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SMALL TURBINE COLUMN:

Rooftop Wind—Determining Your Resource

by Mick Sagrillo

There's a very funny thing about wind turbines and those enamored by them: everybody thinks that they live in a very windy place—usually without knowing what their wind resource actually is. It's not uncommon to hear something like, "It's always windy here," with nothing to back the statement up other than the fact that the wind happens to be blowing at the time.

Years ago, conventional wisdom said that you needed "to monitor the wind speed at your site for at least a year before investing in a wind turbine." This was due to the belief that "wind is site specific," and without knowing the amount of wind flowing over your property, you may not be making a wise investment. Not a bad idea at the time given how little we actually knew about our wind resources.

Interestingly, neither solar nor hydro installers were bound by this same rule. Solar folks simply checked a book for the number of sun hours in the area and designed their systems accordingly. Small hydroelectric installers went through a bit more work, actually measuring the head and flow of the hopefully continuously flowing stream to get an idea of how much electricity the proposed hydro system would generate. This exercise might entail up to an hour of measurement and calculation, a bit longer than the simple exercise solar installers were subjected to. But those interested in wind were told that they needed to monitor their site for at least a year, seemingly because wind is "site specific." Decades later, even though we have a far greater understanding about wind resources, this old saw persists, promulgated primarily by those who see wind not as part of a renewable solution, but as competition with their own preferred technologies.

Our understanding of the nature and amount of a wind resource in a given area has grown enormously over just the past decade, culminating in the excellent wind resource maps that are now available for most states. While it takes some training and expertise to understand and interpret what these maps are saying, we now understand that wind resources cover vast areas, provided we follow a few relatively simple rules for determining small wind tower heights.

Rules of thumb

Our basic understanding is that the tower must be tall enough to get the wind turbine away from the surface of the earth to overcome the friction, known as ground drag, between moving air masses and the stationary earth. The tower must also get the wind turbine above the ground clutter, the trees and buildings that cause the turbulence which diminishes the quality of the wind resource. The resulting simple rule of thumb used for determining the minimum tower height at a site to assure minimum wind resource quantity and quality is that the entire rotor of the wind turbine must be at least 30 feet above anything within 500 feet of the tower, or the treeline in the area, whichever is higher. A coronary rule is that the installer must take into consideration not the current tree height, but the height that the trees will grow to over the 20 to 30 year life of the wind system. We've learned that trees grow over time, while a tower will never get any taller than the day it was installed.

In other words, the small wind industry standard is that you've got to get the wind turbine's "collector," the rotor, into the free flow of the wind where it can do its job properly. As a result of this understanding, I have advocated for the past decade that by using the latest wind resource map available for an area in combination with these two rules, wind systems can be specified and installed that will not disappoint the owner with their performance. And it is not just me I who has come to this conclusion. Steve Wilke of Bergey Windpower summarizes this understanding as, "You cannot change the site, but you can increase the height."

In fact, thousands of systems that perform as predicted have been installed by people who understand and follow these two siting rules. These systems have been sold by manufacturers, installers, and dealers more interested in successful wind systems than making a buck on the next sale. It's not about number of turbines sold, but about kilowatt-hours of renewably generated electricity that makes for a successful small wind industry.

The allure of rooftop turbines

The only problem with this approach is that many prospective homeowners take themselves out of the pool of potential wind turbine owners because of their aversion to height, or the misguided notion that the most cost-effective solution is the one with the cheapest up-front cost. The misconception that you can install a wind turbine on a short tower or rooftop, either to save money or because the potential owner does not want to climb, completely ignores our scientific understanding of the principles of fluid dynamics in physics that define how and why air flows over and around obstacles. Few people, given that most prospective buyers are convinced they have an excellent wind resource at their rooftop or that their wind turbine design will succeed regardless of ground drag and turbulence, are willing to actually quantify what that resource is, instead preferring the improper use of a wind resource map.

A classic example of someone who did not follow this approach is the Valley Community Library in Peckville, Pennsylvania.. Since there is a small wind farm about 16 miles away on a ridge, the library was advised that they are located in an area of the state with a good wind resource—class 4, with 12.5 to 13.4 mph at 164 feet, according to an old National Renewable Energy Laboratory wind map. However, a more recent wind resource map from AWS Truewind puts the location at a "poor" to "marginal" class 1 (0 to 12.5 mph) to 2 (12.5 to 14.3 mph) at 164 feet. While this average wind range may be marginal for a wind farm, it is nonetheless a respectable wind resource for a small wind turbine.

The library was advised that they could put a wind turbine on their roof that is "designed to work at full force in 8 mph winds," and that the turbine would help drive down the $4,500 to $6,000 monthly electrical bills. Anyone would jump at such a seemingly good investment, but the library staff, concerned about due diligence in spending taxpayer dollars, decided to invest in a $500 wind datalogger and anemometer to actually record the wind resource before investing tens of thousands of dollars in a wind system. After nearly a year of logging wind speeds, the library staff reports that the average wind speed above the roof where the proposed turbine would be mounted is a mere 2.6 mph. Mary Barna, Director of the library, stated, "Sure, we get strong winds in a storm once in a while, but the average indicates that those are not the norm for our location."

Regardless of the facts, the uninformed continue to ask for rooftop wind systems or short towers, and, as governed by our principles of economics, someone will invariably sell them what they want. As a result, a cruise on the Internet reveals that there are now more companies offering rooftop wind turbines than there are companies that will only sell turbines on towers adequately sized for the site—that is, towers that will get the wind turbines well above the surface of the earth and surrounding ground clutter, the accepted industry standard for proper small wind turbine siting.

Given the nature of those who want to buy something and those who want to sell the prospective buyer something, this situation is not going to change. Add the buy-downs offered by public benefit programs available in many states and a popular press more interested in the "latest breakthrough" than in wind systems that actually perform for the owner, and you have a recipe for numerous installations that will ultimately result in the wrong conclusion that small wind simply does not work. From my perspective as an advocate of small wind as a renewable energy solution, a potential crisis is looming for the small wind industry.

The requirements change for rooftops

Again, I concluded about a decade ago that "monitoring your site for at least one year before investing in a small wind system" is not necessary. Instead, a visit by an installer or site assessor to a prospective owner's site, coupled with their correct wind map interpretation for the area, are all that is required to successfully specify a proper wind system and tower height that will perform as expected. However, that was long before today's rooftop wind craze. Given the current public benefits program climate and the prevalence of purveyors of rooftop wind "solutions," I've decided that it is time to

modify my thinking. This is primarily due to the fact that wind maps are simply useless at characterizing the wind resource at the level of home rooftops. Just look at the results from the Valley Community Library in Pennsylvania. Any number of recent and ongoing studies and computer models verify similar poor wind resources on rooftops or short towers. One great example of such an effort is the Warwick Urban Wind Trials, reported on in this column in April, and available on-line at http://www.warwickwindtrials.org.uk/2.html

So, if you are interested in installing a wind system properly specified by a site assessor or installer that understands and utilizes the accepted small wind industry practices, you will get a good estimate of the system's production from their interpretation of your area's wind resource map on a tower specific to the site based on ground clutter. If, on the other hand, you are told it is acceptable to install the wind system either on a tower inadequate for the site or on your rooftop, I strongly advise you to monitor your resource at your proposed hub height before making a down payment on a wind system.

However, you need not do this for one year. A simpler exercise involves mounting an anemometer on a mast at the desired hub height and collecting data for as short as a few weeks. Even short-term data results can be correlated to the wind resource map for your area to get an idea of the long-term average annual wind speed at the height of interest, although you will most certainly need the help of someone with expertise in interpreting wind maps in order to correctly extrapolate down from the wind map height to the hub height you are interested in.

Using wind maps to estimate the wind resource at rooftop height or within the area of ground clutter and trees surrounding a home is a useless and deceptive exercise. Anyone suggesting this technique likely has little if any training in wind site assessment or the use of wind maps. Such advice should be avoided, unless you clearly understand that your investment will be experimental at best.

It is well understood in the small wind industry, as well as public benefits programs, that rooftop turbines, while seemingly an attractive concept, are fraught with all kinds of issues not even mentioned in the column (but covered in others) I do not mean to suggest that rooftop wind turbines or towers too short for the site cannot or will not work to the satisfaction of the owner. I am simply stating that installing such a system without a reasonably good idea of how it will perform is a shot in the dark at best, like buying lottery tickets—you may win, but the likelihood is quite remote.

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