Back to the Basics: Determining Minimum Tower Height

Think tall in order to avoid turbulence.

By **MICK SAGRILLO**

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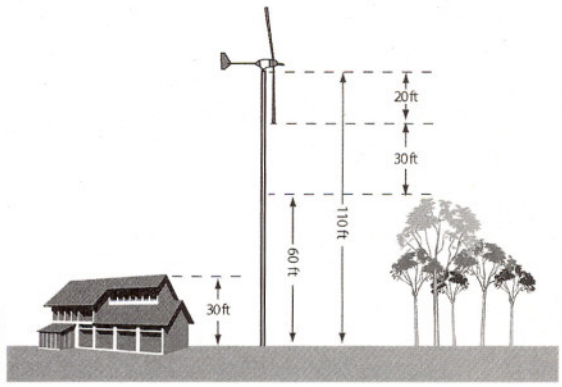
In order to operate as they're designed to, wind generators need to be placed well above ground drag and turbulence.

Ground drag is the friction between moving air masses and the Earth, which reduces the wind's speed or quantity — and therefore the kinetic energy that could have been converted to electricity with a wind turbine. Ground drag decreases with increasing height above the Earth's surface.

Turbulence is the chaotic tumbling and random swirling of wind, which compromises the wind's quality. Turbulence is caused by obstacles on the surface, such as trees and buildings. Turbulence is mitigated with clearance above obstacles and complex terrain. Exposure to good clean winds results in considerably higher energy production, due to the fact that power available to a wind turbine is a function of the cube of the wind speed.

More Height Means Less Turbulence

When siting wind farms, wind prospectors scour the countryside seeking elevated, well-exposed property with sufficient distance from trees and buildings. They want to provide clearance, or horizontal separation, from buildings, fencerows and woodlots in order to maximize wind speed and minimize turbulence. And since they have no vested interest in any given piece of property, wind prospectors are free to scout for the best sites over the landscape, those with minimal ground drag and turbulence.



DAN CHIRAS

A good rule of thumb for sizing towers: The rotor of the wind turbine should be at least 30 feet above anything within 500 feet.

Since most of us are stuck with the piece of real estate we live on, and that property likely is cluttered with buildings and trees, we cannot achieve the horizontal separation that wind prospectors seek. To minimize turbulence and ground drag, we need to increase tower height.

Turbulence reaches up to twice the height of whatever obstacle the wind is passing over. If we use an example of a tree line (tree height) that's 80 feet (24 meters) tall, does this mean that we need a 160-foot (48-meter) tower? In theory, yes. However, at some point, it may simply not be cost effective to install towers this tall for small wind turbines.

The rule of thumb for sizing towers for small wind turbines (up to 100-kilowatts in capacity) is that the entire rotor of the wind turbine must be at least 30 feet (10 meters) above anything within 500 feet (150 meters) of the tower. This is the minimum tower height, not the optimal height. The diagram at left, from Dan Chiras' *Power from the Wind*, graphically illustrates the 30-foot rule.

There are several corollaries to the 30-foot rule that take into consideration a few invariable complications. These include the following situations:

- You will need to know not just the current height of nearby trees, but their mature height — or at least the height that they will grow to over the 20- to 30-year life of the wind system. Over time, trees will grow, but towers don't, no matter how much it rains.
- If you have a prevailing tree height in your area, or your area consists of 50 percent tree cover, that tree height becomes the effective ground level for your tower. Size your tower accordingly.
- In most locations, the strongest seasonal winds come anywhere from one to several prevailing wind directions. To reduce the effect of turbulence from trees and buildings, site the wind turbine upwind of those obstacles with reference to the prevailing wind. In most of the north-central Plains, prevailing wind is from the west — northwest in winter and southwest in summer. Elsewhere, prevailing wind may come off the Gulf of Mexico or may be channeled by a lake or valley. It's important to understand specific site characteristics.

Shop Wisely

Tower height is always site specific. The tower height you calculate for your site based on mature tree height and other obstacles may not correspond to the "one-size-fits-all" tower the manufacturer sells with its turbine, or what the dealer proposes to install. A too short tower not only reduces power output, but also shortens the life of the turbine (and increases maintenance costs) by exposing the rotor and bearings to turbulence.

If you come up against, "A short tower is the only tower we sell," keep looking. Based on decades of successful installations, the 30-foot rule is well established as being the minimum acceptable tower height to mitigate turbulence. ST