

## **New and Improved Wind Power**

For many, home energy costs recently have increased by 50 percent (or more), motivating a growing number of people to look for alternatives. The proliferation of net metering laws, in about 40 states, as well as a growing number of state residential wind incentive programs, has given a strong boost to the small-scale wind turbine industry.

What's more, recent technical developments have reduced blade noise and improved both turbine efficiency and longevity. There now are a number of new home-scale wind turbines with advanced technology, and there's the promise of more to come in the near future.

For many years, residential wind turbines have been most popular in rural locations where zoning laws tend to be less restrictive and neighbors less likely to object to them (mainly on aesthetic grounds). That may be about to change. Many in the small-scale wind turbine industry think residential wind power is about to enter suburbia with simpler, less expensive systems that perform more like household appliances than complicated renewable energy systems. And the potential is enormous; it's estimated there are at least 15 million homes with the resources necessary to make a wind installation cost effective.

But does it really make sense to install a wind turbine in your backyard? Maybe, maybe not. A wind power system that works well in one location may not work in another. There are many variables to consider: the size of your lot, zoning restrictions, wind speeds in your area, the cost and amount of electricity you use, whether your utility offers net metering, and the availability of state rebates and

incentives. (See “Is Wind Power Cost-effective for You?” below, for additional advice.)

## **WIND POWER PICKS UP SPEED**

Harvesting the wind to generate electricity is not a new idea. In 1888, Charles F. Brush of Cleveland created a wind turbine for this purpose. Early turbines could supply enough energy for a house or two. Today, large commercial-scale turbines can produce about 3 megawatts or more, enough to power about 750 U.S. homes. The recent growth of this industry in the United States has been dramatic. Wind power capacity increased by 27 percent in 2006 and is expected to increase an additional 26 percent this year, according to the [American Wind Energy Association](#). Enthusiasm for small-scale wind also is on the rise, with sales for residential systems at \$17 million in 2005, up 62 percent from 2004, according to the association.

Residential wind turbines were first commercialized in the United States in the 1920s and were fairly popular until the Rural Electrification Administration extended electric lines to many remote areas in the 1930s and '40s. The oil crises of the 1970s spurred a flurry of renewed interest in residential wind power until the tax credits and other government incentives that supported the industry ended in the 1980s.

But now, interest in residential wind power is on the rebound. Mike Bergey, president of [Bergey Windpower Co.](#), attributes the company's recent growth to robust state and utility rebate programs and growing interest in clean energy technology. (Visit the [Database of State Incentives for Renewables & Efficiency](#) to see if incentives are available in your state.)

Net metering laws, which simplify the connection of residential renewable energy systems to the electric grid, also have made wind more attractive to those looking for a way to reduce their energy bills. Robert Preus, the founder of [Abundant Renewable Energy](#) (ARE), agrees and points to the impact of grid interconnection on the solar-electric market as instructive. “In the past, the vast majority of solar was battery-connected off-grid; now it’s just the opposite,” he says. Grid-interconnection allows the homeowner to reduce their grid-based energy use, while not requiring them to rely solely on wind for their needs.

Many others in the industry point to the increasing number of financial incentive programs that help reduce the high initial cost of wind systems. But according to Andy Kruse, co-founder of [Southwest Windpower](#), people also are choosing wind simply because it’s the right thing to do. “Another key factor is unquestionably the environment,” he says. “People are looking for ways to make a difference.”

These days there are high hopes in the residential wind industry for the passing of legislation that would establish a federal tax credit for those who purchase wind turbines. According to Bergey, a federal credit would not only be an immediate benefit to taxpayers, but would also drive turbine prices down through increased manufacturing. (For help contacting Congress to voice your support, click [here](#).)

## **THE BASIC TECHNOLOGY**

Residential wind power has come a long way from the 1920s, but in some respects the basic technology hasn’t changed much. Turbine subsystems include a rotor (the blades) that convert the wind’s energy into rotational shaft energy; a nacelle (enclosure)

containing a drive train and a generator; the tower to support the turbine; and electronic controls, electrical cables and grid interconnection equipment. Off-grid turbines do not have interconnection equipment, but normally have banks of batteries to store electricity for use during windless periods. Grid-connected turbines, on the other hand, essentially use the grid as their storage battery.

Because the rotor is what actually captures the wind, its size is extremely important. In general, the larger the rotor the better, as long as it's matched to an appropriately sized generator.

Improved airfoil designs have boosted efficiency by as much as 35 percent at the average wind speeds typical of many residential locations. Wooden blades have been replaced by reinforced fiberglass, which reduces blade maintenance (although routine turbine and tower upkeep is still extremely important). The blades also have been redesigned to reduce the amount of noise they produce. Bergey Windpower, for example, used the new airfoil design in its 10-kilowatt BWC Excel model to improve efficiency in wind speeds as low as 9 miles per hour. In addition, new direct-drive permanent magnet alternators have been paired with sophisticated controls and inverters designed specifically for small wind turbines. Alternator efficiency on some models has been improved by about 25 percent. "We introduced the Excel back in 1983," Bergey says. "But the one you buy today has vastly improved rotor blades and power electronics."

Some of these advances owe at least partial credit to research and development conducted by the [National Renewable Energy Laboratory's Wind Technology Center](#) in Golden, Colo. Bergey Windpower and several others have benefited from collaboration

with the laboratory. The team-up helped Abundant Renewable Energy design two new residential, grid-connected turbines that are especially well-suited for harsh environments. In January 2006, the company shipped its first 2.5-kilowatt unit (the ARE 110), followed later that year by the 10-kilowatt model (the ARE 442). Both turbines are designed to operate quietly and produce more electricity in lower wind speed locations.

Southwest Windpower, which also collaborates with the laboratory, has been producing battery-charging wind turbines since 1987. Recently Southwest released a grid-connected turbine, the Skystream 3.7, that is paired with a monopole tower as short as 33 feet to make it easier to install in residential settings where zoning regulations often limit taller structures. Among a number of improvements, the new 1.8-kilowatt turbine has an extremely low “cogging torque” (resistance to start up), making it easier to start in low winds. The Skystream is a smaller unit with a lower price tag than industry averages (see “Residential Wind at a Glance,” below).

### **PLUG AND PLAY**

One thing that sets the Skystream apart from the competition is its “plug and play” design. All of the sophisticated electronic components that would normally be located in separate boxes at or near the base of the tower have been incorporated into the turbine itself, making the connection to your home’s electrical system (and the grid) a relatively simple matter. Another characteristic that sets the Skystream apart is its use of the generator to control the rotor speed. Most other small wind turbines use a “furling” strategy, which turns or tilts the turbine and blades out of the wind to protect them from overspeeding in high winds, which can destroy

the generator. The Skystream, on the other hand, uses what amounts to dynamic braking by the generator to limit rotor speed.

Jim Green, senior project leader at the Wind Technology Center, explains the advantages and disadvantages of these two strategies: “The furling method is passive and relatively fail-safe because when the wind forces become sufficiently high the turbine will furl,” he says. “The alternative approach used by Skystream hopefully will be a reliable strategy, but it does require some active control in the machine. They address that by having redundant systems and fairly fail-safe power designs.” If the power goes off in a grid failure, for example, there is a switch that stops the turbine.

“One of the reasons I think the Skystream approach is going to be attractive is that the rotor speed is truly limited,” Green says. “Furling wind turbines, on the other hand, tend to let the rotor accelerate to generate the high thrust that causes the furling to take place. So, there are some higher speeds and higher forces involved that the whole machine has to deal with in that approach — but with proper design that’s OK.”

However, when it comes to tower height, residential wind expert Mick Sagrillo and others in the industry stress that the 33-foot tower that’s often part of the Skystream package is simply not tall enough to avoid wind turbulence; most in the industry recommend an 80-foot tower minimum.

“The site always determines the height of the tower,” Sagrillo says. The three most common mistakes that people make with small wind installations, according to Sagrillo, are: 1. Too short a tower; 2. Too short a tower; and 3. Too short a tower. Bergey also

emphasizes this point by comparing a turbine on a short tower to a solar power collector in the shade.

Kruse argues that a general rule of thumb is to ensure the rotor extends at least 20 to 30 feet above any surrounding object within 500 feet of the tower. He agrees that a site should be thoroughly assessed; while the 33-foot monopole tower may perform well in the Texas panhandle, a taller tower might be required in areas such as upstate New York or Vermont.

At least one new Skystream feature impresses virtually all observers — the turbine’s wireless communication system. It enables the homeowner to track the turbine’s output and other operational statistics on their home computer and also allows for real-time troubleshooting if a problem should develop. Software patches and other system upgrades can be uploaded to the turbine via the same system, eliminating the need to lower the turbine to the ground for these procedures.

#### **REAL-WORLD PERFORMANCE**

So, how do residential wind turbines actually perform? If they are properly installed and maintained, the record is good. Bergey Windpower, with installations in all 50 states and more than 90 countries, has a long track record of success. Abundant Renewable Energy has only a small number of its new ARE 110 turbines installed so far, but early feedback has been positive.

We did have an initial problem with a turbine component,” says Tom Carter, director of operations at [Crossroads for Youth](#), a residential school for at risk children in Oxford, Mich. “But after it was repaired, the system has operated flawlessly. We’re very pleased with it.”

Southwest Windpower's Skystream 3.7 turbine is new to the market, but one prototype has been in successful operation at the Wind Technology Center for more than two years. An additional 20 Skystreams have been in a beta testing program for more than six months in various residential locations around the country. The tests have gone well overall, and except for the usual minor glitches for any new product, no major system failures have been reported. Paul Westbrook of Fairview, Texas, had his beta Skystream installed in September 2006.

"Overall it's running fine," he says. Westbrook reports there have been no noise complaints from the neighbors. "In fact, I've been getting inquiries from them about how it works, how much it costs and how much power it's producing," he says. "There's been a lot of interest."

Westbrook does acknowledge the 33-foot tower was not a good match for his site, because part of his property is heavily wooded. "I put the turbine on a clear hill near the street in a corridor that I thought would have pretty good winds, but I have been stunned by how much reduction in wind has resulted from turbulence caused by the trees. Consequently, my power output is running at about one-eighth what it should be." Westbrook plans to install a taller tower to get the turbine well above the trees.

Westbrook had another problem — getting his system connected to the grid. He's served by an electric cooperative that had no net metering provisions and no interest in establishing any. It took five months of persistent negotiation to get the connection. Installation experiences like these highlight how crucial it is to study all the issues involved with a site before you proceed. With proper siting,



residential wind may be a great way to reduce your energy costs and make a positive difference for the environment.

With growing consumer interest, there's a good deal of optimism in the small wind sector. "We're in a very dynamic, emerging market right now with all these state incentives in place," Green says. "But a lot still depends on the future of energy prices." Kruse agrees. "I'm very optimistic about it," he says. "Provided that the cost of utility energy keeps on going up, and we keep the cost of renewable energy down with innovative technologies, it's going to be very exciting."

*Greg Pahl is the author of [The Citizen-Powered Energy Handbook: Community Solutions to a Global Crisis](#), and [Biodiesel: Growing a New Energy Economy](#). Don't despair if you don't have a good wind site on your property. Coming soon, Greg Pahl will report on wind power projects from which the whole community can benefit by pooling their resources.*

## **Net Metering**

Net metering laws help offset some of the cost of a grid-tied wind system by allowing the homeowner to sell extra energy back to the utility at retail prices. According to the [Database of State Incentives for Renewables and Efficiency](#), 41 states currently require at least some utilities to offer net metering for small wind systems. For information on your state, click [here](#).

## **Residential Wind at a Glance**

### **Bergey Excel**

Average Cost: \$50,000\*

Rated Capacity: 10 kW

Output: 1,600 kWh/month\*\*

Warranty Stats: 5 years. Covers damage by winds up to 123 mph.

### **ARE 442**

Average Cost: \$50,000 to \$80,000\*

Rated Capacity: 10 kW

Output: 1,820 kWh/month\*\*

Warranty Stats: 66 months from date of purchase or 60 months from the date of installation, whichever occurs first. Covers damage by winds up to 100 mph.

### **ARE 110**

Average Cost: \$20,000 to \$35,000\*

Rated Capacity: 2.5 kW

Output: 410 kWh/month\*\*

Warranty Stats: 66 months from date of purchase or 60 months from the date of installation, whichever occurs first. Covers damage by winds up to 100 mph.

### **Skystream 3.7**

Average Cost: \$15,000 to \$16,000\*

Rated Capacity: 1.8 kW

Output: 400 kWh/month\*\*

Warranty Stats: 5 Years. Covers damage by winds up to 145 mph.

\*Figures are based on company estimates, and assume a 100 foot-tower.

\*\*Estimated output assumes a 12 mph wind speed. The average U.S. household uses about 917 kWh of electricity per month.

## **Is Wind Power Cost-effective for You?**

- The more of these conditions apply to you, the shorter your payback period will be.
- You pay more than 10 cents/kWh for electricity, and your electric bill averages at least \$150 per month.
- Your electric utility offers net metering.
- You are located in a class 2 or higher wind site (click [here](#) to see a U.S. wind class map). Your state has a substantial wind power rebate program that will help offset the system's cost.

### **Wind Power Warranty Considerations**

- Exactly what does the warranty cover?
- Is the turbine covered for at least five years?
- What are the exclusions or restrictions? Read them carefully.
- What is the top wind speed, after which warranty coverage is excluded? (The warranty should be good for winds of at least 100 mph.)
- Is the warranty transferable to the next homeowner?
- If you do not understand any part of the warranty, don't be afraid to ask questions.