# DWEA Small Wind Model Zoning Ordinance
# Companion Document

## Section 1 Purpose

The purpose of the DWEA Small Wind Model Zoning Ordinance Companion Document is to convey to all audiences the reasoning behind the recommendations made in the DWEA Small Wind Model Zoning Ordinance. When used in conjunction with the DWEA Model Ordinance, the Companion Document provides the reader with necessary background and technical information to understand how and why the recommendations in the DWEA Model Ordinance are made, and how those recommendations promote safe, productive installations. For easy reference, the Companion Document follows the same topic sequence as the Model Ordinance document.

## Section 2 Findings

The Findings section of any ordinance is important as it forms the foundation of the ordinance and lays out the premise upon which the ordinance is written. The Findings serve to clarify a municipality's rationale for establishing a small wind ordinance, state the reasons for adopting the regulations and lay out the goals of the ordinance. The Findings should highlight the benefits of small wind energy systems and explain why they should be protected through the development of the ordinance.

## Section 3 Definitions

Clear definitions can prevent misunderstandings both during and after the permit application process. In the case of small wind, understanding the characteristics of these systems is important to writing an effective ordinance. For example, understanding the differences between *tower height*, *total system height* and *hub height* can prevent zoning decisions that arbitrarily disallow the use of small wind turbines. Some technical terms that commonly cause confusion or misunderstanding are explained below.

### 3.1 Small Wind Energy System

This definition explains the scope of wind turbine systems that the Model Ordinance seeks to address. Differentiating between small and large (utility-scale) wind turbines is critical in the ordinance because regulations suitable for large wind turbines are often inappropriate and unnecessarily onerous for small wind turbines. Imposing the same regulations on small and utility scale wind turbines is akin to imposing the same regulations on bicycles as on semi-tractor trailers. While both have wheels and are used for transportation, no one can argue logically that their impact on roads or traffic is the same, or that they should be required to adhere to the same regulations.

This definition of a small wind turbine (having a rated power output of 100kW or less) is specified by the Department of Energy (DOE) and the National Renewable Energy Laboratory (NREL). A parameter such as tower height is not appropriate for defining the size category of a wind turbine system. Tower height is dictated by external factors, such as the obstructions around an installation site, and is not specific to the turbine.

### 3.2 Total System Height

This defines the highest point reached by the wind turbine system (e.g. the top of the rotor arc for a typical propeller-style turbine). It is important for defining setbacks and determining whether FAA notification is necessary.

### 3.3 Rated Power Output

This term not only helps to define what a small wind turbine is (see 3.1), but also accurately defines a term that has otherwise been open to interpretation. Defining the rated power output for a wind turbine at a specific wind speed avoids potential confusion that can arise when various entities set their own definitions. This definition is taken directly from the American Wind Energy Association (AWEA) Standard 9.1 that is used for certification of small wind turbines (see 4.6 for details on certification). It is recognized by organizations that certify to international small wind turbine standards, the small wind industry, and the Distributed Wind Energy Association (DWEA).

### 3.4 Tower

The *tower* is a necessary part of an effective wind turbine installation and a common focus of zoning ordinances. The importance of the tower to an effective wind turbine installation is discussed in detail in section 4.1 below.

### 3.5 Hub Height

*Hub height* describes the height of the center of a wind turbine rotor. It is important to define the term because manufacturers and installers will often recommend a minimum hub height for a wind turbine for purposes of productivity. This height recommendation can vary due to local terrain and obstructions.

### 3.6 Obstruction

Wind turbines require access to smooth, strong winds to be productive and reliable. *Obstructions* disturb wind flow and have a direct impact on decisions regarding wind turbine total system height and installation location. Obstructions include trees, buildings and other structures, and some terrain features surrounding the wind turbine installation site.

### 3.7 Swept Area

This defines the area "swept" by a spinning wind turbine rotor and is important because the wind turbine rotor represents the energy collector of the system. All things being equal, a wind turbine with a larger *swept area* will capture more wind energy and generate more electricity than a wind turbine with a smaller swept area. This is important to keep in mind as some companies touting "break-through technologies" in wind energy often make outlandish claims of impossibly high energy output from small rotors.

### 3.8x Aggregate Net Metering

*Aggregate net metering* allows for proper siting of wind turbines at more productive and cost-effective locations that may be far from where the electricity is consumed. Aggregate net metering policies vary by state and utility.

## Section 4 Permitted Use

*Permitted Use* is a category of common uses or structures that entitles an applicant to a building permit by right provided the applicant meets all requirements specified in the zoning ordinance. Categorizing small wind turbines as a Permitted Use significantly streamlines the permitting process. This not only allows for reduced time and cost to the permitting authority, but also avoids the addition of unnecessary, non-value-added cost (in time and money) to property owners wishing to install a small wind electric system. As such, Permitted Use is the preferred and most appropriate permitting category in most cases. Bear in mind that the US Department of Agriculture considers wind turbines to be qualifying pieces of farm equipment in agricultural districts and requires that municipalities permit them by-right, provided that all routine building permit requirements are met. In such cases, a permit for a properly planned small wind turbine may not be denied.

### 4.1. System Height

For a successful, cost-effective small wind installation, the wind at the site must be of sufficiently high quantity and high quality. This means that wind turbines not only need adequate wind speed (quantity), but they also need smooth, laminar, horizontal wind flow (quality) in order to function properly, generate useable amounts of electricity, and live a long, productive life.

Wind speed increases with height above ground and above obstacles such as trees and buildings. Conversely, wind speed decreases closer to the ground and around trees, buildings, and other obstacles. This well-known and applied principle is often used to buffer the impact of wind where we do not want to feel its effects. For example, snow fences, fence rows and evergreen tree wind-breaks are often used to shield homes, barnyards, and highways from unwanted wind and snow. The effect of the obstacle is that it slows the wind speed, and disrupts the smooth, laminar flow of the wind.

Not only do obstacles reduce the quantity of wind by "blocking" its flow, but they also reduce the quality of the wind by creating significant amounts of turbulence (tumbling, churning, buffeting wind). Turbulence reduces wind quality and contains less harvestable energy, resulting in significantly reduced electricity production from a small wind system. In addition, turbulence causes damage to a wind turbine by accelerating wear and tear on the equipment.

Regardless of rotor orientation (horizontal or vertical axis), blade configuration, or the number of blades, turbulence is detrimental to the proper function of a small wind turbine and to the generation of electricity. Technology "advances" or so-called "break-through technologies" do not - and cannot - change or improve the wind resource. Only vertical separation between obstacles and the wind turbine rotor can do that.

As such, the small wind industry best practice, based on many years of empirical research, engineering, data and experience, is to site the wind turbine so that its entire rotor is a minimum of 30 feet higher than any obstacle within 500 feet of the tower, or the tree line in the area, whichever is higher. This "30/500 rule" establishes the *minimum* acceptable tower height for a small wind turbine.

Since small wind turbines are expected to operate for 20 to 30 years, the prudent installer will also take tree growth into consideration, making an upward adjustment to the minimum acceptable tower height recommendation to account for decades of tree growth. Quoting one industry expert, "Trees grow, but towers do not." As nearby trees grow, turbulence increases and the productivity and life-expectancy of the wind turbine are negatively affected.

### 4.1.1 Minimum Hub Height

Even in the most ideal conditions (e.g. flat, wide open terrain with no obstacles to obstruct wind or cause turbulence) it is the accepted practice in the small wind industry that in addition to the 30/500 rule stated above, a minimum hub height of 60 feet should also be applied to all small wind installations. Consider that a hub height of 60 feet, even under ideal conditions of flat, wide open terrain, will typically only be tall enough to allow the turbine to generate minimum amounts of electricity.

Not only will placing a wind turbine higher than the minimal hub height result in a more productive wind energy system, it may also extend the life of the system since turbulence - which batters a wind turbine - decreases with height. In any case, when a manufacturer, qualified site assessor or qualified installer specifies or recommends a hub height that is higher than this minimum, their recommendations should be followed. These recommendations are usually based on specific site conditions that would affect the performance of the system. Keep in mind that wind turbines with larger rotors will require taller towers to achieve recommended clearances.

Based on the proven correlation between increased height and increased productivity, some incentive programs (including state and USDA) mandate proper height in order for an installation to qualify for funding. Allowing for, and even requiring, proper height not only helps facilitate higher quality installations, but has proven to provide a better return on investment.

#### 4.1.2 Total System Height Limit

Arbitrary system height limits in an ordinance can unrealistically constrain the productivity and, therefore, the economics of a small wind system.

Small wind turbines are typically installed on towers from 80 to 140 feet tall, although they are sometimes installed on 160 foot towers. Note that *tower height* is not the same as *total system height*, since *total system height* includes the highest extension of the blades or other components of the turbine. The applicant should provide the *total system height* as well as the *tower height* in the permit application.

Taller tower height can add considerable installation and system costs. These costs are not linear with height. For example, while a 140 foot tower is only 17% taller than a 120 foot tower, that additional 20 feet can add up to 33% more to the cost of the tower and its foundation. At the same time, the additional height can also add significant amounts of electricity (therefore cost-effectiveness) generated by the system. It should be up to the applicant, not the municipality, to determine whether the additional cost of the increased tower height is worth the additional investment.

As mentioned above, some incentive programs require proper tower height (following the 30/500 rule) in order for an installation to be eligible for incentive dollars. Ordinances should not conflict with incentive programs by placing arbitrary height limitations on small wind turbine systems.

At 140 feet (or 160 feet in some cases), most small wind turbine towers have reached the upper limit of their cost-effectiveness as compared to the increased electricity that can be generated. While taller towers (300 to 400-feet) are used for utility scale turbines where the productivity and efficiency offsets the additional cost, it is unlikely that small wind will utilize tower heights greater than 140 to

160-feet in the foreseeable future, given the state of the technology and current costs of steel and concrete.

The Federal Aviation Administration (FAA) may stipulate a total system height upper limit based on proximity to an airport or location of the wind system. The FAA has no authority over private airstrips. (Notice requirements for the FAA are addressed in section 4.8 of this document).

#### 4.1.3 Building-Mounted Systems

*Building-mounted wind turbines* are often touted by a fringe segment of the small wind industry as a cost-effective alternative to tall towers. In order to understand the full scope of why building integrated wind turbines are not a good idea and why they are not supported by the industry, we have to consider them from two main vantage points: first, from an engineering, structural and mechanical perspective; and second, from a productivity, durability and economic perspective.

The old adage that, “Just because you can, doesn’t mean you should” applies to building-mounted wind turbines. Existing buildings are not designed or engineered to support the static, dynamic, and cyclic loads and forces from a wind turbine. For structural and mechanical confidence, considerable re-engineering and structural reinforcements are required to assure the building integrity for a wind turbine.

Much is known about the physics of airflow and turbulence, and how destructive turbulence is for wind turbines. From a durability perspective, the turbulence caused by the buildings and trees creates a far “tougher” environment for a wind turbine than does a tall tower, often compromising system reliability. Studies regarding the flow of wind around building and other obstacles confirm the industry’s stance that tall towers are the correct way to deploy wind turbines, regardless of rotor axis orientation (horizontal or vertical).

The industry, through various channels, has actively engaged in efforts to gather data that could either corroborate or refute reliability, failure rate, and production claims made by manufacturers of equipment marketed as “building integrated” or “breakthrough technology.” After many years, however, the industry has only been provided with minuscule amounts of data. The limited data we do have does not support the claimed benefits of building-mounted or building-integrated wind turbines.

However, if or when building-mounted wind turbines are permitted by a municipality, the same guidelines that are used for tower-mounted wind turbines must be followed: The entire rotor must be at least 30-feet higher than any obstacle within 500-feet of the turbine (including the building to which the turbine is mounted), or the surrounding tree line, whichever is higher.

For example, if a turbine is mounted on the flat roof of a 75-foot tall building, then the turbine should still be placed on a tower that allows a minimum of 30-feet of clearance between the roof and the bottom of the rotor. In most cases, this would mean a tower no less than 40 to 50-feet tall. Finally, remember that additional structural and mechanical engineering is necessary to ensure that the mounting method and the existing building are structurally sound and can accommodate the loads posed by that specific wind turbine, on that specific tower, on that specific roof.

The "public perception" difficulty with building-integrated or rooftop wind systems is that the unsuspecting public typically lacks the knowledge and tools to decipher the technical information presented or to gauge the legitimacy of claims. (More on how product certifications will help in section 4.6 of this document). A consumer that buys into the hyped claims for a rooftop turbine will ultimately be disappointed by poor reliability, durability and productivity. All too often, this results in abandoned equipment and a potential nuisance problem for the municipality.

For these reasons, small wind industry best practice dictates that wind turbines should not be building-mounted or building integrated. DWEA does not recommend building-mounted wind turbines.

### Section 4.2 Setback

In general, setbacks serve two purposes: to ensure safety and to protect property rights. In order to apply an effective setback that accomplishes both purposes, it is important for a permitting authority to understand a few basics regarding how small wind turbines and towers function, and also understand what has - and has not - actually occurred in regard to injury or property damage. Too often, setbacks are dictated based on misinformation or fear, resulting in setback requirements that are arbitrary in nature and only serve to deter installation.

Because setback requirements typically vary widely from municipality to municipality, by application, and by type of structure, the most effective way to address setbacks for small wind is to provide "minimum" and "maximum" setback recommendation options. Since 10 feet seems to be the standard setback for engineered structures, building, and construction setback in many municipalities across the US, this minimum setback was recommended in DWEA's model as a way to encourage continuity for standard municipality construction setbacks. For the maximum, we relied on industry experts' input regarding engineering, safety, and realistic expectations of what can and cannot happen to a small wind turbine and its tower under normal, as well as extreme, operating conditions.

Reputable manufacturers build wind turbines and towers that are highly engineered and designed with safety in mind. Contrary to the misconception that towers can be blown over like trees, towers actually buckle or crumple under catastrophic failure conditions. They cannot and do not leap from their foundations, bounce across the landscape and "land" (which implies flight) on neighboring properties. Additionally, there are no known or documented injuries or deaths to non-service persons that can be attributed to small wind electric systems.

Another often cited - but misguided - reason used to justify excessive setback requirements for wind turbines is the perceived danger of ice being "thrown" from the blades. Setbacks based on this thinking are unwarranted and ignore the physics governing how wind turbines operate.

While ice shedding can occur from any structure (i.e. roofs, trees, utility or communication towers, antennas, or a wind turbine or its tower), ice is not "thrown" from these structures. Instead, ice is *shed* as it melts.

Wind turbine blades are a balanced set of moving airfoils that, when iced over, will slow and eventually stop rotating altogether as the ice hinders the aerodynamic performance of the blades. The process is akin to ice building up on the wings of an airplane. As the ice builds up, the airplane's wings lose their ability to generate the lift that keeps the airplane aloft. If this continues, eventually the airplane will lose all lift (a condition known as "stall") and be unable to fly. Similarly, wind turbine blades stall as ice builds up. As ice melts, it is shed from the wind turbine's blades. Since ice builds up on blades in thin sheets (it cannot accumulate as clumps or chunks), it breaks apart into smaller pieces as it sheds and falls. Once all of the ice is shed from all the blades, the blades are able to spin freely again. Since a wind turbine rotor cannot spin as designed when coated in ice, it cannot throw ice.

Occasionally, during a strong winter storm, small pieces of ice falling from overhead structures (i.e. roofs, trees, utility or communication towers, antennas, or a wind turbine or its tower) can be carried by the wind. Common sense dictates that individuals should avoid standing directly beneath a wind turbine or any other overhead structure when ice shedding is possible. Extended setbacks are not applied to other structures that shed ice, and extended setbacks are not warranted for wind turbines for reasons of ice shedding.

### 4.2.1 Neighboring Inhabited Dwelling

Regardless of what the setbacks are from the property lines, a wind turbine should not be placed less than the system height away from an existing *inhabited neighboring dwelling*. This is a “good neighbor” practice that reduces the potential for issues such as sound and aesthetics to arise. The key words in this section are “existing” and “inhabited” when referencing a neighboring dwelling.

The word “inhabited” is recommended because the common concerns of sound and aesthetics would not be considered legitimate for unoccupied buildings or for buildings used for livestock, storage, shop work or other similar activities. The building must not only be inhabited, but must already be permitted for such a use at the time the wind turbine application is submitted. The word “existing” is recommended to assure that future plans do not prevent legitimate wind turbine installations by claiming that someone “intends to build someday,” thereby forcing the wind turbine to be placed an undetermined number of feet from that potential future building location.

Setbacks do not apply to buildings or dwellings on the turbine owner’s property for several reasons. First, turbines are quite often built very close to accessory buildings, and in many cases have technical reasons for doing so (i.e. electrical and wire run limitations, efficiency losses, grid interconnection location). Second, the turbine owners bear their own liability and are not affecting others by locating their tower in close proximity to their own home or other building on their property. As mentioned above, there are no documented cases of injury or death to a non-service person that can be attributed to small wind electric systems.

DWEA recommends that wind turbines be treated as any other permitted use with regards to aesthetics or sound. Municipalities should defer to their standard nuisance ordinance regarding these or other complaints.

### 4.2.2 Neighboring Property Line

Requiring that all parts of the wind system meet current setbacks for structures, except when a neighbor allows it to be closer, has three main functions: First, applying existing setbacks provides consistency within municipal ordinances and protects the permitting authority from the appearance of discrimination.

Second, it closes language loopholes. For example, without this clear language, a wind turbine could be installed so that the base of a wind turbine was placed within a legal 10-foot setback, while a part of that turbine (perhaps a blade or tail that is longer than 10 feet) might overhang the property line.

Third, it is not uncommon for two parcels to be owned by the same person or family, and for the ideal turbine site to be close to the line between the two parcels. When written permission is granted by the affected property owner, allowing an exception to the setback provides conditions under which the wind turbine can be properly sited on an appropriately tall tower without violating setback rules.

With aggregate net metering (the ability to have excess credit from one meter be "rolled over" onto another meter that is owned by the same person or entity, but that is located at another site) becoming more available in electric utility regulations, this is a good way for a small wind ordinance to work with other institutions and policies that support the proper siting of renewable energy equipment.

### 4.2.3 Overhead Power Lines and Other Setbacks

Sometimes the reason for a setback is for the safety of workers and protection of the equipment. Such is the case for setbacks from *overhead power lines*. Ultimately, the setback from overhead power lines is a utility and an installer issue, and therefore not required in the ordinance. Clearance from power lines should be based on utility requirements and judgment of the installer.

Setbacks for roads, public buildings and buried utilities each have their own requirements that must be observed. Additional setbacks are unnecessary and not recommended.

### 4.2.4 Multiple Wind Turbines

Wind turbines create 'wakes' of turbulence behind their rotors. The larger the rotor, the larger (and longer) the wake, regardless of rotor axis orientation (horizontal or vertical) or claims made to the contrary. One wind turbine's wake could detract from the productivity, efficiency and durability of a second turbine located too close to or downwind of the first. It is considered best practice that the appropriate distance between multiple turbines be determined by a qualified site assessor, installer or the wind turbine manufacturer(s).

It is almost always more cost-effective to install one larger turbine on a tall tower. Occasionally, however, multiple turbines may be a better solution. DWEA recommends that ordinances do not set arbitrary limits on the number of turbines allowed on a property, provided the installations meet all requirements regarding setbacks and recommendations for turbine spacing as specified by the qualified site assessor, installer, or the wind turbine manufacturer(s).

## Section 4.3 Access

Wind turbine access refers not only to climbing the tower, but also access to the electrical switching or electronics that are located at or near the base of the tower. For safety and liability reasons, both must be considered when specifying methods by which access should be limited.

Historically, the fear or risk of unauthorized climbing has been a perceived risk not borne out by reality. There is no documented evidence that an unauthorized person has ever climbed a small wind turbine tower and been injured. Anti-climb requirements (fencing or razor wire) often present a greater and more immediate danger than the perceived tower climbing danger. For example, fencing can significantly delay emergency access to the tower should rescue of a climber or technician be required. Injured climbers have a limited amount of time before permanent injury or even death can occur, and delaying access can cost a service person their limbs or their life.

Sometimes the switching or electronics at the base of the tower must be reached by the local utility company to de-energize the system. Similar to the conditions outlined above, impeding access with fencing can be dangerous as well as illegal. Impeding access to electrical controls and switches often violates utility regulations and possibly the National Electrical Code (NEC).

Liability and legal concerns should also be considered. If an emergency worker were to become injured while attempting to climb over a municipality-mandated fence to get to a tower, the municipality may find themselves at the receiving end of legal action. If the permitting authority required the fence, then they will likely bear a legal liability to both the injured party and the landowner that was required to install the fence. In the end, fences simply have not been found to offer any additional protection to the turbine owner, neighbors, or the municipality.

Even though wind turbine towers are inherently difficult to climb and no serious injury or death resulting from unauthorized climbing of a small wind turbine has ever been documented, some reasonable measures should be taken to mitigate the perceived risk of unauthorized climbing.

- For freestanding lattice and monopole towers, removal of climbing pegs and ladders up to 10-feet above ground level is sufficient to inhibit unauthorized climbing.
- For guy wire lattice towers, installation of climb-guards (a smooth surface, such as sheet metal or painted plywood) covering at least 4 feet of the lower 10-feet of the tower is effective.
- To discourage unauthorized access, it is also common practice to install appropriate warning signage, such as “Danger: High Voltage,” or “Electrocution Hazard” or “Fall Hazard” in a location clearly visible by persons standing near the

base of the tower. This has been used for years throughout the US and elsewhere on utility electrical towers ("high tension lines"). There are millions of electrical transmission towers and poles installed across the US and they are not required to have fences or climb-guards at their bases to restrict access.

**Section 4.4 Signage**

As noted in the "Access" section above, it is common practice to install appropriate warning signage in a location clearly visible by persons standing near the base of the tower. The utility company may also have their own requirements regarding signage for disconnect switches or other electrical components. It is recommended that the small wind ordinance defer to the utility and National Electric Code requirements for signage of this type.

**Section 4.5 Sound**

In order to set reasonable zoning policy regarding wind turbine sound, it is important to understand some basic technical facts. First, wind turbines are machines. Like other machines we live with, such as motorized appliances and vehicles, they are not silent when operating. Also, because they are intentionally installed in the wind, their presence - like a tree - will generate sound as the wind passes through. It is impractical and unfair to set sound limits that ignore these basic facts.

Sources of sound from a wind turbine include the mechanical machinery, the airflow over the blades, and, to a lesser extent, the wind passing through the tower and guy wires. Modern wind turbines have been designed with specific features – such as blade tip and airfoil shapes, and reduced rotor speeds – that minimize the sound they emit.

Small wind turbines may emit more sound during extreme wind events or power outages. However, these events are infrequent and often result in other sources of sound such as strong wind gusts through trees and over structures, and combustion engine-powered back-up generators. An exception to any sound restrictions during these infrequent events is therefore warranted in general, not just for wind turbines.

Sound diminishes with the square of the distance from the source. This means that doubling the distance between the source and the listener reduces the sound heard by a factor of four. Therefore, a small wind turbine on a taller tower will sound quieter than the same turbine on a shorter tower since it would be vertically further away from a listener on the ground.

In summary, wind turbines are designed to operate quietly through their range of operation, but none of them are silent and it is unreasonable to expect them to be so. Permitting authorities need to be fair when addressing and enforcing sound emissions from wind turbines, as they would with any other sources of sound. DWEA believes that wind turbines should not be singled out in device-specific noise ordinances, but should instead be required to comply with existing ordinances that are applied to all sound sources (e.g., air-conditioning units, motorized vehicles, yard equipment, pets, and outdoor parties). It is a fair approach to treat wind turbine sound through the application of the existing nuisance section of the municipality's zoning ordinance.

**Section 4.6 Certified Wind Turbines**

DWEA recommends that permits only be issued to the highest quality small wind turbines, namely those that demonstrate compliance with national and international standards.

Small wind turbines with rotor areas up to 200 $m^2$ (equivalent to a propeller-style rotor 52.5 ft in diameter) can be certified to the AWEA 9.1-2009 national standard. A copy of this standard is available at:

> http://www.awea.org/learnabout/smallwind/upload/AWEA_Small_Turbine_Standard_Adopted_Dec09.pdf

The AWEA standard requires performance, acoustics, safety, and durability testing, as well as a detailed structural analysis, and is based on international standards.

Certification for small wind turbines is available from accredited organizations such as the Small Wind Certification Council (SWCC) (www.smallwindcertification.org) and Intertek (www.intertek.com/wind/).

Certification is available for wind turbines with rotor areas larger than 200 $m^2$ (a propeller-style rotor with a diameter larger than 52.5 ft) under international power performance (IEC 61400-12-1) and acoustic (IEC 61400-11) standards. To be eligible for a permit, DWEA recommends that these turbines be tested to these standards in the same manner as smaller machines under the AWEA 9.1-2009 standard. However, because these larger machines cannot be certified to the safety, durability and design review aspects of the AWEA 9.1-2009 standard, manufacturers should describe, in detail, the turbine's safety features. Turbines in this larger size category (which also tend to carry much higher installation price tags), have typically undergone more extensive engineering and testing than their smaller counterparts.

Turbine certification is expensive and time-consuming for manufacturers, but helps to ensure that wind turbines will operate effectively and safely. Testing to standards also provides realistic performance and acoustics information that facilitates fair and direct comparison of products.

Turbines that have been granted a provisional certification to recognized standards other than those mentioned above (e.g., certification to a similar foreign standard such as RenewableUK or MCS [Microgeneration Certification Scheme] in the UK, but not yet certified to AWEA 9.1-2009) should be considered on a case-by-case basis.

## Section 4.7 Compliance with Building Codes

The process of designing a wind turbine tower is similar to that for most other structures and, as such, requires similar engineering and inspections. In its engineering and design by the manufacturer, any structure must meet strength requirements to support all expected loads, including live, dead, cyclic, and transient loads. For a wind turbine tower, dead loads include the weight of the wind turbine as well as the tower itself (the "vertical" loads). Live and transient loads include significant changing forces due to factors such as wind speed, wind direction and ice loading. Cyclic loads include blades passing by the tower and any resonant frequencies set up between the rotor or electrical generator and the tower. When engineered and designed correctly (as validated by certification) by the manufacturer, the turbine and tower will be capable of withstanding all anticipated loads. No additional engineering or third-party review is necessary for these systems.

### 4.7.1 Tower and Foundation Drawings

Wind turbine towers are engineered specifically to handle the loads that an operating turbine will place on the structure over its lifetime. Unlike houses or other standard structures, wind turbines are designed to be sensitive and reactive to the wind. This sensitivity means wind turbine towers are subject to considerable wind loads. These loads are calculated and accounted for by a qualified engineer employed by the manufacturer during the structural design process. These professional wind turbine engineers not only understand structural engineering, but also understand the physics of airflow and the interaction between the turbine, tower, foundation, and the wind.

Requiring additional independently reviewed engineering drawings or wet-stamps from an in-state engineer (over and above the drawings already provided by the manufacturer's qualified structural engineer) results in unnecessary, non-value-added costs, and serves only to deter wind turbine installations. Tower engineering and drawings that are properly completed in accordance with existing international standards (Unified Building Code specifications) are sufficient, just as they are for any other engineered structure. The engineering performed specifically by the manufacturer's engineers should be respected and accepted.

The tower foundation is also an engineered structure but, unlike the tower or turbine, is "fabricated" by an installer or contractor. The best protection that a municipality can have is to inspect the tower foundation as the forms are installed and again after the concrete has been poured to assure that the foundation has been constructed as specified by the manufacturer's drawings. This is typically already common practice in many municipalities for foundations of other permitted structures.

### 4.7.2 Roof Mounted Turbines

Existing houses and buildings are not designed to accommodate the significant additional loads imposed by an operating wind turbine. Since adequate structural support is critical to a safe wind turbine installation, it must be demonstrated that existing buildings and roofs can safely withstand the additional loads imposed by the wind turbine, or that the structures will be adequately strengthened to do so. DWEA recommends that this be accomplished by requiring a thorough structural analysis that includes a local, third-party engineering analysis and report.

## Section 4.8 Compliance with FAA Regulations

The FAA regulates not only the location of tall structures that are deemed obstructions to air navigation, but also any lighting that may be required on those structures. To determine whether or not notification for a new structure is required, installers should refer to the Code of Federal Regulations Title 14, PART 77-"Safe, Efficient Use, and Preservation of the Navigable Airspace." Typically, unless the proposed structure is within 3.8 miles of a commercial runway over 3,200 feet long, any structure under 200' in height above ground level does not require FAA notification or lighting.

To assist with determining the need for FAA notification, a Notice Criteria Tool is available on the FAA website at https://oeaaa.faa.gov/oeaaa/external/gisTools/gisAction.jsp?action=showNoNoticeRequiredToolForm.

## Section 4.9 Compliance with the National Electric Code (NEC)

Small wind turbine installations should comply with the requirements of the most current edition of the National Electric Code (NEC). Local electrical codes or the manufacturer's recommendations should only be used in place of the NEC if or when they exceed NEC requirements. Prior to the 2011 NEC, there was no existing code specific to wind turbines. However, there is now a section in the NEC, Section 694, specifically pertaining to wind turbines that should be used as a reference for inspections and code enforcement.

## Section 4.10 Utility Notification

Local utilities require notification of the intent to grid-connect a wind turbine. DWEA recommends that the utility be notified prior to the start of any construction or installation of components. Different utilities have different notification requirements that should be followed.

In general, the notification should consist of a letter of intent from the customer to the utility, with a return acknowledgment sent from the utility to the customer. It is not unusual for a utility to have an interconnection process which may include interconnection requirements and electrical equipment specifications, an application processing fee, preliminary approval to install and test the system, a final interconnection inspection via desktop review, perhaps a site inspection, and a final approval to operate the wind turbine. Requirements vary by utility and are imposed on the turbine owner. Utility interconnection requirements are not the responsibility of the permitting authority. Any evidence supplied by the applicant that she or he is complying with utility requirements is sufficient.

### Section 4.11 Antennas

Larger tower-mounted telecommunication equipment can vary significantly in size and weight. Towers designed to support wind turbines may not be adequate to support additional large loads. Additional loading imposed on the tower by larger antennas requires a sign-off from an engineer assuring that the structure can handle the additional loading. If that condition can be met, then dual-use of wind turbine towers should be considered. Allowing for the dual-use of wind turbine towers as antenna towers provides a benefit to the public at large while eliminating the need for, and costs associated with, installing additional single-purpose antenna towers.

An exception to the engineering requirement should be made for small antennas. One example is the internet repeaters that are often installed on wind turbine towers for the benefit of the community.

### Section 4.12 Fee

Since the Code requirements (structural and electrical) for small wind systems are similar to other standard structures, the fee should also be similar to other structures permitted by the municipality. Sometimes the fee is calculated as a function of total installed cost. In other cases, square footage of the foundation or another metric might be used. In any case, the wind turbine application fee structure should correspond to other building and construction fees within that jurisdiction.

### Section 4.13 Decommissioning

Wind turbines that have reached the end of their service life should be dismantled. A wind turbine can be defined as reaching the end of its service life when it fails to produce electricity for 12 consecutive months. The municipality should notify the turbine owner in writing of this determination, and the owner should be given six months to remove the wind turbine from the tower or return it to operable use. Exceptions or extensions should be granted when good faith efforts to repair, reuse or repurpose all or part of the system can be demonstrated by the system owner, and when no public safety issues are imminent. The underlying principle is that inoperable equipment should be dealt with responsibly and not be allowed to be abandoned.