# Is Wind Electricity *Right* for You?

by Ian Woofenden
& Mick Sagrillo

Shawn Schreiner

Vince Culp of Energy Unlimited gets ready to raise an Endurance S-343 on a 90-foot hydraulic tilt-up tower.

**Wind electricity is an enticing technology, drawing attention to itself with every turn of the blade. But for the uneducated consumer, wind power can end up being the most disappointing of RE technologies. This is not because it's a hopeless endeavor to capture the energy in the wind, but because it's a difficult job. Unfortunately, the technology also seems to attract more backyard "inventors" and hucksters than other renewable technologies.**

Before you are hired for a new job or are accepted as a new student, you need to pass interviews, tests, and other evaluations. Perhaps wind electricity consumers should put themselves through a similar grilling before taking on the job of wind-electric system owner. In this article, we'll run you through some tests to see if you qualify.

## Site Evaluation

One early step is to look at your physical site. Productive wind-electric systems take *space*. If you live in a city lot, an apartment, or even on a small suburban lot, installing a wind-electric system may be difficult or impossible. Even if you have the space, most urban settings have little, if any, wind resource.

Freestanding towers can have a very small footprint, and in fact can be installed on very small lots. Fixed guyed and tilt-up towers both need a more substantial footprint, for the guy wires and for tilting down. These are often not options on small lots.

Successful wind-electric systems need tall towers that put the wind generator in the smooth, strong wind, well above obstructions. This can be very difficult on small lots, and may also lead to objections by neighbors and others.

The hard reality is that in today's cultural and legal climate, small wind systems are primarily successful as a rural technology. If you don't have an acre or more of ground, you'll have an uphill battle to permit and install a system that generates the electricity expected from it.

## Legal Limitations

In addition to space and neighbor constraints, you'll often face legal hurdles, especially in the city and suburbs. Objections to wind energy systems come with their own ignorance, fear, and misconceptions. Unfortunately, local officials are sometimes ill-informed and may give too much credence to fear-mongering or antiwind zealots.

It's common to find local or state statutes that restrict tower height to 30 to 60 feet—heights that hamstring a system to poor performance. These sorts of limits need to be challenged in administrative offices and courtrooms. Better yet, do the necessary education and change the permitting language proactively to avoid battles later on. Bowing to ordinances that limit tower height only results in poorly performing systems, and sets a bad precedent.

Courtesy Endurance Wind Power

Tilt-up towers require a large, open site to raise and lower the tower, but guyed towers can be sited on cluttered sites and even between buildings.

## Power Available & Wind Speed

| % of Rated Wind Speed | Wind Speed (mph) | % of Power Available |
|---|---|---|
| 100.00% | 24.0 | 100.00% |
| 50.00% | 12.0 | 12.50% |
| 25.00% | 6.0 | 1.60% |
| 12.50% | 3.0 | 0.20% |
| 6.25% | 1.5 | 0.02% |

Laws that require a distance between your tower and buildings or property lines are called "setbacks," and they can set your project back—in dollars and productivity. These restrictions vary by jurisdiction; we wonder why utility poles and towers are allowed close to roads, homes, and schools, while similarly engineered wind generator towers typically are not. Tower failures are rare, and real-world results show that, in the unlikely event that a failure occurs, the tower tends to buckle, instead of falling to its full height. Correcting unreasonable setbacks will make your project more functional, and help the industry mature.

Local jurisdictions may suggest or even require that you get comments or consent from neighbors before you are granted a building permit for your wind-electric project. Such requirements rarely, if ever, are enacted for other building or construction projects, and wind systems should not be treated any differently. Community pressure can change ill-conceived regulations. Meanwhile, we suggest that you become friendly with your neighbors, share your renewable energy passion, and get them on your side before it becomes a legal issue.

### Resource Assessment

If you have the space and can deal with the bureaucracy, a next step is to find out what sort of wind resource you have. "It's always windy here" is not a scientific observation, and it's also rarely true. Wind is the fuel, and finding out its strength and quality will be crucial to your wind-electric system's performance.

What you want to find is an *average wind speed*. This is not a guess, not a peak gust, not an observation, but a measured or extrapolated *average* of the winds on your site over the years. At home sites where the turbine sits on a tall tower, a realistic average is between 6 and 14 mph. However, a 6 mph average wind speed site is not ideal for on-grid systems, and is marginal at best for off-grid ones. A site with an average wind speed of 14 mph will give high production (and will require robust equipment), but is rare where most people live. While there are certainly exceptions, average wind speeds of 10 to 12 mph at tower-top height are typical at rural home sites.

Determining the average wind speed on your site is not always easy. You may be able to do short-term monitoring with anemometry and correlate with nearby data, but this is difficult to do without proper training and experience. More likely, you'll lean on a professional site assessment or wind mapping data. Don't grab map data and take it at face value, though. Most trained site assessors have learned what data they can trust, and know how to derate or adjust the mapping data to determine real-world conditions in your area.

With an estimate of your average annual wind speed at hub height (the wind generator's rotor center), you can look at production estimates from manufacturers (see the wind turbines table on pages 56–59). Then you'll have a rough idea of what you can expect in annual energy production (kilowatt-hours; kWh) from your system, and compare it to your energy use. In this way, you'll be realistic about what portion of your energy consumption and utility bill the system will offset.

### Tower Economics

Once it has been determined that a good resource exists, the most common mistake for small wind systems is putting a wind generator on too short of a tower. This is akin to putting a solar collector in the shade. Wind power is a cubic resource—doubling its speed increases the power available to the system eight times. So going a little higher to get into faster wind speeds can reap large rewards.

Since most people don't live in a perpetual "tornado alley," where winds are constant and high, another way to think of this is in reverse—what happens when wind speeds are cut in half, or even more? The "Power Available & Wind Speed" table gives you an idea of how much power is available in winds *below* the rated wind speed (often about 24 mph) of most well-designed wind turbines.

**Inset: A wind turbine on a short tower is a waste of money if your goal is to produce energy.**

**Main: To recoup your investment, wind turbines should be sited far from, and well above, any obstructions to the wind.**

Courtesy Ian Woofenden (2)

## Turbine Choices

Choosing your wind turbine is, first of all, a match between your electricity loads—how many kWh per year you use—and the prediction of what your system's production will be—also in kWh per year—based on the average wind speed at your site. Scan the table across the row for average wind speed, to see which of the turbines listed can meet your needs.

In addition to predicted energy output, you should consider the turbine's durability, which is harder to gauge. Heavier-built turbines will tend to stand up better in rough storm conditions. Within a particular size range, more expensive turbines may also fare better. Turbines with longer warranties perhaps will last longer, or at least you'll have recourse if there are problems.

This year, the first "certified" turbines will be available in the United States. As of mid-April, the Small Wind Certification Council (SWCC; www.smallwindcertification.org) had applications from 21 companies for 25 different turbine models. By the end of the year, some turbines will receive their certification with verified testing of energy production. This is an exciting development in the industry, which has been troubled for years by misleading marketing claims.

## Turbine Size

"There's no replacement for displacement" is a common phrase in the engine world. "Swept area matters" is the analogous statement in small wind circles. The "rotor"—the blades and hub, which sweep a circle measured in square feet—is the collector area. More collector means more wind energy collection. Ignore advertising claims that you can get lots and lots of energy out of a small collector. They're just not true.

If you don't have verified production numbers for the turbine, swept area is as good of a comparative measure as we have to guess at wind turbine production. In general, home-scale turbines fall within the 12- to 50-foot-diameter range if your goal is to meet a significant portion of your home's energy needs.

*(continued on page 60)*

Courtesy Bergey Windpower

**Although smaller turbines are manufactured, the Bergey XL.1 is the smallest in our survey of residential-scale turbines.**

## What's in the Table?

The table on pages 56 through 59 shows basic specifications for small wind turbines available and supported in North America. Understanding the specs will help you make intelligent turbine-buying choices.

The *manufacturer* indicates the source of the wind turbines listed, either manufactured in North America or imported.

*Swept area* is the area in square feet of the rotor. This is the "wind collector" area, and besides average wind speed, is the biggest factor influencing turbine output. A larger rotor will capture more energy.

*Warranty* is noted in years, but we urge you to find out what is covered and what is not. Usually it only covers the equipment, not the replacement labor costs and shipping, which can be significant. Several manufacturers also offer extended warranties for an additional cost.

*SWCC status* refers to the Small Wind Certification Council (SWCC), an independent certification body, which certifies that small wind turbines meet or exceed the requirements of the AWEA Small Wind Turbine Performance and Safety Standard. This certification provides a common North American standard for reporting turbine energy and sound-level performance. The table notes whether the manufacturer has applied for certification with the SWCC, but not the status of the application or how far along the testing is. Turbine certification will likely be required to qualify for some states' financial incentives. Since these agencies typically fund only grid-tied systems, manufacturers are unlikely to apply for certification for off-grid systems, which are usually the "smaller" small turbines.

While only a handful of manufacturers are in the process of *SWCC* certification, other companies may be pursuing certification from other agencies. For example, there are several certification bodies in Europe, and many of the turbines listed are manufactured there. In addition, other organizations in other parts of the world offer various types of certification for turbines or turbine components. However, since public benefits programs will likely rely on SWCC certification, this is the certification status to keep an eye on.

*Predicted annual energy output (AEO) at hub height at average wind speed* shows manufacturers' projected production for that turbine at wind speeds from 8 through 14 mph. These present some general numbers to match to your site's average wind speed and your energy needs. All of the AEOs provided in the table were supplied by the manufacturers. Your turbine's performance on your site may vary, sometimes significantly. You may want to derate the listed AEOs by about 25%. We have no evidence that all manufacturer AEOs are overstated, although some seem to be. It is certainly better to underpredict AEO, and be pleasantly surprised, than to overpredict and be disappointed.

For *installer evaluations* of the manufacturers and their equipment, 65 installers who are active and earning a living in the small wind industry were sent surveys. Using an "A to F" convention, installers were asked to "grade" the turbines and the level of service that the manufacturers provide. The table includes the average of their responses to questions, which included:

- Manufacturer's pre-sales response to product questions
- Overall quality of the product
- Completeness of order
- Post-sales technical support
- Reliability of system

We also asked installers to answer "Yes" or "No" to the following questions:

- Would you sell or install this turbine to another customer?
- Would you buy and install this turbine for yourself?


XL.1


Raum 1.3


Proven 7

| | XL.1 | Whisper 200 | 1.3 | e300i | Proven 7 |
|---|---|---|---|---|---|
| **Manufacturer** | Bergey Windpower | Southwest Windpower | Raum | Kestrel | Proven Energy |
| Website | bergey.com | windenergy.com | raumenergy.com | kestrelwind.co.za | provenenergy.co.uk |
| **Specs** | | | | | |
| Swept area (sq. ft.)* | 53.0 | 63.5 | 73.0 | 76.0 | 103.6 |
| Warranty (years)* | 5 | 5 | 5 | 5 | 5 |
| SWCC certification application | No | No | No | No | No |
| **Predicted Annual Energy Output (kWh)*** | | | | | |
| 8 mph | 420 | 794 | 908 | 973 | 1,704 |
| 9 mph | 610 | 1,121 | 1,110 | 1,315 | 2,438 |
| 10 mph | 840 | 1,483 | 1,539 | 1,726 | 3,494 |
| 11 mph | 1,110 | 1,865 | 2,004 | 2,131 | 4,417 |
| 12 mph | 1,400 | 2,254 | 2,479 | 2,551 | 5,627 |
| 13 mph | 1,710 | 2,637 | 2,940 | 2,966 | 6,614 |
| 14 mph | 2,040 | 3,005 | 3,365 | 3,356 | 7,842 |
| **Survey of North American Wind Installers** | | | | | |
| Number of responses | 5 | 0 | 0 | 0 | 2 |
| Turbines installed by respondents | 26 | 0 | 0 | 0 | 4 |
| Manufacturer presales response | B+ | | | | C- |
| Product quality | B+ | | | | B |
| Completeness of order | A- | | | | B |
| Ease of serviceability | A- | | | | B |
| Post sales tech support | A- | | | | C- |
| System reliability | B+ | | | | A- |
| Average overall grade | B+ | | | | B- |
| Would you sell or install this turbine to another customer? Yes / Maybe / No | 4–1–0 | | | | 1–0–1 |
| Would you buy & install this turbine for yourself? Yes / Maybe / No | 3–0–2 | | | | 2–0–0 |

*Manufacturers' data from 2010


Whisper 200


e300i


Xzeres 110


Skystream 3.7


Raum 3.5


Montana

| | Xzeres 110 | Skystream 3.7 | e400i | 3.5 | Whisper 500 | Montana | R9000 | |
|---|---|---|---|---|---|---|---|---|
| | Xzeres | Southwest Windpower | Kestrel | Raum | Southwest Windpower | Fortis | Evance | |
| | xzeres.com | windenergy.com | kestrelwind.co.za | raumenergy.com | windenergy.com | fortiswind.com | evancewind.com | |
| | 110.0 | 113.0 | 135.0 | 135.0 | 176.0 | 211.0 | 246.0 | |
| | 10 | 5 | 5 | 5 | 5 | 5 | 5 | |
| | No | Yes | Yes | No | No | No | Yes | |
| | 1,629 | 914 | 2,010 | 2,021 | 1,474 | 3,459 | 3,500 | |
| | 2,274 | 1,373 | 2,781 | 3,213 | 2,139 | 4,438 | 5,030 | |
| | 3,039 | 1,925 | 3,807 | 4,380 | 2,907 | 5,443 | 6,670 | |
| | 3,894 | 2,594 | 5,050 | 5,811 | 3,749 | 6,444 | 9,012 | |
| | 4,801 | 3,216 | 5,996 | 7,447 | 4,637 | 7,410 | 10,590 | |
| | 5,728 | 3,898 | 7,230 | 8,631 | 5,544 | 8,315 | 12,530 | |
| | 6,643 | 4,575 | 8,285 | 10,272 | 6,445 | 9,132 | 14,500 | |
| | 8 | 5 | 0 | 0 | 1 | 0 | 1 | |
| | 13 | 30 | 0 | 0 | 1 | 0 | 1 | |
| | B | B | | | B | | A- | |
| | B- | B- | | | C | | A- | |
| | B- | A | | | A | | A | |
| | C+ | C | | | C | | B | |
| | C | C- | | | C | | A- | |
| | C+ | C | | | C | | A | |
| | C+ | B- | | | B- | | A- | |
| | 1–3–4 | 2–1–2 | | | 0–1–0 | | 1–0–0 | |
| | 1–2–5 | 2–1–2 | | | 0–0–1 | | 1–0–0 | |


e400i


Whisper 500


R9000


Proven 11


S-343


Excel-S

| | Proven 11 | Scirocco | S-343 | Excel-R | Excel-S |
|---|---|---|---|---|---|
| **Manufacturer** | Proven Energy | Eoltec | Endurance Windpower | Bergey Windpower | Bergey Windpower |
| URL | provenenergy.co.uk | eoltec.com | endurancewindpower.com | bergey.com | bergey.com |
| **Specs** | | | | | |
| Swept area (sq. ft.)* | 255.6 | 265.0 | 343.0 | 415.0 | 415.0 |
| Warranty (years)* | 5 | 5 | 5 | 10 | 10 |
| SWCC certification application | No | No | Yes | No | Yes |
| **Predicted Annual Energy Output (kWh)*** | | | | | |
| 8 mph | 2,773 | 3,496 | 5,249 | 3,600 | 5,000 |
| 9 mph | 3,973 | 4,997 | 7,293 | 5,400 | 7,100 |
| 10 mph | 5,752 | 6,746 | 9,498 | 7,500 | 9,600 |
| 11 mph | 7,358 | 8,687 | 11,781 | 9,700 | 12,700 |
| 12 mph | 9,526 | 10,751 | 14,065 | 12,100 | 15,900 |
| 13 mph | 11,331 | 12,870 | 16,282 | 14,500 | 19,500 |
| 14 mph | 13,606 | 14,983 | 18,375 | 16,800 | 23,300 |
| **Survey of North American Wind Installers** | | | | | |
| Number of responses | 3 | 3 | 8 | 1 | 18 |
| Turbines installed by respondents | 4 | 6 | 40 | 3 | 110 |
| Manufacturer presales response | C+ | C+ | B+ | B | B+ |
| Product quality | B | A | B+ | B | A- |
| Completeness of order | B+ | B+ | B+ | A | A- |
| Ease of serviceability | C | B | B | A | B+ |
| Post sales tech support | D+ | C | A- | A | B+ |
| System reliability | C | B | B | B | B+ |
| Average overall grade | C+ | B | B+ | A- | B+ |
| Would you sell or install this turbine to another customer? | | | | | |
| Yes / Maybe / No | 1–0–2 | 1–0–2 | 7–0–1 | 1–0–0 | 17–1–0 |
| Would you buy & install this turbine for yourself? | | | | | |
| Yes / Maybe / No | 0–0–3 | 1–0–2 | 6–0–2 | 1–0–0 | 15–1–2 |

*Manufacturers' data from 2010


Scirocco


Excel-R

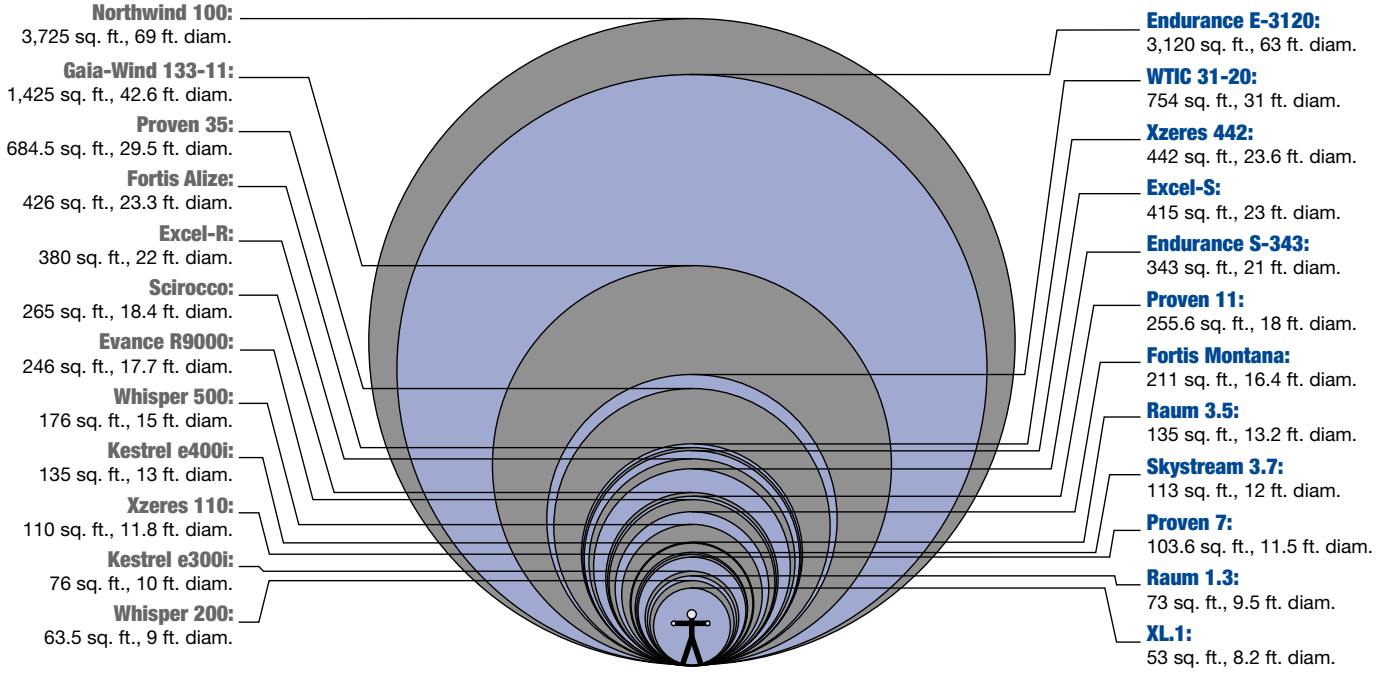

Alize




| | Alize | Xzeres 442SR | Proven 35 | 31-20 | 133-11 | E-3120 | Northwind 100 | |
|---|---|---|---|---|---|---|---|---|
| | **Fortis** | **Xzeres** | **Proven Energy** | **WTIC** | **Gaia-Wind** | **Endurance Windpower** | **Northern Power Systems** | |
| | fortiswind.com | xzeres.com | provenenergy.co.uk | windturbine.net | gaia-wind.com | endurancewindpower.com | northernpower.com | |
| | 426.0 | 442.0 | 684.5 | 754.0 | 1,425.0 | 3,120.0 | 3,725.0 | |
| | 5 | 10 | 5 | 5 | 5 | 5 | 2 (5 optional) | |
| | No | Yes | No | No | Yes | Not applicable | Not applicable | |
| | 11,098 | 7,081 | 10,759 | 7,295 | 11,535 | 48,145 | 49,099 | |
| | 14,659 | 9,910 | 14,826 | 10,689 | 17,004 | 68,890 | 69,742 | |
| | 18,456 | 13,198 | 20,400 | 14,966 | 22,962 | 91,758 | 98,996 | |
| | 22,344 | 16,819 | 25,057 | 20,066 | 29,127 | 115,746 | 124,508 | |
| | 26,156 | 20,628 | 30,895 | 25,836 | 35,263 | 139,955 | 158,135 | |
| | 29,728 | 24,483 | 35,448 | 32,070 | 41,167 | 163,647 | 185,796 | |
| | 32,925 | 28,267 | 40,863 | 38,552 | 48,676 | 186,254 | 220,558 | |
| | 0 | 8 | 9 | 6 | 3 | 4 | 6 | |
| | 0 | 16 | 18 | 39 | 4 | 33 | 20 | |
| | | A- | B | B+ | B+ | B | A | |
| | | C+ | C | B | A | B- | A | |
| | | C | C | A- | A | C+ | A- | |
| | | C+ | D | C+ | A | B | A- | |
| | | B- | C | B- | A | B+ | A- | |
| | | C | C | B | A | C+ | B+ | |
| | | C+ | C | B | A | B- | A- | |
| | | 3–1–4 | 2–1–6 | 4–1–1 | 3–0–0 | 2–1–1 | 6–0–0 | |
| | | 3–1–4 | 1–1–7 | 2–2–2 | 2–1–0 | 2–0–2 | 4–1–1 | |



# Rotor Diameter & Swept Area




## Maintenance

*All* wind generators need regular maintenance. A turbine is a dynamic piece of spinning equipment operating in a severe environment. Compare the rpm and lifetime of a wind generator with your car. Let's assume you drive your car for 200,000 miles at an average speed of 50 mph before trading it in. This equates to 4,000 hours of driving. That's all! There are 8,760 hours in a year, and your wind turbine is likely spinning and generating energy about 80% of that time, or about 7,000 hours. That's nearly two car lifetimes in a single year of turbine operation.

Well-designed wind turbines are projected to last 20 to 30 years before a complete rebuild is necessary. No one in their right mind would buy a car and expect to drive it for even 2,000 hours without inspections, service, and maintenance. Why believe otherwise about a wind turbine?

If you don't change the oil in your car, it will die an early death. If you don't maintain your wind generator, it will die an early—and probably a very dramatic—death. Turbine owners should stick with a regular schedule to keep up with maintenance.

Most required "maintenance" is centered around thorough inspections of the turbine as well as the tower. This means at least once a year (ideally twice), you need to climb or lower your tower, give it a thorough go-over, and do all necessary maintenance and repair. There's no shortcut here; no such thing as a "maintenance-free" wind turbine. As the saying goes: "If you don't pay your turbine a visit at least annually for a preventive maintenance inspection, someday, it may come down and pay you a visit." If you want a technology that doesn't require this level of maintenance, buy PV modules—they have no moving parts to maintain.

## Do You Pass the Test?

So, how did you do? Ask yourself these questions:

- ☐ Do you have the space for a tower, and the type of neighbors who can live with it?
- ☐ Can you deal with (or work to change) local permitting or zoning regulations to install a productive system?
- ☐ Is there a reasonable wind resource at your site, preferably an average that falls within a 10 to 14 mph range?
- ☐ Can you afford to install a tall tower that gets your wind turbine rotor at least 30 feet above all nearby obstructions, including growing trees, for the life of the system?
- ☐ Can you afford a durable turbine that will stand up to conditions at your site for decades?
- ☐ Can you afford a large enough turbine to significantly offset your energy needs?
- ☐ Are you willing to maintain the turbine and tower or pay someone to do this on a regular basis, and are you prepared to deal the inevitable repair?

If your answer to any of these questions is "no," there are many other options for you to reach your renewable energy goals. It will be better to have a successful solar- or hydro-electric system (along with household energy-efficiency improvements) than a poorly performing or failed wind system.

If your answers are yes all the way down the list, you may be a candidate for wind electricity. Take your time, do your homework, and carefully design and install a system that will be productive and safe for the long term. There's really nothing like living with a successful wind system!

## Is That "Breakthrough" Real?

Over the past few years, the media has focused attention on new small wind inventions and "technology breakthroughs," creating havoc and confusion among consumers, The hype of selling a new turbine design is often initiated in a press release that's poorly vetted by the unsuspecting or uneducated reporter. Most of these designs are marketed as being roof-mounted, and many, though not all, are vertical axis technologies.

We frequently get questions about such designs, although it is very difficult to educate a reporter or homeowner on the physics and fluid dynamics of airflow and the engineering of such designs in a few paragraphs or a short phone call. However, examining the history of small turbines can be very useful.

Vertical axis technology actually predated "modern" horizontal wind-electric turbine designs. In the 80-plus years since their invention, vertical axis turbines and most all other manner of unique rotor designs have given way to two- or three-bladed horizontal axis turbines atop tall towers. Why? Because they work, they generate electricity, and most importantly, they do so economically over many years.

The latest eye-candy gizmo that inevitably generates little energy because it sports a small collector (that is, rotor) and is sited on a rooftop or short tower where there is little to no usable fuel is soon abandoned in the marketplace. This is Darwinian economics at its best. To quote Dutch wind expert Eize de Vries, successful modern wind turbine designs have come from "evolution, not revolution."

If you insist on pursuing unusual designs that are touted as new or superior technologies, but provide little to back up their claims, make sure that you look beyond the marketing hype. Then, seek out satisfied owners—those without a vested interest in the sale—and ask them about their experiences with the turbines. Don't take it from us, but listen to the many people who have been burned and, unfortunately, soured on small wind technology because they made a poor investment choice.

Courtesy Gary Harcourt

**If you (and your site) are right for wind electricity, wind electricity will be right for you.**

### Access

Ian Woofenden (ian.woofenden@homepower.com) teaches, writes and consults about, and uses wind energy at his home in Washington's San Juan Islands, and prefers to bicycle down–wind, because he knows wind is cubic power.

Mick Sagrillo (msagrillo@wizunwired.net) teaches and writes about, consults on, and uses wind energy, having gained his experience by installing many ill-conceived—as well as well-designed—turbines at his home in Wisconsin.