Colorado State University Extension

Wind Energy for Colorado Home Owners, Farmers and Small Businesses

Fact Sheet No. **10.623** Consumer Series | **Energy**

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1. Is wind energy practical for me?

A small wind energy system may provide you with an economical source of electricity if you live in an area with fairly steady strong winds and at least one-half acre of open land.

Personal impressions of the windiness of a site are often not reliable—it is better to use an objective measure. The most precise information can be obtained by placing an anemometer (a device that measures wind speed) on your site for at least one year. You may be able to put an anemometer on your site from Colorado's free anemometer loan program http://projects-web.engr.colostate.edu/ALP/index.htm.

A faster but less reliable method is to look up wind data from the Colorado wind resource map and the anemometer loan program. Winds on your site should be at least class 2 (annual wind speeds averaging 9.8 to 11.5 mph at 50 meters above ground level) to be suitable for wind generation. The U.S. Department of Energy has more information on siting turbines, and the American Wind Energy Association offers a detailed siting handbook.

You also need to make sure your local zoning codes or covenants allow wind turbines and the tall towers that allow them to catch enough wind to make electricity. You also need to do enough research to learn whether a turbine will pay for itself quickly enough to meet your financial requirements.

The cost of residential wind turbines varies depending on how much power they can produce and other factors. A rough range is $4,000 to $8,000 per rated kilowatt. A system that would offset most of an average home's electricity use (10,000 kwh/year) will cost roughly $50,000 before incentives.

While the cost of a wind turbine is steep, the wind energy system will not require further electrical purchases for approximately 20 years. This allows you to avoid unpredictable future costs of other fuels by paying for wind energy upfront.

2. How does a wind turbine work?

Wind energy generates power in accordance with this equation:

$$\text{Power} = 0.5 \times \text{Swept Area} \times \text{Air Density} \times \text{wind Velocity}^3$$

Practical takeaways from this equation are:

1. Siting your turbine in an area where there is good wind is the most important consideration since power increases with velocity as a cubed function. This means that small increases in wind speed will dramatically increase power output.
2. The bigger the blades of the turbine (swept area), the more energy it will be able to capture. Very small turbines will not be able to produce much power, no matter how efficient.

A wind turbine works by catching the energy in the wind, using it to turn blades, and converting the energy to electricity through a generator in the part of the turbine called a nacelle. However, the turbine is only one part of the system. A tower lifts the blades high in the air where the wind is stronger. Because winds are more powerful and less turbulent higher off the ground, taller towers increase a turbine's energy production dramatically. In addition, the presence of trees and buildings interferes with the wind resource. One rule of thumb is that the bottom of the area swept by a turbine's blade should be a minimum of 30 feet above any trees or buildings within 300 feet. However, because increases in tower height

Quick Facts

- Winds on your site should be at least class 2 (annual wind speeds averaging 9.8 to 11.5 mph at 50 meters above ground level) to be suitable for wind generation.
- A state law passed in 2008 requires all utilities to allow residential turbines of up to 10 kilowatts and commercial turbines up to 25kw to connect to the grid.
- The cost of residential wind turbines varies depending on how much power they can produce and other factors.
- No matter what kind of electricity you are using, the best way to reduce expenditures is to use less.

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so dramatically increase power output, consider investing in the tallest tower possible; the return on the investment is worth it.

An inverter converts direct current (DC) electricity to alternating current (AC). For wind machines that use batteries to store the power, a controller manages the electrical input to the batteries, turbines that are linked to the grid do not require batteries.

3. What is the difference between grid-tied and off-the-grid?

Until fairly recently, most of the small wind turbines in Colorado were installed by people who lived "off-the-grid," that is away from a power company that supplied them electricity. They relied on their own ability to make power with a wind turbine and perhaps solar panels, with backup batteries to store power. But that is changing.

A state law passed in 2008 requires all utilities to allow residential and commercial users up to a certain size to connect to the grid. The grid performs the same function as a battery storage system. Power generated in excess of daily consumption gets credited back to the consumer at retail rate. This credit goes towards power consumed during calm periods, when electricity is not being generated. Colorado's law is designed for people to offset their own power use, not sell it back to make an overall profit. It allows residential turbines up to 10kw of rated production and commercial turbines up to 25kw. Net metering is only allowed for systems sized up to 120 percent of the customer's annual average consumption. At the end of the year, any power that is generated in excess of consumption is bought by the utility, generally at very low rates. Therefore, it does not make financial sense to oversize your system.

This "net-metering" law has sparked a lot more interest in small wind turbines that connect to the power grid. Because these turbines are tied directly into the electricity system, they will not work when the power goes out—unless there is a battery backup system.

4. How big a system do I need?

Most small wind turbines have a rating or size based on the maximum electricity they can generate such as 1.8kw or 5kw. But that is not a very useful number for most consumers, since power ratings are not an apples-to-apples comparison. It is better to use the certified ratings from the Small Wind Certification Council (http://smallwindcertification.org) (SWCC). The SWCC rating will show the kWh (Kilowatt hour) production of a turbine at a rated windspeed, giving the turbine its 'rated power.'

However, the important decision factor is what the power output is at your average windspeed. If the rated windspeed (11.2 mph) does not match the average windspeed at your location, use the power curve supplied by the manufacturer, showing how much electricity the machine produces at a given wind speed. Use this to estimate how much electricity (kWh) the turbine will produce each month or year at the average wind speed you expect or measure at your site. Match this output with your annual energy consumption. To determine this number, check your monthly bills to come up with the annual total of kilowatt hours of electricity you use.

Once you have determined your annual electricity use, you can decide how much electricity you want to offset with a turbine, based on budget and other considerations. For example, if you want to offset nearly all your electricity use and have determined you have annual usage of 10,000 kWh, select a turbine that will produce that much power over the course of a year at your average wind speed.

5. How much will it cost?

The cost of residential wind turbines vary depending on how much power they can produce and other factors. A rough range is $4,000 to $8,000 per rated kilowatt. A system that would offset most of an average home's electricity use (10,000 kWh/year) will cost roughly $50,000 before incentives.

6. How do I calculate a payback?

Determine the amount you pay on electricity bills before you install your system, or if planning an off-grid system, determine how much electricity you think you will use on a yearly basis. If your system offsets all your electricity, you can divide its cost by the annual bill to determine how many years it will take to pay off. If you are only offsetting part of your use, you need to adjust the calculation accordingly.

The National Renewable Energy Laboratory has a calculator and a paper on the economics of grid-tied small wind.

7. Sticker shock?

No matter what kind of electricity you use, the best way to reduce expenditures is to use less. That means making your home more efficient and finding ways to cut your use, such as opening your windows on cool nights and closing them as the day heats up. Turning off lights and unplugging appliances when not in use can really add up. For more information, see CSu Extension fact sheet 10.610, *Energy Conservation in the Home*.

For further cost reduction, look for rebates and tax incentives. The Database for State Incentives for Renewable Energy and Efficiency maintains a list of Federal and State rebates and incentives.

8. What zoning issues might I run into?

Zoning regulations vary dramatically across states, counties and municipalities. Check with your county planning and zoning office before proceeding. In many urban counties, height restrictions may rule out a wind tower. It is always a good idea to discuss the idea with your neighbors, as they may have input on placement.

9. What kind of maintenance is there?

Maintenance varies by system, so ask about requirements when you are considering which kind of turbine to buy and when you are reviewing literature from different manufacturers. Wind turbines require regular maintenance that generally consists of periodic inspections and adjustments; if performing this kind of maintenance, sometimes at the top of a tall tower, is not something you are either willing to do or to pay for, wind energy is not right for you. Representatives of manufacturers can give you an idea of the expected maintenance schedule and help you arrange maintenance. A rule of thumb is to allocate about 1 percent of the installed cost of the wind system for operation and maintenance expenses over the life of the system.

10. How long will the system last?

When you considering buying a system, ask about its anticipated lifespan. Most reputable small turbines should perform well for many years with only periodic maintenance required. Buy a turbine that has a good track record and a good warranty—at least five years is preferable. A warranty is one indication of the manufacturer's confidence in the product. In general, you can expect 20 years from a properly maintained turbine from a reputable manufacturer.

11. Do I have to think about insurance?

You will want to insure your turbine against possible damage and liability claims, and some counties require insurance. Ask your property insurance company whether they will insure the turbine. Generally, the most cost-effective way to insure a wind system is under an existing homeowner's insurance policy on your house; it is often insured as an "appurtenant structure" (an uninhabitable structure).

12. How will it affect the value of my house/ranch/farm?

A small wind turbine, like other capital investments, should increase the value of your property. If you can tell a prospective buyer that your electricity bills are almost nothing, the value of the installed turbine may be an attractive incentive.

13. What is the impact on the environment?

Small wind turbines emit no pollution and need no water. They also reduce the amount of pollutants that your utility would emit if you were relying on electricity from burning coal, for example. According to the American Wind Energy Association, over its life, a small residential wind turbine can offset approximately 1.2 tons of air pollutants and 200 tons of greenhouse gas pollutants (carbon dioxide and other gases which cause global warming). Although the impact of wind turbines on wildlife, especially birds, is of concern to many people, research has shown that bird impacts with small, unlighted turbines are quite rare. House windows and outdoor cats have a much greater negative impact. The National Wind Coordinating Collaborative (https://nationalwind.org/) has a list of wildlife/wind interaction publications for more information.

Most modern residential turbines are fairly quiet—similar to ambient noise levels under average wind conditions.

14. What other renewable energy resources should I think about?

Before considering adding any renewable energy to your home, ranch or farm, experts advise you to do everything reasonable to reduce the energy you are using through conservation and efficiency. After that, adding renewables depends on your location and budget.

Solar photovoltaic panels may make more sense than small wind turbines in most urban areas. A combination of the two, perhaps with a diesel generator backup, often makes sense for people who want to live completely independent of the power company.

A ground-source geothermal heat pump, which takes advantage of the relatively uniform temperature of the earth, makes sense for heating and cooling, especially in new construction. And if you have water running downhill on your property, a micro-hydro generator might be a good option to consider.

Ongoing regulations vary dramatically across states, counties and municipalities. Check with your county planning and zoning office before proceeding.

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