing? Plan ahead! 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 and return the incremental initial investment with greater energy generation revenues over the lifetime of the turbine. But, taller towers are more expensive.

The question you need to answer is whether the increased tower height is economically justified compared with the increased electricity production. A sample calculation on how to answer this question is available on Renew Wisconsin's Web site at http://www.renewwisconsin.org/wind/Toolbox-Homeowners/Towers%204-Tower%20Costs%20versus%20Power.pdf . Remember to use Kansas wind speeds.

An equation for estimating wind velocity at a different height is: $V2 = V1 * (H2/H1)^n$, where n = 0.15 for short grass or fallow ground, and n = 0.20 for tall row crops or low woods. Remember that available energy varies with the cube of wind velocity. (Refer to Step 2.) So for typical Western Kansas conditions, changing tower heights results in these differences in available energy compared to a tower 100 feet tall:

- 120 feet: add 8 to 10 percent to output at 100 feet
- 80 feet: deduct 10 to 11 percent from output at 100 feet
- 60 feet: deduct 21 to 24 percent from output at 100 feet

4. Find out what incentives (rebates, grants, and loans) are available, and whether you qualify for a USDA Section 9007 (formerly 9006) grant.

Owners of small wind systems with 100 kilowatts (kW) of capacity or less can receive a federal tax credit for 30 percent of the total installed cost of the system.

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 .

Section 9007 of the 2008 Farm Bill allows small businesses and agricultural producers to apply for grants and guaranteed loans for financing renewable energy projects and energy efficiency improvements, or grants for a stand-alone feasibility study. Section 9007 provides grants of $2,500 to $500,000 or up to 25 percent of the eligible costs of rural renewable energy projects. For more, see: http://www.rurdev.usda.gov/ma/reap.htm

The grants are only available for agricultural producers who earn at least 50 percent of their income from agricultural products. Small rural businesses also are eligible. But the application process for a grant or loan under Section 9007 can be complicated and time-consuming. A sample 9006 application form can be found on DOE's energy efficiency and renewable energy (EERE) Web site: http://www.eere.energy.gov/windandhydro/windpoweringamerica/pdfs/farm_bill_small_wind_sample_application.pdf .

5. Determine estimated installed cost of system and calculate savings and payback.

A very general rule of thumb for estimating the cost of a small wind system is $3 to $5 per installed watt ($3,000 to $5,000 per kW), but it can be higher, especially on smaller systems. The total installed cost is the cost of the wind generator and tower plus the cost of permitting, installation, and interconnection to the grid. Better system cost estimates can be obtained from the dealers/installers discussed in Section 8 below.

You can estimate the cost of energy produced by a small wind system and potential savings with the Small Wind Capital Cost Recovery Worksheet. The payback period for a small wind system is the amount of time it takes for the system to pay for itself in energy savings. The payback time will vary depending on how much of the electricity you use versus the amount sold back. A simple payback estimation can also be found here; be sure to read the footnote assumptions: http://www.mwenergy.com/windpayback.aspx . If you use Microsoft Excel, try this more sophisticated model: http://www.kec.org/smallwindcashflow.aspx (Click on the link to "Small Wind Cash Flow Model".)

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

Zoning. Zoning regulations vary from town to town and county to county. Contact local 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. AWEA has developed a comprehensive guide for local governments contemplating zoning regulations for small wind: http://www.awea.org/smallwind/pdf/InThePublicInterest.pdf

If zoning hearings are required, 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, county commission, 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.

7. Ask Midwest Energy about interconnection requirements.

If you have not already talked with Midwest Energy 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 (or your dealer/installer) need to make sure that the system meets the criteria for interconnection.

Start with the "Technical Requirements" section at the bottom of this Web page http://www.mwenergy.com/windprojectdev.aspx to learn about Midwest Energy's requirements. You only need to complete the application found in Exhibit A if you select an inverter-based unit 10 kW or less in size. Exhibit B is the application form for larger units. The interconnection agreement in Exhibit F will be supplied by Midwest Energy.

Some of the interconnection requirements and application forms appear complex. That's OK; we don't expect you to be an engineer. But, your dealer/installer should certainly understand these concepts, or you should find a different dealer!

8. Find a small wind system dealer/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 turbine you are interested in for recommendations and suggestions for authorized installers. AWEA provides a list of turbine manufactures: http://www.awea.org/smallwind/smsyslst.html .

Contact at least three installers for quotes for the equipment and installation. Be sure to ask for references, licenses and certifications, proof of insurance, and a performance bond. Question any quote that appears to be too high or too low. Some questions to ask when considering an installer are:

- Does the company have experience installing grid-connected systems? What models?
- Does the company use licensed and certified contractors? Is the company insured?
- Does the company have any consumer complaints, judgments, or liens against it?
- Will the company help with the applications required by the local building permitting agency and the utility for grid-connected systems?
- How much, if any, of the work will be contracted out?
- When will construction begin and how long will it take?
- What warranty is offered on the installation (covering workmanship for tower and turbine assembly, electrical, and foundation work)? Will company provide a performance bond?
- Does the company do service and repairs on the equipment?
- Will the company provide references of previous consumers?

AWEA suggests these questions: http://www.awea.org/smallwind/sagrillo/questions08.html

The North American Board of Certified Energy Professionals plans to create a certification program for small wind turbine installers. Status of this effort is uncertain. The knowledge, skills, and abilities required for the installation and maintenance of a small wind system are discussed in the board's task analysis at http://www.nabcep.org/wp-content/uploads/2009/01/smallwindta1206finalv10.pdf and http://www.nabcep.org/certification/the-need-for-certification

9. **Repeat Steps 3 and 5 for at least one other manufacturer or turbine size. The economic analysis results can change significantly.**

   If you are satisfied with the results of your analysis, proceed to Step 10.

10. **Order the turbine (including tower and accessories) and contract for installation.**

    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 for the specific turbine that you will be purchasing, be sure there is a warranty and ask about a maintenance contract and the availability of spare parts.