

## Summary

*In order for a wind turbine to generate electricity as designed, it needs to be installed on a tower tall enough to access non-turbulent laminar wind flow.*

## The Biggest Barrier

Tower height limitations are the single biggest regulatory barrier to the use of distributed wind systems in the United States. To be effective, distributed wind turbines must be, at the very least, 60 feet above the ground in completely open country. In areas with nearby trees and other obstructions, they need to be higher. Outmoded zoning ordinances limit tower heights to unworkably low levels, such as 35 feet. Putting a wind turbine on a short tower is like putting a solar system in the shade: you can't expect it to work.

## It's the Physics

Wind energy is kinetic energy, the energy of moving air masses. Trees, buildings and other structures represent barriers to the wind, creating two problems for capturing this energy. First, the obstructions reduce the available amount of wind. People take advantage of this fact when they duck behind a building to get out of the wind. Second, the obstructions disrupt the wind flow, causing turbulence. This also reduces the amount of extractable energy available in the wind, and significantly increases wear and tear on a wind turbine. Wind turbulence is visible in the erratic waving of a flag located next to a building. Contrary to claims of some wind industry hucksters, there are no wind turbine technologies that can overcome the harmful effects of turbulence and the resulting poor energy production due to short towers. Hype changes, but physics does not. As industry experts put it, "short towers shortchange customers."

## Tall Towers are a Must

The industry guidance on *minimum* wind turbine height – based on decades of experience that include tens of thousands of wind turbine installations - states that the lowest extension of a wind turbine rotor must be 60 feet above the ground, assuming no surrounding obstacles. Where obstacles are present, the wind turbine rotor should be **at least** 30 feet above the tallest obstacle within a 500-foot radius. If trees are not fully grown, then the tower height must be adjusted for growth over the next two or so decades, the life of a wind turbine. For example if the mature height of trees in the area is 75' and the turbine rotor diameter is 20', then the minimum recommended tower height is:

$75' \text{ (tree height)} + 30' \text{ (clearance to bottom of rotor)} + 10' \text{ (half rotor diameter)} = 115' \text{ tower height}$

This defines the minimum recommended tower height. If a 115' tower is not a standard tower height option, the next option - say a 120' standard-height tower - would be the appropriate choice.

Tall towers not only minimize turbulence, they also maximize the performance of the turbine by exposing the system to higher wind speeds. As an example, a 5 kW residential wind turbine on a 35' tower in an open area might produce 1,200 kWh annually in a moderate wind regime. The same turbine on a 115' tower would generate 9,000 kWh per year. In other words, it would take *eight turbines* at 35' to equal the output of one properly sited turbine at 115'. This is because the energy in the wind increases exponentially with wind speed, so small differences in wind speed produce large increases in turbine output.

## **Why Not Height Restrictions?**

The common 35' height restrictions seen in many zoning ordinances were introduced over a century ago as a fire safety measure because that was how high the manual fire pumps of the day could pump water. Unfortunately for potential distributed wind customers, these antiquated height limits were not adjusted as fire engine technology improved.

Applying the 35' height restriction to distributed wind installations is arbitrary and discriminates for a number of reasons. First, almost all zoning jurisdictions contain utility structures (power poles) that exceed 100 feet. Second, the Federal Aviation Administration has no restrictions on structures below 200 feet, except near airports. Third, towers designed to the latest edition of the International Building Code (IBC) are stronger than nearby homes and buildings. Finally, there will never be a tall, man-made structure that does not generate some aesthetics criticism, as was the case with the Eiffel Tower, the Brooklyn Bridge and the Statue of Liberty. However, complaints from a minority should be kept in perspective and balanced against the overwhelming societal good of wind energy.

**DWEA recommends that no height restrictions be imposed on certified wind turbines installed on properties of at least one acre in size, provided the tower meets local structural building codes, setbacks, and FAA notification regulations.**